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Brazil
The New Growth Agenda
(In Two Volumes) Volume II: Detailed Report

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The Metric System is used throughout the report.

FISCAL YEAR

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ACRONNYMS AND ABBREVIATIONS

CPMF	Temporary Tax on Financial Transactions
EMU	European Monetary Union
FDI	Foreign Direct Investment
FIAS	Foreign Investment Advisory Service
GDP	Gross Domestic Product
ICT	Information and Communications Technology
INPI	National Institute of Intelectual Property (Instituto Nacional de Propriedade Intelectual)
IT	Information Technology
OECD	Organization for Economics Cooperation and Development
R&D	Research and Development
RGPS	General Regime for Social Security (Regime Geral da Previdência Social)
RJU	Pension Regime for Government Workers (Regime Jurídico Único)
SOE	State Owned Enterprise
TFP	Total Factor Productivity

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BRAZIL
THE NEW GROWTH AGENDA

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EXECUTIVE SUMMARY OF VOLUME II

1. This is the second of two volumes, and collects together seven background papers written for the World Bank's Brazilian growth study. The first volume summarizes the overall conclusions for policy drawn from these background papers and other relevant research, as well as giving a historical account of the driving forces behind Brazilian economic growth since the 1960s. This summary limits itself to the content of this volume.

Hypotheses

2. Chapter 1 surveys economic growth theory and describes the factors emphasized by the theory that will drive the report's recommendations. The report considers growth determinants traditionally emphasized, such as the level of physical investment (private and public), saving, macroeconomic balance, government consumption, and health and education. But the report also emphasizes factors that newer theories suggest may be important: the environment for knowledge creation and the adoption of new technologies, the analysis of tertiary versus basic education, and the dynamic effects of foreign direct investment. The chapter then outlines a list of candidate hypotheses to explain the seemingly sluggish response of the Brazilian economy to the successful stabilization of the mid-1990s. *It should be noted that these are hypotheses: their relevance or lack thereof is to be determined by appealing to empirical observation:*

- Cost of capital and crowding out of private investment by the public sector borrowing requirement?
- Human capital deficiencies, particularly relating to health, primary, secondary, or tertiary education and training?
- Deficiencies in the flow of knowledge and innovation, related to intellectual property rights and/or use of foreign technology?
- Overly rigid and costly formal-sector labor-market regulations driving up the cost of labor, including lengthy and unpredictable labor court delays?
- High tariffs and relative isolation from international trade flows?
- High public-sector investment composition combined with the low-productivity of public-sector investments and/or a lack of investment in infrastructure?
- Poor climate for private investment, including regulatory and administrative barriers and an inefficient judicial system?

- Macroeconomic instability, including rollover risk of external debt, remaining uncertainty surrounding public debt sustainability and inflation?

- Constraints related to demographics and migration, including the decrease in migratory flows from rural to metropolitan areas, and from the Northeast to the South and Southeast regions?

- High and distortionary taxes, including cascading taxes on exports, a financial transactions tax, and an overall tax burden greater than 30 percent of GDP?

3. It is not the case that every chapter introduces evidence on every one of the above topics. However, most chapters touch upon several, allowing the report to build up a "body of evidence" on Brazilian growth, its determinants, and its main constraints. Table 1 at the end of this summary describes the ways in which chapters shed light on hypotheses. After the introduction of the main concepts and framework in chapter 1, the remaining chapters fall into two parts. Part I (chapters 2-4) consists of data analysis, while Part II (chapters 5-7) focuses on particular areas of policy suggested as important by Part I.

Part I: New Data

4. Chapter 2 uses aggregate data—time series data for Brazil since 1960, and panel data for an international data set—to analyze Brazil's macroeconomic growth determinants. Time series data suggest that saving is uncorrelated with Brazilian economic growth. And capital accumulation does not seem to have been the driving factor behind Brazilian economic growth in the period: economic growth precedes (in a time-series sense) both private and public investment. A growth accounting exercise corroborates this result: the fall in growth between the 1970s and now is only accounted for in small part by a fall in physical capital formation, while human capital formation increased in the 1980s and 1990s, leaving TFP changes to explain the lion's share of the reduction in growth.

5. Cross-country regression techniques fail to explain more than half of the decline in Brazilian economic growth between the 1990s and the 1970s, and 1990s Brazil is an outlier in this analysis. World economic conditions, inflation (in the early 1990s), higher initial income (cf. convergence theory), a reliance on primary exports, and terms of trade shocks all reduced Brazilian growth in the 1990s. These effects were not fully offset by those factors that did improve, in particular human capital formation, trade opening, and improved macroeconomic stability. The chapter concludes that despite these areas of unmistakable progress, Brazil has fallen further behind the OECD and East Asian economies in important areas: human capital, financial depth, governance, and public infrastructure.

6. Chapter 3 examines the causes of Brazilian industrial productivity growth using a new panel data set constructed from the Brazilian annual industrial survey. At the firm level, Brazilian TFP growth was on average negative in the 1980s before recovering modestly in the 1990s. Performance differed widely by industry, with the automotive and electrical equipment industries showing the strongest productivity growth in the 1990s. Less technological sectors—food, textiles, leather, and non-metallic minerals—showed the worst performance and actually declined in productivity during the 1990s. It is worthy of mention that the industrial composition of the

manufacturing sector in the North and Northeast of Brazil led to lower TFP growth in these regions relative to the South and Southeast.

7. TFP and TFP growth regressions across firms within industries suggest that trade opening may have contributed to raise average TFP by about 6 percent. Market penetration by foreign competitors raised the level of TFP, though not its growth rate. On the other hand, export orientation does not raise TFP in the Brazilian data; indeed this relationship is negative. Other findings suggest the importance of technological innovation: higher shares of IT in physical capital raised both TFP and its growth rate. To complement this result, firms employing more skilled labor, in the form of a higher white-to-blue collar ratio, showed faster TFP growth, suggesting that Brazilian human capital investments contribute to TFP growth. Foreign machinery, on the other hand, had no significant effect, questioning the role of this as a conduit of embodied technological change in Brazilian growth. Given evidence from firms elsewhere on the importance of international knowledge flows (Chapters 5 and 7), this result raises the concern that Brazil's integration into international production is not generating all its potential possible benefits, perhaps owing to a bias towards regional trade, perhaps owing to impediments to technology transfer. Finally, new firms possessed higher and faster-growing TFP, suggesting that measures to ease their entry may be a source of future productivity gains for Brazil.

8. Chapter 4 uses stacked annual household data sets (PNAD, 1981-98) to analyze growth of average household income and of average household income among the poorest 25 percent of the population. These data reveal that only since the *real* plan stabilization has significant convergence occurred between the poorer and richer Brazilian states, and that a large part of the convergence pattern is owing to the pro-poor impact of eradicating inflation. International evidence suggests that any growth strategy that jeopardizes this central achievement is likely to fail. This chapter suggests that, furthermore, it is likely to hurt the poor most.

9. Comparison of the income growth of the average household with that of the average *poor* household reveals that the poor do benefit from general income growth, although their incomes do not rise proportionally with the rest: that is, a general income rise of one percent corresponds to an income rise of less than one percent for the poor. Moreover, this effect tends to increase as growth increases, implying that higher growth has tended to raise income inequality between households. These effects have been attenuated in the late 1990s, however.

10. Panel regression analysis of differences in household income growth by state and age cohort reveals the primacy of education as an influence on income growth in Brazil. However, the effect of average education on the income growth of the poor is nil: improvements in basic education among the poor have not (yet) significantly fed into income growth. Further analysis suggests that investments in upper basic education are central both to increasing income growth and attacking inequality.

11. Finally, other factors are important growth determinants for household income. Local infrastructure (e.g., electrification, trash collection) plays a significant role in subsequent income growth. And international trade and political stability also help income growth. These factors vary in their importance to the poor relative to the average. Electrification seems to have been particularly important for the income growth of the poor.

Part II: Policy Foci

12. Chapter 5 investigates Brazil's positioning to take advantage of the knowledge economy along four dimensions: (1) economic incentives and institutions, (2) the innovation system, (3) human capital, and (4) information infrastructure. International benchmarking reveals that Brazil is particularly badly placed with respect to (2), its innovation system, the consequence of low business R&D, few patent applications, and low revealed comparative advantage in technology. This is despite high spending on tertiary education in Brazil, and a high index of entrepreneurship. On (1), Brazil's otherwise average ranking on economic incentives and institutions is reduced by a low score for government effectiveness, poor relative performance on corruption and rule of law, and low trade volumes. On (3), Brazil's suffers from having few technical workers, low tertiary enrollment, and poor labor relations. Analysis of (4) reveals that Brazil has a relatively strong information infrastructure.

13. The authors conclude that, in order to increase its benefit from international knowledge flows and technological innovation, Brazil could explore ways to increase the recruitment of researchers by enterprises, and more generally the R&D links between enterprises and the university sector (e.g., through industrial R&D PhDs). And increased efforts to improve the climate surrounding the protection of intellectual property rights are recommended.

14. However, increased public funding for the tertiary education sector need not follow as an implication of this analysis; indeed Chapter 6, which develops a Brazilian human capital growth strategy, illustrates that the opposite holds for Brazil. The chapter surveys the economic literature on human capital and highly successful episodes in the USA and South Korea, and concludes that such "leapfrogging" in human capital investments do not constitute a viable strategy. Oft-cited examples, such as India's technology initiatives, do not withstand scrutiny. While there is some evidence of knowledge related spillovers, there is little proof of growth-related externalities associated with higher education. And at current levels of graduation from high school, public initiatives to expand higher education do not qualify as non-elitist.

15. Brazil has made an "epidemiological transition"—its health related achievements reflect middle-income status—yet has still to make what may analogously be termed a "pedagogical transition." Chapter 6 recommends a heightened focus on increasing upper primary school completion and secondary school enrollment. Brazil will face declining primary enrollments for demographic reasons, and has the opportunity to plan for a strategy of gradually increasing the resources it devotes to secondary education: a challenge as both primary and secondary education are sub-national responsibilities. New international evidence, corroborated by evidence from Brazil, also suggests increasing pre-primary interventions. In this way, Brazil may at last embark on the "pedagogical transition" that its recent successes in primary education have made it possible to envision.

16. The growth effects of such a strategy will not be immediate. Correlations using time series data for Brazil confirm international evidence: short-term correlations between human capital and growth are as weak as long-term associations are strong. Countries should view human capital policies as instruments of long-term growth, not as devices to spark short-term growth spurts.

17. Chapter 7 investigates the role of public governance in nurturing private-sector activity, and uses two lenses to examine this facet of the investment climate. The first lens is the regulatory burden on entrepreneurship, in particular pertaining to start-up firms. The second is public policy effects in foreign direct investment (FDI). Both are particularly relevant for innovation, technological progress, and productivity growth, given earlier findings of this volume. And Chapter 7 illustrates that measures of the quality of public governance suggest concern in both these areas.

18. The chapter goes on to enumerate regulations and procedures that impede start-ups. Although financial costs are not great in international comparison, Brazil imposes long time delays on its entrepreneurs, increasing the uncertainty and thus the risk of investing. Many of these delays are associated with dealing with the three levels of the federal structure t various ends such as registration, site licenses, and taxation; experience from the US suggests that such complexity is unnecessary. A further area where attention is recommended is the judicial system, where the evidence suggests that increased capital budget, technology, and managerial activism are more promising approaches than traditional reforms emphasizing staff numbers, remuneration, and training.

19. Chapter 7 also illustrates the link between public governance factors and FDI flows. Despite large flows into a limited number of non-tradable service sectors (notably telecom and financial services), there are large untapped efficiency gains in such sectors as food and retailing, which FDI could help to capture. Moreover, governance considerations are shown to be a factor in Brazil's low volume of export-oriented FDI, which is more sensitive to the investment climate than is market-seeking FDI. Improved governance may therefore also be seen as one tool to improve Brazil's external accounts and hence its long-term sustainable growth rate.

Levelheaded Hopes

20. By focusing on a few key areas suggested by data analysis as important, the report hopes to avoid the pitfall of recommending "everything all at once." While it is impossible to quantify the growth effects of every policy intervention, the report nonetheless suggests a list of priority actions focusing on the *investment climate* (short term, physical investment), the *innovation system* (medium term, TFP growth), and *secondary education* (long term, human capital).

21. Returning to Chapter 1, this volume cautions against Panglossian expectations of the benefits that will flow from a comprehensive economic growth program along the lines described above. Since 1980, very few large economies have sustained growth averages above 5 percent. In Latin America, only Chile has sustained decadal growth averages above 6 percent. With the significant microeconomic reforms suggested here, and conditional on continued macroeconomic stability (low inflation and measures to reduce total public liabilities over the long term), we estimate that Brazil could attain sustained GDP growth in the vicinity of 6 percent.

Table E1: Investigation Strategy

Volume II		Part I—New Data			Part 3—Policy Foci		
	Chapter	2 *Countries*	3 *Companies*	4 *Households*	5 *Innovation*	6 *Skills*	7 *Institutions*
Possible Growth Constraint							
Cost of Capital	Brazil's high capital cost, owing to fiscal deficits and high spreads, reduces investment and thus growth	Causality between savings or investment and growth	Have capital-intensive firms grown less or larger firms more?				Firms' assessment of capital costs as an obstacle to investing
Human Capital (HC)	Brazil's historically low health or education levels constrain growth through both innovation and investment	Correlations between human capital measures and growth	**Link between skills mix and TFP growth**	**Does initial education by state & age cohort cause growth?**	Description of Brazil's HC in the context of knowledge flows	**Detailed assessment of Brazil's HC mix in an international light**	Firms' assessment of human capital as an obstacle to investing
Knowledge	Brazil's economic isolation and innovation system reduces knowledge flows, innovation, and thus TFP		Effects of foreign capital or intermediates on productivity		**Description of bottlenecks in the innovation system**	Have HC policies favored knowledge-based growth?	**FDI composition re other FDI recipients. FDI survey evidence**
Labor Regulation	Brazil's labor code and dual labor market deter investment and productivity growth		Shrinking versus growing firms' labor costs	Does formal sector extent affect income growth?		Assessment of international evidence on training initiatives	Firms' assessment of labor regulations as an obstacle to investment
Macro-Trade	Brazil's tariffs, bureaucracy and taxation have a net negative effect on the trade account limiting growth	Trade and tariffs indicators and their relation to growth	**Effects of export orientation or foreign penetration on TFP**	Effect of measures of trade connectedness on state growth	Description of Brazil's trade regime and its effects on innovation		Extent of export-oriented FDI
Investment Composition & Infrastructure	Public investment and/or rent-seeking in private investment divert resources to unproductive uses	Does public/private composition in Brazil affect growth?	Do resources flow to less productive uses?	**Local infrastructure affects household income growth?**	Extent of public versus private innovation activities		Firms' assessment of infrastructure as an obstacle to investing
Investment Climate	Bureaucratic barriers to entrepreneurship hinder economic dynamism and constrict the SME sector	Do governance measures matter in growth regressions?	**Do new firms show higher productivity? Do small firms grow?**	Does policy or political instability at the state level explain growth?	Description of investment climate institutions		**Do companies report greater obstacles than overseas?**
Macro Stability	Remaining uncertainty in economic expectations deters long-term planning and investment	**Granger causation between stability and growth?**	**Time pattern of firm-level productivity growth**	**Time pattern of household income growth**			**Firms cite instability as a main obstacle to investing?**
Demographics and Migration	Congestion, crime and other constraints in large cities have curtailed productivity growth through migration			Has growth slowed more in immigration recipient states?			
Taxation	High overall tax burden, high marginal taxes, and distortions impede growth significantly	Tax and spending measures in growth regressions					Do firms report taxes as a main obstacle to investing?

Dark Yellow (13): strong evidence for reform. Light Yellow (11): weak or partial evidence for reform. White (15): opposite, contradictory, or no evidence for reform.

1. CONCEPTS, FRAMEWORK, ROADMAP

Prepared by Mark Roland Thomas and Indermit Gill

I. INFORMING BRAZILIAN ECONOMIC POLICY

Foreword

1.1 This volume is the second of two, and comprises the original background research that underpins Volume I, the policy summary. Volume I draws on the work in this volume, but also on additional sources where these inform the policy choices faced by the authorities.

1.2 This report overall represents an attempt to apply the insights of economic theory and empirical studies to suggest directions for economic policy makers in Brazil. It almost goes without saying that this is an enterprise of some magnitude, so let us first limit the scope and ambitiousness of the task.

1.3 First, any attempt to use theory and data to cast light on questions of economic growth policy is subject two fundamental constraints: (a) the scarcity of agreement regarding the appropriateness of competing theoretical models and thus ultimately the relative importance of different causal factors, and (b) the scarcity of reliable data. Neither of these constraints having been lifted for the study at hand, the aim is to add evidence, inform, provoke, and refocus attention around certain policy issues, rather than provide categorical answers to sweeping questions. We do not wish to add hubris to the list of pitfalls.

1.4 Second, this volume will not address all the public policy areas that impinge on Brazil's growth performance. The report's overall form is the result of consultations that took place during its inception, and which were specifically designed to circumscribe its range. Policy areas were excluded according to three basic criteria: (a) areas that were already the subject of recent existing work or work currently under way, (b) areas where the state of advancement of knowledge was deemed to be sufficient, or where the basic directions of Brazilian public policy were clearly established, and (c) the expressed interest of the study's Brazilian audience.[1]

1.5 There is therefore a long list of subjects that are not explicitly dwelt upon by the present volume, among them fiscal sustainability and the associated vulnerability to market volatility, tax policy, competition policy, privatization, and infrastructure provision and regulation. By way of example, the first of these, fiscal sustainability, has been the focus of many recent studies

[1] The audience is understood primarily to be decision makers in the Federal Government, but the report aims to be of interest also to a wider audience that includes other government levels, Brazilian civil society, academics, professional economists with an interest in Brazil, and development practitioners in other countries.

conducted on behalf of the Brazilian authorities by the World Bank and others, and has therefore been placed beyond the scope of the present study. That is not to say that it should not be a primary concern of the authorities in the pursuit of economic growth—external vulnerability is indeed still the main constraint on Brazil's macroeconomic performance. But rather than say a little that is already known about a wide array of topics, the present study aims to add knowledge in a few areas of microeconomic policy.

Background

New Brazil, New Economy?

1.6 Much has changed in the past decade in Brazil and in the world economy. It is still somewhat an open question to what extent the three fundamental Brazilian macroeconomic reforms of the 1990s—trade opening, fiscal stabilization, and the eradication of inflation—will be sufficient in the longer term to generate GDP growth rates of the order of 6 percent, say.[2] The hypothesis of this report is that there are significant improvements that are open to Brazil in its new, more stable, environment. Indeed, some of these improvements—greater innovation associated with longer-term investments, greater investment in skills and training, the reform of institutions governing the private sector—have only been conceivable under the clearer ground rules that macro stabilization has brought about. If there has been some debate over how "new" the "new world economy" really is, there can be little debate that the "new Brazilian economy" of the late 1990s does indeed represent a new departure.

1.7 At the same time as the Brazilian landscape has changed, so have the world economy and economists' perceptions of it. "Globalization" is a term that is rarely precisely defined, but in the present context we understand it to mean increased international trade, increased international knowledge flows (in particular pertaining to technological innovations), and greater capital mobility. (It is usually more enlightening to consider these three changes in incentives and constraints as separate entities, since each entails distinct consequences.) As these changes have set in, economists' models of growth have shifted their emphasis from factor accumulation towards the harnessing of knowledge and innovation to enhance productivity. A key factor in this context is the openness of economies, both to trade in goods and services and to foreign investment.

1.8 This report therefore focuses on these ingredients of economic growth, and asks what conclusions for Brazil's public policies might look different in the new environment. The report examines Brazil and other countries' recent experiences and looks forward to the economic circumstances that Brazil can reasonably expect to obtain in the coming years. Given these, it designs policy recommendations that are founded upon Brazilian experience and realities, and are reasonable given Brazil's political and economic constraints.

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[2] At the time of writing, most observers put Brazil's potential GDP growth rate at about 4.5 to 5 percent, that is, higher growth than this would lead either to inflation or to a balance of payments crisis, and thus not be sustained. Brazil is expected to grow under 3 percent in 2001 owing to an energy shortage.

Economic Approach

1.9 How have economists studied the causes of economic growth? Broadly, one discerns two types of study that encompass the majority of the research program since Harrod, Domar, and Solow invented the modern form of the subject in the middle of the 20th century. The first category is "within-country" inquiries in developed countries. Solow's 1956 paper on the USA is an obvious example, and there are of course many others. The second category is cross-country comparisons, which have been undertaken for the developed and the developing world. The debate surrounding economic convergence is one instance of this category. We echo the second approach in chapter 2, but in the rest of this volume, the emphasis will rather be on developing a less common product: a within-country enquiry for a developing country with the focus on government action. What is the context of such action in Brazil in 2001?

1.10 The Brazilian economy underwent three structural changes during the 1990s, changes that progressively transformed Brazil from inward-oriented, inflation-prone, and crisis-vulnerable, to open, price-stable, and economically well managed. The task is not complete, but any assessment must recognize how far Brazil has come since 1990. First, the Collor reforms of 1990-92 put in place measures opening Brazilian industry to more external competitive pressures: Brazil embraced *Mercosul* and its average external tariff fell from 51 percent in 1987 to about 14 percent in 1993 (it is still about this level at the time of writing). Next, in 1994, came the *Plano Real*, well documented elsewhere (see Cardoso and Helwege, 1999, for a succinct but full treatment). Finally, in January 1999, came the forced but successfully navigated abandonment of the exchange-rate anchor in favor of macroeconomic management centered on inflation targeting and a necessarily greater degree of credibility of fiscal and monetary management.

1.11 Against this backdrop, and in particular with the combination of stability, openness, and exchange-rate depreciation, many Brazilians have expressed dissatisfaction with the country's economic growth performance, currently forecast to remain around the 4 percent mark for the next two to three years (and this with a high degree of uncertainty). Recent macro performance has suggested that current account imbalances make higher growth than this unsustainable even in the medium term. In recent years, other middle-income countries have been able to post significantly higher growth rates—above 6 percent over a number of years in the cases of Chile or some of the East Asian economies—without incurring such external imbalances.

1.12 This prognosis provokes a range of questions: What is Brazil's potential growth rate with the "right" reforms? Is the main obstacle still the high base interest rate arising from fiscal imbalance? Has Brazil really reformed adequately in areas such as trade and infrastructure regulation? Should Brazil intensify industrial policy to create competitive advantage in higher-technology sectors? What should be Brazil's reaction to the challenges of the "new economy" of knowledge and innovation represented by the internet? Which areas of education and training promise the highest growth returns in this new environment? How can the country be sure that the right policies for growth do not militate against the poorest groups of society? These are the classes of question this report proposes to address.

1.13 We close this introductory section by setting expectations, regarding both the report and the Brazilian economy. First, as already emphasized, the report cannot answer the most sweeping questions about prioritizing public reforms in Brazil. Is tax reform more important than labor-market

reform for economic growth? We do not know. Both are no doubt necessary for the country to fulfill its potential. There is neither the data nor the theoretical consensus to provide a convincing case in favor or against any particular quantification of such priorities. Where the report will focus, however, it will bring to light new evidence specific to Brazil, interpret this evidence within a framework appropriate for Brazil, and make proposals that are realistic for Brazil.

1.14 Second, with regard to the performance of the Brazilian economy, a quick look at international patterns since 1980 suggests a levelheaded discussion of growth targets for Brazil. Very few large economies have sustained decadal growth averages above 5 percent, and even when considering these, comparisons across space and time must of course be made with some skepticism. Table 1.1 displays decade growth averages for 1980-90, 1985-95, and 1990-2000 for some star performers in addition to some regional comparisons for Brazil. In Latin America, only Chile sustained average growth rates above 6 percent. Even outside the region such cases are rare, and it is unclear how much one can generalize from, say, China to Brazil. Even with fairly significant microeconomic reforms, we estimate that Brazil should not count on sustained growth rates beyond the vicinity of 6 percent.

Table 1.1
Selected Decade GDP Growth Averages

Country	1980-1990	1985-1995	1990-2000
China	9.4	10.0	9.7
Korea	7.8	8.5	6.4
Indonesia	6.4	7.0	4.6
Ireland	3.1	4.0	6.8
Chile	4.2	7.4	6.4
Argentina	-0.9	2.5	4.4
Mexico	2.2	2.5	3.3
Brazil	2.9	2.9	1.8

Source: World Bank (Live Database)

1.15 The next two sections build the conceptual framework by distilling current thinking among economists working on economic growth, and casting the debate in a Brazilian light. The two sections after those discuss some hypotheses about current constraints on Brazilian economic growth and outline how one might then bring data to these questions within our framework. The final section gives a roadmap to the remaining chapters.

II. Economic Growth: from Theory to Practice

Fifty Years is Not Enough

1.16 Robert Solow, in the 1956 paper that gave birth to the modern subject of economic growth and won the Nobel Prize for Economics, showed how growth through capital deepening could simply be viewed as a social choice between consumption and saving (and investment). This view is undoubtedly still relevant for Brazil today, exhibiting as Brazil does quite low savings rates, private and public. Solow's principal insight, however, lay in what his steady-state model did not explain. Long-run growth in the Solow growth model peters out in the absence of exogenous technological progress, which is needed to augment the level of output attainable with a fixed level

of factor inputs: labor, capital, and, in later incarnations of this model, human capital. Since the experience of the developed world and parts of the developing world in the 19th and 20th centuries suggests that long-run economic growth is not petering out, Solow's discussion in fact focuses attention on such increases in so-called "total factor productivity" (TFP) as the source of sustained economic growth.[3]

1.17 Solow's current discourse reflects the two fundamental insights that his model generates: first, that TFP should be the object of economists' attention; second, that over the horizon of most political cycles, the assumption that the economy has reached a steady state in which the nation's capital stock would remain constant in the absence of TFP growth is almost certainly wrong.

> *"If they mean anything at all, those many right-hand side variables in growth regressions are determinants of TFP. But then they should be selected with that function in mind, and TFP (or its growth rate) should be the left-side variable..."*
>
> *"... many countries, much of the time, are nowhere near steady-state growth. This suggests that comparative studies should focus less on "the" growth rate and more on comparing and understanding whole time paths."*
>
> Robert M. Solow, 26 February 2001
> Keynote speech made at the World Bank conference:
> "What have we learned from a decade of empirical research on growth?"

1.18 Both these insights formed the basis of the departures of Romer (1986), Lucas (1988), and Mankiw, Romer, and Weil (1992). These authors augmented Solow's treatment of physical capital deepening with (at least) three observations. First, that technological progress could be viewed as a by-product of production or of investment itself (learning by doing), and that this assumption was sufficient to give long-run growth as a steady state phenomenon. Second, that human capital accumulation also increases the productivity of the other factors (capital and labor), and that simply incorporating this into Solow's model and examining its convergence to steady state gave much improved predictive performance. And third, that these ingredients could be combined to give a view of human capital accumulation that is also driven by learning by doing. These authors thus shifted attention onto human capital and thus from a policy perspective onto education, workforce characteristics, training, labor-market relations, and on-the-job learning as significant determinants of economies' growth performance. These factors will be addressed by the present study in the Brazilian context, and in particular by chapter 6.

1.19 Other authors have analyzed episodes of economic growth in countries in the light of the theories referred to above. Young (1995) characterizes post-war growth in the East Asian economies. Hong Kong's growth can be attributed more to sustained improvements in TFP than that of almost any other country. Jorgenson and Stiroh (2000) also make the case that the strong performance of the US economy in the late 1990s was significantly driven by technological progress increasing TFP. These cases could be contrasted with, say, Indian or Russian postwar

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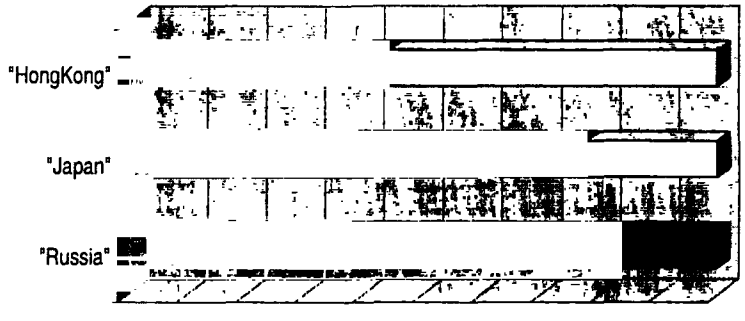
[3] Grossman and Helpman (1991) point out that "classical writers such as Mill and Marx had speculated that standards of living could not rise indefinitely unless advances in technology served to augment the productivity of resources."

growth: between 1970 and 1990 TFP in these economies did not improve, and economic growth was entirely accounted for by capital deepening (Young, 1993). Japan or South Korea seem to have been intermediate cases, with moderate TFP growth allied with fast capital (and human capital) deepening. Turning to Brazil, it is of note that Abreu and Verner (1997) find that Brazilian growth during the period 1930-94 could be explained predominantly as a phenomenon of physical capital accumulation: human capital and total factor productivity did not explain a large part of Brazil's rapid growth during the period. We return to this matter in Chapter 2.

1.20 This discussion raises the possibility of "different kinds" of per capita economic growth. A schematic representation is shown in Figure 1.1. The issue in distinguishing between these scenarios is long-run sustainability. If the above typology is correct, then a quick look at what has happened during the 1990s to Russia and Japan is salutary. The reasons why economic growth in the absence of TFP growth may not be sustainable echoes Solow. Without TFP growth, fast economic growth is not an equilibrium phenomenon. It is possible that economic growth occurs "off the equilibrium path"—if past impediments are removed or if structural parameters such as the savings rate or human capital stock change. But unless such changes occur continually, such growth should be expected to peter out. Another way of seeing the argument is through the prism of a small open economy. Growth in output per worker that is not founded in TFP growth must follow from capital deepening. *Ceteris paribus* in an open economy (in particular holding the domestic savings rate constant), this implies greater capital inflows. These in turn imply a higher interest rate than the international rate or an appreciating exchange rate. Neither is an equilibrium state.

Figure 1.1
Schematic Forms of Economic Growth Composition



□ Labor Growth ■ Capital Deepening □ TFP Growth

1.21 It is the premise of this report that the Brazil of the new millennium will only return to the growth rates it enjoyed during the "miracle years" if it finds ways to enhance TFP through technology innovation or adaptation, and through increasing the quality of its human capital stock. Turning to cross country evidence that includes the developing countries, Easterly and Levine (2001) echo Solow and list five stylized facts about growth:

- Factor accumulation accounts for much less of the differences between countries' growth rates than does TFP
- Countries have tended to diverge economically rather than converge

- Growth is not persistent over time: *"Much of the world is characterized by miracles and disasters... and not by countries with stable long-run growth rates."*

- Factors of production and hence economic activity tend to be highly spatially concentrated

- National policies influence long-run growth: *"In models that emphasize TFP growth, national policies that enhance the efficiency of capital or labor or alter the rate of technological change can accelerate long-run growth."*

1.22 This report will also present some cross-country findings (chapter 2) in a descriptive spirit, as background to the more in-depth analysis of episodes in one country, which Solow recommends. As many commentators have pointed out, cross-country growth regressions are plagued by issues of reverse causality (from growth to the supposedly independent variables on the right-hand side), omitted variable bias, and difficulties of interpretation. Nonetheless, performing within country analysis without looking at international evidence always begs the question whether the latter broadly corroborates the former. In particular, chapter 2 will focus on the fifth of Easterly and Levine's stylized facts above, and examine, through regression analysis, the descriptive partial correlation between national policies and economic growth. After this initial presentation of international evidence, the other two empirical chapters of the report will dwell on the recent growth experience of Brazil, again attempting to trace possible policy effects. The final three chapters then turn to more detailed discussions of the policies themselves, with attention to the Brazilian context, yet drawing mainly on international lessons.

Policy as a Determinant of TFP

1.23 The discussion so far has led us to formulate public policies as determinants of TFP growth, which in turn it is argued is the source of sustainable long-run economic growth. Yet how are we to conceptualize the effects of public policies on TFP?

1.24 While "policy as a determinant of TFP" has perhaps not explicitly been the message of much of the economic growth literature, it is easy to adapt modern growth theory to this end. First, policy may affect TFP through its effects on innovation in the economy: we turn to this below. Second, public policy may affect the returns to factors in the economy, affecting the investment decisions of agents and thereby TFP. Third, policy may be thought of as directly creating certain factors, such as in the case of public education.

1.25 Klenow (1998) has argued that the evidence of within country growth experience favors the view that ideas and thus innovation are behind TFP growth.[4] It is worth emphasizing that such innovation need not necessarily be "technological" but may for instance be embodied in improvements to managerial techniques. McKinsey Global Institute (1999) recently completed a detailed analysis of Brazilian productivity based on case studies in selected industries, and came to the conclusion that the major inefficiencies reside in the lack of penetration of international best practice in management methods, partly owing to a lack of competition in certain sectors, whether

[4] Barro (2000) gives a theoretical account of how R&D may be built into a growth accounting framework, in the context of Grossman and Helpman style models of innovation-led growth.

domestic (suggesting changes to competition policy)[5] or foreign (suggesting further trade opening).[6]

1.26 Many models of endogenous growth, in particular those of Romer (e.g., 1986), give a critical role for policy in determining the location of activities and subsequent agglomeration effects. In Romer's words, policy can be "hypercritical":

> *"... small changes in [choices] can now imply much bigger changes in equilibrium outcomes. So, if you build models that have complementarity plus fixed costs, you could have, in the aggregate, forms of increasing returns and positive feedback which make policy much more effective."*

1.27 Concluding that policy may have a critical role is not the same as detecting its effects. Indeed, in cross-country studies issues of endogeneity make such inferences of causal relations impossible to make. This leads to Solow and others' recommendation of the study of country "episodes" or experiences across periods of time. This will be the spirit of chapters 3-7 of the present volume.

1.28 Perhaps the clearest exposition of a class of models in which public policy and institutions can have these kinds of critical effects have been developed by Grossman and Helpman (many of their models are collected in Grossman and Helpman, 1991). Their discussions emphasize technological innovation and adaptation (or imitation) as equilibrium activities undertaken by firms who gain monopolistic rents from the fruits of their research and development activities. Note that the monopolistic competition that these models assume may follow from similar assumptions to Romer's fixed costs and increasing returns (cf. Models of economic geography and path dependency such as Krugman, 1991a, 1991b). Within this class of models, economic growth is driven by the level of innovative (and adaptive) activities in the economy, but this innovation is an equilibrium choice by firms rather than simply a by-product of investment or production. The role for policy may in turn depend on the scope of knowledge spillover effects (e.g., national or international in scope), on human capital and other resource endowments, and on country size. Perhaps more important, the types of policy that government's may contemplate may differ from those suggested by the models so far, as we discuss in the next section.

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[5] A recent OECD (2000) assessment of Brazilian competition policy was, however, broadly positive, and suggested that Brazil was not an outlier in this dimension with respect to many better-performing developing economies.

[6] It is of note that despite its drastically reducing trade barriers in the early 1990s, Brazil's trade regime is still not particularly open by international comparison. Average tariffs have in fact risen slightly since the mid-1990s, owing to renegotiations within Mercosul (although it should be recognized that Brazil does not practice the "tariff spikes" – extremely high tariffs against narrow groups of products – practiced by many industrial countries, including some of Brazil's trading partners). International trade as a fraction of GDP is still low in Brazil by international standards (controlling for other factors such as country size).

III. THE NEW GROWTH AGENDA

Knowledge and Innovation in the International Economy

1.29 If innovation, and thus flows of knowledge, drive growth, we must still follow the advice of Robert Solow to "put TFP on the left-hand side of our regressions." The determinants of TFP may now look different, however.

1.30 The first important point to emphasize is that knowledge is in many cases a public good: its use by one innovator does not preclude its use by another. How can emerging economies such as Brazil maximize the flows of knowledge into their economies?

1.31 If knowledge is (at least to some extent) a public good, innovation is nonetheless not a free good, and Grossman and Helpman's models recognize this explicitly. Indeed, it is an empirical fact and a theoretical assumption in the models that innovation is human-capital intensive. This poses a policy quandary for developing countries, in which human capital is typically scarce. Although one class of policy recommendations centers on how to make human capital less scarce in Brazil (see chapter 6), this parameter can only change relatively slowly over time as, say education reforms take approximately a generation to work their way fully into the labor market. One question facing Brazil is therefore whether its scarce human capital is employed to a greater extent in more or less innovative or knowledge generating activities.

1.32 Fortunately for countries scarce in human capital, innovation and thus productivity growth can also be imported via foreign direct investment, foreign machinery, imported intermediates, and even competition in export markets and greater competition in domestic markets from abroad. The vectors of this information flow are thus trade, foreign investment, foreign competition, and information and communication technology. In the new economy, these areas of policy are placed under the spotlight.

The Importance of Public Policy

1.33 In this framework, a country's comparative advantage is dynamic: no longer does it follow directly from its endowments of factors such as labor and natural resources. Rather, these endowments set the initial conditions that are but one parameter facing the country. Government policies towards different sectors of the economy or factors may induce implicit or explicit subsidies or taxes, and these may permanently affect the pattern of specialization of the country. As Grossman and Helpman (1991) note,

> *"Historical data also link various government policies with exceptional growth performance. Countries with high shares of government consumption in GDP have on average grown more slowly than others, whereas those with high rates of government investment have tended to grow more rapidly. High marginal tax rates are associated with slow growth in output, holding constant the average rate of taxation. Kuznets (1988) tries to identify the common features in the successful growth performances of Japan, Taiwan, and South Korea, and concludes that all three countries have pursued a policy of encouraging the corporate sector and of removing regulatory restrictions on business activity. Finally, several researchers*

find a strong relationship between a country's trade policy regime and its dynamic performance."

1.34 Table 1.2 illustrates the central policy emphases that the three main waves of economic growth theory since Solow, and briefly outlined in this section, have suggested. Each in some way builds upon and generalizes the earlier work. Accordingly, the report plans to examine policy options using all of these "lenses." But the role of policy in the new growth agenda is richer than before, and the costs of the wrong policy choices have likely been raised. What can or should government do?

1.35 It should be stressed that economic theory does not provide straight answers to the riddles of economic growth and how to attain it through government policy. Indeed, in the more sophisticated models of the new growth theories—incorporating knowledge spillovers both national and international in scope, small and large countries, and sectors with and without innovation—almost any desired result can be generated by tailoring the assumptions. The onus thus shifts back onto the data and the judicious interpretation of country experience to suggest the right mix of public interventions.

Table 1.2
Policies Emphasized by Different Classes of Growth Model

Class	Main Elements	Policy Emphasis and Lessons
Exogenous Growth Solow (1956) Shell (1967)	Saving rates Capital deepening Exogenous technological progress Basic research	Total factor productivity may increase from investment in basic research Suggests government investment versus government consumption High fiscal deficits will reduce growth Growth rates determined by propensity to save and marginal capital product Forced saving may increase growth but not necessarily welfare
Endogenous Growth Romer (1986) Lucas (1988) Mankiw, Romer & Weil (1992)	Learning by doing Human Capital Economies of scale Investment externalities	Importance of education for growth Possible gains from promoting investments in human or physical capital High marginal tax rates reduce growth Gains from openness Persistent effects of good or bad policy
Technological Growth Grossman & Helpman (1991, 1993) Aghion & Hewitt (1992)	Imperfect competition Investment in R&D Investment externalities Imitation Dynamic comparative advantage First mover advantage	Past production patterns may affect current level of innovation Importance of international knowledge spillovers for developing countries R&D activities divert resources Gains from openness Strategic role played by workforce skills *Possibility* of strategic trade and investment policy

IV. Possible Constraints on Brazilian Growth

History and Hypotheses

1.36 Brazil was by some measures the fastest growing economy of the 20th Century. It was by all measures one of the world's most dynamic economies in the 1960s and 1970s, prompting references to the "Brazilian Economic Miracle" of that period. What caused economic growth to cease? Are the same factors responsible for Brazil's seemingly sluggish response to stabilization in the 1990s? And today, what are Brazil's "binding constraints" with regard to economic growth?

22. Reflecting the discussion so far, this report considers growth determinants traditionally emphasized, such as the level of physical investment (private and public), saving, macroeconomic balance, government consumption, and health and education. But we also emphasizes factors that the newer theories suggest may be important: the environment for knowledge creation and the adoption of new technologies, the analysis of tertiary versus basic education, and the dynamic effects of foreign direct investment. Observers differ in their rankings, but the following is a list of hypotheses worthy of discussion. *It should be noted that these are hypotheses: their relevance or lack thereof is to be determined by appealing to empirical observation:*

- Cost of capital and crowding out of private investment by the public sector borrowing requirement?
- Human capital deficiencies, particularly relating to health, primary, secondary, or tertiary education and training?
- Deficiencies in the flow of knowledge and innovation, related to intellectual property rights and/or use of foreign technology?
- Overly rigid and costly formal-sector labor-market regulations driving up the cost of labor, including lengthy and unpredictable labor court delays?
- High tariffs and relative isolation from international trade flows?
- High public-sector investment composition combined with the low-productivity of public-sector investments and/or a lack of investment in infrastructure?
- Poor climate for private investment, including regulatory and administrative barriers and an inefficient judicial system?
- Macroeconomic instability, including rollover risk of external debt, remaining uncertainty surrounding public debt sustainability and inflation?
- Constraints related to demographics and migration, including the decrease in migratory flows from rural to metropolitan areas, and from the Northeast to the South and Southeast regions?
- High and distortionary taxes, including cascading taxes on exports, a financial transactions tax, and an overall tax burden greater than 30 percent of GDP?

V. Bringing Data to the Question

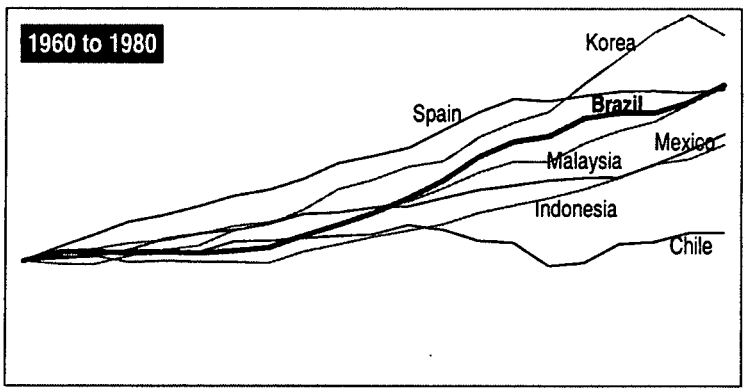
Data Analysis as Description

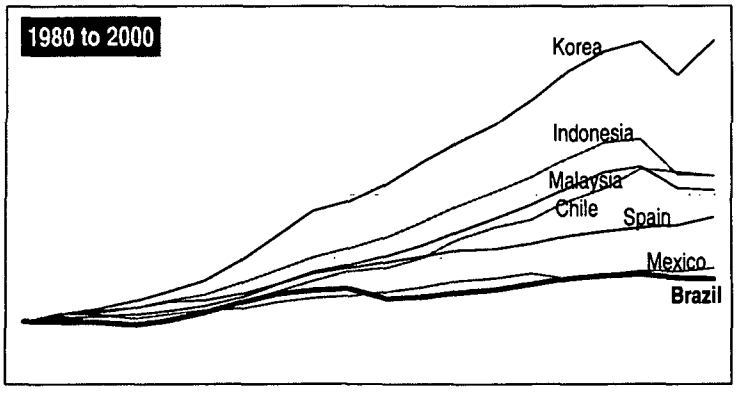
1.37 In this volume we present data—whether from countries, firms, households, or episodic accounts—in a descriptive spirit. To use an analogy that we owe to Paul Romer, we are not so much testing models as building up evidence in the way of a detective solving a crime. The evidence we amass will be at best suggestive and circumstantial. We hope it will nonetheless provide the platform for thinking about sensible policies for Brazil's economic growth.

Country Data

1.38 An initial question is: where does Brazil fit in the growth data? As Figure 1.2 illustrates, Brazil has been through periods of both high and low growth during the past 50 years. Until 1980, Brazil was generally cited as a positive example for developing countries to emulate when designing growth policies. For the period 1966-76, Brazilian GDP growth averaged above 9 percent. Two external events changed the story. The first was the 1973 oil shock, which put in place underlying imbalances that would cost Brazil dearly by 1982, when the first debt crisis pulled Mexico and then Brazil into brutally severe recessions. As has been well documented, the remainder of the 1980s and the early 1990s were a period of stagnation for Brazil, with per capita growth rates around zero averaging over the period. The establishment of price stability since 1993 has allowed the country to return to positive growth territory, but there are no signs as yet of the potential to grow at the sustained levels of 6 percent and above that some of the East Asian economies, Chile, and certain European economies such as Spain, Portugal, and Ireland have exhibited since 1980.

Figure 1.2
Two Periods of Brazilian Economic Growth in Context





Source: World Bank (Live Database)

1.39 A second question might be: where does Brazilian *policy* fit in the data? We recognize limitations in our ability to answer this question quantitatively: policy comparisons across countries are not readily available. Moreover, policy coefficients from regressions are not enough in themselves to draw conclusions, owing to the fact that both policy and income growth are jointly determined. Nonetheless, in the spirit of analysis as description alluded to at the beginning of this section, it is desirable to analyze Brazilian policy and growth through the lens of some cross-comparisons.

Company Data

1.40 A further source of information on the processes of innovation and growth is firms themselves. For example, Olley and Pakes (1996) find that for the US telecom industry, "the productivity increases that followed deregulation were primarily a result of a reallocation of capital towards more productive establishments." Findings of this nature for Brazil would suggest the mechanisms of recent productivity growth, important for understanding how this growth might be increased.

State Data

1.41 A further feature of growth emphasized by Easterly and Levine is the concentration of activity, both internationally and within countries. This certainly characterizes Brazil: with a combined population of 49 million, or 30 percent of Brazil's total, the two states of São Paulo and Rio de Janeiro account for about half of the country's GDP. Table 1.3 shows indices of population and economic activity by region for Brazil in 1998.

Table 1.3
Indicators of Concentration in Brazil's Regions

Region	Population	GDP	Industry	Communications
Southeast	43	58	63	65
Northeast	28	13	10	13
South	15	17	21	11
North	7	4	4	2
Center-West	7	7	2	9

(column percent, may not add to 100 owing to rounding.) Source: IBGE

1.42 Economic concentration is of course closely related to the issue of the distribution of income, which may be viewed (World Bank, 2000a) as one important dimension of the "quality of growth." Are there tradeoffs between quantity and quality? Are there public policies that promote more equitable growth? While these are not the central issues of this report, it is appropriate in a treatment of Brazilian growth that some attention is paid to matters of distribution.

1.43 If growth is unevenly distributed in Brazil geographically, people can of course migrate. Indeed Brazil's economic history has been marked by waves of migration of the *sertanejos* of the Northeast to the industrial centers of the Southeast. This migration continues to some extent but recent research (Fiess and Verner, 2001) suggests that the relationship between the regions in this regard has changed in the past 20 years, with migratory flows even returning towards the Northeastern cities from the Southeast.

1.44 If workers only migrate slowly owing to cultural or economic barriers (such as the fixed costs), capital could also migrate, potentially more rapidly. Yet it is clear that in Brazil this does not occur to any great degree: why not? The economics literature suggests two possible (and not mutually exclusive) explanations: local policies and complementary inputs (i.e., agglomeration). Unfortunately, the state of the art in econometrics cannot satisfactorily distinguish between these two hypotheses, so from the policy perspective the appropriate advice would seemingly be to hedge and assume that both are at work. The challenge is then to define what is "good policy," and at a second stage to ask in what activities the country and its regions may have comparative advantage in which to specialize, in the hope of then benefiting from the concentration of economic activity in Brazil (or in its poorer regions).

Other Work

1.45 Finally in the context of factors that affect the income distribution, it is worth situating the present study in the context of two other imminent World Bank studies that to some extent delineate its boundaries, particularly with regard to questions of income distribution. The first will address reforms to Brazil's labor market regulations (forthcoming, 2002), the second the causes and consequences of Brazil's high levels of inequality (forthcoming, 2001). The present volume does not, therefore, propose an in depth treatment of either of these issues, despite their obvious relevance to economic growth.

Choosing Episodes to Understand Policy Effects

1.46 Despite the desirability of presenting and analyzing data as a descriptive device, ambiguity about causality and the ever-present problem of omitted variables will always mean that such evidence is unconvincing in isolation. The second approach we wish to follow is then to focus on country episodes as evidence of what works and does not in the various areas the report isolates as important for growth in the new Brazilian economy: the nexus of innovation, trade, skills, productivity, and investment.

Knowledge and Innovation

1.47 Again, the central hypothesis is that innovation, adaptation, or in general the use of knowledge as an input in production is central to increasing the rate of growth of TFP. Recent work at the World Bank emphasizes four "pillars" that support this process: economic incentives and institutions; education and skills; information infrastructure; and the innovation climate. It is not enough to focus on any subset of these without the others to foster the optimal environment for knowledge-based economic growth.

Human Capital and Innovation

1.48 The interaction between innovation and human capital is a particularly thorny one for policy-makers in developing economies, since they are operating under competing constraints and objectives. On the one hand, human capital is scarce, despite the investments that many countries including Brazil are making in this area. On the other, governments often aim to foster at least two types of activity through public policies: the first consists of poles of industrial activity or national champions, often pursued through explicit industrial policies and subsidies; the second is research and development itself, often pursued through subsidies to higher education and science and technology initiatives. It is far from clear in an environment of scarce human capital that all these objectives can be met at once. The development of a growth strategy therefore calls for a setting of priorities among these aims. The right balance of policies for education, training, and industrial or science and technology policy should then follow from this strategy.

The Investment Climate

1.49 Finally, much technological progress is undoubtedly embodied in new investment in physical capital. Physical investment is thus a necessary condition for innovation to lead to growth.[7] Yet capital formation is also sensitive to the institutional environment, both private and public, in which it is embedded. The recent passing of a new corporate law in Brazil, which among other objectives brings in line with international practice the levels of protection afforded to minority shareholders in Brazilian firms, reflects this realization. The role of public institutions—local government, the courts, property rights, bureaucratic impediments to business—is less well understood in the Brazilian context.[8] This therefore forms another area in which the present report aims to develop recommendations.

VI. A Roadmap to the Rest of this Volume

1.50 The preceding discussion defines the locus of our analysis. The next few paragraphs describe the chapters to come in this volume. Chapters 2, 3, and 4 present and analyze new data. Chapters 5, 6, and 7 present and analyze episodes and areas of policy. Volume I draws on this

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[7] If not a sufficient condition: witness the earlier discussion relating to TFP, and Easterly and Levine, 2001.

[8] There are some significant exceptions to this statement. Castelar (2001), for example, provides an in depth analysis of the effects of the judicial system on economic growth in Brazil.

and other work, and within the framework described earlier in this section presents policy proposals to increase economic growth in Brazil.

1.51 In chapter 2, Norman Loayza[9] presents new cross country evidence and macroeconomic data from Brazil. He looks at growth patterns using time series and panel data that has been updated and expanded for the purpose of this report, in light of the framework described above. This situates Brazil's experience in a global context and establishes some correlates of growth, including aspects of government policy.

1.52 In chapter 3, Marc-Andreas Muendler,[10] Luis Servén,[11] and Claudia Paz Sepulveda[12] use Brazilian firm data to try to understand recent productivity growth. The data are a newly constructed panel from 1986-98 for Brazilian firms (collected annually by the Brazilian Statistical Institute[13]) and the authors examine by sector the importance of factors such as export orientation, firm size, capital intensity, technology, and human capital in determining changes in total factor-productivity during the period, with particular emphasis on the 1990s since the *real* plan.

1.53 In chapter 4, Naércio Menezes-Filho[14] and Mark Roland Thomas[15] analyze Brazilian state economic growth for the period 1981-98. The authors analyze both the quantity and one aspect of the quality of recent Brazilian growth: its incidence among the poor. They use repeated cross-section household data[16] to analyze variations in income growth across states and age cohorts for the poor and non-poor. Their methodology gives a novel description of the patterns of Brazilian growth, establishes the correlates of pro-poor growth, and allows an investigation of spatial impediments to income growth (c.f. Jalan and Ravallion, 2000).

1.54 In chapter 5, Carl Dahlman, Anuja Adhar Utz, Jean-Eric Aubert,[17] and Christine Zhen-Wei Qiang[18] ask the question: how can Brazil increase technological innovation and gain access to the most dynamic markets in the global economy? This chapter examines improvements needed according to the four "pillars of the knowledge economy" described above: economic incentives and institutions; information infrastructure; human resources; and the innovation system. The authors highlight the lessons of international experience particularly in the areas they categorize as the innovation system.

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[16] Stacked annual data from the national household survey (*Pesquisa Nacional por Amostra de Domicílios*: PNAD).

[17] World Bank Institute.

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1.55 In chapter 6, Indermit Gill[19] and Harry Patrinos[20] ask: what type of human capital investments will promote skills formation for innovation and competitiveness while at the same time ensuring equitable distribution of the gains from economic growth in Brazil? The authors examine policies and public expenditures towards health, education, and training, using international experience in the OECD and East Asia to develop a strategy appropriate for Brazil in this area. They develop policy proposals that take into account both Brazil's short-term constraints and the significant progress the country has made in improving health and basic education in recent years.

1.56 In chapter 7, Hoon Soh[21] asks: how can Brazil improve its institutions to encourage sustained capital investment? The author discusses the effects of public governance on domestic investment, and on the size and composition of FDI. This leads to a characterization of the dimensions of the investment climate that public policy should focus on in order to increase both the quantity and the allocative efficiency of capital investments in Brazil.

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PART I

NEW DATA

2. AGGREGATE GROWTH IN BRAZIL

Prepared by Norman Loayza with the collaboration of César Calderón

I. INTRODUCTION

2.1 The objective of this study is to characterize Brazil's economic growth performance in the last four decades. For this, we take a macroeconomic (aggregate) perspective, using regional and world trends as benchmarks for comparison.

2.2 Section II describes the main stylized facts of growth in Brazil. We first review the long-run growth trends in this country and Latin America by decades from the 1960s to the 90s. Then, we examine the sectoral composition of growth in Brazil to determine the extent of its structural transformation. Next, we study the dynamic relationship between saving, investment, and growth, using a VAR methodology applied previously by Attanasio et al.(2000) in a cross-country panel setting. Finally, we attempt a decomposition of growth in Brazil into its sources related to capital accumulation, expansion of the labor force, and total factor productivity growth.

2.3 In section III, we attempt to explain the economic growth performance in Brazil from a cross-country perspective. We follow the approach in Barro and Lee (1994) and Easterly, Loayza, and Montiel (1997), which consists of linking aggregate economic, political, and social variables to growth rates in per capita GDP for a large sample of countries. The estimated model is then used to forecast the growth rate in the country and examine whether its performance has been close to expected values.

2.4 In section IV, we present some economic and social areas of relatively weak performance in Brazil. We argue that improvement in these areas will be accompanied by higher economic growth in the country. Section V presents some concluding remarks.

II. STYLIZED FACTS

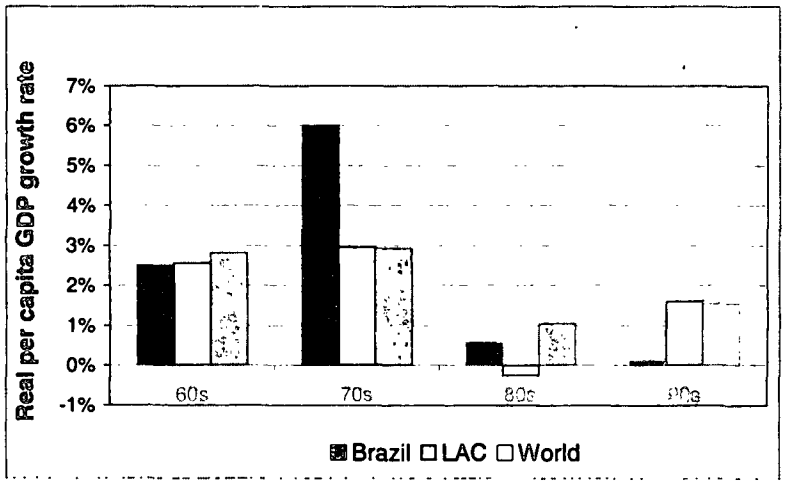
1. Long-Run Growth Trends in Brazil, Latin America, and the World

2.5 Figure 1 presents the per capita real GDP growth rate in Brazil by decade averages. For comparison purposes, it also presents the growth rates of the median countries in Latin America and the Caribbean (LAC) and the world, respectively. While in the 1960s the growth performance in Brazil was very similar to the typical LAC and world countries, in the 1970s Brazil's growth rate surged to become twice bigger than the world and regional growth rates. This outstanding performance was not to last: Brazil's growth rate decreased drastically in the 1980s and fell even

further in the 1990s. The typical country in LAC did worse than Brazil in the 1980s (reminding us why this time is called "Latin America's lost decade"); however, while the region recovered in the 1990s, Brazil did not.

2.6 The decline in Brazil's growth rate is an important stylized fact and, as such, must be analyzed. We do this in section III, where we take a cross-country-regression approach to explain the changes in growth rates by decades. In this empirical exercise, we mainly consider domestic conditions that drive output growth; however, we also take into account the changing international conditions in recent decades. From Figure 1, it is noteworthy the declining growth trend in the world with respect to the 1960s and 1970s. This is bound to have some role in explaining why the growth rate in Brazil was smaller in the last two decades.

Figure 2.1
Per Capita Income Growth



2. Sector Composition of Output Growth in Brazil

2.7 Table 1 presents the average output growth rates of agriculture, industry, and services by decades in Brazil. For industry and services, we also present growth rates by further disaggregated sectors. Industry and services grew strongly in the 1960s and 70s, and agriculture and livestock joined them as a highly growing sector in the 1970s. However, all major sectors decelerated in the last twenty years. The rise and decline of growth in Brazil was a phenomenon shared by all areas in the economy. The fact that the high growth of the 1970s was balanced across sectors but also short-lived may indicate that it was mainly fueled by an expansion in aggregate demand, possibly coming from public sources. We return to this issue in section III.

Table 2.1
Output Growth Rates

Sector	65-99	65-69	70-79	80-89	90-99
Agriculture and Livestock	*4.60%*	*2.25%*	*8.35%*	*3.56%*	*2.46%*
Industry	*4.32%*	*9.21%*	*9.17%*	*1.91%*	*0.73%*
Mining and Quarrying	5.12%	5.80%	6.65%	7.51%	0.92%
Manufacturing	4.17%	9.34%	9.15%	1.52%	0.34%
Construction	4.06%	8.22%	8.79%	0.91%	0.82%
Gas, Electricity and Water	7.40%	6.76%	11.64%	6.66%	4.17%
Services	*4.96%*	*8.37%*	*8.35%*	*3.59%*	*2.07%*
Wholesale and retail trade	4.06%	6.53%	7.80%	1.77%	1.61%
Transport	5.48%	2.53%	11.04%	3.77%	2.81%
Communications	11.69%	4.56%	12.50%	13.09%	12.32%
Banking	4.48%	5.05%	12.58%	2.99%	-2.36%
Public Administration	3.98%	6.96%	7.34%	1.93%	1.49%
Other Services	8.72%	21.88%	13.14%	4.34%	3.41%
GDP	***4.51%***	***7.24%***	***8.09%***	***2.81%***	***1.70%***

Source: Instituto Brasileiro de Geografía e Estatística (IBGE) Diretoria de Pesquisas, Departamento de Contas Nacionais.

2.8 The decline in industrial growth in the 1980s and 1990s was mostly due to the fall in manufacturing, construction, and, less severely, public utilities. Mining and quarrying remained strong in the 1980s but fell with the others in the 1990s. Considering that mining activity has always had a small share of value added in Brazil (see below), its pattern of growth indicates that resource extraction was not the reason behind the expansion and decline of growth in the country. In the service sector, the only area whose growth rate remained high in the last two decades was communications; the others, including, trade, transport, and banking decelerated considerably with respect to the 1970s.

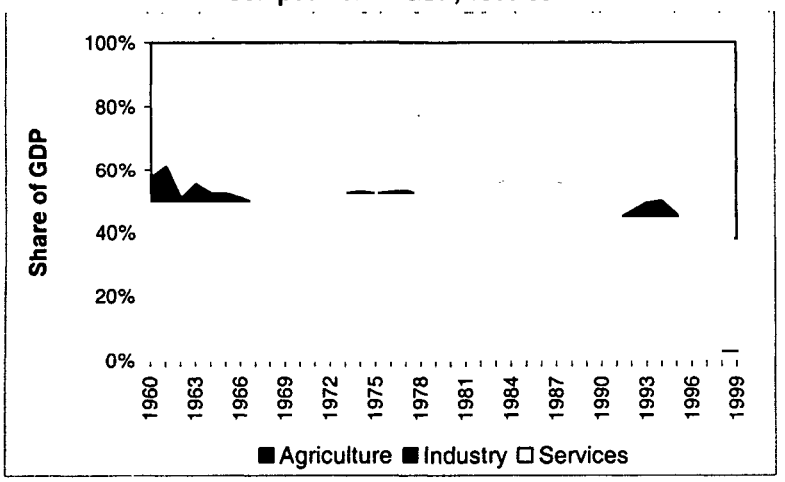
2.9 Table 1a and Figure 2 show the corresponding sectoral shares in GDP over the last forty years. The share of agriculture decreased gradually from about 11% in the early 1960s to less than 8% in the late 1990s. The share of industry was roughly 40% from the 1960s to the 80s, but then declined to one third of GDP in the 1990s. Within industry, manufacturing remains the strongest sector, but over the years it has lost some ground to construction and utilities. Mining and quarrying has remained a small sector reaching slightly over 1% of GDP in Brazil. The share of services was also roughly the same in the first three decades at about 50% of GDP; in the 1990s, it rose to about 60% at the expense of both agriculture and industry. Within services, banking has become the dominant sector, displacing wholesale and retail trade whose share in GDP has fallen by half since the mid 1960s. Communications has continuously gained a larger share although still remains a small sector.

Table 2.1a
Structure of Production

Sector	65-99	65-69	70-79	80-89	90-99
Agriculture and Livestock	*9.4*	*11.3*	*10.2*	*9.3*	*7.6*
Industry	*37.5*	*38.4*	*39.4*	*39.6*	*33.1*
Mining and Quarrying	1.3	1.2	1.0	1.9	1.1
Manufacturing	27.4	29.4	30.5	29.1	21.5
Construction	6.9	6.5	6.4	6.5	8.0
Gas, Electricity and Water	1.9	1.3	1.4	2.1	2.5
Services	*53.1*	*50.2*	*50.4*	*51.1*	*59.3*
Wholesale and retail trade	10.5	14.8	13.5	8.5	7.5
Transport	3.7	4.1	3.9	3.8	3.1
Communications	1.1	0.7	0.8	1.0	1.6
Banking	9.8	7.8	7.6	11.4	11.6
Public Administration	9.8	10.0	8.9	7.0	13.5
Other Services	18.2	12.8	15.7	19.5	22.0
Total Value Added	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Instituto Brasileiro de Geografía e Estatística (IBGE) Diretoria de Pesquisas, Departamento de Contas Nacionais.

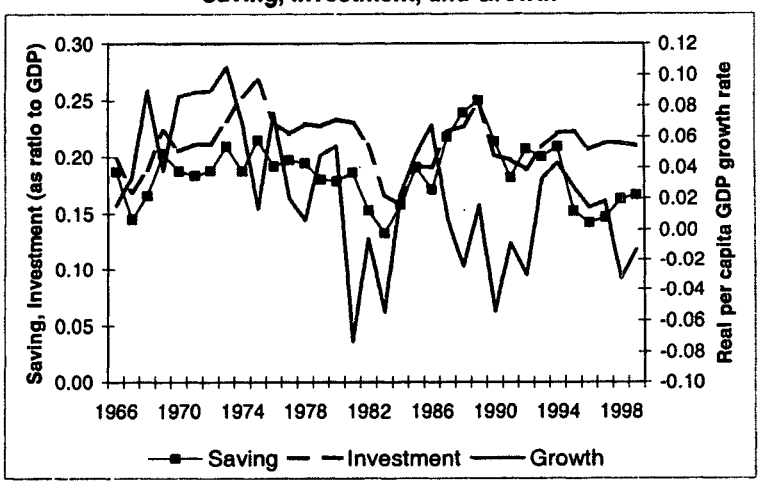
Figure 2.2
Composition of GDP, 1960-99



3. Growth, Saving, and Investment in Brazil

2.10 Figure 3 shows the annual per capita GDP growth rate and the saving and investment ratios to GDP, for the period 1965-1998. Although there is a fair degree of over-time variation in the investment ratio, its average level seems to have remained similar over the years. The saving ratio also remained stable until the mid-1990s, but then it dropped drastically, producing a large current account deficit. We expect that in the coming years there will be a correction in either investment or saving ratios to close the external gap. Most likely, it will be the saving ratio, which will increase back to its historical levels once the growth rate recovers.

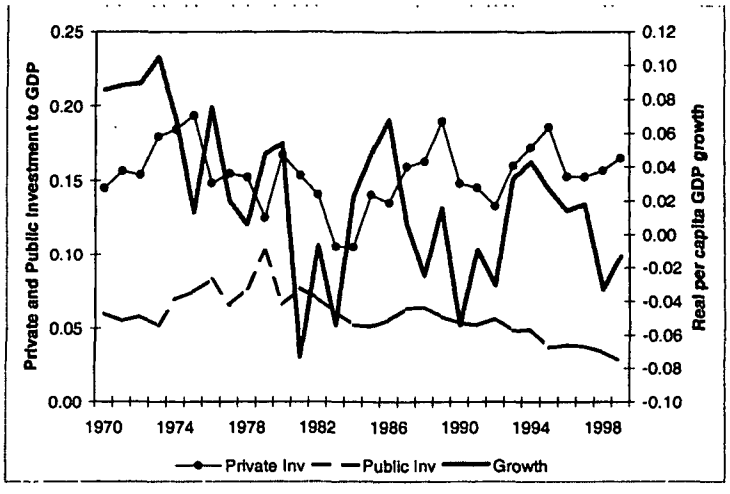
Figure 2.3
Saving, Investment, and Growth



2.11 Contrary to the long-run stability of the investment (and, until recently, saving) rates, the growth rate experienced a level drop in the 1980s (see also Figure 1). This is the case even considering a few years of strong performance in the latter period (such as 1993, 1994). When we decompose investment, we notice a slight reduction of its public component in the 1990s and concurrent increase in private investment (see Figure 3a). However, the compositional changes in investment are modest and there remains the indication --confirmed in the econometric exercises that follow-- that the drop of growth cannot be explained by changes in the level or composition of investment.

2.12 We now begin to explore the dynamic relationship between the growth rate and the saving and investment ratios. Following Attanasio, Picci, and Scorcu (2000), we study these relationships by running VAR systems on annual data. We consider two bivariate systems, namely, Growth-Saving and Growth-Investment. The VARs include two lags of each variable (further lags do not enter significantly in the regressions and are, thus, excluded in the final estimated system.) Table 2 presents the results. The dynamic relationship between saving and growth in Brazil appears to be not significant at annual frequencies according to the Granger-causality and forecasting tests. Judging only by the sign of the coefficients, past growth is positively related with future saving, while saving rises in anticipation of future lower growth. The former result can be explained by resorting to the theories of subsistence consumption and habit formation, while the latter follows from a precautionary motive (the "saving-for-a-rainy-day" effect.) However, neither effect is statistically significant.

Figure 2.3a
Public and Private Investment and Growth



2.13 The dynamic relationship between investment and growth at annual frequencies is more interesting. Past growth has a positive link with current investment. This can be explained by considering that past growth creates incentives to new investment by making future growth more likely. On the other hand, past investment has a surprising negative link with current growth. Apparently this result contradicts the cross-country evidence, which finds a positive effect of investment on growth. However, the two results are not necessarily contradictory given that the dynamic relationship estimated here considers only short-run effects (with lags of at most two years) while the cross-country analysis focuses on long periods. Attanasio et al. (2000) and Blomstrom, Lipsey, and Zejan (1996) also find a negative (short-run) link between past investment and current growth. They explain it either by considering that investment is limited by saving, which anticipates growth negatively, or by taking into account that growth behaves cyclically, with high growth and investment preceding low growth.

2.14 Next we consider the dynamic relationship between growth and, respectively, private and public investment. The first result is qualitatively the same as for total domestic investment: a rise in growth precedes an increase in both private and public investment. The second result entails some difference between the two components of investment: while an increase in private investment is associated with a future fall in the growth rate, there is no significant effect coming from public investment. Regarding the fit of the regression, the dynamic model can explain public investment (R-square = 0.64) better than private investment (R-square = 0.39).

Table 2: Saving, Investment, and Growth in Brazil
VAR Estimation, Annual Data 1960-99

	Saving	Growth	Investment	Growth
Growth (-1)	0.1369*	0.3627**	0.1296**	0.3495**
(Std. Error)	(0.0734)	(0.1134)	(0.0490)	(0.1191)
Growth (-2)	-0.0454	0.2133	0.1424**	0.3619**
(Std. Error)	(0.0915)	(0.1586)	(0.0811)	(0.1487)
Saving (-1)	0.6994**	0.0973		
(Std. Error)	(0.1802)	(0.3352)		
Saving (-2)	-0.1349	-0.2661		
(Std. Error)	(0.1477)	(0.2686)		
Investment (-1)			0.5501**	-0.5747
(Std. Error)			(0.1502)	(0.4032)
Investment (-2)			-0.1020	-0.0602
(Std. Error)			(0.1203)	(0.2703)
Sum Growth Coeff.	0.0916	0.5760	0.2720	0.7115
(p-value)	(0.3497)	(0.0005)	(0.0008)	(0.0000)
Sum Saving Coeff.	0.5645	-0.1688		
(p-value)	(0.0000)	(0.5429)		
Sum Investment Coeff.			0.4481	-0.6349
(p-value)			(0.0006)	(0.0701)
Granger Causality Tests [p-values]				
- From Growth:	3.4916	15.9774	14.3115	20.2590
	(0.1745)	(0.0003)	(0.0008)	(0.0000)
- From Saving	22.4516	1.1228		
	(0.0000)	(0.5704)		
- From Investment			15.4742	3.2893
			(0.0004)	(0.1931)
R Squared	0.4446	0.2606	0.6002	0.3238
Observations	32	32	37	37

Note: Saving and Investment expressed as ratios to GDP. Growth rate is the real per capita GDP growth rate.

Table 2.2a: Private Investment, Public Investment, and Growth in Brazil
VAR Estimation, Annual Data 1960-99

	Private Investment		Growth		Public Investment		Growth	
Growth (-1)		0.1345**		0.3549**		0.0014		0.3357**
(Std. Error)	(0.0684)		(0.1220)		(0.0334)		(0.1356)	
Growth (-2)		0.1209*		0.3579**		0.0959**		0.1583
(Std. Error)	(0.0844)		(0.1644)		(0.0326)		(0.1770)	
Private Investment (-1)		0.2637*		-0.8249**				
(Std. Error)	(0.1792)		(0.4045)					
Private Investment (-2)		0.0229		0.1791				
(Std. Error)	(0.1180)		(0.4329)					
Public Investment (-1)						0.5316**		1.1281**
(Std. Error)					(0.2549)		(0.5619)	
Public Investment (-2)						0.3570**		-1.4295*
(Std. Error)					(0.1330)		(0.8090)	
Sum Growth Coeff.		0.2553		0.7128		0.0973		0.4940
(p-value)	(0.0055)		(0.0001)		(0.0084)		(0.0084)	
Sum Private Inv Coeff.		0.2866		-0.6458				
(p-value)	(0.1107)		(0.1106)					
Sum Public Inv Coeff.						0.8886		-0.3015
(p-value)					(0.0000)			(0.5011)
Granger Causality Tests [p-values]								
- From Growth:	8.2287		17.8452		10.1705		9.1141	
	(0.0163)		(0.0001)		(0.0062)		(0.0105)	
- From Private Investment	2.6707		4.8057					
	(0.2631)		(0.0905)					
- From Public Investment					100.4527		4.0463	
					(0.0000)		(0.1322)	
R Squared	0.3875		0.3185			0.6449	0.3253	
Observations		28		28		28		28

Note: Saving and Investment expressed as ratios to GDP. Growth rate is the real per capita GDP growth rate.

4. Growth Accounting in Brazil

2.15 The last exercise on stylized facts is a Solow-style decomposition of per capita output growth into the contributions of capital and productivity growth. We use two methods to derive measures of total factor productivity growth per capita (or the Solow residual). Both are residuals from aggregate production functions. The first measure (*TFP1*) builds on the neoclassical production function with physical capital *K*, labor *L*, and the level of total factor productivity *A*. Assuming a Cobb-Douglas production function, we have,

$$Y = AK^{\alpha}L^{1-\alpha}$$

2.16 To solve for the growth rate of productivity, we take logs and time derivatives. Assuming a capital share α=0.3 and solving for the growth rate of productivity, we have,

$$TFP1 = GdpGrowth - 0.3 * CapGrowth - 0.7 * LaborForceGrowth$$

The first measure of total factor productivity growth ignores human capital accumulation. The next measure includes human capital, *H*, in the aggregate production function. We use the average years of schooling in the adult population (Barro and Lee 2000) as proxy for the human capital stock in the economy. We follow Mankiw (1995) by augmenting the neoclassical production function as follows:

$$Y = AK^{\alpha}H^{\gamma}L^{1-\alpha-\gamma}$$

2.17 We assume that α=0.3 and γ=0.5 (as in Mankiw 1995), since about two thirds of labor income can be considered return to human capital. We then solve for the second measure of growth in TFP (*TFP2*),

$$TFP2 = GdpGrowth - 0.3 * CapGrowth - 0.5 * SchoolGrowth - 0.2 * LaborForceGrowth$$

where *SchoolGrowth* is the growth rate in average years of schooling.

2.18 Table 3 presents the growth accounting results. Figure 4 shows the growth decomposition considering only the contributions of the labor force, physical capital, and *TFP1*, while Figure 5 adds the contribution of human capital. Both growth accounting exercises give the same qualitative result: total factor productivity expanded strongly in the 1960s and 70s but then fell drastically in the 1980s and did not recover in the 90s. The contribution of physical capital enlarged in the 1970s and, although it fell in the next two decades, remained positive throughout the period. The contribution of human capital expanded in the 1980s to a level even bigger than that of physical capital. The positive contributions of labor and physical and human capital reflect, by construction, the positive growth that their respective stocks experienced in the last few decades (see first panel of Table 3).

2.19 The results from growth accounting corroborate the suggestion from previous exercises that capital accumulation is not the main factor driving economic growth in Brazil. However, before rejecting the "capital fundamentalism" hypothesis, we should consider that not all investment that is measured by national accounts represents an increase in productive capital (see Pritchett 2001).

Besides, there are also good reasons to doubt the quality of investment data during periods of high and accelerating inflation. Also, the value of α=0.3 assumed for these decompositions may not be appropriate for Brazil: Brazilian national accounts data yield a ratio of α=0.5, and Castelar et. al. (2001) for example, compute these decompositions using both α=0.3 and α=0.7. But in any case, variations in TFP growth account for a significant fraction of the variation in economic growth rates since the 1970s.

Table 2.3: Growth Accounting in Brazil, 1960-99

(in average annual growth rate per decade)

	Output	Physical Capital	Human Capital	Labor Force	Total Factor Productivity TFP1	TFP2
A. Growth Rates						
60s	5.89%	4.75%	3.39%	3.06%	...	...
70s	8.05%	10.70%	3.64%	3.45%	...	...
80s	1.44%	5.96%	5.50%	3.16%	...	...
90s	1.98%	4.09%	4.29%	2.15%	...	...
B. Contribution to Output Growth (TFP1 = Solow Residual)						
60s	5.89%	1.42%	...	2.15%	2.32%	...
70s	8.05%	3.21%	...	2.41%	2.43%	...
80s	1.44%	1.79%	...	2.21%	-2.57%	...
90s	1.98%	1.23%	...	1.51%	-0.75%	...
C. Contribution to Output Growth (TFP2 = Education-Augmented Solow Residual)						
60s	5.89%	1.42%	1.69%	0.61%	...	2.15%
70s	8.05%	3.21%	1.82%	0.69%	...	2.33%
80s	1.44%	1.79%	2.75%	0.63%	...	-3.74%
90s	1.98%	1.23%	2.15%	0.43%	...	-1.82%

Figure 2.4
Growth Accounting for Brazil, 1960-99

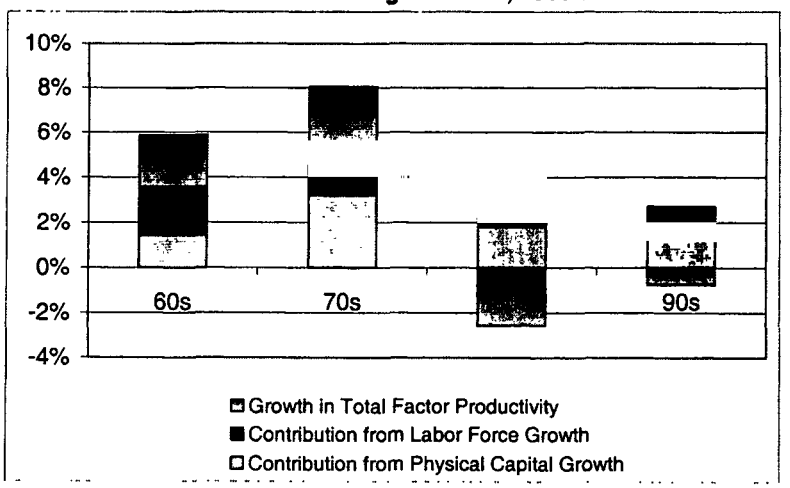
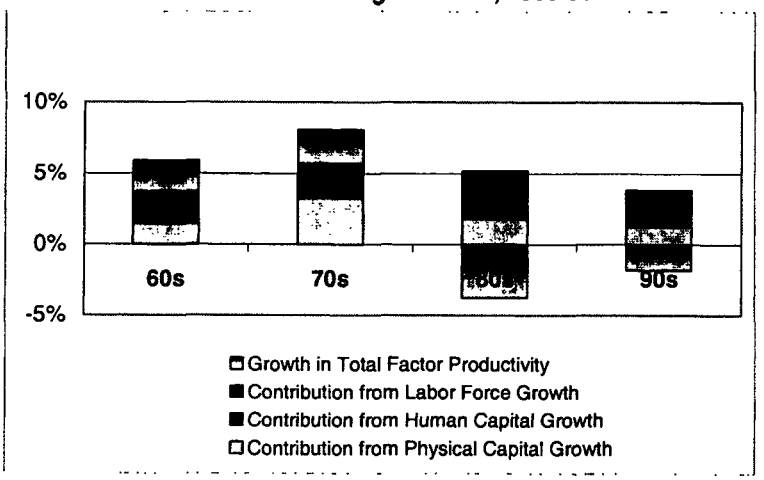


Figure 2.5
Growth Accounting for Brazil, 1960-99



III. Implications for Brazil from a Cross-Country Perspective

2.20 In this section, we attempt to explain the economic growth performance in Brazil from a cross-country perspective. We follow the approach in Barro and Lee (1994) and Easterly, Loayza, and Montiel (1997), which consists of linking aggregate economic, political, and social variables to growth rates in per capita GDP for a large sample of countries. The estimated model is then used to project the growth rate in the country and examine whether its performance has been close to expected values.

2.21 The regression equation to be estimated is the following:

$$y_{i,t} - y_{i,t-1} = \alpha y_{i,t-1} + \beta' X_{i,t} + \mu_t + \eta_i + \varepsilon_{i,t} \qquad (1)$$

where y is per capita output, X is a set variables postulated as growth determinants, μ_t is a period-specific effect, and η_i represents unobserved country-specific factors, and ε is the regression residual. The subscripts i and t refer to country and time period, respectively. The sample consists of an unbalanced panel of 73 countries for the years 1960-98. In order to smooth out transitory fluctuations, we work with decade averages of all variables. Therefore, for each country we have at most 4 periods and at least 3 consecutive periods (which is the minimum required to run the instrumental variable procedure outlined below.)

2.22 The growth regression equation (1) is dynamic, in the sense that it can be rewritten as a lagged-dependent variable model. The inclusion of the initial level of per capita output ($y_{i,t-1}$) follows from the neoclassical growth model and captures the transitional convergence effect. The time-specific effect, μ_t, allows to control for international conditions that change over time and affect the growth performance of countries in the sample. The term η_i accounts for unobserved country-specific factors that both drive growth and are potentially correlated with the explanatory variables.

2.23 There is a large variety of economic and social variables that can be proposed as growth determinants, X. We use the variables that are most popular in the empirical growth literature given both their quality as indicators of development in specific areas and their data availability. The list of explanatory variables is the following (see Appendix 1 for details on definitions and sources),

(a) Initial level of per capita GDP -- to capture transitional convergence

(b) The average years of schooling of the adult population -- to proxy for human capital in the working force

(c) The ratio of domestic credit to the private sector to GDP -- to measure financial development

(d) The share of primary in total exports -- to measure trade orientation and dependence on commodity markets

(e) The ratio of government consumption to GDP -- to measure the burden of government size and taxation to private activity

(f) The black market premium on foreign exchange --to proxy for relative price distortions and government intervention in external markets

(g) The inflation rate -- to proxy for the lack of fiscal and monetary discipline

(h) A binary variable for whether the country is landlocked or not -- to indicate the difficulty in accessing trade markets

(i) . A qualitative variable measuring the overall quality of governance in the country, including the efficiency and honesty of the bureaucracy, the rule of law, and the peaceful resolution of conflicts

(j) Terms of trade shocks -- to account for the effect of international conditions on the country's trade markets.

2.24 The proposed growth regression poses some challenges for estimation. The first is the presence of unobserved period- and country-specific effects. While the inclusion of decade-specific dummy variables can account for the period effects, the common methods to deal with country-specific effects ("within" or differences estimators) are inappropriate given the dynamic nature of the regression. The second challenge is that most explanatory variables are likely to be jointly endogenous with economic growth. That is, we need to control for the biases resulting from simultaneous or reverse causation. In the following paragraphs we outline the econometric methodology we use to control for country-specific effects and joint endogeneity in a dynamic model of panel data.

Econometric Methodology

2.25 We use the Generalized-Method-of-Moments (GMM) estimators developed for dynamic models of panel data that were introduced by Holtz-Eakin, Newey, and Rosen (1988), Arellano and Bond (1991), and Arellano and Bover (1995). After accounting for the time-specific effects, we can rewrite equation (1) as follows,

$$y_{i,t} = \alpha y_{i,t-1} + \beta' X_{i,t} + \eta_i + \varepsilon_{i,t} \qquad (2)$$

In order to eliminate the country-specific effect, we take first-differences of equation (2),

$$y_{i,t} - y_{i,t-1} = \alpha\left(y_{i,t-1} - y_{i,t-2}\right) + \beta'\left(X_{i,t} - X_{i,t-1}\right) + \left(\varepsilon_{i,t} - \varepsilon_{i,t-1}\right) \qquad (3)$$

2.26 The use of instruments is required to deal with (1) the likely endogeneity of the explanatory variables, and, (2) the problem that, by construction, the new error term, $\varepsilon_{i,t} - \varepsilon_{i,t-1}$, is correlated with the lagged dependent variable, $y_{i,t-1} - y_{i,t-2}$. This instrumental-variable method does not allow the *X* variables to be fully endogenous. Given that it relies on past values of all variables as instruments, the method only allows current and future values of the explanatory variables to be affected by the error term. Thus, under the assumptions that (a) the error term, ε,

is not serially correlated, and (b) the explanatory variables, *X*, are weakly exogenous (i.e., the explanatory variables are assumed to be uncorrelated with future realizations of the error term), the GMM dynamic panel estimator uses the following moment conditions.

$$E\left[y_{i,t-s}\cdot\left(\varepsilon_{i,t}-\varepsilon_{i,t-1}\right)\right] = 0 \quad for\, s\geq 2; t=3,\ldots,T \tag{4}$$

$$E\left[X_{i,t-s}\cdot\left(\varepsilon_{i,t}-\varepsilon_{i,t-1}\right)\right] = 0 \quad for\, s\geq 2; t=3,\ldots,T \tag{5}$$

2.27 The GMM estimator based on these conditions is known as the *difference* estimator. Notwithstanding its advantages with respect to simpler panel data estimators, there are important statistical shortcomings with the difference estimator. Alonso-Borrego and Arellano (1996) and Blundell and Bond (1997) show that when the explanatory variables are persistent over time, lagged levels of these variables are weak instruments for the regression equation in differences. Instrument weakness influences the asymptotic and small-sample performance of the difference estimator. Asymptotically, the variance of the coefficients rises. In small samples, Monte Carlo experiments show that the weakness of the instruments can produce biased coefficients.[22]

2.28 To reduce the potential biases and imprecision associated with the usual difference estimator, we use a new estimator that combines in a *system* the regression in differences with the regression in levels (developed in Arellano and Bover 1995 and Blundell and Bond 1997). The instruments for the regression in differences are the same as above. The instruments for the regression in levels are the lagged *differences* of the corresponding variables. These are appropriate instruments under the following additional assumption: although there may be correlation between the levels of the right-hand side variables and the country-specific effect in equation (2), there is no correlation between the *differences* of these variables and the country-specific effect. This assumption results from the following stationarity property,

$$\begin{aligned} &E\left[y_{i,t+p}\cdot\eta_i\right]=E\left[y_{i,t+q}\cdot\eta_i\right] \\ &and\quad E\left[X_{i,t+p}\cdot\eta_i\right]=E\left[X_{i,t+q}\cdot\eta_i\right] \quad for\ all\ p\ and\ q \end{aligned} \tag{6}$$

2.29 The additional moment conditions for the second part of the system (the regression in levels) are:[23]

$$E\left[\left(y_{i,t-1}-y_{i,t-2}\right)\cdot\left(\eta_i+\varepsilon_{i,t}\right)\right]=0 \tag{7}$$

$$E\left[\left(X_{i,t-1}-X_{i,t-2}\right)\cdot\left(\eta_i+\varepsilon_{i,t}\right)\right]=0 \tag{8}$$

---

[22] An additional problem with the simple *difference* estimator relates to measurement error: differencing may exacerbate the bias due to errors in variables by decreasing the signal-to-noise ratio (see Griliches and Hausman, 1986).

[23] Given that lagged levels are used as instruments in the differences specification, only the most recent difference is used as instrument in the levels specification. Using other lagged differences would result in redundant moment conditions. (see Arellano and Bover 1995).

Thus, we use the moment conditions presented in equations (4), (5), (7), and (8) and employ a GMM procedure to generate consistent and efficient parameter estimates.

2.30 Using the moment conditions presented in equations (4), (5), (7), and (8), we employ a Generalized Method of Moments (GMM) procedure to generate consistent estimates of the parameters of interest and their asymptotic variance-covariance (Arellano and Bond 1991, and Arellano and Bover 1995). These are given by the following formulas:

$$\hat{\theta} = (\overline{X}'Z\hat{\Omega}^{-1}Z'\overline{X})^{-1}\overline{X}'Z\hat{\Omega}^{-1}Z'\overline{y} \tag{4}$$

$$AVAR(\hat{\theta}) = (\overline{X}'Z\hat{\Omega}^{-1}Z'\overline{X})^{-1} \tag{5}$$

where θ is the vector of parameters of interest (α, β), $\overline{y}$ is the dependent variable stacked first in differences and then in levels, $\overline{X}$ is the explanatory-variable matrix including the lagged dependent variable (y_{t-1}, X) stacked first in differences and then in levels, Z is the matrix of instruments derived from the moment conditions, and $\hat{\Omega}$ is a consistent estimate of the variance-covariance matrix of the moment conditions.[24]

2.31 Consistency of the GMM estimator depends on the validity of the instruments. To address this issue we consider a specification test of the Sargan type. This test of over-identifying restrictions examines the overall validity of the instruments by analyzing the sample analog of the moment conditions used in the estimation process.

Results

2.32 Table 4 presents the estimation results. The Sargan test cannot reject the null hypothesis of correct specification of our model. The estimated coefficients on all explanatory variables have the expected sign and are statistically significant. First, economic growth is affected by economic characteristics of development. Thus, the growth rate rises with a lower initial level of output (relative convergence effect), better-educated labor force, deeper financial markets, and a smaller share of primary (commodity) exports. Second, economic growth is shaped by the country's type of government. Consequently, the growth rate rises with better governance, smaller government size, less inflation, and shorter black-market premium (less relative price distortions). Third, the country's natural endowment and current international conditions also determine economic growth. Thus, the growth rate is higher in countries that have access to the sea and increases with positive terms of trade shocks. The negative and significant coefficients on the period dummy variables indicate that the 1980s and 1990s were less propitious for growth throughout the world than the 1970s were.

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[24] In practice, Arellano and Bond (1991) suggest the following two-step procedure to obtain consistent and efficient GMM estimates. First, assume that the residuals, $\varepsilon_{i,t}$, are independent and homoskedastic both across countries and over time. This assumption corresponds to a specific weighting matrix that is used to produce first-step coefficient estimates. Then, construct a consistent estimate of the variance-covariance matrix of the moment conditions with the residuals obtained in the first step, and use this matrix to re-estimate the parameters of interest (i.e. second-step estimates). Asymptotically, the second-step estimates are superior to the first-step ones in so far as efficiency is concerned.

Table 4: Determinants of Economic Growth
Estimation Technique: Arellano and Bover (1995)
GMM-IV System Estimator

Dependent Variable: Growth Rate of GDP per Capita	
Constant	50.95035 **
	(4.2287)
Initial GDP per capita	-1.43649 **
(in logs)	(0.1750)
Average Years of Schooling	0.791679 **
(in logs)	(0.3614)
Terms of Trade Shocks	6.728587 **
(log difference of the terms of trade)	(1.7153)
Domestic Credit to Private Sector	0.510894 **
(as ratio to GDP, in logs)	(0.1897)
Government Consumption	-2.22178 **
(as ratio to GDP, in logs)	(0.4797)
Inflation	-2.00755 **
(log of 1 + inflation rate)	(0.6484)
Black Market Premium	-4.78281 **
(in log of 1 + bmp)	(0.5575)
Primary Export Orientation	-1.11538 **
(as ratio to total exports, in logs)	(0.1976)
Landlocked	-0.9456 **
(dummy: 1 = landlocked)	(0.3069)
Governance Index	4.438432 **
	(2.0726)
Dummy 80s vs. 70s	-1.22523 **
	(0.1608)
Dummy 90s vs. 70s	-1.49846 **
	(0.2417)
Sargan Test (p-value)	0.165
(Ho: Instruments are valid)	
Number of Countries/Observations	65/116

Numbers in parentheses represent standard errors.
** (**) Significant at the 10 (5) percent level.*
In column [1], inflation is proxied by log(1+inf), whereas in column [2], it is proxied by inf/(1+inf).

2.33 Our regression model can be used to explain the *changes* over time in economic growth for any country in the sample. We cannot, however, explain the *levels* of growth given that we do not estimate the unobserved country-specific effects (although we control for them).[25] We are interested in assessing the extent to which our model can account for the different growth performance in the 1980s and 1990s with respect to the 1970s. We present the results for Brazil and a few other Latin American countries in Table 5. The accuracy of the projection depends on the country (although in all cases the projected and actual growth differences have the same sign). For Chile, Colombia, Mexico, and Peru, the projected growth difference approximates closely its actual value. For Argentina and Venezuela, at least one period is projected accurately. It is for Brazil and Ecuador that the model performs poorly. In both cases, the actual drop in growth rates in the 1980s and 1990s with respect to the 1970s was larger than what the model predicted. This is particularly the case for the comparisons related to the 1990s --the growth residuals are found in the 10% tail of the distribution.

2.34 In Brazil, the drop in the growth rate from the 1970s to, respectively, the 1980s and 1990s was 5.55 and 5.68 (there is little growth difference between the latter two decades). We can explain 70% and 35% of these amounts, respectively. In table 6, we assess the contribution of each explanatory variable to the projected difference in the growth rate. Regarding the growth deceleration from the 1970s to the 80s, less favorable international conditions and the rise in inflation and price distortions played the biggest role. Decreasing returns and the forces behind conditional convergence also contributed to the growth slowdown. As mentioned before, explaining the poor growth performance of the 1990s vis-à-vis the 1970s is more difficult. Conditional convergence, a reduction of world growth, and the presence of inflation (at the beginning of the decade) contributed to the fall in Brazilian growth rates. However, the reduction of price distortions, favorable terms of trade, a better-educated labor force, and a higher trade orientation toward manufactured products predicted an increase in the growth rate of the 1990s with respect to the 70s.

2.35 Explaining why the growth rate in the 1970s and even 1960s was so significantly larger than in more recent decades remains an area for future research. In this investigation, it will be important to assess the extent to which the growth rate in the 1960s and 1970s was due to temporary factors. Looking to replicate the policies of those years may be a mistake if the growth experienced then was exceptional or maybe even the source for the ensuing slowdown.

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[25] For the same reason, cross-country level comparisons are not feasible with our model.

Table 2.5: Comparison of Actual and Projected Growth Changes for Selected Latin American Countries

		Actual	Projected	Residual
Argentina	80s vs. 70s	-3.8761	-2.3769	-1.4992
	90s vs. 70s	1.4214	1.6462	-0.2247
Brazil	**80s vs. 70s**	**-5.55**	**-3.86**	**-1.68**
	90s vs. 70s	**-5.68**	**-2.08**	**-3.60***
Chile	80s vs. 70s	1.27	1.37	-0.10
	90s vs. 70s	3.82	2.68	1.14
Colombia	80s vs. 70s	-2.10	-2.17	0.07
	90s vs. 70s	-2.33	-2.26	-0.08
Ecuador	80s vs. 70s	-6.04	-3.23	-2.82
	90s vs. 70s	-5.28	-1.21	-4.07**
Mexico	80s vs. 70s	-3.89	-4.03	0.14
	90s vs. 70s	-1.73	-1.28	-0.45
Peru	80s vs. 70s	-2.91	-2.95	0.04
	90s vs. 70s	1.43	0.02	1.41
Venezuela	80s vs. 70s	-3.77	-2.96	-0.81
	90s vs. 70s	-0.18	-3.08	2.90

Notes: The standard deviation for the residuals are 1.9221 for the 80/70 period and 1.919 for the 90/70 period.
** (**) indicates that the residual is different from zero at the 10 (5) percent significance level.*

Table 2.6: Sources of Growth

Sources	80s / 70s	90s / 70s
Actual Growth	**-5.55**	**-5.68**
Projected Growth	**-3.86**	**-2.08**
Initial Income per capita	-0.82	-0.73
Avg. Years Schooling	0.05	0.20
Terms of Trade Shocks	-0.04	0.27
Domestic Credit to Private Sector	-0.10	0.00
Government Size	-0.10	-0.07
Inflation Rate	-1.24	-1.15
Black Market Premium	-0.75	0.31
Primary Exports	0.35	0.58
Time Dummies	-1.23	-1.50

IV. AREAS FOR IMPROVEMENT

Brazil Compared to Latin America, East Asia, and the OECD

2.36 The empirical exercise presented in the previous section can help explain the growth performance in Brazil by drawing from the cross-country evidence. This approach requires long series of data for a large sample of countries. Thus, data availability constrains the quantity and type of variables that can be used as growth determinants in econometric exercises. In this section, we consider a wider variety of economic and social indicators given that our interest is not to conduct econometric estimation but to evaluate qualitatively the economic and social areas where Brazil needs most improvement. In the selection of these economic and social indicators, we are implicitly assuming that they contribute to economic growth. For each indicator we compare Brazil with the typical country in Latin America and the Caribbean (LAC), the seven rapidly growing East Asian countries (EAP7), and the industrialized countries (OECD).

2.37 We have selected indicators in the following areas: human capital, government-induced distortions, financial development, governance, and public infrastructure. Table 7 presents the indicators and their respective values for Brazil, LAC, EAP7, and the OECD, corresponding to the last years of the 1990s. Figures 6-10 present these values graphically and, in addition, show the evolution of the corresponding gaps between Brazil and the three regions in the 1990s. Examining the evolution of these gaps will help assess whether Brazil is making progress in the factors that drive economic growth. The main results are presented in the following paragraphs.

2.38 *Human capital.* Brazil lags behind LAC, the EAP7, and the OECD in both years of schooling and life expectancy. The gaps with respect to LAC and OECD are not closing, and the gap with respect to the EAP7 has actually expanded in the 1990s (see Figure 6).

2.39 *Government-induced distortions.* By 1998, Brazil already had made much progress in controlling inflation and reducing the black market premium (see Figure 7). In fact, following the trend in Latin America, inflation was sharply reduced and the price distortions on foreign exchange were cut down considerably. Thus, the gaps with respect to the EAP7 and OECD basically disappeared by the end of the 1990s. These improvements in monetary management have been strengthened by the implementation of inflation targeting and flexible exchange rates in 1999.

2.40 *Financial Development.* Although Brazil is similar to the typical LAC country regarding the depth and private-sector orientation of the financial system, it lags considerably behind the EAP7 and OECD. Although the gap with respect to the OECD closed somewhat, the difference with the EAP7 rose notably (see Figure 8).

2.41 *Governance.* As with financial development, Brazil's quality of governance appears to be close to the typical LAC country but still far from the EAP7 and OECD. It is particularly worrisome that the Brazilian gap with respect to these regions has increased in the 1990s (see Figure 9). In the areas of government corruption and law and order, the gap expansion has been due to the deterioration of these indicators in Brazil.

Table 2.7: Challenges for Growth

	Brazil	LAC	OECD	EAP7
I. Human Capital				
Average Years of Schooling, 1999				
- Primary	3.36	3.97	5.50	4.90
- Secondary	0.92	1.49	3.29	2.86
- Tertiary	0.28	0.36	0.64	0.45
- Total	4.56	5.74	9.54	8.12
Life Expectancy	67.0	70.7	77.5	72.3
II. Government-Induced Distortions				
Black Market Premium	0.0114	0.0184	0.0000	0.0095
Inflation	0.0769	0.0721	0.0148	0.0354
III. Finance				
Liquid Liabilities	0.2864	0.3337	0.7238	0.8958
Private Sector Credit	0.3102	0.2777	0.8107	1.3577
IV. Governance [0-1]				
Corruption	0.5000	0.5000	0.8333	0.6667
Bureaucratic Quality	0.6667	0.5000	1.0000	0.8333
Law and Order	0.5000	0.5000	1.0000	0.8333
V. Infrastructure				
Main Telephone Lines (thousands)	17445	559	5721	4863
(lines per 100 workers)	23	23	110	49
Energy (in MW)	62972	1490	23347	19723
(in MW per 100 people)	0.08	0.08	0.39	0.14
Paved Roads (in km.)	173166	6385	135531	52405
(in km. per 100 people)	0.23	0.18	2.28	0.19
VI. Capital Stock per worker				
(in 1990 PPP US$ thousands)	32.4	20.2	101.4	53.2

Note: We present the median for all the variables

2.42 *Infrastructure.* In the areas of telecommunications, energy generating capacity, and transportation, the difference between Brazil and the EAP7 and, particularly, the OECD are quite large. The gap with respect to the industrialized countries has not closed in the 1990s, and that with respect to the EAP7 has actually expanded (see Figure 10). Brazil's progress in these areas has been just as slow as in the typical Latin American country.

V. Summary of Conclusions

2.43 Capital accumulation has not been the main driving force for growth in Brazil. The large growth differences between the 1970s and the following decades have not been matched by comparable changes in capital accumulation. Furthermore, we present evidence that investment follows rather than precedes output growth.

2.44 Less favorable international conditions, domestic macroeconomic instability—mostly brought about by inflation and price distortions—and diminishing returns explain about half of the growth deceleration in Brazil between the last two decades and the 1970s.

2.45 The reasons behind the extraordinary growth performance in Brazil in the 1970s are not fully understood in this study and merit further research.

2.46 Regarding the progress Brazil made in the 1990s on the factors that drive growth, the most important one was in the area of macroeconomic stability. The sharp reduction of inflation and the elimination of price distortions, particularly in external markets, have set the ground for future growth. The implementation of a monetary regime based on inflation targeting and flexible exchange rates in Brazil is the keystone for macroeconomic stability.

2.47 Regarding other areas of structural reform, Brazil's is still largely underdeveloped. In the areas of human capital, financial depth, governance, and public infrastructure, Brazil not only lags behind the OECD and East Asian countries, but its gap with respect to them has mostly expanded in the 1990s.

Figure 2.6
Human Capital

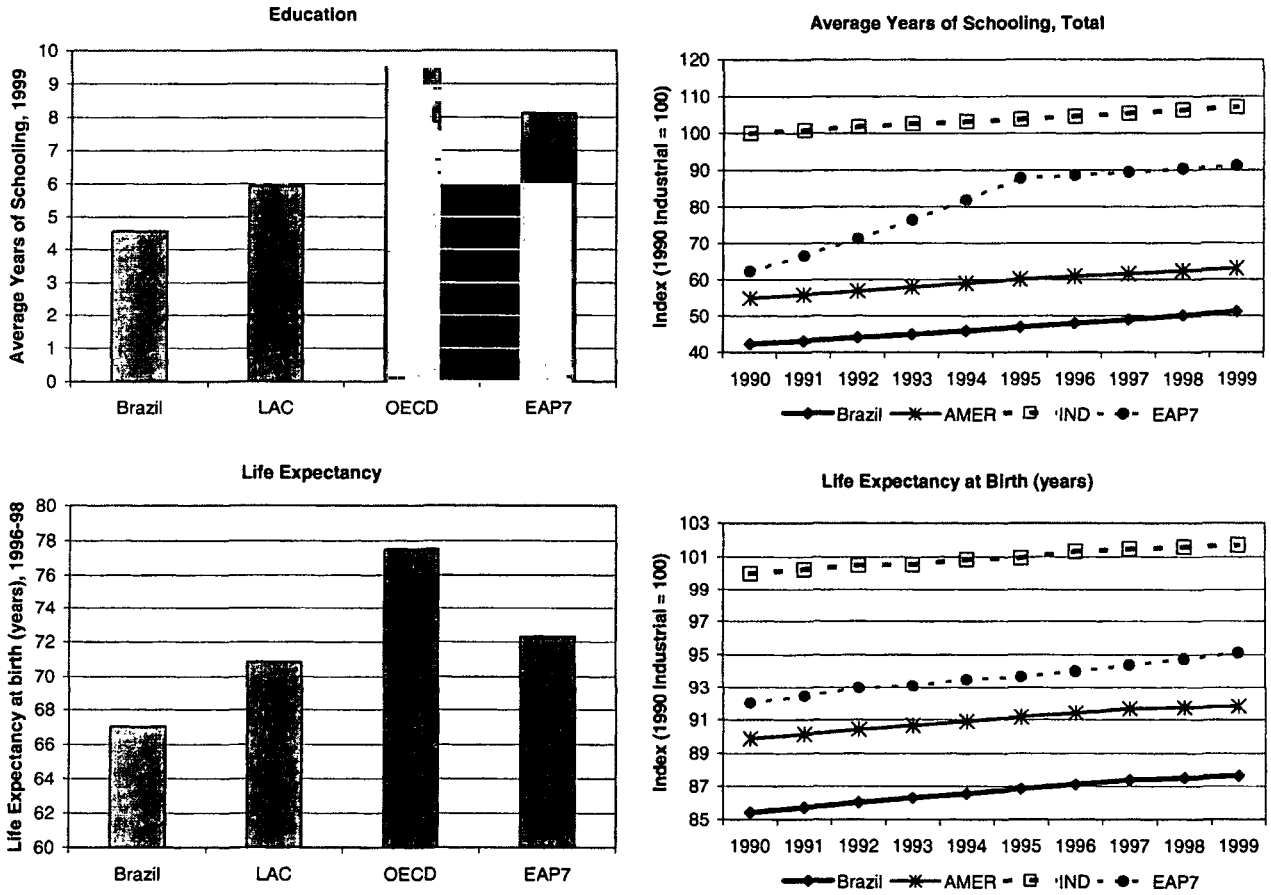


Figure 2.7
Government Induced Distortions

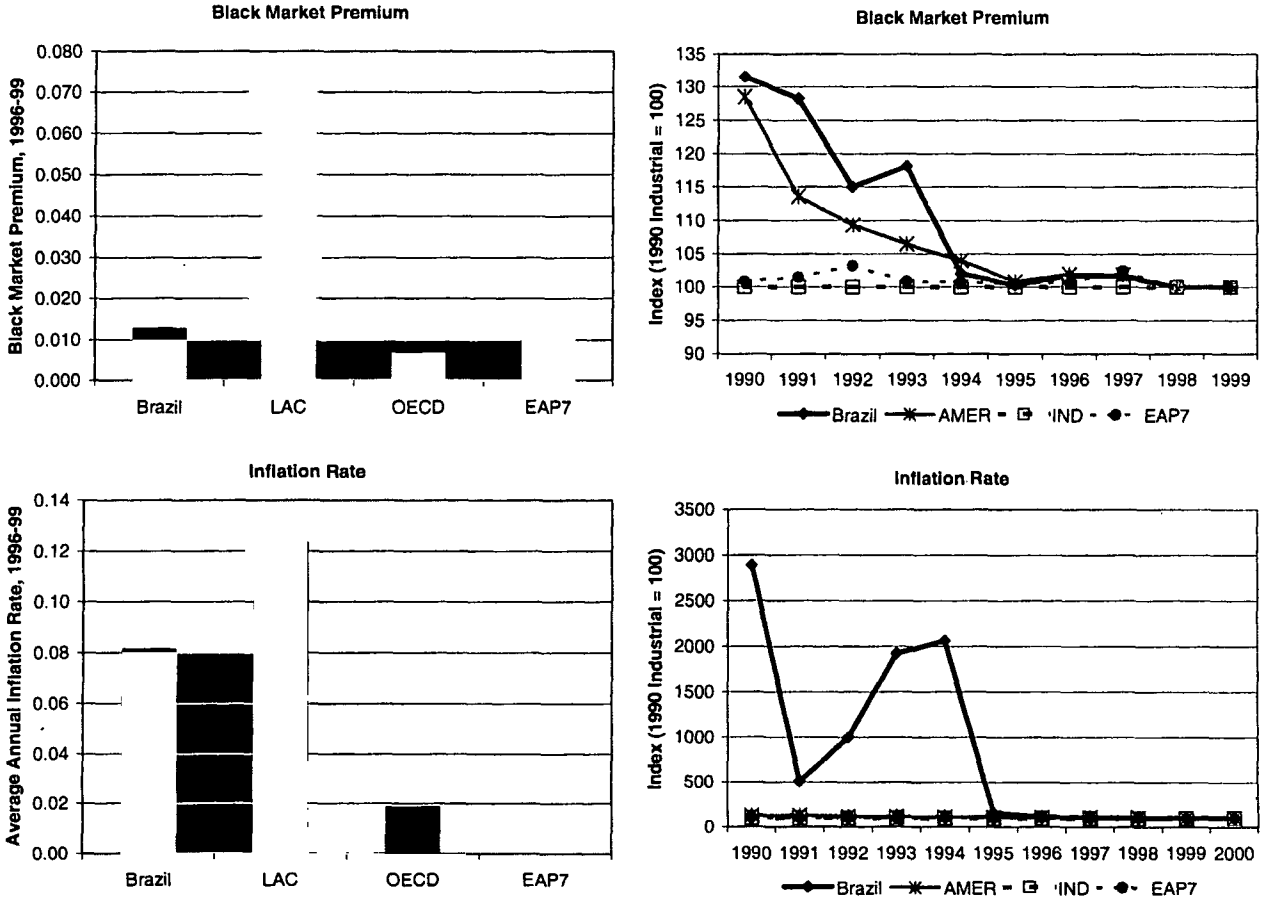


Figure 2.8
Financial Development

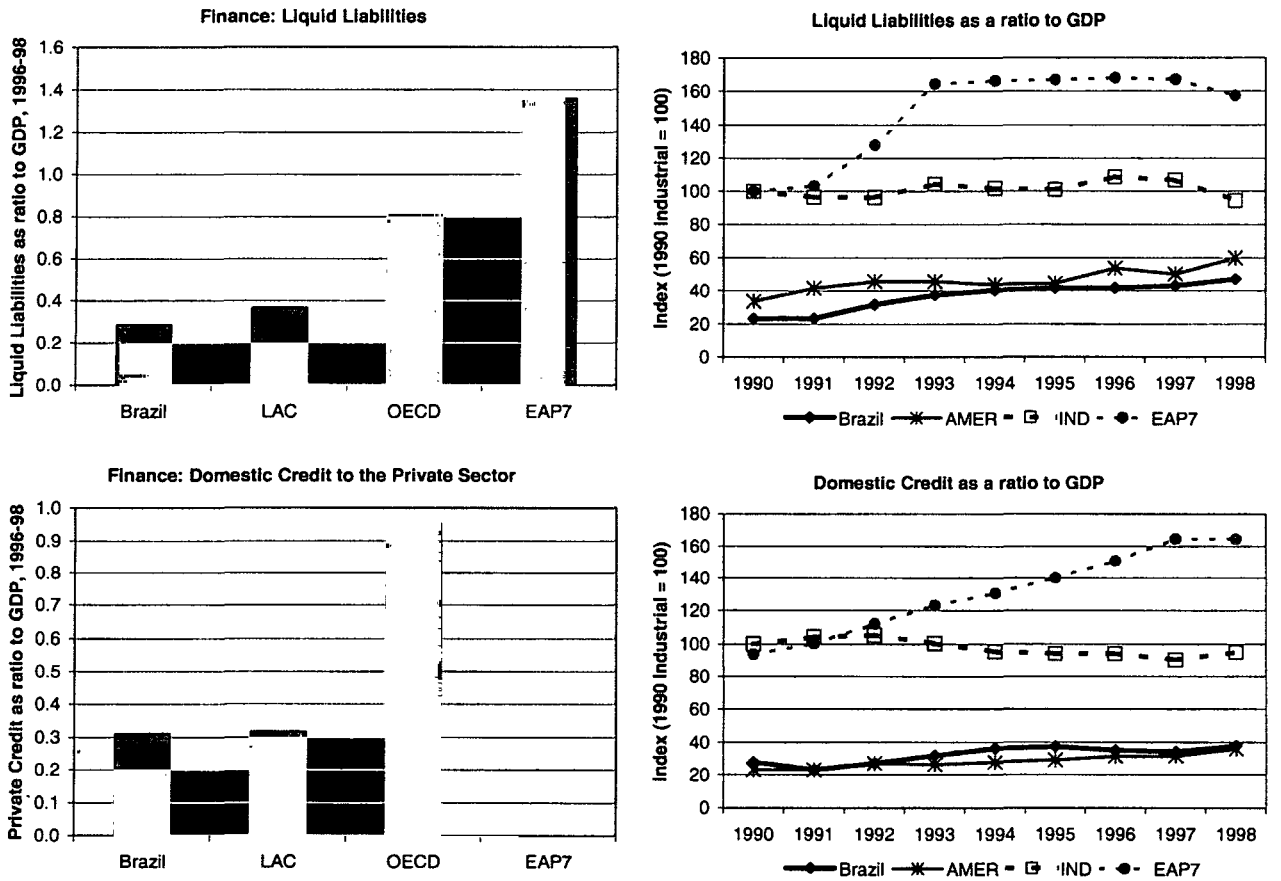


Figure 2.9
Governance Indicators
(high scores mean better performance)

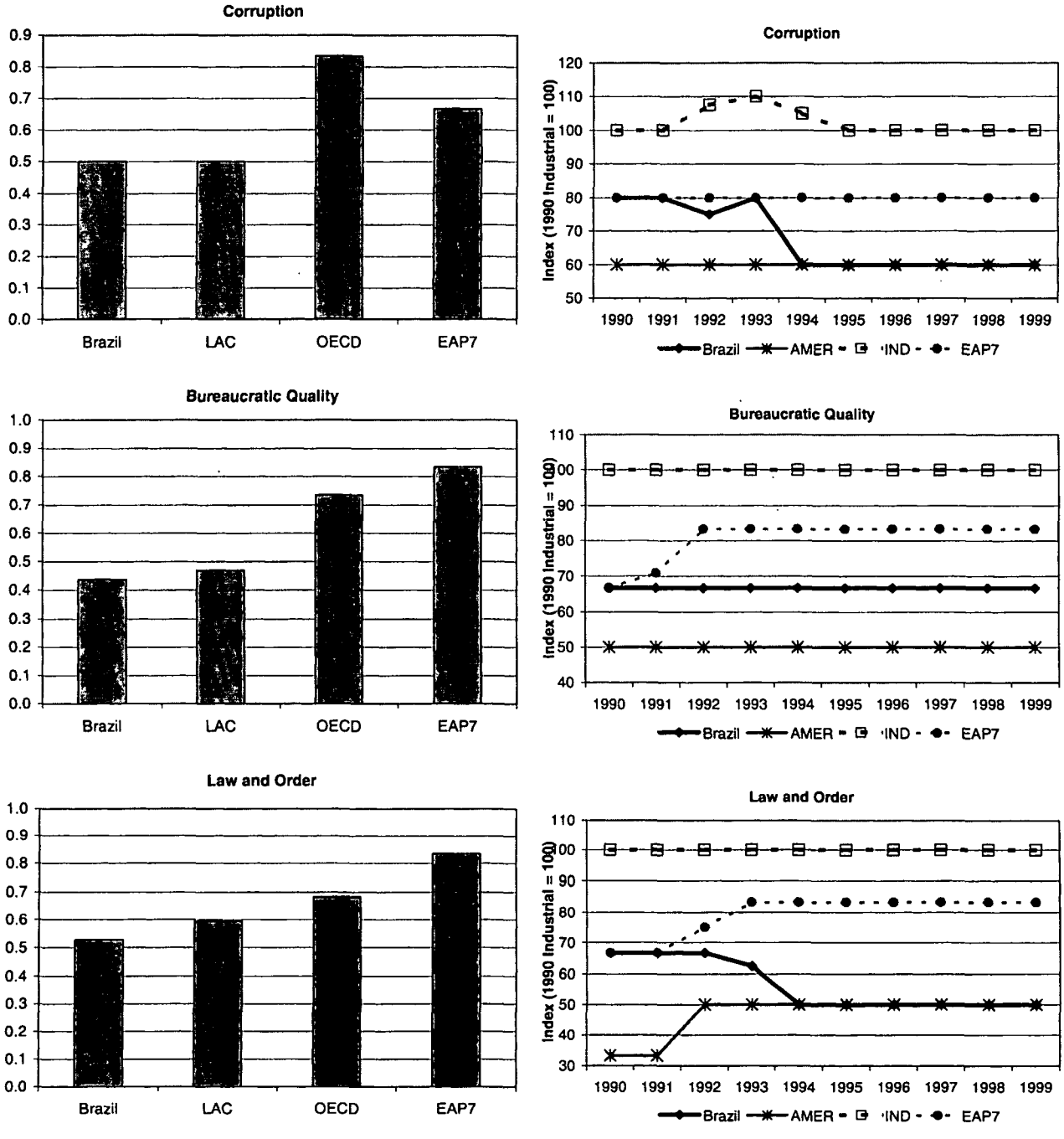
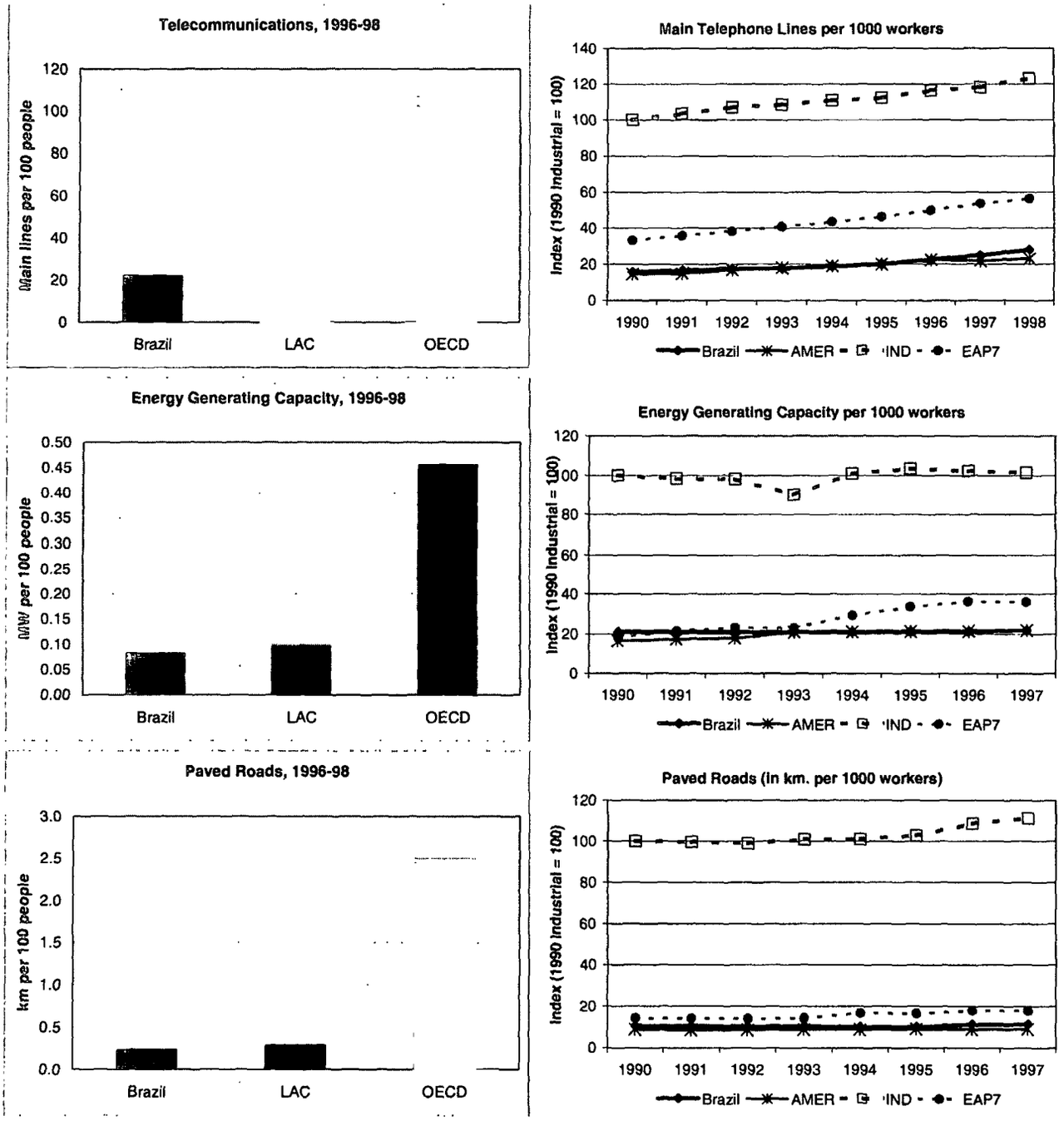


Figure 2.10
Infrastructure



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Appendix 2.1: Variables and Sources

Variable	Source
Output	
Real per capita GDP (in 1990 PPP US$)	Summers and Heston (1991), The World Bank (2000)
Share of Agriculture in Total Value Added (%)	The World Bank (2000) "World Development Indicators".
Share of Industry in Total Value Added (%)	The World Bank (2000) "World Development Indicators".
Share of Services in Total Value Added (%)	The World Bank (2000) "World Development Indicators".
Physical and Human Capital	
Domestic Capital Stock	Summers and Heston (1991), The World Bank (2000)
Investment as a ratio to GDP	The World Bank (2000) "World Development Indicators".
Labor Force, Total	The World Bank (2000) "World Development Indicators".
Average Years of Schooling	Barro and Lee (2000)
Life Expectancy at birth (years)	The World Bank (2000) "World Development Indicators".
External Sector	
Primary Exports (% Total Exports)	The World Bank (2000) "World Development Indicators".
Terms of Trade Shocks	The World Bank (2000) "World Development Indicators".
Finance	
Liquid Liabilities	Beck, Demirguc-Kunt and Levine (2000)
Domestic Credit to the Private Sector	Beck, Demirguc-Kunt and Levine (2000)
Government-Induced Distortions	
Inflation Rate	International Monetary Fund - International Financial Statistics
Black Market Premium (BMP)	Wood (1988), International Currency Analysis (various issues)
Democracy and Governance	
Corruption	International Country Risk Guide (ICRG)
Bureaucratic Quality	International Country Risk Guide (ICRG)
Law and Order	International Country Risk Guide (ICRG)
Infrastructure	
Main Telephone Lines	Canning (1998), International Telecommunications Union
Energy Generating Capacity (in MW)	Canning (1998), United Nations
Paved Roads (in km.)	Canning (1998), International Road Federation
Government	
Government Consumption (% GDP)	
Fixed Factors	
Dummy for Landlocked Countries	Gallup and Sachs (1998)

3. PRODUCTIVITY GROWTH IN BRAZILIAN INDUSTRY

Prepared by Marc Muendler, Luis Servén, and Claudia Sepulveda

I. INTRODUCTION

3.1 Gains in total factor productivity – that is, the ability to produce more outputs from the same inputs – have long been recognized as a major driving force of improvements in income and welfare. Indeed, it has been argued that productivity growth is the main factor behind the observed differences in long-term per capita income growth across countries.[26]

3.2 In many developing countries the industrial sector has traditionally been protected from foreign competition and, as a result, has performed poorly in terms of productivity growth. Brazil has been no exception in this regard, and until the late 1980s its industrial sector was largely sheltered from foreign competition in a government-led import-substitution industrialization model. During the last decade, however, Brazil implemented a series of reforms aimed at enhancing the role of market forces and building an export-oriented economy. The reforms started in 1988 with trade liberalization, the Mercosur trade agreement in 1991, and the privatization program initiated in the early 1990s and accelerated in 1996. The drive towards reform, however, was hampered by persistent high inflation and macroeconomic instability during the late 1980s and much of the 1990s.

3.3 During this period, Brazil's industrial sector lost ground in terms of value added and employment relative to aggregate economic activity. Industrial GDP declined from 45 percent of total GDP in the early 1980s to 38 percent in 1990 and under 30 percent in 1999 (Figure 3.1). Similarly, industrial employment decreased by 26 percent in the period 1990-99 (Figure 3.2). Nevertheless, the economic reforms of the 1990s generated renewed interest in the evolution of productivity in industry, and existing studies tend to find a marked productivity improvement during the 1990s.[27]

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[26] See for example Klenow and Rodriguez-Clare (1997) and Easterly and Levine (2000).

[27] Recent studies focusing on the industrial sector include Hay (1997), Bonelli and Fonseca (1998), Rossi and Ferreira (1999) and Gomes (2001).

Figure 3.1
Composition of GDP, 1960-99

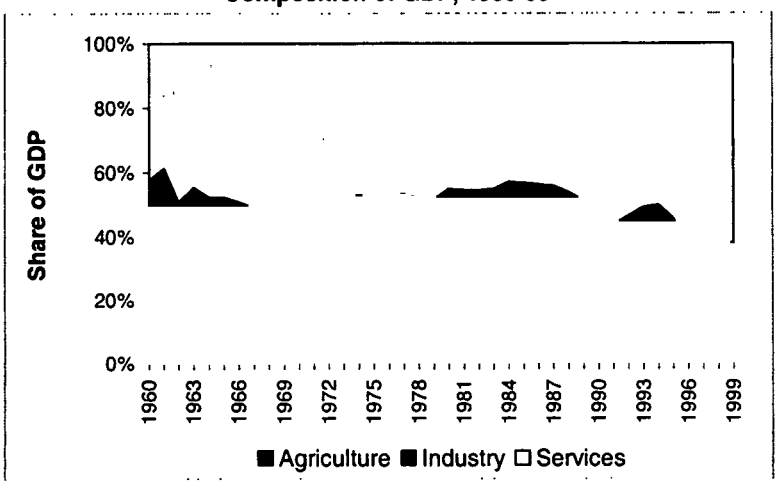
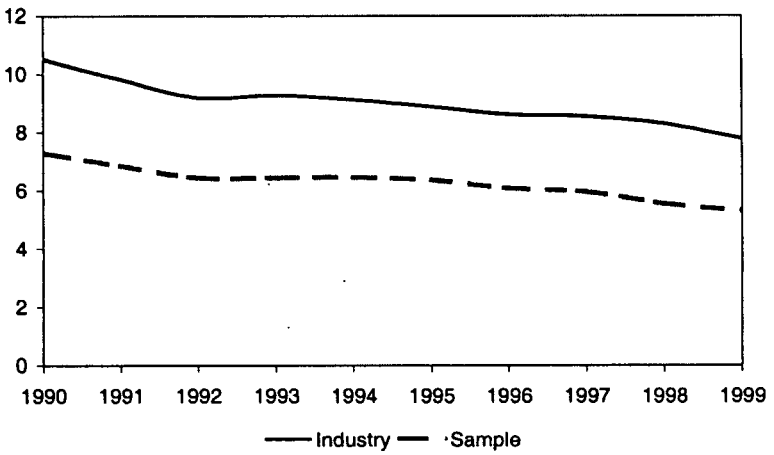


Figure 3.2
Employment in Industry (million)



3.4 This paper takes a fresh look at the evolution and determinants of total factor productivity (henceforth TFP) growth in Brazil's industrial sector during the 1980s and 1990s. The objective is to identify the factors that contributed to shape the observed TFP performance during that period. The analysis focuses on four main issues: the impact of trade liberalization, the contribution of knowledge embodied in input quality, the role of resource reallocation across firms and sectors, and the factors and constraints shaping firms' investment decisions.

3.5 Unlike most previous empirical studies of TFP in Brazil, which make use of economy- or industry-wide aggregates, this paper breaks new ground by performing the first systematic exploration of a large firm-level data set available in Brazil, the *Pesquisa Industrial Annual.* On *a priori* grounds, microeconomic data offer two important advantages over aggregate data from the perspective of studying TFP. First, aggregate TFP patterns may conceal widely diverging trends among different subsectors and/or types of firms. For example, TFP performance may vary systematically with firm-specific characteristics (e.g., size, composition of input mix etc), and these

relations would be masked in aggregate data. Second, measures of TFP growth based on aggregate data mix together firm-level TFP growth with the effects on TFP of reallocation of inputs and outputs across microeconomic units with different productivity levels (through channels such as changing market shares of incumbent firms or entry and exit of firms).[28] With disaggregated data it is possible to disentangle the contribution to overall TFP performance of these two conceptually distinct forces.

3.6 In the case of Brazil, however, the microeconomic data also pose major challenges concerning the coverage, consistency and reliability of the information. PIA presents methodological breaks that hamper comparability of the data across different time periods, lacks information on the utilization of productive inputs -- even on capital stocks after 1995 -- and much of its time coverage corresponds to years of extreme inflation, which complicates considerably the construction of key variables for the analysis. While we have made a major effort to correct some of these shortcomings, and we believe that we have been largely successful in limiting the extent of measurement error embedded in our TFP estimates, the empirical results reported below should be taken with a considerable dose of caution.

3.7 The paper draws extensively from Muendler (2001a, b). It is organized as follows. In Section 2 we provide an overview of a selected group of earlier studies of productivity growth in Brazil. Section 3 lays out the methodological approach to the estimation of total factor productivity with firm-level data, and summarizes the main features, as well as problems, of our data set. Section 4 describes the patterns of the resulting TFP estimates over time, across industrial sectors and geographical regions. Section 5 examines the factors behind the observed TFP performance to shed light on the issues under investigation.. Section 6 presents some concluding remarks.

[28] This reallocation effect may be particularly important for the evolution of aggregate TFP over short periods; see Jorgenson (1990).

Table 3.1
Some Recent Studies of TFP Growth in Brazil

Authors	Aggregation Level	Period	Total Factor Productivity Growth (annual)	Labor Productivity Growth (annual)
Bacha and Bonelli (2001)	GDP	1940-00	0.32	
		1970-80	0.09	
		1980-91	-2.28	
		1991-00	1.73	
	Industry (excluding construction)	1950-99		3.38
		1980-91		0.47
		1991-99		4.80
Bonelli and Fonseca (1998)	GDP	1980-89	0.10	
		1990-97	0.20	
	Transformation Industries	1989-89	-0.73	
		1990-97	3.38	
	General Industry	1992-97		9.59
	Textiles			6.20
	Non-metallic mineral products			11.46
De Gregorio and Lee (1999)	GDP	1960-90	0.80	
		1980-89	-1.40	
Elías (1990)	GDP	1940-90	0.80	
Gomes (2001)	GDP	1975-98		0.21-0.3
		1975-89	0.56	0.14-0.12
	Industry	1990-98	3.2-4.07	0.39-0.46
Hofman (2000)	GDP	1950-89	2.60	3.90
		1990-98	0.10	0.40
		1992-98	0.70	1.00
	Industry	1976-89	0.37	
		1986-98	0.78-1.37	
		1976-98		3.76
		1986-98		3.5-4.7

II. Overview of Earlier Studies

3.8 The evolution of productivity in Brazil has been the focus of a number of empirical studies. Some are concerned with productivity at the aggregate (GDP) level, while others focus on the industrial sector as a whole, or on specific subsectors. Among the former group, several studies offer cross-country results and therefore allow a comparative perspective on Brazil's productivity performance.

3.9 Table 3.1 summarizes the results of some recent empirical analyses. Among aggregate-level studies, De Gregorio and Lee (1999) estimated a TFP growth rate for the period 1960-90 of 0.80 percent (below the average in Latin America). When they considered the decade of the 1980s only, however, they found that the Brazilian economy experienced a negative TFP growth of -1.40 percent. In turn, Bonelli and Fonseca (1998) found average TFP growth of 0.1 percent in the period 1980-89, and 0.2 percent over 1990-97. Using data for a much longer period, Hofman (2000) estimates a TFP growth rate of 2.60 percent for Brazil in 1950-89. This contrasts with the earlier results in Elías (1990), who finds a much lower TFP growth rate (0.8) over a similarly long period, 1940-90. Over the 1990s, however, Hofman finds that TFP growth slowed down to 0.10 percent (similar to the results of Bonelli and Fonseca), although with a considerable acceleration (to 0.70 percent) after 1992.

3.10 Finally, two of the most recent studies of aggregate TFP, by Teixeira da Silva (2001) and Gomes (2001), find a similar pattern of fall and recovery in spite of using different methodologies and data. According to the results of Teixeira da Silva, TFP fell at an annual rate of –0.70 percent over 1980-92, and then rose at an average rate of 0.9 percent over 1993-2000. Moreover, aggregate labor productivity is found to display a very similar pattern. In turn, Gomes finds a similar turnaround in TFP growth, from 0.6-0.7 percent in 1985-89 to 4.7-5.7 percent in 1991-98, with the exact figure depending on the specific method used.

3.11 In turn, studies of TFP in Brazil's industry vary considerably in terms of coverage. Among the earliest studies, Braga and Rossi (1988) analyzed factor productivity for 21 sectors in industry for the period 1970-83 using a translog production function. They found that 10 of the 21 sectors had experienced negative TFP growth rate in this period.[29] Bonelli (1992) used a growth accounting method to estimate TFP growth in manufacturing between 1975-85 using data from the industrial census of 1970, 1975 and 1980. He found average TFP growth in manufacturing of 0.80 percent yearly. In his study, only leather, pharmaceuticals and furniture presented negative TFP growth rates.

3.12 The economic reforms of the 1990s renewed interest in estimates of TFP in manufacturing. Bonelli and Fonseca (1998) estimate TFP growth for overall manufacturing and for 21 individual sectors. At the aggregate manufacturing level, they calculate a negative TFP growth rate of -0.73 percent in the 1980s. For the 1990s, in contrast, they find positive TFP growth of 3.4 percent per annum. Likewise, Rossi and Ferreira (1999) calculate TFP and labor productivity for 16 industrial sectors in the period 1985-97. They find that TFP and labor productivity growth accelerated for

[29] Another early study is that of Pinheiro (1989), which is based on firm-level data from the 1970 and 1980 census.

virtually all sectors after 1991. On average, TFP grew at 2.2 percent in 1991-97, while in 1985-90 it had declined at an annual rate of –2.5. Finally, the already-cited study by Gomes (2001) also reports estimates of aggregate industrial TFP that display a similar acceleration in the recent period: according to this study, annual TFP growth rose from 0.4 percent in 1976-89 to 3.4-4.4 percent in 1991-98.

3.13 How does this performance compare with that of other countries? The development in recent years of several large international data sets has made it possible to compare the growth experience of a substantial number of countries by employing a transparent methodology. A review of these studies is presented in Table 3.2.

3.14 Elías (1990) presents TFP growth for a group of seven Latin American countries for the period 1940-90. Among them Brazil shows TFP growth below the Latin America average, and below Chile's and Mexico's TFP growth. De Gregorio and Lee (1999) examine TFP growth for a larger sample of Latin American countries (21) for the years 1960-90, a shorter time span than Elías (1990). They found for Brazil a TFP growth higher than the average TFP growth for Latin America.

3.15 Across the time dimension, Latin America TFP grew in the 1960s at 1.9 percent per annum, in the 1970s at 0.7 percent and in the 1980s at –2.0 percent per annum. On the other hand, Brazil's TFP growth in the 1960s, 1970s and 1980s was1.5 , 2.5 and –1.4 percent respectively. To sum up, Brazil's TFP growth (decline) was above (below) Latin America's TFP growth (decline) in the three decades covered by De Gregorio and Lee study, with the exception of the 1960-69 period. Indeed in the 1970s Brazil's TFP growth was almost three times the average of Latin America.

3.16 Collins and Bosworth (1996) present estimates of TFP growth for the East Asian countries between 1960-94. All East Asian countries, with the exception of the Philippines, experienced TFP growth above 1.0 percent per annum. In the same period TFP in the United States grew at 0.3 percent per year, and in the other industrialized countries at 1.1 percent per year. Moreover, TFP growth in the East Asian countries did not follow the pattern across time observed in Latin America. In all three decades from the 1960s to the 1990s, TFP growth is positive, with the exception of Philippines.

3.17 Nehru and Dhareshwar (1994), using a sample of 83 industrial and developing countries for the period 1960-87, obtain an average TFP growth for Brazil, Chile and Mexico of 1.39, 0.37 and 0.68 percent per annum respectively. These figures are higher than the ones observed in the studies of Elías (1990) and De Gregorio and Lee (1999) with a smaller sample of countries. Moreover, Brazil's TFP growth is higher than the average TFP growth for the OECD and Latin America countries in the same period.

3.18 It is interesting to compare the performance of industrial TFP in Brazil with other countries. Jorgensen and Stiroh (2000) report TFP growth for 37 industries in the United States using a growth accounting methodology for the period 1958-96. Industry-wide TFP grew 0.48 percent per year over this period. However, industry TFP growth ranged from 1.97 percent in Electronic and Electric Equipment to –0.44 percent in Printing and Publishing. Many industries (9) experienced negative productivity growth for a period of nearly 40 years.

3.19 Table 3.2
International Studies of TFP Growth

Authors	Aggregation Level	Period	Total Factor Productivity Growth (annual)
Collins and Bosworth (1996)	*GDP*		
	Latin America	1960-94	0.2
	East Asia		1.1
	Taiwan		2.0
	Korea		1.5
	United States		0.3
De Gregorio and Lee (1999)	*GDP*		
	Latin America	1960-90	0.1
	Argentina		-0.5
	Brazil		0.8
	Chile		0.9
	México		0.5
	Latin America	1960-69	1.9
	Argentina		0.7
	Brazil		1.5
	Chile		1.6
	México		2.3
	Latin America	1970-79	0.7
	Argentina		0.6
	Brazil		2..5
	Chile		0.5
	México		1.2
	Latin America	1980-89	-2.0
	Argentina		-2.6
	Brazil		-.1.4
	Chile		0.6
	México		-.1.8
Elías (1990)	*GDP*		
	Latin America	1940-900	1.2
	Argentina		0.5
	Chile		1.4
	Colombia		0.8
	Mexico		1.1
Nehru and Dhareshwar (1994)	*GDP*		
	Latin America	1960-87	0.13
	Brazil		1.39
	Chile		0.37
	Mexico		0.68
	OECD		0.76

3.20 Liang and Jorgenson (1999) present industry TFP growth for Taiwan, one of the Asian newly industrialized economies, in the period 1961-93. Liang and Jorgenson measure TFP growth using a translog production function. TFP growth rate of the manufacturing sector increased from 0.2 percent per annum during 1961-82 to 0.55 percent during 1982-93, and 0.32 percent for the whole period. In the period 1961-82, the highest TFP growth was in Electrical Machinery and Electronics with a 5.44 percent per annum followed by textiles and food. The laggards were wood and furniture products with -12.35 percent per annum and Paper and Printing with –8.66 percent.

3.21 In Latin America, the World Bank (1999) presents TFP growth for Manufacturing in Mexico during the period 1993-97. Between 1993 and 1995 TFP growth accelerated from 0.6 percent per annum to 13.8 percent. Subsequently TFP growth rates declined 1.3 percent in 1995-96 to –3.9 percent in 1996-97. TFP growth estimated at the two-digit industry show two groups. The first group - Food Textiles and Apparel, Wood Product and Furniture and Clay and Cement Products has lower TFP growth than the industry average. The second group, Paper and Printing, Chemicals, Metals, Machinery and Other Industries has higher rates of TFP growth.

3.22 On the whole, the international evidence suggests that (i) productivity growth in Brazil has lagged behind that of East Asian economies in recent decades, but was roughly on par with that in the rest of Latin America; (ii) Brazil, like other developing economies, experienced a TFP acceleration in the 1990s, after its disappointing performance during the 1980s; and (iii) industrial TFP growth in Brazil, as well as in other developed and developing countries, varies widely across sectors, and negative TFP growth rates at the sector level are often encountered in existing studies.

3.23 Several of the Brazil studies offer hypotheses – and a few studies actually test some of them -- regarding the reasons behind this time path of TFP. We should note that one likely reason behind the recovery of TFP in the 1990s in Brazil (as well as other Latin American economies) is the procyclicality of productivity estimates, that tend to follow the pattern of recession in the 1980s and recovery in the 1990s experienced by many economies in the region.

3.24 This is particularly clear from the annual TFP growth figures underlying the period-average TFP growth rates in Brazil to which we have referred so far. These figures display large swings from year to year, tracking closely the economy's annual growth performance. For example, most estimates show abrupt TFP declines in the severe recessions of 1983 and, especially, 1990 (Teixeira da Silva 2001, Gomes 2001, Bonelli and Fonseca 1998).[30] Indeed, estimated TFP growth is strongly correlated with the growth rate of the corresponding value added aggregate, whether at the economy-wide level (GDP) or the industrial level (industrial GDP). For example, Gomes (2001) reports that the correlation between his estimates of aggregate TFP growth and observed GDP growth is in the range .72-.76, while for industrial TFP the correlation is even higher, .86-.88. This procyclicality reflects in part measurement error regarding the utilization of labor and capital, for which no good proxies exist in the Brazilian case, as well as the possible action of economies of scale unaccounted for in the methodologies underlying the TFP estimates in the available studies.

3.25 But there are also other factors at play behind this dynamic pattern. First, the decline in macroeconomic instability in the 1990s relative to the preceding decade, particularly reflected in

[30] For this reason, Gomes (2001) excludes the year 1990 when computing period averages of TFP growth.

the containment of inflation after 1994, likely played an important role in the recovery of TFP, by facilitating investment decisions and restoring the informational value of relative prices to guide resource allocation, as argued by Teixeira da Silva (2001) and McKinsey (1998).

3.26 Secondly, the structural reforms of the 1990s, that strengthened the role of domestic and foreign competition, have also been underscored by several studies, which have particularly emphasized the impact on TFP of the lowering of foreign trade barriers that took place over the last decade (Hay 1997, McKinsey 1998, Rossi and Ferreira 1999, Gomes 2001).

3.27 The decline in public infrastructure investment as part of the fiscal crunch of the 1980s, and the action of labor regulations constraining firms' ability to shed labor (and hence their willingness to employ it) are also among the reasons that have been offered to explain the productivity slowdown of the 1980s. These are explored in some detail in McKinsey (1988), which concludes that they did not play a major role in the observed time path of TFP in Brazil. We shall revisit these issues in section 5 below.

III. Framework and Data

3.28 Against the background provided by these earlier studies, this paper brings original evidence on the evolution of TFP in Brazil's industrial sector, based on the a large firm-level data set that has remained virtually unexplored so far. This section outlines the analytical framework employed to construct these new TFP estimates and summarizes the main features of our data, as well their potential shortcomings.

Estimating TFP

3.29 The analytical approach underlying our estimations of TFP is described in detail in Muendler (2001a); here we just summarize the main features. The approach is based on the estimation of sector-specific Cobb-Douglas production functions relating output to capital, intermediate materials and skilled and unskilled labor:

$$y_{it} = \beta_k k_{it} + \beta_{bl} l_{it}^{bl} + \beta_{wh} l_{it}^{wh} + \beta_m m_{it} + \omega_{it} + \varepsilon_{it} \qquad (1)$$

3.30 Here y denotes real output, k is capital, m are materials and l is labor input, with the superindices bl and wh respectively denoting the unskilled and skilled categories (more precisely, blue and white-collar in our case). All variables are expressed in logs, and the subscripts i and t refer to the firm and period, respectively. (Log) TFP is measured by the composite error term, which consists of a serially corelated productivity index ω observed by the firm, and an unobservable random technology shock ε.

3.31 Estimation of (1) using firm-level data poses two well-known problems. The first one is that firms can choose their inputs on the basis of the observed productivity index ω, which renders the right-hand side variables endogenous and requires an instrumental variable procedure for consistent estimation of the βs. The second, related problem is that firms' entry and exit decision will likewise depend on their level of productivity; this means that at any given time the available sample of firms suffers from selection bias – due to the exit of the least productive firms and the

entry / survival of the most productive ones. The estimation procedure adopted here follows that of Olley and Pakes (1996) and is designed to overcome the simultaneity and selection problems when estimating production functions.

3.32 In this manner, we can recover from estimation of (1) firm-level values of TFP and hence its growth rate. To arrive at sector- or industry-wide TFP growth estimates, which often are of direct interest, it is important to note that aggregate TFP change between two periods can be decomposed into four ingredients:[31] (i) the TFP growth of incumbent firms, given their size (i.e., given their respective shares in total output); (ii) the change in size of incumbent firms, given their respective TFP levels; (iii) the TFP level of new entrants; (iv) the TFP level of exiting firms. We shall return to this decomposition below.

3.33 To assess empirically the factors behind observed TFP performance, we rely mainly on a regression framework relating TFP, as estimated from (1) above, to a set of explanatory variables that summarize firm and sector characteristics. The basic specification is of the form

$$\omega_{it} = \mathbf{x}_{it}\delta + \alpha_i + u_{it} \qquad (2)$$

where **x** is a vector of explanatory variables, δ are the parameters to be estimated, α is a firm-specific time-invariant effect and u is a random disturbance. In the experiments reported below, parameter estimates for equation (2) were obtained using fixed-effects regressions, since Hausman tests unambiguously rejected the random effects specification.

3.34 In addition to (2), we also estimated specifications with the dependent variable in first differences, to assess the effects of different factors on TFP growth. In these equations the explanatory variables were lagged one period, since the objective is to examine the role of firm and sector features on subsequent TFP growth performance. For both the level and difference regressions we checked for residual autocorrelation using the technique developed by Baltagi and Wu (1999), devised to control for time gaps in the sample (i.e., the unavailability of PIA in 1991) in unbalanced panels. In general we found no evidence of serial correlation.

Data

3.35 Our source of firm-level data is the ***Pesquisa Industrial Anual*** (henceforth PIA), an annual survey of manufacturing firms[32] administered by the Brazilian census bureau since 1986, and available until 1998 (with the exception of 1991, in which no survey was conducted). The survey is biased towards medium and large firms, and thus cannot be viewed as representative of the manufacturing sector as a whole, which includes a very large number of small firms. The features of PIA are described in detail elsewhere (Muendler 2001b), so that here we will limit the discussion to a few key issues.

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[31] The decomposition we use follows along the lines of Baily, Hulten and Campbell (1992).

[32] PIA contains also plant-level data, although much less comprehensive than the firm-level data used here.

3.36 ***Sample:*** The sampling method, and thus the representativity of the sample vis-à-vis the universe of larger industrial firms, has changed over time. When the survey was first launched, it included all of the largest manufacturing firms, plus a random sample of medium-sized ones, and a non-random selection of (large) new entrants. Over the years, all surviving originally-surveyed firms remained in the sample, while the inclusion of new entrants was discontinued in 1993. Exit of old firms and absence of new entrants must have surely reduced the representativity of this evolving sample. Further, in 1996, almost a third of the original sample was dropped from the PIA records due to a change in sampling method. As a result, the data before and after 1995 might not be strictly comparable.

3.37 ***Measurement issues:*** PIA contains income statement and balance sheet data, plus information on a few economic variables -- among them, number of workers and investment flows. From the perspective of TFP estimation along the lines described earlier, these data pose major measurement problems:

- Only the number of workers (divided into white and blue-collar) is available, not hours worked. No information is available either regarding utilization of the capital stock -- although this problem is often encountered in developing as well as developed-country firm-level data. As a result, standard estimation procedures such as ours will incorrectly identify as TFP changes any output fluctuations derived from varying utilization of labor (and capital) inputs. As hours worked are strongly procyclical, our TFP estimates will tend to behave procyclically as well – although as we shall see below this seems to be less of a problem with our data than in earlier studies.[33]

- Brazil's high inflation environment during most of the period of analysis (the inflation rate averaged 820% over 1986-94) introduces considerable difficulties for the calculation of real output and intermediate input series from the information in PIA. These series must be constructed from income statements, which are reported in nominal terms. Hence the task requires adequate price deflators for outputs and intermediate inputs; in the absence of firm-level price data, it is customary to use some kind of sector-level price indices. In our case, the measurement error generated by the use of these 'approximate' deflators is likely to be magnified by the high degree of relative price volatility that usually accompanies extreme inflation[34], as well as by the fluctuation in output sales, input purchases and inflation over the year. Considerable effort was devoted to the construction of adequate sector-specific price indices for input purchases, and a number of alternative deflators were considered for output.[35] But in spite of our efforts it is

[33] There are reasons other than measurement error why productivity should be procyclical; see Basu and Fernald (2000). However, in our data these are very likely of secondary importance relative to the measurement error mentioned in the text.

[34] For the Brazilian case, see Fava and Cyrillo (1999).

[35] The results reported in this draft make use of the sectoral WPI. See Muendler (2001b) for extensive details on the efforts made to construct appropriate deflators for output, intermediate inputs and capital.

nevertheless possible that the resulting measures of firm-level real output and inputs may still contain substantial measurement error.

- Construction of the capital stock poses similar difficulties. Up to 1994, our capital stock figures are mainly based on balance sheet data (which typically include an adjustment for inflation based on government-mandated price indices that tended to understate actual inflation). The situation is more complicated after 1995, because PIA ceases to include balance sheet data and capital stock figures for later years must be constructed on the basis of investment flows. As with value added, considerable efforts were made to arrive at suitable deflators for investment and the capital stock; yet measurement error is still likely to remain in the constructed capital stock series.

3.38 In summary, these measurement problems[36] imply that the TFP estimates reported below should be taken with considerable caution. But it is also worth noting that in the context of regressions such as (2) much of the measurement problem error is likely to wash out. As it is well-known, measurement error in the dependent variable should not affect the consistency of the parameter estimates provided the measurement error is uncorrelated with the right-hand side variables. If this latter condition is met, the inferences drawn from estimation of equations like (2) regarding the determinants of TFP should remain valid even if TFP itself is measured with error.

3.39 ***Sample selection and aggregation:*** Firms in the sample were grouped into sectors according to their 2-digit level industrial classification -- the so-called *Nível 50* classification -- which comprises a total of 27 industrial sectors accounting for roughly two-thirds of total industrial value added in the late 1990s.[37] For most of the empirical analysis, however, only thirteen sectors possessing the largest number of firm-year observations[38] were retained. In the late 1990s, these thirteen sectors accounted for about half of the value added by *Nível 50* industry, or about one-third of value added in overall industry (Figure 3.3). Equation (1) was separately estimated for each of these thirteen sectors. Appendix Table A1 presents the detailed list of industrial sectors in *Nível 50* as well as those retained for the analysis.

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[36] We should also note that, like many other firm-level studies, we also lack information on input quality -- other than the crude distinction between blue- and white-collar workers. One should keep in mind that changing input quality has been shown to be a major factor behind TFP growth; see Jorgenson (1990) and Gu and Ho (2000) for some illustrative figures for the US and Canada.

[37] *Nível 50* excludes 5 sectors included in overall industry: Minerals, Oil and gas, Other industries, Utilities and Construction. The latter is by far the largest, accounting for nearly 10 percent of GDP.

[38] 2,500 at a minimum.

Figure 3.3
Industrial Aggregates
(Percent of Total Industrial Value Added)

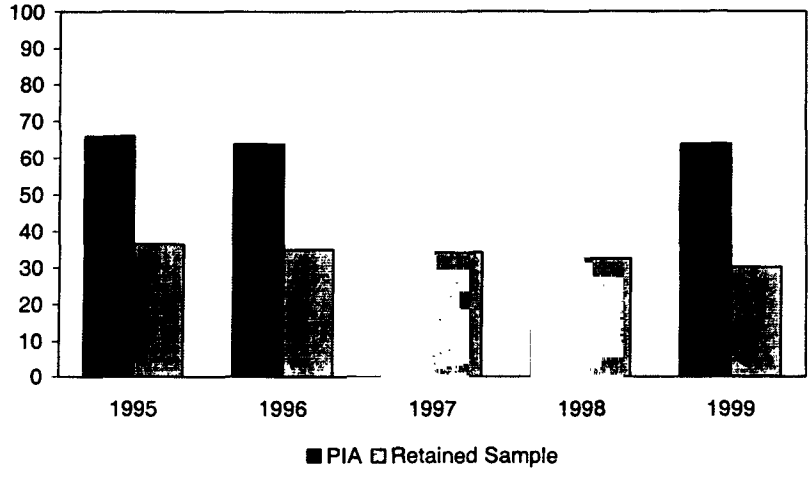
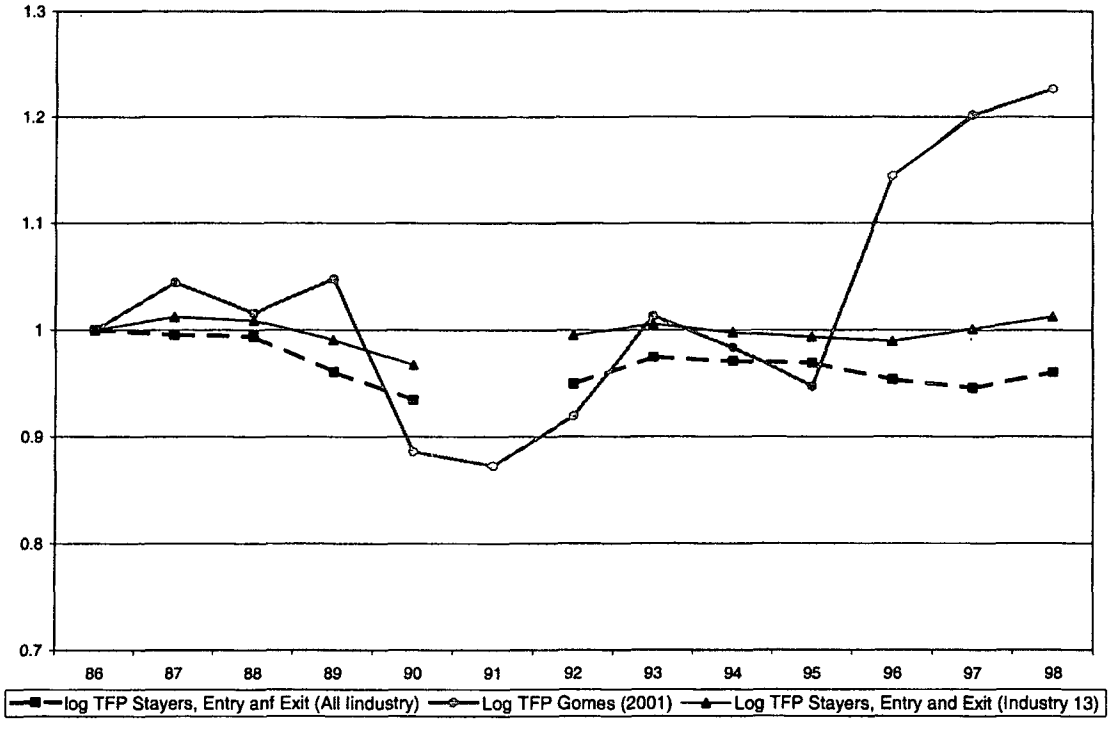


Figure 3.4
Industry-wide TFP, 1986-98



IV. PATTERNS OF TFP GROWTH IN BRAZILIAN INDUSTRY

Overview

3.40 We next review the TFP estimates obtained from PIA using the methodology described in the preceding section.[39] We first review the industry-wide results and then examine their sectoral and regional breakdown. Figure 3.4 plots the estimated (log) TFP series for all (*Nivel 50*) industry, as well as that corresponding to the 13 sectors under consideration. In addition, for the purpose of comparison the figure presents also the industry-wide log TFP series estimated by Gomes (2001) on the basis of data from PIM (*Pesquisa Industrial Mensal*[40]). For ease of comparability, all three series are rebased to equal 1 in 1986.

3.41 The time pattern of our firm-level data estimates of TFP is qualitatively similar to that found by most of the studies summarized in section 2 above: TFP experiences a declining trend in the late 1980s, and then recovers in the 1990s (note that the year 1991 is omitted because no PIA survey was conducted). However, the amplitude of this cycle is very small, and on the whole the figure suggests that Brazil's industry-wide TFP has shown little change over the period of analysis. This conclusion is further strengthened if we ignore the year 1990, in which the severe recession that accompanied the Collor plan results in a largely artificial collapse of measured TFP due to the sharp decline in labor and capital utilization.

3.42 As Figure 3.4 also shows, until 1995 the PIA-based TFP estimates display a time pattern roughly similar to that of Gomes' (2001) PIM-based estimates, but the volatility of the former is much smaller than that of the latter. This suggests that the PIA-based estimates may be less subject to measurement error, and hence display less procyclicality, than the estimates obtained by Gomes. After 1995, however, the two sources yield divergent TFP estimates, with those of Gomes showing a steep increase that is absent from the estimates obtained here.

3.43 As noted earlier, aggregate TFP growth reflects resource reallocation across firms in the form of exit by old firms, entry by new ones, and changes in the productivity of staying firms (with this latter component in turn including both productivity changes at the firm level and changes in the relative size of staying firms).[41] Using the PIA firm-level information we can separate the effects of entry and exit from the change in the TFP of the group of staying firms. The results of this decomposition are displayed in Figure 3.6 which compares the time path of aggregate TFP for the

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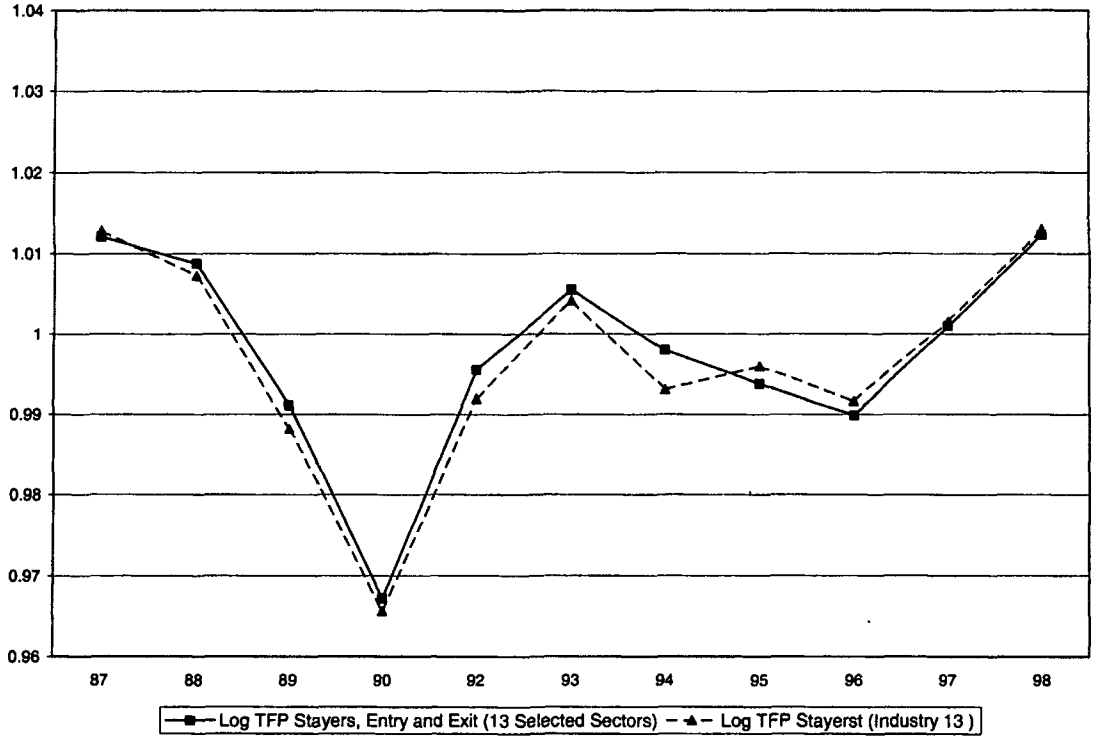
[39] Any TFP decomposition is influenced by the methodology used. Therefore one should view these results with cautious, since each one of these methodologies has strengths and weaknesses.

[40] Unlike PIA, whose unit of observation is the firm, PIM is based on production-line data (although the study by Gomes cited in the text is based on aggregated PIM information, rather than the raw data). While PIM's sample size is considerably more limited that that of PIA, PIM offers the advantage that it contains information on hours worked, so that utilization can be taken into consideration in the analysis. See Gomes (2001) for details.

[41] The importance of these reallocation effects for aggregate measures of TFP has been amply documented – e.g., by Jorgenson (1990) at the macroeconomic level and by Olley and Pakes (1996) at the firm level.

13 sectors of analysis (already shown in Figure 4) with the one that results from ignoring entrants and exiters. The two series move very closely together; the biggest gap between them arises in 1994, but its magnitude is virtually negligible. This is essentially a reflection of the limited role of entry in the PIA sample.

Figure 3.5
Brazil Industry-wide TFP
13 Sectors, All firms and Stayers, 1986-98

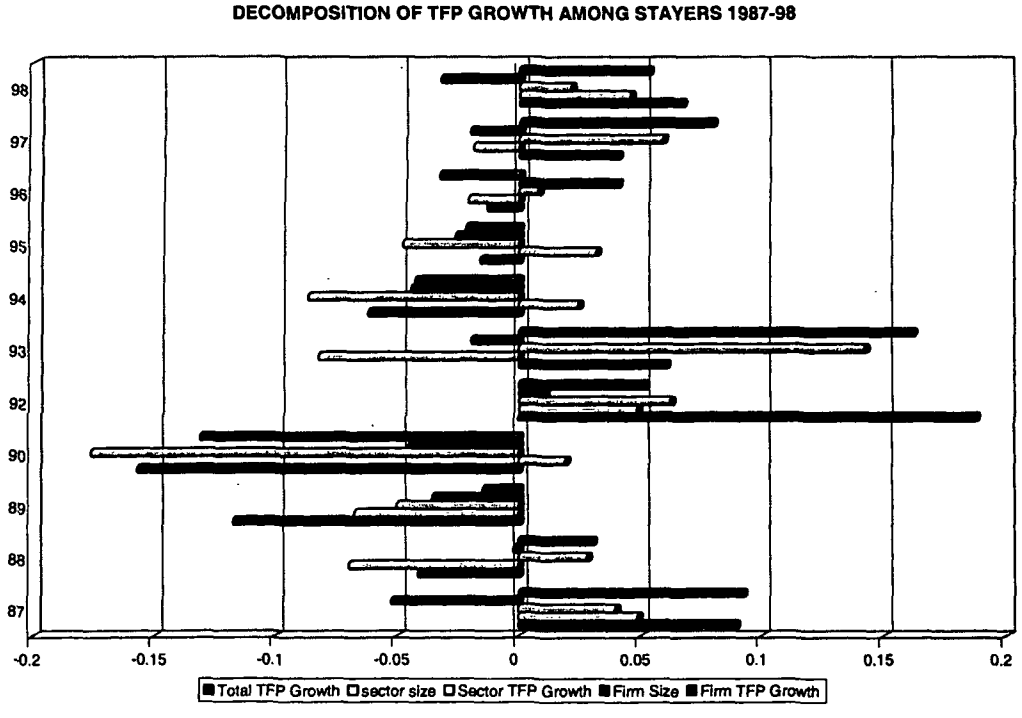


3.44 In sum, our estimates agree with previous results in that they show a recovery of TFP in the 1990s, but disagree in that they also show much less TFP variation over time than earlier estimates. Table 3.5 condenses the information in Figure 3.5 in terms of the average TFP growth rate over the 1980s and 1990s resulting from the PIA data; for comparison the figures from Gomes (2001) are also presented. In the 1980s TFP declined, at an annual rate of 0.8 percent (0.3 if 1990 is ignored) for the 13 sectors of analysis, and 1.6 percent for overall industry (1.3 without 1990). In the 1990s, however, TFP grew at positive (albeit modest) rates, of 0.3 percent per annum for the combined 13 industrial sectors on which we focus, and 0.2 percent for overall industry.

Table 3.5
Brazil Industry-wide annual TFP Growth, 1987-98

	13 Selected Sectors	All Industry (Nivel 50)	Gomes(2001)
1987-89	-0.29	-1.30	1.67
1987-90	-0.81	-1.62	-2.49
1991-98	0.29	0.19	5.99
1987-98	0.10	-0.33	2.12

Figure 3.6
Decomposition of TFP Growth among Stayers by Sector, 1987-98



3.45 As mentioned earlier, the evolution of aggregate productivity of staying firms reflects two forces: the time path of firm-level TFP, and the changes in firms' relative size. It is useful to examine the separate contributions of these two factors to the observed pattern of TFP over the sample period. The decomposition is provided by Figure 3.6, which for each year in the sample shows the contribution to TFP growth from firm-level TFP and changing firm- and sector size. It is apparent that firm size changes actually *detracted* from aggregate productivity in most years, with the only exceptions of 1992 and 1996, while sector size changes had a more mixed contribution to observed TFP growth. This seems to suggest that resource reallocation proceeded in a way harmful to aggregate productivity; we shall return to this issue later on.

Details by Sector

3.46 The sectoral patterns of TFP growth underlying these aggregate figures from PIA are summarized in Table 3.6. To save space, we only report average TFP growth rates over the same subperiods as in the preceding table; the figures include only the group of staying firms for the 13 sectors under consideration. The annual detail by sector can be found in Table A.2 in the Appendix. In general, it shows a fairly homogeneous time profile across sectors, with the majority of them experiencing a drop in TFP around 1989-90, a recovery in 1992-93 and a more diverse pattern thereafter.

3.47 According to the sector-specific TFP growth rates in Table 3.6, the period up to 1990 was characterized by a TFP slump in virtually all sectors under consideration, with the only exception of Other Metallic Products, which exhibited positive TFP growth during the late 1980s. In this period, the worst performance corresponded to Apparel and Wood and Furniture, for which the estimated TFP decline is particularly large. Again, exclusion of 1990 would considerably reduce the magnitude of some of these seeming TFP declines – but would not reverse them. In the 1990s, in contrast, 9 out of 13 sectors experienced positive TFP growth, at especially high rates in Electrical Equipment and Vehicles and Parts; these two sectors are also the ones that display fastest TFP growth over the entire period of analysis. Four sectors continued to experience a TFP slump in the 1990s: Food, Textiles, Leather and Non-Metallic Minerals.

3.48 This pattern is broadly similar to that reported by Rossi and Ferreira (1999) using aggregate PIA data (as opposed to the firm-level data used here). While their sector disaggregation differs somewhat from ours, for the sectoral aggregates common to both studies they also report a uniform TFP decline in 1985-90, followed (in their case) by a uniform increase in 1991-97. Further, in their results the Vehicles and Parts sector is also the performance leader in the most recent subperiod, with the Electrical Equipment sector among the top performers as well.[42] The rapid productivity gains achieved by the Vehicles and Parts sector in the 1990s are also documented in McKinsey (1998), which traces them to the developments in trade opening in the 1990s, to be reviewed below.

[42] They also find rapid TFP gains during 1991-97 in the Chemical sector, which is not included in our analysis. We should note, however, that our sectoral TFP performance rankings are fairly different from those reported by Gomes (2001), who uses using National Accounts data on industrial value added by sector. He reports negative TFP growth over 1990-98 in 8 out of our 13 sectors. This might reflect his inclusion of the year 1990 in the period of analysis. In that year, most sectors display a TFP decline, which basically reflects the deep recession that took place. Nevertheless, Gomes also finds that the Automobiles sector was the at the top in terms of TFP growth in the 1990s.

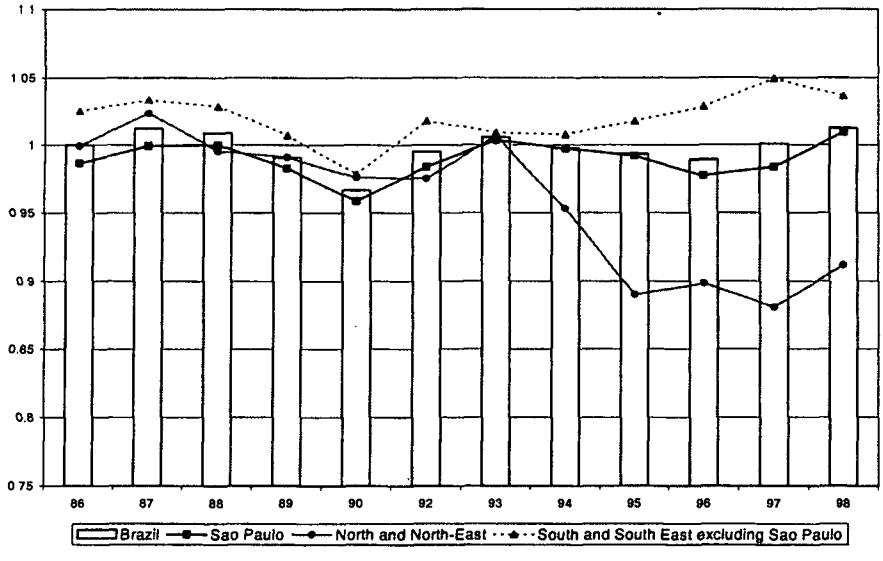
Table 3.6
TFP Growth by Sector

	1987-90	1991-98	1987-98
Non Metallic Mineral Products	-7.77	-1.16	-3.56
Other Metallic Products	1.17	1.15	1.16
Manufacturing and Maintenance of Machinery	-5.42	3.06	-0.02
Electrical Equipment	-3.32	12.07	6.48
Wood and Furniture	-12.94	0.43	-4.43
Paper, Pulp and Cardboard	-0.02	2.83	1.80
Plastics	-5.76	0.14	-2.01
Textiles	-1.25	-2.06	-1.77
Apparel	-16.73	6.05	-2.23
Leather Products and Footwear	-0.79	-2.34	-1.78
Processed and Edible Products	-7.31	0.03	-2.64
Food and Beverages	-3.06	-4.10	-3.72
Vehicles and Parts	-3.34	6.95	3.21

Details by Region

3.49 Finally, we examine the patterns of TFP growth from a regional perspective. For this purpose, we divide the country into three geographical regions: São Paulo, the South and the rest of the Southeast, and the Northeast. It is important to note from the outset that these regions differ considerably in terms of size of their industrial sectors. In 1997, São Paulo contributed 44 percent of all-Brazil industrial value added. Adding the South and the rest of the South East, the figure rises to 85 percent. The Northeast region accounts for the remaining 15 percent. Further, the three regions differ also considerably in terms of the sector composition of their industries. Since not all sectors are significantly represented in every region, we focus only on industry aggregates.

Figure 3.7
Brazil Industry-wide TFP by Region
13 Sectors, Stayers, 1986-98



3.50 Figure 3.7 plots the time pattern of TFP across the three regions, as well as the all-Brazil average for comparison. The figures correspond to the 13-sector aggregate, and include only staying firms. Until 1990, the profile is fairly homogeneous across regions – they all experience declining TFP. In the 1990s, however, a large gap opens between the Northeast, which experiences a further abrupt decline in TFP in 1994-95, and the other two regions, which show rising TFP, especially rapid in the South and Southeast region. This contrasting regional performance likely reflects the limited presence in the Northeast of the industrial sectors that were the TFP performance leaders in the 1990s (such as Cars and Parts and Electrical Equipment).[43]

[43] Indeed, if we perform the same exercise but including all industrial sectors – rather than the 13 in the text – the estimated TFP performance of the Northeast compares much more favorably with that of the other regions.

V. TFP GROWTH AND RESOURCE ALLOCATION

3.51 We next study the policy and structural factors shaping TFP performance and, more broadly, firm performance in Brazil's industry, using firm-level data from PIA and the firm-level TFP estimates constructed as described in section 3 above. The ultimate objective is to assess how selected aspects of the policy and regulatory framework have impacted on the observed evolution of Brazilian industrial firms over the last decade.

3.52 Specifically, we focus on four broad questions:

- **Trade barriers**: how has the changing exposure to foreign competition affected firm productivity? Did the decline in protection witnessed during the 1990s encourage TFP improvements?

- **Knowledge**: what has been the role of knowledge embodied in physical and human capital in promoting firm productivity? Has the latter been positively affected by the availability and use of foreign equipment—which may embody the latest technology available in world markets—information equipment and human capital?

- **Resource allocation**: How do firm size and TFP relate to each other? Do newer firms bring in higher-productivity techniques? Does higher capital intensity of production result in higher or lower TFP? Over the sample period, did the regulatory environment result in resource reallocation towards the most productive firms? How did the rules and regulations that constrain labor adjustment affect firm performance? Did they pose a significant burden to those firms seeking to downsize their operation?

- **Physical capital and investment**: was insufficient investment an obstacle for productivity improvement? What factors constrained firms' ability to expand their capital stocks?

3.53 To address these issues, we rely mainly on the results from the multivariate regressions introduced in section 3 above. To avoid biases resulting from omitted regressors, we include simultaneously in the regressions a set of explanatory variables that attempt to capture the various factors affecting TFP.

3.54 Thus, to reflect the changing exposure of domestic producers to foreign competition, we include in the regressions the value added-weighted nominal tariff rates by sector constructed by Kume, Piani and Souza (2000); the real exchange rate; the sector-specific degree of local market penetration by foreign exporters (defined as the ratio of imports over total final uses for each sector's goods, based on Ramos and Zonnenschain 2000), and the firm-specific ratio of exports to total sales.

3.55 Next, regarding the impact of embodied knowledge, we examine the effects on TFP of the composition of capital and labor inputs. Regarding capital, we focus on the ratio of used machinery

to total and the ratio of imported machinery to the total. For labor we examine the effects of the white / blue collar composition of the labor force, as a proxy for its skilled / unskilled composition.[44]

3.56 Regarding resource allocation, the available regressors are the capital / labor ratio, the age of the firm and its size. The latter is measured by both value added and output, to capture possible differential effects across the two variables. Further, for both size and age we allow for nonlinear effects by including quadratic terms in the regressions.[45]

3.57 In addition to these basic regressions, we also performed additional empirical experiments to assess the determinants of firm size change, the effects of labor regulations, and the determinants of investment. These experiments are described in detail in Muendler (2001b); below we limit ourselves to a brief summary of the results.

3.58 Not all of the regressors listed above are available in each sample year. Specifically, the composition of the capital stock (foreign and used machinery, as well as computers) is available in 1986-95. In turn, the export ratio to sales is unavailable prior to 1989. Thus we the only observations for which all candidate regressors are simultaneously available are 1989-95.[46] For this reason, below we present two sets of regression results, corresponding respectively to the periods 1989-98 (thus excluding the variables describing the composition of capital) and 1989-95 (including them). Descriptive statistics for the dependent and independent variables in the alternative regression samples and specifications are shown in Table 3.7.

3.59 The parameter estimates from the regressions appear in Table 3.8. We defer discussion of the individual coefficients to the subsections that follow, but here we note that on the whole the regressions possess a satisfactory explanatory power given the huge sample sizes, especially in the case of the equations with TFP level as the dependent variable. Nevertheless, the R-squared reported at the bottom of the table suggests that unobserved factors may be responsible for much of the variation in TFP and its growth rate. In any case, the estimated parameters are in all cases highly significant jointly, as implied by the corresponding Wald statistics. Finally, we should note that these regression results should be interpreted with some caution, as we cannot rule out the possibility of reverse causation from TFP to some of the regressors – e.g., high tariffs might result from successful lobbying by low-productivity firms, rather than the other way round.

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[44] For the years 1996-98 PIA also includes information on the ratio of foreign materials to total materials used. In these years, however, the composition of the capital stock is not available. Nevertheless, we performed some additional regressions using only 1996-98 data to assess the effect of the composition of intermediate goods on TFP and its growth rate. The results were never significant, and hence we opt for not reporting these regressions in the text.

[45] In addition, the regressions also include regional dummies, which were invariably insignificant and hence are not reported below, and the inflation rate, to control for cyclical factors – rather than just the effect of inflation itself. For this reason we regard its estimated coefficient as uninformative and ignore it in the discussion below.

[46] Ignoring the information on the composition of intermediates available for 1996-98 only.

Table 3.7
Descriptive Statistics for alternative samples

	TFP				TFP growth			
	1989-98		1989-95		1989-98		1989-95	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Trade								
Tariff	0.2288	0.1470	0.2125	0.1315	0.2110	0.1384	0.1978	0.1186
Real Exchange Rate	1.0006	0.1299	1.0444	0.1396	1.030	0.1362	1.0655	0.1366
Exports to sales Ratio	0.5627	0.1370	0.0587	0.1361	0.058	0.1358	0.0590	0.1334
Foreign Penetration	0.0651	0.0635	0.0611	0.0587	0.0644	0.0612	0.0621	0..0594
Knowledge								
Used Machinery to Total Machinery			0.0586	0.1505			0.0579	0.1479
Imported Machinery to Total Machinery			0.0467	0.1191			0.0489	0.1209
Computer Equipment to Total Machinery			0.0070	0.0124			0.0071	0.0120
Skilled Employees to Total Workers	0.2514	0.1748	0.2614	0.1767	0.2521	0.1739	0.2585	0.1744
Resource Allocation								
Age	25.5432	16.7961	27.3608	16.54	27.0833	16.8392	27.8095	16.5874
Size (Output)	5.49E+07	2.74E+08	6.33E+07	3.04E+08	6.06E+07	3.02E+08	6.73E+07	3.27E+08
Physical Investment								
Capital-Labor Ratio	9841.54	25046.65	9232.446	24747.6	9529..551	24372.42	9080.968	24157.72
Total Factor Productivity								
TFP	5.944	2.0232	6.009	2.0440				
TFP Growth					0.0438	0.3863	0.0514	0.3774

Table 3.8
Regression Coefficients from TFP Level and Growth Equations

	TFP		TFP growth	
	1989-98	1989-95	1989-98	1989-95
Trade				
Tariff	-0.1688**	-0.0543**	-0.1449**	-0.2299**
Real Exchange Rate	-0.0580**	-0.0106	-0.9248**	-0.9809
Exports to sales Ratio	-0.0741**	-0.1477**	-0.1239*	-0.2057*
Foreign Penetration	1.6274**	0.9048**	-0.7590**	-0.6825**
Knowledge				
Used Machinery to Total Machinery		0.0023		-0.0010
Imported Machinery to Total Machinery		0.0557		0.0268
Computer Equipment to Total Machinery		2.0329**		1.3266**
Skilled Employees to Total Workers	-0.0057	0.0317	0.0642**	0.1157**
Resource Allocation				
Age	-0.0301**	-0.0049	-0.0333**	-0.0519**
Age Squared	-0.0001**	-0.0002**	0.0000	0.0001
Size (Output)	2.19E-09**	2.41E-09**	1.47E-09**	1.70E-09**
Size Squared	-1.95E-19**	-1.95E-19**	-1.25E-19**	-1.35E-19**
Physical Investment				
Capital-Labor Ratio	-8.05E-07**	1.92E-06**	7.97E-07**	3.25E-06**
R^2 within	0.1373	0.1018	0.0653	0.0838
No of Observations	30913	15739	20679	12164
Wald Test of joint significance of all parameters (p value)	0.0000	0.0000	0.0000	0.0000

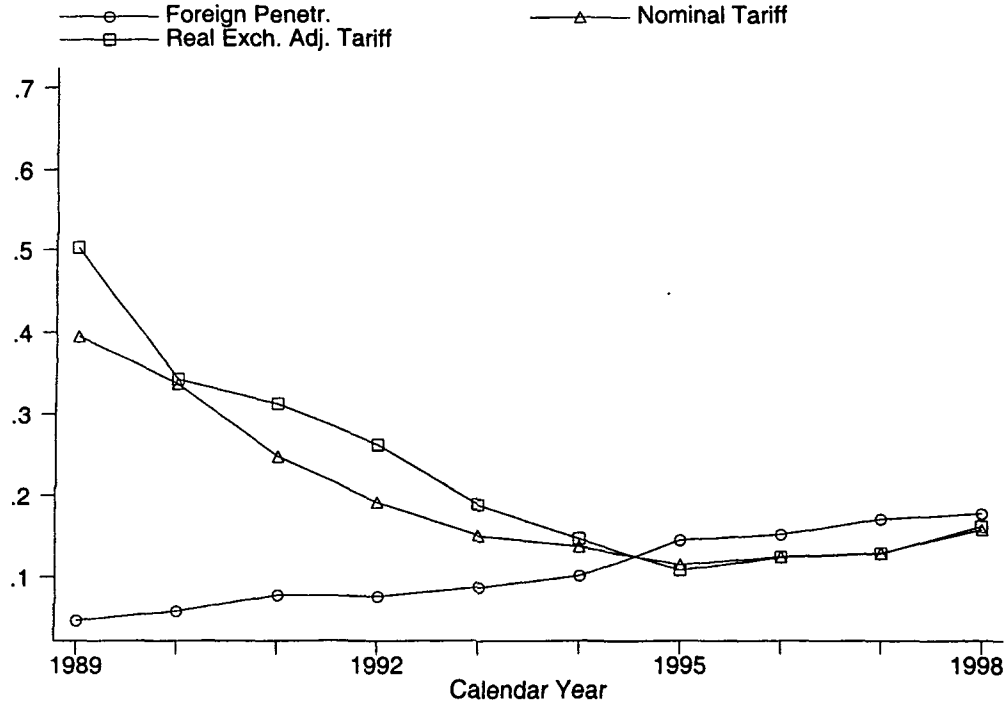
Note: **significant at 5 percent level, * significant at 10 percent level

TFP and Exposure to Foreign Trade

3.60 Until the late 1980s, Brazil's industrialization had been effectively based on high import barriers sheltering domestic producers from foreign competition. The process of trade liberalization—involving the elimination of non-tariff barriers and the reduction of tariffs—started in the late 1980s and gained momentum in the 1990s, although it suffered a partial reversal in the latter part of the decade. Thus, the external liberalization coincided with the privatization and domestic deregulation that also took place in the 1990s.

3.61 Trade liberalization proceeded in four stages (Kume, Piani and Souza 2000). In 1987-89, the reforms sought primarily the removal of redundant tariffs, which were quite numerous due to the pervasive non-tariff barriers. As a result, the (value-weighted) average effective tariff declined from 68 to 39 percent. In the second stage (up to 1993), non-tariff barriers were removed -- leaving tariffs and the real exchange rate as the main protection instruments -- and tariffs reduced, bringing the average effective tariff down to 15%. Next, in 1994 with the advent of the Real plan the process of tariff reduction sped up, and the average effective tariff fell to 12%. Finally, in 1995-98 a partial reversal took place. First some rates were raised – on automobiles, consumer durables, textiles – and then a generalized 3% increase was imposed, so that the effective rate rose back to an average of 15%.

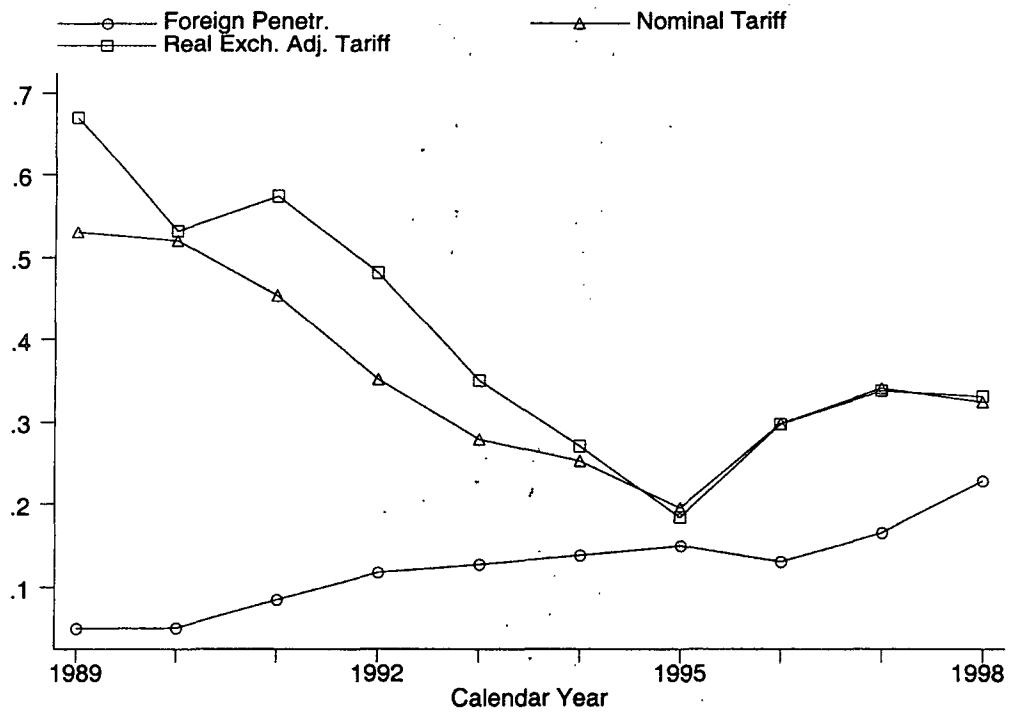
Figure 3.8
Average Nominal Tariff and Import Penetration
All Industry, 1989-98



3.62 Figure 3.8 plots the time path of the average nominal tariff, with and without adjustment for the protection accorded by the level of the real exchange rate, as well as the degree of foreign market penetration (as defined above), with all variables corresponding to the overall industry average. The steep decline in protection after 1989 is apparent from the figure, as is the partial reversal of the reform after 1995 and the steady increase in foreign penetration.

3.63 This general framework conceals significant variation in the experience with trade liberalization across sectors. One interesting experience is that of the automobile and car parts industry, that prior to the liberalization enjoyed one of the highest nominal protection rates, as well as the highest effective protection rate throughout the reform period (Kume, Piani and Souza 2000). As figure 3.9 shows, in this case the pattern of abrupt tariff decline and reversal is particularly striking, as is the steady increase in foreign penetration in spite of the partial rollback of the tariff cuts in the late 1990s.

Figure 3.9
Average Nominal Tariff and Import Penetration
Auto and Car Parts, 1989-98



3.64 A few studies have focused on the impact of this reduction in trade barriers on Brazil's TFP performance. Hay (1997) examines the impact of nominal and effective protection rates on the TFP of a group of large industrial firms. He finds strong negative effects of both variables, as well as from protection accorded by depreciated real exchange rates, and concludes that both the elimination of non-tariff barriers at the end of the 1980s and the reduction in tariffs in the 1990s had strong positive effects on the level of TFP – along with the domestic deregulation and privatization. In turn, Rossi and Ferreira (1999) likewise find a strong negative impact of nominal and effective tariffs on the growth rate of aggregate TFP, and conclude that the process of trade opening was a

key factor behind the observed TFP recovery in the 1990s. Finally, the report by McKinsey (1998) also emphasizes tariff reductions as the main force behind the observed productivity improvements in the automobile and auto parts sectors, and underscores the obstacle that high tariffs on capital goods (particularly telecommunication equipment) posed to investment and plant modernization at the beginning of the reform period.

3.65 The first group of coefficients in Table 3.8 allow us to assess the impact on TFP and its growth rate of this opening up to foreign competition.[47] On *a priori* grounds, we expect protection via tariffs and/or the real exchange rate to have a negative impact on TFP, while market penetration by foreigners and contact with export markets should be expected to have a positive effect.

3.66 Starting with tariff levels, we find that higher tariffs are invariably associated with lower TFP levels and growth rates in both sample periods. In the case of TFP levels, however, the association is significant only in the longer sample. In the case of TFP growth rates, the coefficients are significant in both samples.. They suggest a positive effect on TFP growth around 0.2 percent for each point decline in tariff rates. Thus, a 30-percentage point decline in tariff rates (roughly the observed decline in the average tariff rate over the reform period) would yield, other things equal, a 6 percentage point acceleration in TFP growth.

3.67 In turn, the real exchange rate also carries a uniformly negative coefficient, both in the regressions of TFP level and growth rate, although like with tariffs the coefficient is insignificant in the level regression for the 1989-95 sample. More depreciated (=higher) real exchange rates allow domestic firms additional protection from foreign competition. They also tend to raise the real cost of imported intermediates and machinery. On the whole, the regression results suggest that the net result is that a higher real exchange rate allows firms to get by with lower and/or more slowly growing TFP.[48]

3.68 Foreign penetration in local markets has a significant positive effect on the TFP level in both sample periods (columns 1-2). However, it has a negative impact on the subsequent growth rate of TFP (columns 3-4), which seems somewhat puzzling.

3.69 Finally, in the case of export orientation we find a negative and significant association with TFP and its growth rate in both sample periods, contrary to expectations. We should note, however, that in this experiment we are holding constant a number of key variables – skill intensity, machinery use, age and size of the firm – which other studies have found to be significantly associated with export orientation. Thus, the interpretation of this result is somewhat unclear.[49]

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[47] In addition, trade opening allows enhanced access to foreign capital, which may have an impact on productivity if its quality is above that of domestic equipment. We return to this issue in the next subsection.

[48] However, caution is necessary regarding this result. The reason is that the real exchange rate measure included in the regressions lacks cross-sectional variation and only displays time variation. Thus, it may partly capture the effects of other aggregate shocks affecting Brazilian industry, in addition to the effects of the real exchange rate itself.

[49] Moreover, additional work in progress by Muendler (forthcoming) using a different econometric approach finds that export orientation and TFP show a positive association among Brazilian manufacturing firms.

TFP and Knowledge Embodied in Input Quality

3.70 We turn to the second broad issue, namely the role of knowledge embodied in physical and human capital. To explore this question, we focus on the variables describing the composition of the physical capital stock – specifically, the ratios of used machinery, imported machinery and computer equipment to total machinery -- and the white / blue collar composition of the labor force. It is worth noting that the foreign machinery ratio reflects access to foreign markets on the input side, as opposed to the output side access discussed in the preceding subsection. On *a priori* grounds, we would expect all these input quality / embodied knowledge measures to be positively related to TFP performance – with the exception of the used machinery ratio, which should exert a negative effect.

3.71 Of all the variables just listed, only the skill ratio is available in both samples under study. Table 3.8 (second group of coefficients) shows that it has a positive and significant effect on TFP growth in both periods, and no significant effect on the TFP level in either period.

3.72 Regarding the composition of the capital stock (available for 1989-95 only), the ratio of computers to machinery is significantly associated with higher TFP and TFP growth, and its coefficient is of large magnitude.[50] In contrast, neither the used nor the foreign machinery ratio exhibit any significant effect on TFP or its growth rate. The latter result, in particular, suggests that quality differences between domestic and foreign machinery are inconsequential from the perspective of productivity.[51] Finally, the same conclusion applies to foreign intermediates: their ratio to total intermediate inputs not significantly associated with TFP level or TFP growth.

Resource Allocation

3.73 We now turn to the role of resource allocation in the observed patterns of TFP. In particular, we are interested in four questions: (i) does productivity varies systematically with firm age and size – i.e., do newer / smaller firms bring in higher-productivity techniques? (ii) does capital intensity bear any relationship to TFP? (iii) did more productive firms tend to expand further than less productive ones? and (iv) do labor regulations pose a significant burden on firms' operation?

3.74 To answer the first two questions we can look at the third group of estimates in Table 3.8. Regarding age, in general we find that older firms exhibit significantly lower TFP as well as TFP growth. In the case of the TFP level, the effect is more than proportional – it becomes stronger as firms become older. Its magnitude seems considerable: other things equal, a one-year increase in age lowers TFP growth by 3-5 percent (note than mean age is around 25-30 years). In interpreting this result, however, it is important to keep in mind that other features that vary systematically with firm age – e.g., firm size – are being held constant.

3.75 Regarding firm size, which in the regressions is measured both by output and value added, in both cases we find a strongly significant effect, which in the case of value added is nonlinear: larger firms exhibit higher productivity and faster productivity growth, although beyond a certain

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[50] The computer / machinery ratio is generally very small. Its sample mean is just 0.6 percent.

[51] As noted earlier, the same result was found for foreign intermediates over the shorter 1996-98 sample.

size the relationship changes sign. Near the sample mean, a 10-percent increase in size as measured by value added is associated with an increase in TFP of about 0.5-0.8 percentage points, and an increase in TFP growth of roughly the same magnitude. In turn, an increase in size as measured by output yields a more modest (but still positive) impact on TFP.

3.76 As for the impact of capital intensity on TFP performance, Table 3.8 shows that it exerts a positive and highly significant effect on TFP growth in both sample periods. Its impact on the level of TFP, however, is less clear – it is positive in the 1989-95 sample, when the variables describing the capital stock composition are available, and negative in 1989-98 – when they are not.

3.77 We next focus on changes in firm size. In section 4 above we saw that, contrary to expectations, the contribution of firm size changes to aggregate TFP was negative in several years. In other words, firm size change acted as a drag on aggregate productivity. It is worth inspecting this result more closely and asking whether, other things equal, low productivity prompted firm size increases over the sample period. If the question were answered in the affirmative, the suggested implication would be that the overall regulatory regime tended to encourage inefficiency.

3.78 To answer this question, we ran fixed-effects regressions with firm size change (as measured by value added) as the dependent variable, and with the same explanatory variables (other than size) as the TFP regressions summarized above, including as additional regressors the profit rate and the TFP level. The details are given in Muendler (2001a). On the whole, these regressions had a high explanatory power (with R-square coefficients around .20). The main result they yield is that size change is strongly positively affected by firm TFP levels. Thus, other things equal, more productive firms did tend to expand faster over the sample period. Other things, of course, did not remain equal, and must lie behind the negative contribution of firm size changes to aggregate TFP growth that arises from Figure 3.6 above.[52]

3.79 Finally, we also examined the effect of labor regulations on firm performance using additional regression experiments. Specifically, we tried to assess indirectly the burden posed by regulations on dismissals on firms' ability to adjust to changing conditions, by looking at the share of labor costs in total costs for those firms that were shrinking. The constraints on labor shedding should be reflected in rising shares of labor costs for those firms. The main finding from these experiments (see Muendler 2001a) is that shrinking output is indeed associated with higher cost shares of labor, after controlling for other firm characteristics, which seems consistent with the above reasoning. However, it is difficult to establish the direction of causality underlying this association, and hence it cannot be viewed as conclusive.

Physical Investment

3.80 Given the result above that capital intensity encourages TFP growth, it is of interest to investigate the factors that shape firms' investment decisions. To do this, our final set of empirical experiments involved the estimation of investment equations relating fixed capital formation to a set of real and financial variables; see Muendler (2001a) for details. Among the real regressors, we

[52] More precisely, while the *unconditional* correlation between size change and TFP level is negative in the sample, the *conditional* correlation (that is, controlling for the other factors mentioned in the text) is significantly positive.

added to the variables used so far the firm's TFP level and its capital / output ratio. In turn, the financial variables included the profit and credit ratios to output and a set of indicators of the financial structure of the firm.

3.81 The two key results from this analysis were: (i) TFP affects investment negatively – which might be interpreted as reflecting a 'catch-up' effect: firms invest precisely to raise productivity, and slow down their investment once productivity has reached a high enough level; and (ii) investment is systematically affected by financial variables, such as the profit ratio, the ratio of credit to output, the ratio of long-term credit to the total, and the credit / equity ratio. The first three of these variables are positively associated with investment; the fourth is negatively related to it. It is tempting to conclude that this reflects the action of financial constraints on firm investment; as before, however, it is difficult to establish causality, and hence the empirical association of investment with these variables has to be interpreted with considerable caution.

VI. Concluding Remarks

3.82 The pattern of TFP performance of Brazil's industrial sector has been the focus of several empirical studies in recent years. This study represents a significant addition to existing analyses in that it performs the first systematic exploration of TFP in Brazil making use of a large firm-level data set. We have focused on the evolution of productivity in 13 major industrial sectors over the period 1986-98, and examined the contribution of various factors to the observed TFP performance of firms in these industries. The major findings from the study can be summarized in six points.

3.83 On the whole, our results show that industry-wide TFP has shown little change since the late 1980s. Like in previous studies, we do find a cycle of initial productivity stagnation followed by recovery, but its magnitude is quite small. Qualitatively, the time path of TFP broadly matches that of Brazil's aggregate economic performance, suggesting that the reduction in macroeconomic instability in the 1990s played a role in the TFP recovery, as pointed out by a number of previous studies. Yet the estimated annual growth rate of TFP in the 1990s, in the 0.2-0.3 range, was still fairly modest.

3.84 While there were considerable differences in TFP growth across industrial sectors over the sample period, on the whole we find that the pattern of decline first and recovery later was fairly uniform, so that the majority of sectors experienced falling TFP in the 1980s and rising TFP in the 1990s. Comparison with earlier studies is hampered by differences in time coverage and sector disaggregation. Nevertheless, our findings agree with some previous studies in identifying the automotive and electrical equipment sectors among the top productivity performers after 1990.

3.85 The increased exposure of domestic producers to foreign competition resulting from the process of trade opening of the 1990s had a strong favorable impact on TFP. This is in agreement with the conclusions from previous studies. Our empirical estimates suggest that the 30 percentage-point reduction in the average nominal tariff may have contributed to raise industry-average TFP growth by as much as 6 percent over what it would have otherwise been. Market penetration by foreign competitors also appears to have raised the TFP level, although not its growth rate.

3.86 Some aspects of firms' input mix bear a systematic relationship to TFP, reflecting the contribution of knowledge to productivity. Thus, higher shares of IT equipment in total physical capital raise both TFP and its growth rate. Likewise, the skilled / unskilled composition of the labor force (proxied by its white / blue collar composition) also has a positive impact on TFP growth – which suggests that human capital investment may contribute significantly to raising TFP. In contrast, more intensive use of foreign machinery (relative to total machinery) does not seem to be associated with better TFP performance, and the same applies to the breakdown of machinery into new and used equipment.

3.87 Unfortunately, our data set does not allow proper study of the impact of new firm entry on overall TFP, but we do find that newer firms typically possess higher, and faster-growing, productivity levels. This suggests that measures that facilitate entry of new firms – by making the regulations governing entry simpler and more transparent and reducing red tape – could go along way towards raising aggregate TFP growth. In turn, TFP and its growth rate are positively associated with firm size – although beyond a certain size threshold the relationship is reversed. It is somewhat puzzling that over our sample period resource reallocation among existing firms (i.e., changes in their relative size) contributed little, if at all, to improve aggregate TFP performance. Nevertheless, we do find that, other things equal, TFP has a positive effect on size change – i.e., more productive firms tend to expand more. In this sense, resource reallocation proceeded in the 'right' direction.

3.88 Finally, the capital / labor ratio is positively related to TFP growth. Thus, capital deepening tends to speed up productivity. This suggests that raising investment could have a significant payoff in terms of TFP in Brazil's industrial sector. In this regard, we also find evidence that firm investment is systematically related to financial conditions – profits, long-term credit availability, and firms' debt/equity ratio. While the evidence is not conclusive, it could be consistent with the view that physical investment is constrained by financial market imperfections.

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Table A1

Manufacturing sectors at Nível 50

Nível 50 Code	Description
4	**Non-metallic mineral products**
5	Ferrous metal products
6	Non-ferrous metal products
7	**Other metal products**
8	**Machinery**
10	**Electrical equipment**
11	Electronic equipment
12	**Automobiles**
13	**Other vehicles**
14	**Wood and furniture**
15	**Paper, pulp, and cardboard**
16	Rubber products
17	Non-petrochemical chemical elements
18	Fuels, petrochemicals, and resins
19	Chemicals
20	Pharmaceuticals and perfumes
21	**Plastics**
22	**Natural and artificial textiles**
23	**Apparel**
24	**Leather products and footwear**
25	Coffee products
26	**Processed edible products**
27	Meat and poultry
28	Processed dairy products
29	Sugar
30	Vegetable oil
31	**Other food products and beverages**

Note: The 14 sectors shown in boldface were retained for the firm-level analysis. For this purpose, sectors 12 and 13 were combined into one single sector.

Table 3.A2

TFP growth by sector 1987-98

Year	Non Metallic Mineral Products	Other Metallic Products	Manufacturing and Maintenance of Machinery	Electrical Equipment	Wood and Furniture	Paper Pulp and Cardboard	Plastics	Textiles	Apparel	Leather Products and Footwear	Processed and Edible Products	Food and Beverages	Vehicles and Parts
87	-11.68	5.99	6.32	16.31	1.77	18.35	8.59	5.35	-3.18	8.55	-6.42	-2.24	7.95
88	-1.77	7.72	1.03	10.22	-0.32	16.52	-9.40	8.42	-3.26	-8.92	6.44	2.24	2.47
89	-5.86	1.61	-17.25	-7.84	-38.59	-13.52	-7.73	-11.83	-63.40	-7.89	-12.61	19.20	7.89
90	-11.76	-10.62	-11.78	-31.98	-14.61	-21.43	-14.50	-6.96	2.93	5.10	-16.65	-31.42	-31.66
92	3.25	-4.05	3.13	23.53	7.00	1.34	3.79	1.02	10.89	11.23	-1.38	-9.15	21.73
93	10.29	2.97	20.98	22.51	-5.47	-8.58	11.25	9.51	16.18	10.22	25.97	2.30	27.09
94	-17.43	-6.96	-17.15	-8.43	6.30	23.04	-14.75	-13.34	10.23	-27.43	-22.37	-7.53	-5.99
95	-7.54	-3.55	-19.61	9.04	-21.66	-5.00	-5.21	-9.45	4.89	-5.44	-2.59	-4.61	-1.07
96	-1.49	13.70	11.90	20.68	8.53	1.74	-0.17	-8.85	-20.47	-13.81	-4.68	-14.33	2.59
97	4.53	1.12	15.69	8.44	3.99	4.81	6.60	5.07	14.31	4.25	8.14	-0.42	5.65
98	0.28	4.80	6.52	8.74	4.29	2.49	-0.54	1.59	6.29	4.61	-2.86	5.02	-1.35

4. HOUSEHOLD INCOME GROWTH AND ITS DISTRIBUTION

Prepared by Naércio Aquino Menezes-Filho and Mark Roland Thomas

I. GROWTH ACROSS STATES AND INCOME GROUPS

One Dimension of the Quality of Growth: The Equality of Growth

4.1 An old debate, recently invigorated in Brazil as elsewhere, centers upon the question of whether economic growth *per se* is the correct focus of public policy efforts and discussions, or indeed whether economic growth even corresponds at all with underlying concepts of public welfare. At one end of the spectrum stand those who claim that globalization and capitalism have evolved to serve a plutocracy of multinational corporations, their shareholders, and the politically elites. For proponents of this view, economic growth is at best an irrelevance, the wrong measure, at worst a symptom of the repression of the needy. At the other end of this spectrum lie observers who point out the high correlation between measures of income such as GDP per capita and other pertinent measures of the human condition: health indicators, education and literacy, even the environment. For these observers, despite its philosophical oversimplification, economic growth is a satisfactory "sufficient statistic" for welfare for most purposes of policy design.

4.2 An intermediate position is that most commonly taken by development organizations and politicians of the center, that growth should be a principal but not the sole aim of public action, and in particular that there is sufficient divergence between income growth and some other welfare components to warrant separate foci on the "multiple facets" of welfare (and, by extension, poverty).

4.3 This paper focuses on the quantity of growth and one further dimension: its distribution, in particular, how much economic growth accrues to the poor. This is neither to claim that this is the only other dimension that matters, nor that there are necessarily tradeoffs between distribution and growth. Our position will be pragmatic: that one sensible objective might be to reduce the *poverty gap*, and that this being the case, the relevant prism through which to pass measures of income growth is how the poor fared as a subset of the total.

4.4 This returns us to the earlier question of whether this prism is likely to change ones conclusions much from those given by taking population-wide economic growth as the objective. Dollar and Kray (2000) have recently found that growth in GDP per capita across countries is more or less unrelated to changes in measures of their inequality. This finding can be interpreted in two ways: it refutes the arguments of those who claim that growth an irrelevant measure, that it is systematically regressive because it is generated and captured by elites; but it also suggests that

the distribution of growth might be an interesting second statistic to examine, since it is essentially "orthogonal," that is unrelated to, the level of growth. We will treat this as an open question for Brazil, and to answer it will compare patterns in aggregate income growth with those in its distribution. The paper will then go further, by examining the causes underlying both growth and its distribution. We shall return to possible explanations of growth and its pattern later in this section.

4.5 As a final prefatory remark, we wish to emphasize a distinction. In debates about growth, inequality, and the welfare of the poor, the latter two are sometimes confused with one another. Let us try to avoid such misunderstandings. Economic growth may or may not come with rising inequality; the premise that it did would *not* imply that, if consulted, the poor would opt for less growth (and hence, under the premise, less inequality). The relevant question in this light might rather be: did the income of the poor rise (and by how much)? Responding to this question, we shall mostly restrict attention to one measure in addition to overall per-capita income growth: the percentage growth in the per-capita income of the poorest 25 percent[53] of the national population.[54] This measure has the practical advantage that it is computable from repeated cross-sections of household data. We may then proceed in a computationally straightforward way from this measure to one of the change in inequality, without confusing the concept of poor-income growth with the related but distinct concept of inequality.

Measuring Patterns of Growth in Brazilian Household Data

4.6 This paper makes use of stacked household data from the years 1982-98.[55] The data come from Brazil's Annual National Household Survey (*Pesquisa Nacional por Amostra de Domicílios*: PNAD). The approach has two main advantages. First, PNAD has a stratified sample design that makes it representative at the state level. This is useful in itself: it is interesting to compare growth in household incomes across different states, to assess aspects of state performance. Second, using household data to compile income growth measures allows one to focus on income growth among the poor (as well as among the whole population) as discussed above, and subsequently to calculate partial correlation with factors that vary at the household or the local level.

4.7 The PNAD has some fairly well documented shortcomings (see Ferreira, Lanjouw, and Neri, 1998, for the most complete discussion of this topic). In particular, its measures of income are rather partial, since the questionnaire does pay much heed to assessing home production and non-market income (important in rural areas). However, its one overriding advantage for present

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[53] This definition corresponds approximately to the definition of the poverty headcount coming from the food poverty line commonly used in Brazil (see Ferreira, Lanjouw, and Neri, 1998). In 1999 the poverty rate using this line was 23 percent. The analysis was also performed using the poorest 50 percent instead. The results were not materially changed. This is one finding of this study, albeit a secondary one.

[54] There are contexts, some particularly relevant for Brazil, when other measures may be more salient. For example, some authors (e.g., Sanchez and Nunez, 2000) have suggested that certain measures of income spread or inequality are most useful for predicting rates of crime and violence. Inequality may also have specific social and economic effects that work through political channels, if plutocracies corner executive power. These effects are worthy of study in themselves, and indeed are the objects of studies in the World Bank and Brazil; they will not be addresses by this study.

[55] In the context of explaining historical patterns in Brazil, it would have been nice to have comparable data from the 1970s. Unfortunately, such data are not available.

purposes is its comparability across time. Furthermore, the patterns obtained from the PNAD are consistent with the regional accounts (see Azzoni, Menezes-Filho and Menezes, 2001), suggesting at least that the conclusions in their general form are robust to any design faults specific to the PNAD survey.

4.8 The measure of income growth we use is change in log per capita household income.[56] For each year that the survey was performed (1982-98 with the exception of 1994) two such measures are constructed: change in mean income for the population, and change in mean income of the poorest (as measured in the earlier year) 25 percent of the population. These two measures are then treated as the "left-hand side" variable in the regression analysis.

4.9 The implicit unit of analysis for most of the analysis is the state. There are two parts to the presentation of results, the first descriptive, the second analytical. The descriptive part presents state growth rates in four periods: 1981-85, 1985-89, 1989-93, and 1993-98. These periods are characterized briefly below. For the analytical section, the unit of observation is an age cohort within a state. This allows us to make use of greater variation in important dimensions such as educational attainment, health, employment patterns, and access to infrastructure. We do not have repeated observations of the same households over time (panel data), but by aggregating within state-cohort cells, we do have repeated observations of cohort means over time (quasi-panel data: see Deaton, 1980). The analysis then uses panel estimation techniques to derive consistent estimates of partial correlations between state-cohort characteristics and the state-cohort income growth. In this sense, the analysis in the second part of the paper tries to answer the question: what parts of Brazilian state-level characteristics or policies coincided with income growth within the periods studied?

Hypotheses

4.10 To frame the answer to this question, it is necessary to start from some hypotheses about what determines or constrains household income growth in Brazil and its states. There are many such hypotheses; many are not testable using the data and methods of this paper. The following are hypotheses that the paper addresses, with notes on the evidence that would support each.

Education Constraints

4.11 It has been said in reference to Brazil's stellar economic growth performance during the 1960s and 1970s, labeled Brazil's economic miracle, that the real miracle was how the country grew at such rates with so little education among its population. Most other examples of sustained growth among developed economies have been preceded by or accompanied by a fast educational expansion. Brazil's low level of education among its workforce (it ranks behind most of its South American neighbors in most of the statistics) are often cited by investing companies as an

[56] For changes of about 10 percent or less, this measure is approximately equal to the percentage change in income. Using log-differences has certain analytical advantages that make it preferable, however. Parts of the analysis were performed using percentage changes in income, without making a great difference. The main difference between the two is that log-differences deflate large (greater than ten percent, say) income growth figures. The results suggest that this distortion does not do too much harm to the main conclusions of this analysis.

impediment to economic activity. So it is natural to posit this as one of the constraints holding back present-day Brazil.

4.12 Were this the case, one would expect to see states and cohorts with more education among the workforce showing significantly higher levels of income growth. The hypothesis therefore has a clear counterpart in the data. Other work that investigates the role of education in Brazil's growth agenda is by Gill and Patrinos (2001).

The Investment Climate: Political and Policy Uncertainty, and Governance

4.13 Policy uncertainty has been cited by firms in many survey as the number one obstacle to investing in Brazil. It is sometimes difficult to ascertain exactly what this uncertainty consists of: exchange rates, economic uncertainty, unpredictable legal rulings, and so on may all form parts. For present purposes, we shall focus on the educational level of the public sector in a state, the frequency of ideological shifts in government, and the volatility of voting patterns as measures of uncertainty that may impede economic growth. Assuming that these are at least partial proxies for the uncertainty that upsets entrepreneurs, the hypothesis therefore has a counterpart in the data.

Infrastructure Bottlenecks

4.14 Public investment in infrastructure has fallen amid the fiscal constraints of the 1980s and 1990s in Brazil, and the necessary private investment to take its place has not always materialized amid imperfect regulation and scarce credit. To what extent the externalities associated with infrastructure provision are truly a constraint on income generation is an open question, however: Brazil's infrastructure is not worse overall than its neighbors in many categories. There is, however, great variation in infrastructure between the states (e.g., electrification, water, paved roads, and public services such as garbage collection). If infrastructure were a constraining factor, one would expect to see the states best endowed in these dimensions growing faster, *ceteris paribus*.

Labor Rigidities

4.15 Brazil's labor code is onerous by international standards. Payroll taxes are high in comparison with its neighbors, legal regulations applying to all formal labor contracts are numerous, and the rulings of labor courts are slow, unpredictable, and reputed systematically to favor workers versus employers. Again, the extent to which these factors truly impede growth is unclear, but were this the case, then under certain assumptions, one would expect to find lower income growth rates in states and cohorts with higher levels of formal labor contracts.

4.16 The proportion of contracts that are formal is of course endogenously determined as a function of their associated costs and benefits, so the line of analysis suggested in the previous paragraph can only be pursued with some skepticism. However, nearly all the explicit costs of formality are federally imposed, and thus invariant across states and cohorts. Variation in the proportion of contracts that are formal must therefore be owing to other factors, some of which will be controlled for in the analysis: education and employment composition by sector, for example. The assumption needed is thus that remaining variation in the extent of formal contracts is exogenous, meaning that it is not correlated with other unobservable factors that are themselves

correlated with income growth. We shall return to this discussion at the end of the paper when discussing conclusions.

Climatic Constraints

4.17 A long strand of economic literature posits that some countries are geographically doomed to lower growth rates owing to climatic conditions that impede economic activity. The most common evidence cited is the negative coefficient on "tropical" dummy variables in cross country growth regressions. We therefore investigate whether rainfall, latitude or altitude are associated with differences in income growth rates.

Agglomeration and Spatial Factors

4.18 A related hypothesis is that poor areas remain poor owing to low aggregate demand (so-called trading externalities, discussed theoretically in Diamond, 1982). These effects are therefore also "geographical" (see Jalan and Ravallion, 2000, for a fascinating application to China), but would show up in data as low growth rates associated with low local measures of economic activity (e.g., state GDP). We shall not enter into a discussion of the complications that arise in constructing the correct econometric estimates of these effects here: these are discussed at the end in an appendix.

Access to Markets and Trade Volume

4.19 Brazil's economy, despite lowered tariffs in the 1990s, remains relatively closed. There is also variation in the distance to major markets among the states. If integration were constraining growth, we would expect to see those states furthest from markets, and those trading least, growing more slowly (*ceteris paribus*). In the data we use distance from the sea as a proxy for market access, and interstate trading volumes as a proxy for integration into the national economy, to attempt to test for these effects.

Migration

4.20 Brazil's economic miracle included processes of urbanization, transformation of the productive base from traditional industries towards manufacturing, and migration, particularly from the Northeast to the Southeast of the country (see Gordon, 2001). Recently these migratory flows have ceased and even reversed (Fiess and Verner, 2001). It is an interesting question, though one hard to answer convincingly, to what extent this has been a causal factor in Brazil's economic slowdown.

4.21 The question is hard to answer because opportunities for income growth cause and are caused by migration, and so most attempts to assess causality are doomed to ambiguity. We shall touch upon the matter in the latter part of this paper and present some partial correlation between migration and income growth, without offering a satisfying solution to the problem of ascertaining causality.

II. Descriptive Results

Introduction

4.22 This section takes a step back from the hypotheses discussed in the previous one, and first presents the overall patterns in the data. The main issues we are interested in describing before a discussion of underlying causes are the following:

- ***Income Growth over Time.*** How does income growth behave in different periods since 1982? What are the relative performances of the states and regions?
- ***Convergence.*** Is there a tendency for poor states to catch up with richer ones? How fast?
- ***Income Growth Among the Poor.*** To what extent does income growth accrue to the poor? How does this vary by state and region?
- ***Changes in Inequality.*** What are the effects of income growth, and its accrual to the poor, on inequality? Has it risen or fallen? Is there a "tradeoff" between income and inequality?

Four Periods

4.23 For convenience we divide the full period 1981-98 into four approximately five-year sub-periods: the early eighties including and following the debt crisis (1981-85); the late eighties including and following the *cruzado* plan (1985-89); the early nineties including and following the Collor plan (1989-93); and the late nineties including and following the *real* plan and stabilization (1993-98). We give a very brief description of each of these periods below.

4.24 It is probably well-known to the reader that Brazil has endured a series of macroeconomic crises over the past two decades that have created a great deal of volatility in its economic aggregates and two very deep recessions. Two remarks are apposite. First, there is no doubt that economic volatility *per se* has reduced economic growth. The Brazilian economy (with Latin America as a whole) stagnated throughout the 1980s, prompting the "lost decade" moniker. The underlying cause of instability was and remains fiscal. While it is true that repeated bouts of runaway inflation[57] were both cause and effect of high inflationary expectations,[58] the original inflation that led to the expectations was the result of government's recourse to monetizing debt. The need for this was itself the consequence of structural deficits in Brazilian public spending. Brazilian policy-makers are more than aware of this, and public policy continues to focus on fiscal imbalances as public enemy number one. For the purposes of this paper, the effects of economic

[57] The PNAD data used for this paper have been deflated as carefully as possible using new regional price deflators devised by Azzoni and Menezes-Filho (2000).

[58] The interaction between inflation and inflationary expectations is by now well-documented. The original paper by Barro and Gordon (1983) is perhaps still the clearest theoretical exposition.

volatility on growth will not be the focus: this effect is essentially national in scope, and we are here focusing in variation across states as the source of identification of economic growth effects.

4.25 Furthermore, the aim here is not to focus on the crises in themselves, but to try to identify correlates of economic growth. The periods have therefore been constructed to try and avoid their ending in a crisis. Despite this, it will be seen that there are many cases of states experiencing negative income growth in the 1980s and early 1990s, though far fewer in the later 1990s.

4.26 The early eighties period incorporates the debt crisis of early 1982, and the extremely severe recession of 1981-82 that accompanied it. Related work (Neri and Thomas, 1999)[59] has documented the acute effects on household labor incomes of the macroeconomic conditions at the time: falls in real household income of 20 and 30 percent were the average. The two years from 1983 to 1985 then represented a period of relative recovery, although national economic growth rates were never sustained at levels above about 2 percent.

4.27 The period 1985-89 comprised a "heterodox" stabilization effort, the *cruzado* plan, which by introducing a new currency (the *cruzado*) eliminated inflation for a time and led to a boom in 1986-87. This boom relied on price controls and other restrictions that proved unsustainable, however, and 1988 saw another recession, though nothing like as severe as that of 1981-82.

4.28 The period of 1989-93 followed the drafting of the new constitution of 1988, which paved the way for democratic elections in 1990. Inflation had returned, and the Collor plan of 1991 was another failed attempt to eradicate it for good. A steep recession in 1991-92 preceded the impeachment of President Collor in 1992 and a leveling of the economy in 1992-93.

4.29 The final period covers the stabilization achieved in 1993-94, prior to the introduction of the dollar-pegged *real*. 1994-96 was a period of expansion, which also saw an appreciable decline in the poverty rate (World Bank, 2000). By 1998 the economy was entering a phase of stalling, owing to contagion effects from the events of 1997 in the East Asian economies. Growth continued to be positive, though at a lower pace than the early part of the *real* plan, until further deterioration in emerging market asset prices prompted by Russia's renegotiation of its debt forced the float of the *real* in January 1999, which lies outside the period studied in this paper.

State Income Growth

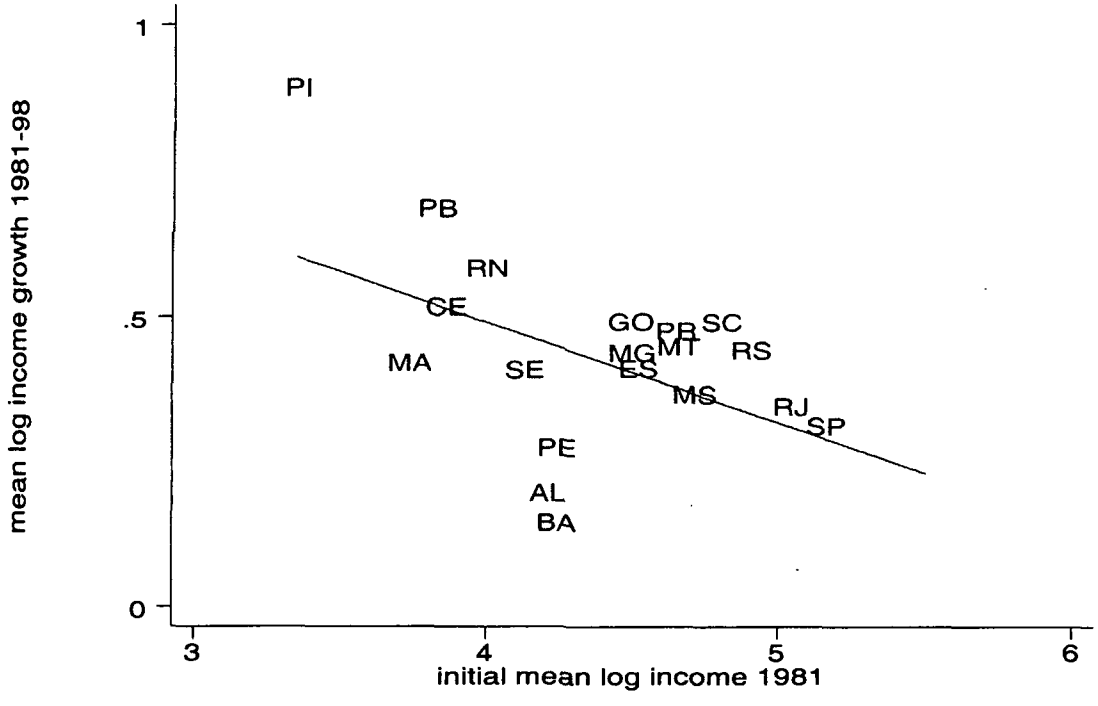
4.30 Figure 1 shows state household-income growth (vertical axis) versus initial household per-capita income (horizontal axis) for the whole period, 1981-98, and show the high divergence between states' growth rates. Only 19 of Brazil's 27 federated units are shown on the diagrams. First, the Federal District comprising Brasília and neighboring towns is not a state. Second, the states of Brazil's Northern region[60] have been excluded. These states are special cases in Brazil owing to their "frontier" characteristics. They have exhibited extremely variable growth rates, mainly

[59] This work is not strictly comparable to the present analysis since it uses the monthly employment survey (PME), which is restricted to six metropolitan areas in Brazil.

[60] Rondônia, Acre, Roraima, Amapá, Pará, and Amazonas. The state of Tocantins, which separated from Goiás only in 1991, has been merged with Goiás for the purpose of comparability across time.

owing to waves of immigration and exploitation of natural resources (e.g., oil in Roraima). Their inclusion would obscure more than it would reveal.

Figure 4.1
Initial Income and Income Growth, 1981-98



4.31 There is some evidence of states falling into regional blocks.[61] Brazil's regions are to some extent economically homogeneous clusters. The Southeast (SP, RJ, MG, ES) is richest and forms the industrial powerhouse of the country. The South (RS, SC, PR) is also relatively wealthy but more agricultural and less industrial than the Southeast. The Center West (MT, MS, GO, DF) is poorer than the first two, and relies mainly on natural resources and agriculture. Its infrastructure is far less developed than that of the South and Southeast of the country. The Northeast (PI, PB, RN, CE, MA, SE, PE, AL, BA) is much poorer. The Northeast's 28 percent of the national population account for only 13 percent of GDP. Its interior contains a large semiarid expanse, the *Sertão*, within which Brazil's most extreme problems of rural poverty are found. Infrastructure and social indicators are also much less advanced in the Northeast.

4.32 Where the states differ to a greater extent within regions is in their public policies. Evidence of clustering into regional growth performance is therefore evidence that initial conditions or conditions that change only slowly (levels of industrialization, some social indicators such as adult literacy) are responsible for a large part of growth differentials. In this context, differences between

[61] Brazil has standardized definitions of its regions. The Southeast comprises São Paulo (SP), Rio de Janeiro (RJ), Minas Gerais (MG), and Espírito Santo (ES). The South comprises Rio Grande do Sul (RS), Santa Catarina (SC), and Paraná (PR). The Center-West comprises Mato Grosso (MT), Mato Grosso do Sul (MS), Goiás (GO) and the Federal District (DF). The Northeast comprises Bahia (BA), Sergipe (SE), Alagoas (AL), Pernambuco (PE), Paraíba (PB), Rio Grande do Norte (RN), Ceará (CE), Piauí (PI), and Maranhão (MA).

seemingly similar states within the same region are notable, although here a more analytical approach is then called for to try to disentangle the causes.

4.33 The South, Southeast, and Center-West all show less within region variation than the Northeast in Figure 1. In the Southeast, for example, the states of Rio de Janeiro and São Paulo are neighbors on the graph. Paraná, Santa Catarina, and Rio Grande do Sul, all had about equal income in 1981 and showed similar growth rates over the period. This suggests that for these regions initial conditions and national considerations dominated state policies in determining economic growth.

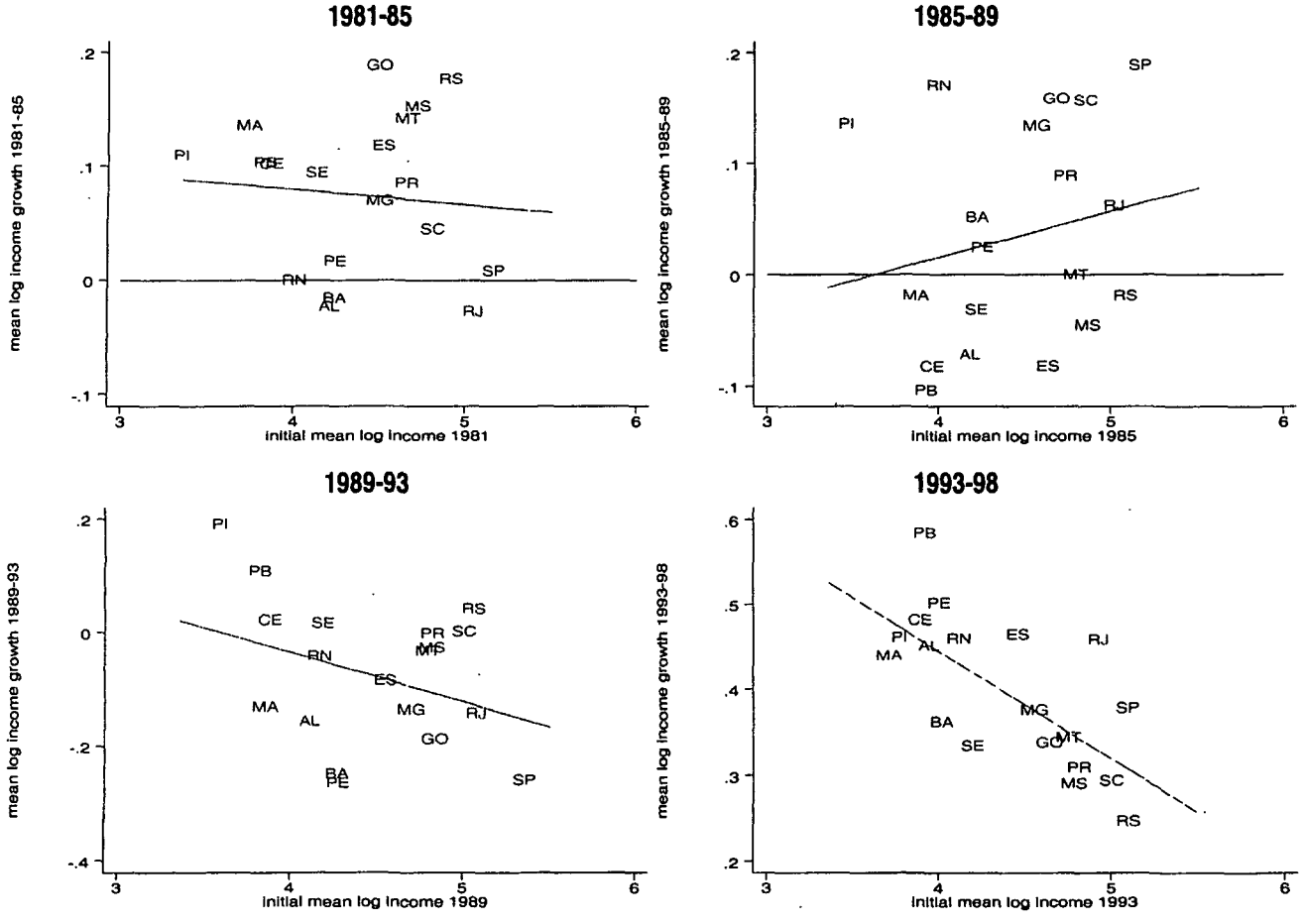
4.34 The Northeast is another story. The region contains Brazil's fastest growing state (within the 19 we are discussing)—Piauí—and its slowest—Bahia. Despite starting from similar initial income, the states of the Northeast displayed widely divergent growth rates over the period. What can explain this? We will argue that at least part of the reason is state public policy.

4.35 It could be argued that the preceding discussion is a little misleading, since so much of it hinges on what happened under past state governments, which have since changed, rendering such backward-looking exercises irrelevant. The next section remedies this by focusing on the four periods individually, and by emphasizing more recent events.

Differences Across Periods

4.36 Figure 2 illustrates growth versus initial income for states in each of the four periods separately. The periods do not resemble one another graphically very much, supporting the argument of the previous paragraph. The PNAD data confirm, at the microeconomic level, the macroeconomic observation that the 1980s were a "lost decade". For 1981-85, four states record negative or zero real per-capita household income growth in the data. For 1985-89 the story is worse: the 19 states are split about in half between those that record negative or zero per-capita income growth and those that record positive growth. And the recession of 1991-92 creates even worse effects in the third period, when only seven states show positive growth. Positive growth returns to the micro data just as it does to the macro data only after 1993. The dispersion between states is also slightly higher in 1989-93 than it is in 1993-98.

Figure 4.2
Initial Income and Economic Growth in Four Periods



4.37 Some of the regional clustering that was apparent for the whole period is less so within sub-periods. A closer look at the data reveals that for the bulk of the growth over the whole period is accounted for by the growth that occurs in the fourth period. It is also in this period that the regional clustering is most apparent, even for the Northeast, though this region still shows greater within-region variation in growth than the other three.

Convergence

A Brief Discussion with Regard to Brazilian States

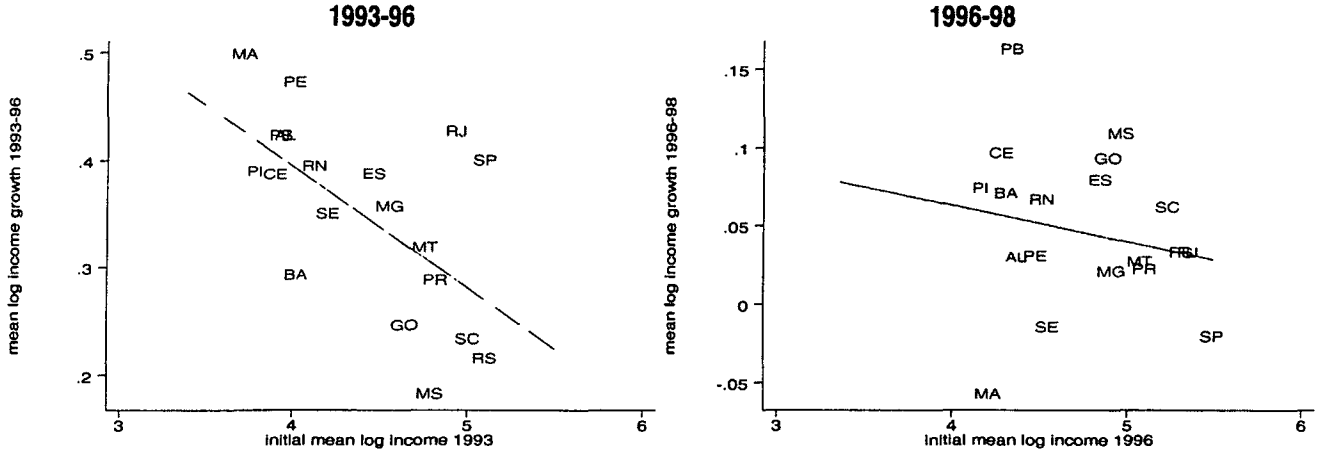
4.38 A now extensive literature discusses the concept of economic convergence between countries, that is, the notion that, for reasons of technological imitation, factor mobility, and higher returns to scarce factors such as capital (physical and human), poor countries ought theoretically to be able to "catch up" with rich countries. Needless to say, the cross-country evidence is mixed, and there are many reasons why "theoretically" may accord with inappropriate theory.

4.39 Nonetheless, the theories that imply convergence between countries ought to apply more readily to states within the same country. Obstacles to factor mobility and to technological imitation are fewer. And many institutional parameters are fixed at the country level and, therefore, to a first approximation are fixed across states, bringing the implicit *ceteris paribus* assumption behind growth comparisons a little closer to reality (see Barro and Sala-i-Martin, 1991, for an analysis of convergence applied to states and regions in the USA and Europe over the long run).

4.40 An analysis of convergence itself is not the object of this study, but Figure 2 shows quite clearly that if it has occurred at all in Brazil since 1981, this has in fact only been since 1993, or possibly, if one reads the third graph charitably, since 1989.[62] In the three earlier periods there is simply no visual (let alone statistically significant) relationship between initial levels of income and subsequent income growth. Since the *real* plan, however, there is a striking relationship: poorer states (particularly those in the Northeast) have exhibited faster income growth. This is no doubt in part because greater macroeconomic stability allows longer-term planning and investment, clearly a necessary component of the convergence story. It is also in part because the costs of high inflation had been disproportionately born by the poor (who could not protect themselves against inflation through asset switching as effectively as richer households). The elimination of inflation in 1993-95 therefore generated relative gains for the poor.

4.41 Which of these two explanations fits the data best can be suggested by dividing the latter period into two: 1993-96 and 1996-98. The gains from the eradication of inflation were concentrated in the first of these. The gains from greater stability and long term investment only began to be felt in the second. Figure 3 shows what happened to convergence in these periods.

Figure 4.3
Splitting the Fourth Period in Two



[62] There is an important distinction made in the literature on the subject between conditional and unconditional convergence. The former is understood to mean relative catch-up in residual income after controlling for many factors such as education and governance, which are at lower standards in poorer countries. The discussion of this section limits itself to the simpler concept of unconditional convergence between states. Azzoni, Menezes-Filho and Menezes (2001) investigate conditional convergence between Brazilian states using the same data, and find some evidence in its favor.

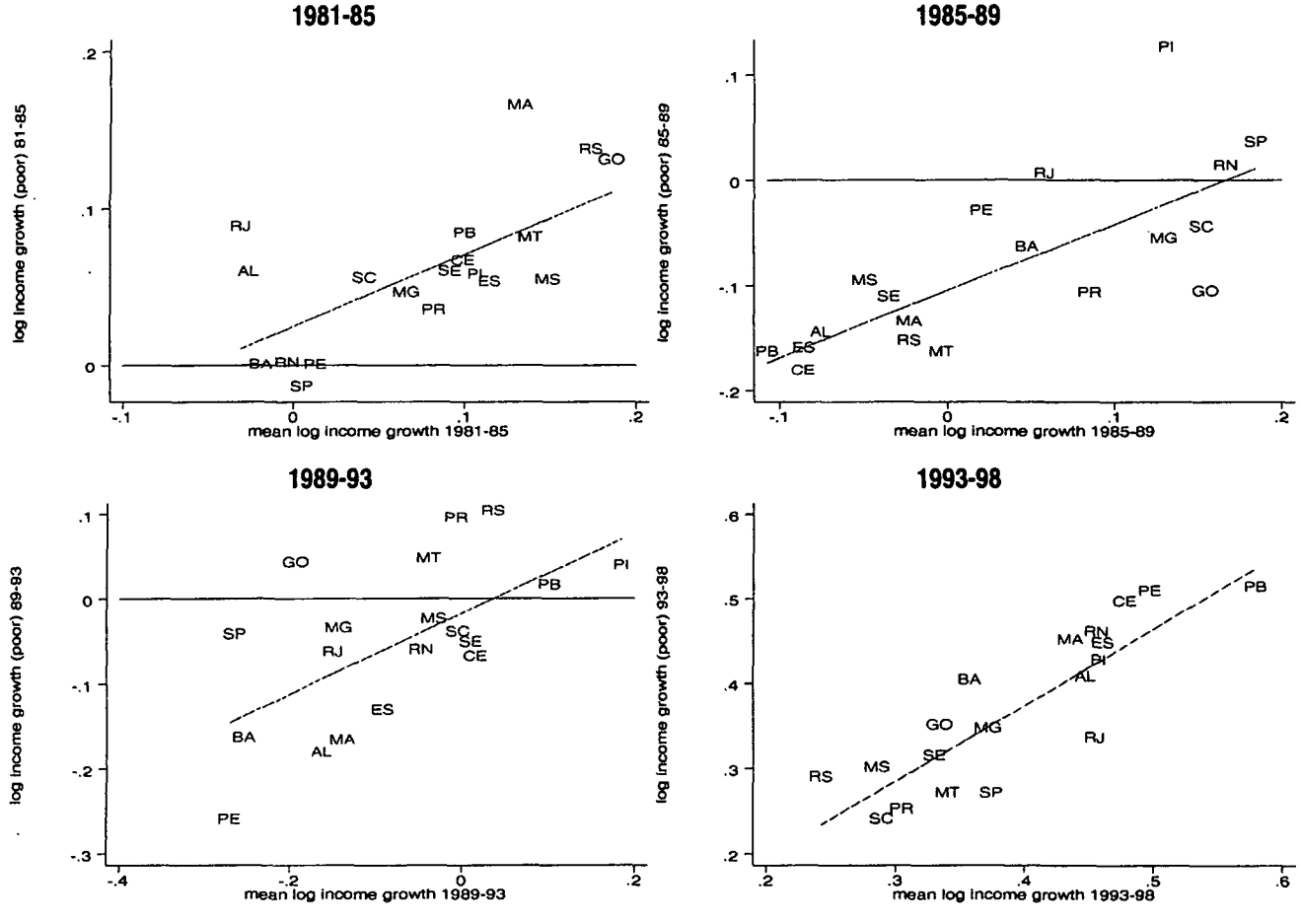
4.42 Figure 3 illustrates that the early part of the real plan accounts for a large part of the convergence effect of the fourth period (1993-98) as a whole. It is likely that the eradication of inflation had beneficial consequences that helped the poor. Earlier changes, such as trade opening, may also have changed market structures during this period in ways that helped the poor. We thus hypothesize that the speed of convergence between 1993 and 1996 may be difficult to recreate without explicit regional initiatives.

4.43 A final note in this regard: the evidence from elsewhere does not suggest that we should expect "automatic" convergence of Brazil's poorer states with its richer ones at any rapid pace. Barro and Sala-i-Martin's (1991) analysis of Europe and the US suggests conditional convergence of around 2 percent per annum. This corresponds to a catch-up "half-life" of about 35 years.

Income Growth among the Poor

4.44 Figure 4 displays the rates of income growth among the poor against general income growth, for the whole period and each of the sub-periods. Between 1981 and 1998 the income of the poor grew at a lower rate than the income of the whole population. Inequality thus increased.

Figure 4.4
Income Growth among the Poor in Four Periods



4.45 A related observation is that the slopes of the lines of best fit in the four quadrants of Figure 4 have slopes of less than one. If one considers a thought experiment in which a "less successful" state takes on the growth characteristics of a "more successful" state, this says that the poor of that state will benefit less than its population as a whole. The situation has improved in the fourth period: the slopes of the lines are, respectively, 0.46, 0.63, 0.48, and 0.90.

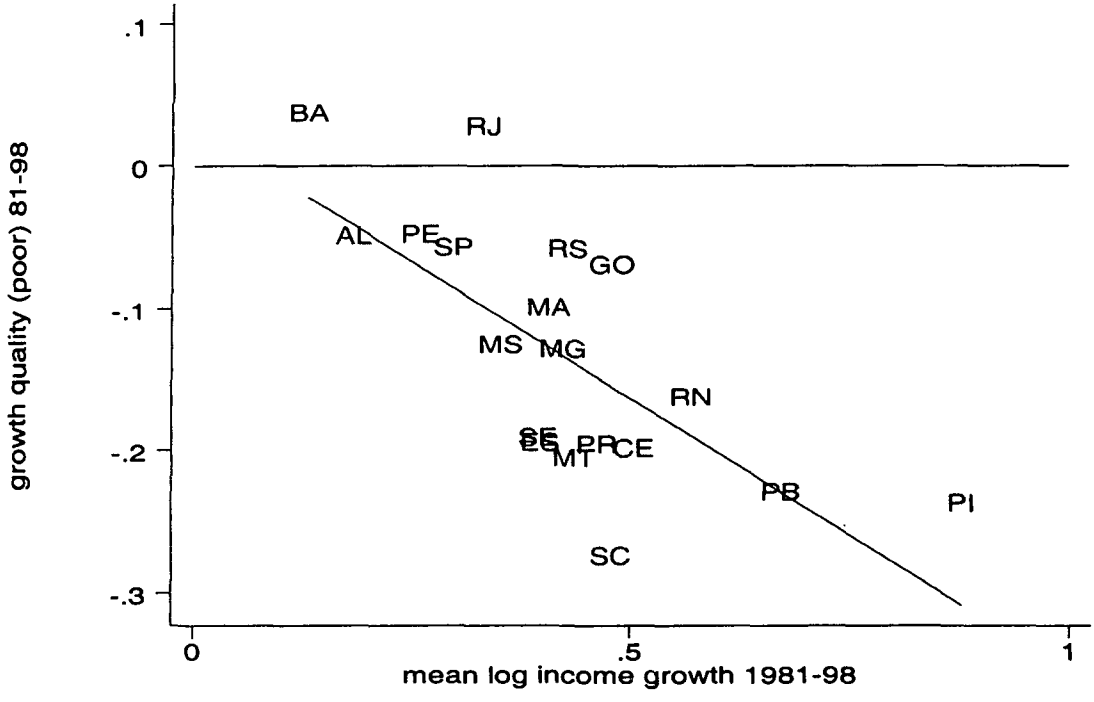
4.46 Perhaps not surprising is that the ordering of states by economic growth over the period does not change markedly whether one considers the poor or the whole population. Indeed in the fourth period the rank correlation between average income growth and poor-income growth in these data is 0.83. Nonetheless, Figure 4 shows that there is variation between one measure and the other, so that even if the choice of measure makes little difference to the ordering of states, it is of interest to focus on the difference between the two measures.

Is There a Tradeoff between Quantity and Quality?

4.47 Figures 5 and 6 plot a measure of the "equality" of growth against the quantity of growth for the whole period and then each of the four sub-periods. This equality measure is a difference in differences measure applied to log income: that is, income growth is calculated (as the difference in log income) for the whole population of a state, and subtracted from the same measure restricting to the poor.[63] Thus, if poor-income grew faster than the average (inequality decreased), then the equality measure is greater than zero. If not (inequality was constant or increased), it is zero or negative.

[63] The ability to construct such a decomposition is an advantage of using the log-difference specification of growth.

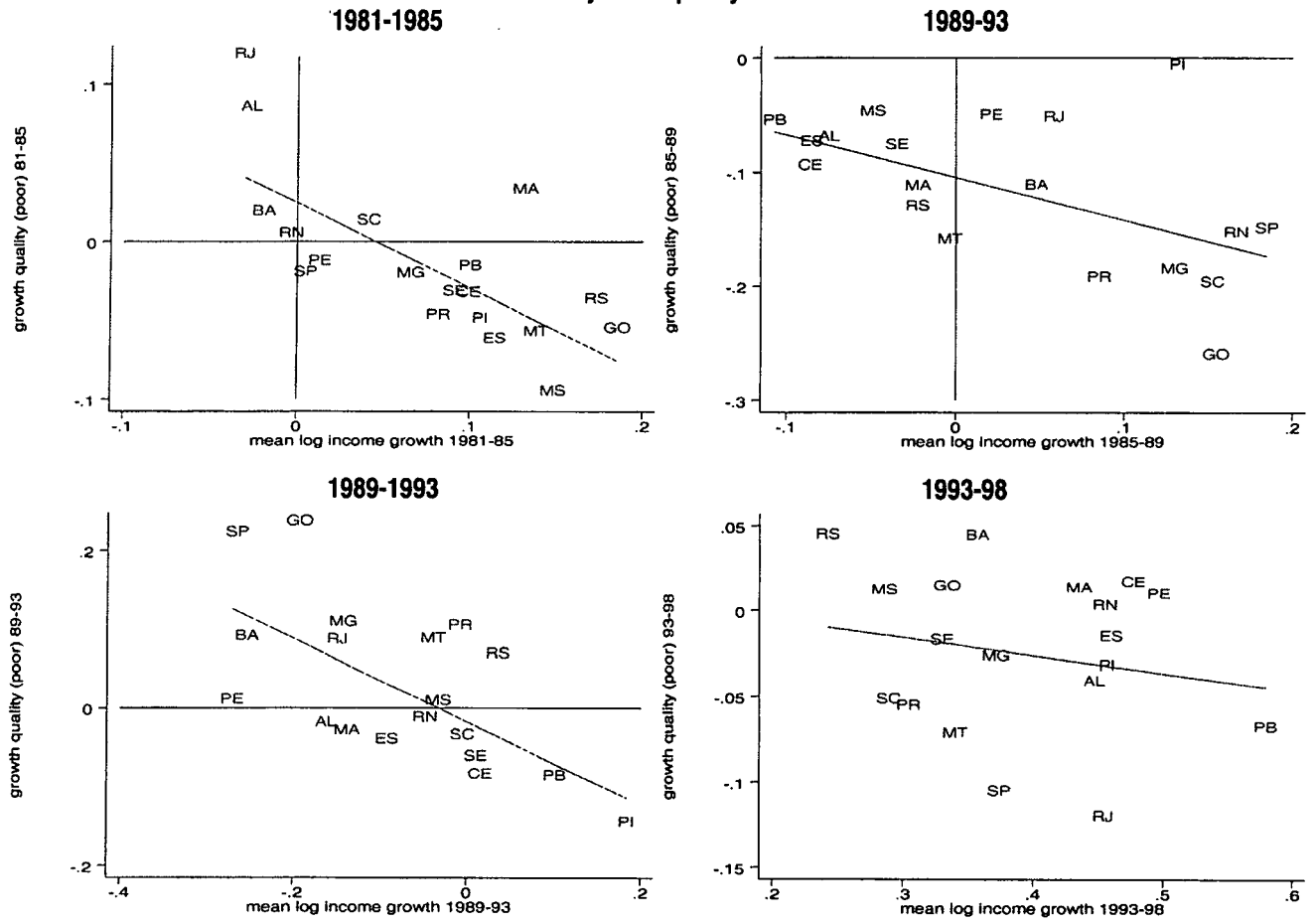
Figure 4.5
Growth: Quantity and Equality, 1981-98



4.48 There has been a systematic relationship between growth and its distribution. Any tradeoff between growth and inequality—between quantity and equality of growth—would show up in these graphs as a downward line of best fit. For the period as a whole, the line of best fit is downward and has a statistically significant slope of –0.38. For the four sub-periods the slopes of these lines of best fit are –0.54, -0.37, -0.52, and –0.10, with the first three statistically different from zero (at a 5-percent level), and the last one not. The last result is in line with the international evidence of Dollar and Kray (2000), showing that changes in inequality (equivalent to our equality measure) are generally uncorrelated with growth rates across countries. Though restricted to the period since 1993, it is perhaps surprising that this result holds in a country as unequal in its initial distribution of assets as Brazil.[64] It is to be hoped that the significant negative relationship between quantity and equality has disappeared entirely since the *real* plan, but this may be over-optimistic given the pro-poor effects of the one-time fall in inflation. It would therefore not be surprising were the "growth-inequality tradeoff" of the earlier periods to return to Brazilian household data in the near future.

[64] Most international comparisons of inequality rank Brazil among the most unequal income distributions in the world. The distribution of assets is probably more unequal than the distribution of income. Forthcoming work (Bourgignon, Ferreira and Leite) suggests that part of the explanation of Brazil's relatively high income-inequality is highly unequal non-labor income. This is likely to be largely related to capital assets.

Figure 4.6
Growth: Quantity and Equality in Four Periods

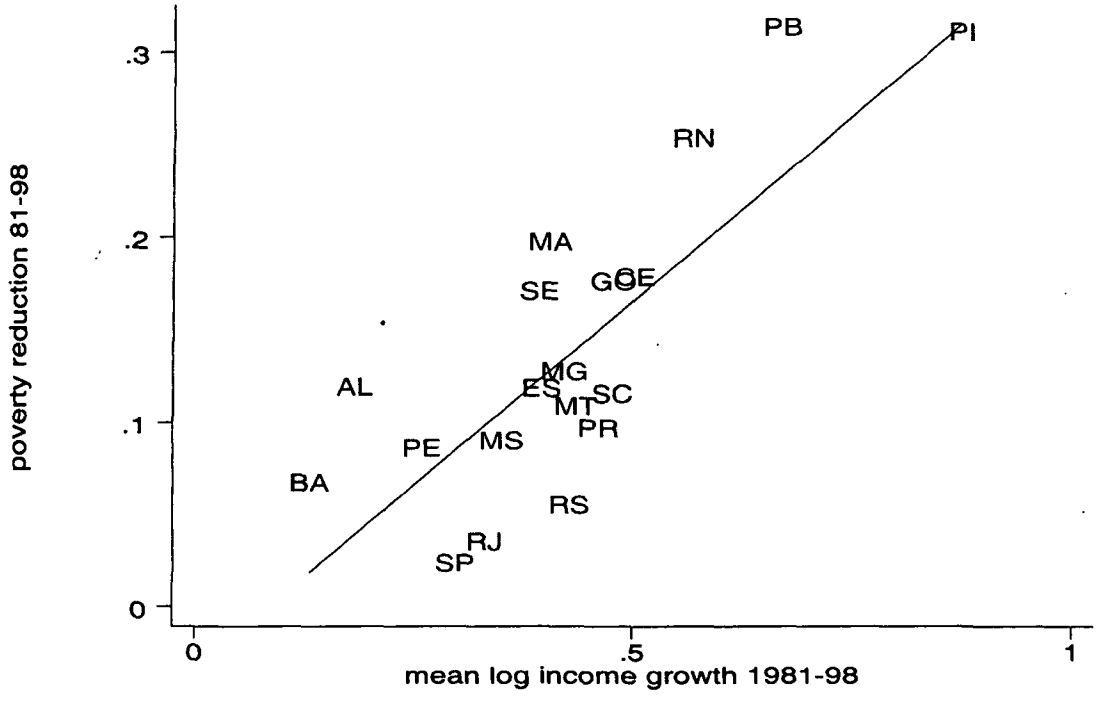


Poverty Reduction

4.49 If the poor-income growth coincides with broader income growth, and if inequality changes are (recently) unrelated to income growth, then we would expect poverty reduction to occur in states where higher income growth occurred. Figures 7 and 8 show that this is indeed the case. The three state with the highest income growth in the period, the small Northeastern states of Piauí, Paraíba and Rio Grande do Norte, also saw the largest falls in the poverty headcount rate.[65] São Paulo and Rio de Janeiro had the lowest falls in the poverty rate, and were among the five lowest rates of economic growth during the period.

[65] The poverty headcount referred to here uses a food-poverty line, and is often also referred to as the extreme poverty rate (or *taxa de indigência*).

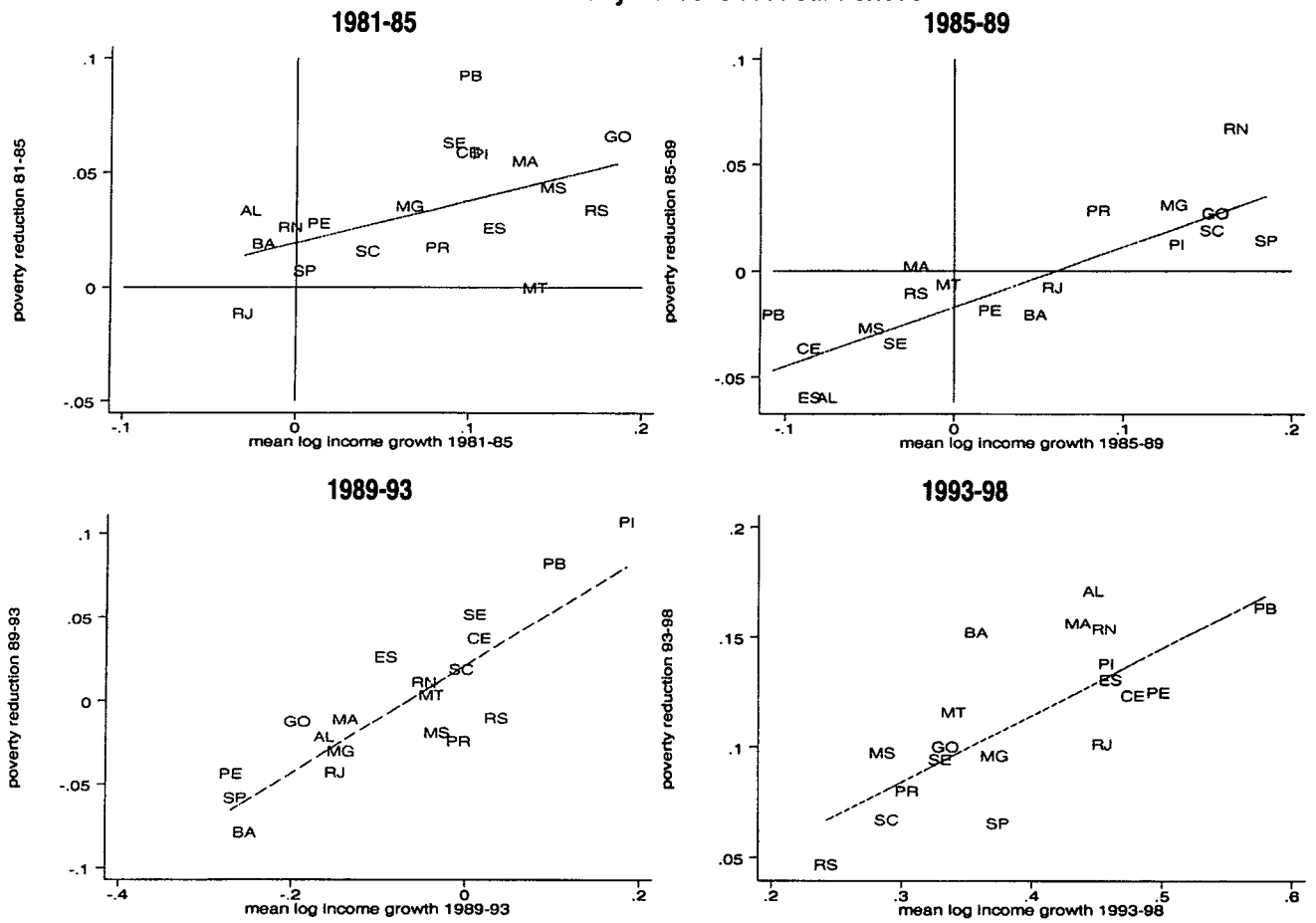
Figure 4.7
Growth and Poverty Reduction, 1981-98



4.50 The relation between growth and poverty reduction has been stronger during the 1990s than it was during the 1980s. This shows itself as a steeper line of best fit through the states in the later two graphs in Figure 8. The magnitudes of these slopes are, respectively, 0.19, 0.28, 0.32, 0.30. If we interpret these slopes as (negative) elasticities of poverty to income growth, these numbers suggest that an extra one percent of income growth translates into a 0.3 percentage point fall in the poverty headcount rate. This estimate is consistent with Neri (1999), who uses a similar methodology to calculate this elasticity for Brazil.[66]

[66] Neri's point estimate is that a 1.0 percent increase in income growth leads to a 0.8 percent decrease in poverty. At a headcount poverty rate of about 25 percent, this implies a percentage point poverty decrease of 0.2. Our point estimate is therefore a little higher than Neri's, though it falls well within his 90 percent confidence interval.

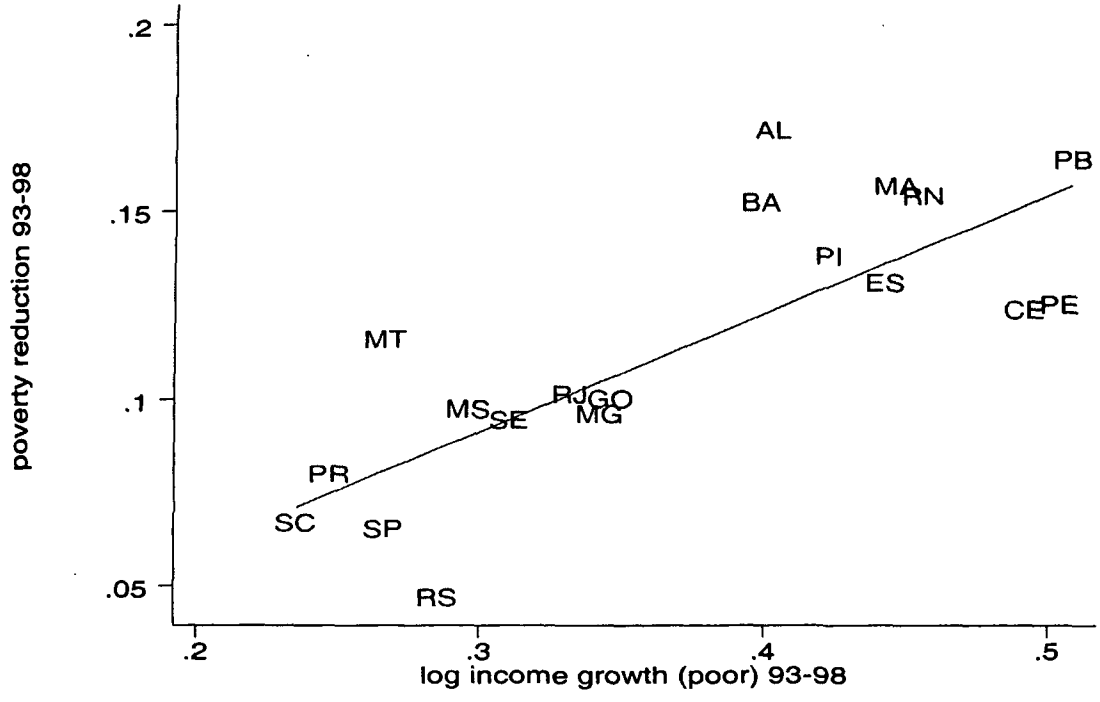
Figure 4.8
Growth and Poverty Reduction in Four Periods



4.51 It is also interesting to compare the recent relationship between the income growth of the poor and poverty reduction, portrayed in Figure 9 for the fourth period. Of course one expects a close relationship between these two measures, the first of which is close in definition to a reduction in the "poverty gap" measure of poverty.[67] The figure shows a the Brazilian states falling into three distinct groups during the period 1993-98. The first group comprises the states of the Northeast, with the exception of Sergipe, and the addition of Espírito Santo (which borders the Northeast and indeed contains areas with more in common with, say, Bahia to the north, than Rio de Janeiro to the south). This group of states has, since 1993, seen both poor-income growth and higher poverty headcount falls than the other two groups. At the other extreme, the second group comprises São Paulo plus the Southern states of Paraná, Santa Catarina, and Rio Grande do Sul. This group has performed worst in the period, both in terms of poor-income growth and of poverty reduction. The third group comprise Rio de Janeiro, Minas Gerais, Mato Grosso, Mato Grosso do Sul, Goiás, plus Sergipe, and is an intermediate case in both dimensions.

[67] That is, P_1 as opposed to P_0, the poverty headcount rate. It is not quite analogous, since income accruing to an individual after they have crossed the poverty line would be included in our measure of poor-income growth but would not technically constitute a reduction of the poverty gap. The reader may judge this to be a fairly casuistic distinction, and we would not disagree.

Figure 4.9
Poverty Reduction and Income Growth among the Poor, 1993-98



Descriptive Conclusions

4.52 Policy conclusions cannot be based on the descriptive methodology used so far in this paper, but we underline the following observations, which are of relevance to public policy.

- Although there was an apparent tradeoff in Brazilian household data between economic growth and inequality until the *real* plan, this tradeoff diminished or disappeared in the data after 1993. Economic growth is highly correlated with the growth of the incomes of the poor, and thus to poverty reduction.

- However, income growth has not accrued proportionately to the poor. For one percent of income growth over the whole period (1981-98), the poor's income rose by a little over half a percent. This ratio has risen to about 0.9 since the *real* plan, but some of this improvement may not be sustained fully beyond the period of inflation eradication.

- For the period 1993-98 we estimate an income elasticity of poverty a little greater than unity. The point estimate is about 1.2, although again because of the strong poverty reduction of 1994-95, the present value of this parameter may be a little smaller than this point estimate.

- Almost all the significant growth in real household incomes in the period has occurred since 1993. Economic stability is clearly a *sine qua non* for improved household welfare, whether of the poor or of the population at large.

- Over the same period, there has been unconditional convergence in states' incomes. Moreover, there are strongly apparent "regional fixed effects" in growth suggesting the importance of initial conditions, economic structure, and also national policies in determining growth, seemingly dominating state policy parameters in their effects.

- The preceding point should be qualified by the case of the Northeast region, whose states have shown a wider divergence of performances over the whole period and over recent years. One possible explanation may be the dependence in certain cases on a small number of crops, which adds volatility to the Northeastern states' economies, although there is no doubt much else going on in the data. Accepting this partial explanation might suggest these states' taking specific measures to insure against these risks.

III. Analytical Results

Introduction

4.53 We now turn to more structural explanations of the above patterns. For this section, as mentioned in the early part of the paper, we use more of the richness of the data than the descriptive section above. First, we pool growth observations for each year (1981-97, since we are using first differences), state (of which we use 19), and age cohort (of which we define 10).

4.54 The aim of this section is to establish which state- and cohort-level variables are correlated with economic growth, pro-poor economic growth and, at a later stage, the difference between the two, which corresponds with our difference-in-differences equality measure described above.

4.55 We attempt to be as exhaustive as the data permit in including exogenous right-hand side variables in the analysis, before turning to a discussion of some possible policy-relevant interpretations of the results. Some variables were constructed from the PNAD while others were imported from other datasets. Table 1 gives a summary of the main variables used. Table 2 describes the evolution through the period of certain of them.

4.56 For education, the average number of completed years of education was used as the simplest "summary statistic." At a second stage of analysis, the proportion of the population that had completed some primary, upper primary (middle school, or grades 5-8)[68], secondary, and tertiary (college or university) was also included. For health status, infant mortality per thousand births, and life expectancy at birth were available at the state level, though not at the cohort level.[69]

4.57 Several variables capturing the effects of infrastructure provision were included: proportion of households served by running water, sewerage, garbage collection, and electrification. In

[68] Called *segundo ciclo do ensino fundamental* in Brazil.

[69] These variables are not discussed in the analysis since they did not appear significantly in any estimation.

practice, these variables are highly collinear, and the results reported later restrict to trash collection and electrification, the variables that showed the most marked effects.

4.58 Three variables were included to capture the influence exerted by government on economic activity and income generation. The first is the average education level of public sector workers in the state: this variable aims to proxy the quality of public governance. It may not be a very accurate measure of this quality, but we include it in all specifications. The other two variables aim to measure political instability at the state level. The first of these two is the sum across political parties of the squares of their changes in vote shares in the previous two state gubernatorial elections. The second simply takes the value one if the most recent state gubernatorial election delivered a change of political coalition in power. The former variable aims to capture *political* uncertainty, while the latter aims to measure *policy* uncertainty.

4.59 We include variables describing the composition of economic activity and the nature of labor markets. For the former, the proportion of households with members working respectively in industry, services and agriculture was calculated. For the latter, the proportion of household heads working in the formal sector[70], and the proportion of households in urban areas, were calculated.

4.60 Next variables were added to the data to capture the effects of trade (inter-state), migration, climate and geographical location (fixed at the state level). For trade, the measure used was the logarithm of the combined volume of exports plus imports. This datum was available only for 1985 and 1995: the 1985 value was used for observations in the 1980s, the 1995 for the 1990s. For migration, the proportion of inhabitants who had migrated from outside the state was available for the years 1989 and 1997. The 1989 value was sued for the 1980s, the 1997 value for the 1990s. This creates a clear problem of endogeneity of this variable in income determination, since economic growth would be expected to cause migration: this variable is excluded from most regressions in this paper and is discussed separately. Average temperature, altitude, distance from the sea, and latitude were included where the specification allowed for identification of state-fixed effects (see discussion below).

4.61 All the results we report in this section come from most efficient and consistent estimation technique available.[71] Similar results were generated from simpler but less econometrically defensible estimation techniques such as ordinary least squares with state-cohort fixed effects, although where there was divergence in results we weaken our conclusions accordingly.

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[70] The definition of the formal sector in Brazil is standard, and is taken to mean that the worker has an "employment booklet" that is signed by his or her employer (*carteira assinada*). The booklet implies that the employment relationship is registered at the labor ministry and that the employee is therefore eligible for a certain set of employment-related benefits such as social security, severance pay, and unemployment insurance.

[71] All reported estimates were estimated using first-difference or quasi-first difference generalized method of moments (GMM) estimation. In first difference specifications, variables that are not strictly exogenous are instrumented with lagged levels of right-hand side variables, following the methodology proposed by Arellano and Bond (1991).

Table 4.1
Summary of Variables Used

Variable Name	Description	Mean	Standard Deviation
Dependent Variables	*NB. "cell" refers to by-state by-cohort groupings.*		
Delta	Difference in mean log income in cell over the year	0.0317	0.231
Delta25	Difference in mean log income of the poorest quartile	0.0215	0.231
Quality	Difference in differences: Delta25-Delta	-0.0119	0.159
Weakly Exogenous Variables			
Educ	Average completed years of schooling of household head	3.51	1.57
Primary	Fraction of cell with completed primary education	0.691	0.189
Middle School	Fraction of cell with completed lower secondary education	0.154	0.125
High School	Fraction of cell with completed high school education	0.103	0.076
College	Fraction of cell that attended college	0.052	0.042
Public Admin	Average years of education of state's public employees	7.14	2.62
Political	Sum of squares of changes in parties' vote shares	0.411	0.287
Policy	Indicator of change in political leaning of governor	0.529	0.499
Elecric	Percentage of electrification in the state	0.773	0.169
Trash	Penetration rate of garbage collection in the state	0.500	0.200
Industry	Fraction of households in cell with industry employee	0.190	0.108
Agriculture	Fraction of households in cell with agricultural employee	0.326	0.136
Services	Fraction of households in cell with services employee	0.366	0.139
Urban	Fraction of cell that lives in an urban area	0.659	0.144
Formal	Fraction of households where head formally employed	0.216	0.150
Rain	Annual rainfall (cm)	103.1	24.6
Latitude	Average Latitude of the State (degrees)	13.34	7.10
Altitude	Average Altitude of the State (m)	328.6	164.9
Distance	Average distance from the sea (km)	226.1	204.2
Migration	Fraction of popualation that immigrated from out of state	0.146	0.109

Table 4.2
Evolution of Selected Variables

Variable	1981	1985	1989	1993	1998
Log Income	4.41	4.48	4.52	4.50	4.91
Log Poor Income	3.51	3.56	3.48	3.44	3.84
Education	3.22	3.36	3.47	3.66	3.90
Primary	0.779	0.738	0.691	0.658	0.583
Middle School	0.106	0.125	0.152	0.176	0.212
High School	0.0640	0.0910	0.105	0.114	0.142
Tertiary	0.0506	0.0454	0.0524	0.0525	0.063
Public Admin	6.99	6.62	6.91	7.15	8.06
Elecric	0.620	0.694	0.772	0.840	0.900
Trash	0.336	0.423	0.477	0.585	0.673
Industry	0.258	0.202	0.196	0.160	0.128
Agriculture	0.354	0.379	0.332	0.300	0.268
Services	0.376	0.403	0.428	0.309	0.287
Urban	0.615	0.627	0.640	0.703	0.709
Formal	0.294	0.273	0.258	0.161	0.117

Average Income Growth

First Difference Estimates Controlling for State-Fixed Effects

4.62 The first column of Table 3 reports coefficients from the regression of observations on overall income growth, pooled over the whole period, on the right-hand side variables. The corresponding OLS specification in first-differences explained 67 percent of the variation in income growth, a high proportion for quasi-panel data. The significant effects are from average years of education, the political and policy variables, the penetration rate of garbage collection, and the level of employment in industry and services (that is, in relative terms, agriculture fared poorly).

4.63 Many studies find positive relationships between the level of education and income (whether analyzing households, countries, or other levels of aggregation): all of the literature on returns to education falls within this category, for instance. Yet, in the instance of our education coefficient, this is not what we are reporting, but rather a significant positive relationship between the *initial level* of education (of an age cohort in a state) and the subsequent *rate of growth* of income (of that age-cohort in that state). It is far less obvious that we should expect to find such a robust effect in the Brazilian data (the coefficient is also large: approximately 0.1, implying an extra year of average education completed increases subsequent income growth by ten percent).

4.64 Similarly, it is worthy of note that political and policy uncertainty both have the expected signs and are significant. States with uncertain political outcomes, or where the governorship moved between different points on the ideological spectrum, grew more slowly.

4.65 The effect of the variable *trash* is interesting. This variable is a proxy for public provision of infrastructure. The interpretation of this effect is of a direct effect of the level of infrastructure on productivity growth. This effect could also be viewed as an indicator of geographical effects: the same people have higher income growth from living in a richer location. Finally, the effects on growth of the proportion of household members working in industry and services are not robust across time-periods or across specifications, so we will not dwell on these at this point.

4.66 The second column of Table 3 reports the coefficients from the same estimation restricting to the later two sub-periods described earlier, covering 1989-98.[72] The education effect is almost identical, while the infrastructure effect (from *trash*) is still significant though smaller. There is also now a significant effect from the other infrastructure variable, the level of electrification of the state. Political uncertainty increases its negative effect, while policy uncertainty does not appear significant. There is now a higher significant positive effect from the proportion of employment in services, as opposed to industry or agriculture.[73] This difference in the behavior of the sector variables across the two periods (1981-98 versus 1989-98) may reflect the true underlying differences in productivity growth across time. It has been reported in other countries that much

[72] It would be desirable from the point of view of contemporary relevance to restrict even further to, say, the period 1993-98, but this is not feasible econometrically since the methodology being used relies on having enough variation in the regressors across time to identify effects.

[73] These differences were not robust across specifications (OLS with state-fixed effects, OLS in first differences).

recent productivity growth has occurred in services relative to manufacturing industry. Finally, there is a significant positive effect from the proportion of workers in the formal sector.[74]

Table 4.3
Coefficients (absolute Z-values)[75] from Income Growth Equations

	I	II	III	IV
Period	**1981-98**	**1989-98**	**1981-98**	**1989-98**
Dependant Variable	***Delta***	***Delta***	***Delta25***	***Delta25***
Coefficients				
Educ	0.103**	0.104**	-0.0076	-0.024
	(7.20)	(6.38)	(0.51)	(1.29)
Public Admin	0.0068**	0.0034	-0.0002	-0.0020
	(3.37)	(1.36)	(0.10)	(0.82)
Political	-0.044**	-0.055**	-0.042**	-0.051**
	(2.27)	(2.93)	(2.23)	(2.63)
Policy	-0.013**	-0.0017	-0.0062	-0.0002
	(2.61)	(0.16)	(1.09)	(0.02)
Electric	0.126	0.343**	0.095	0.402**
	(1.44)	(3.12)	(1.10)	(3.68)
Trash	0.361**	0.605**	0.194*	0.264*
	(4.04)	(4.79)	(1.71)	(1.73)
Industry	0.177*	0.361**	0.106	0.183
	(1.95)	(1.98)	(1.09)	(0.93)
Agriculture	0.152	0.334**	-0.021	0.092
	(1.38)	(2.37)	(0.22)	(0.63)
Services	0.209**	0.591**	-0.080	0.074
	(1.97)	(4.00)	(0.75)	(0.51)
Urban	-0.038	-0.324**	-0.071	-0.223
	(0.32)	(2.06)	(0.59)	(1.39)
Formal	-0.083	0.085	-0.156	-0.144
	(0.74)	(0.54)	(1.28)	(0.79)
Lagged depvar	0.334**	0.327**	0.153**	0.233**
	(12.76)	(9.31)	(4.19)	(5.32)
R squared from OLS	0.67	0.52	0.63	0.43
Number of obs.	2890	1853	2890	1853
Number of groups	190	190	190	190
Mean no. periods	15.2	9.8	15.2	9.8

[74] This effect was absent from the OLS specifications and also from the longer time period.

[75] All statistics are calculated from robust standard errors.

Income Growth among the Poor

First Difference Estimation Controlling for State-Fixed Effects

4.67 Column III of Table 3 reports coefficient estimates using the sample from the whole period restricting to the poor.[76] The results are strikingly different from column I.

4.68 First, education does not appear to be significantly correlated with income growth among the poor. We repeat here that education is undoubtedly correlated with income for this sample of households, but not necessarily with its subsequent rate of growth. Political uncertainty, however, appears with almost an identical negative coefficient to that in column I. Next, the infrastructure effects are attenuated, though similar in pattern to column I. Finally, there are no marked effects from the sector-composition of employment. All in all, for the period 1981-98, income growth among the poor seems harder to explain than it is among the population at large.

4.69 Column IV reports the same results for the period 1989-98. The education effect is again absent, while the effects of political uncertainty are heightened. The infrastructure variables seem to swap roles relative to column II, with electrification (*electric*) highly significant, *trash* less so. There is no significant effect among the sector variables, although the highest point estimate is on the industrial employment variable.

4.70 Taken together, these results suggest that there is far less systematic correlation between state-cohort characteristics and economic growth among the poor than there is in the economy as a whole. This is in itself an interesting finding. One may now ask is whether the differences between the coefficients for the two groups are significant. Since the *difference between income growth* among the poor and among the whole population is precisely our measure of the equality *of growth* from the previous section, this amounts to regressing our equality measure on the same variables.

The "Equality of Growth" and Possible Tradeoffs

4.71 This brings us back to the notion discussed earlier, and common in economic debates since Kuznets, that there may be tradeoffs between the pursuit of economic growth as an end in itself, and the distribution, or equality, of that growth. To the extent that individual variables appear with a significantly smaller coefficient in poor income growth regressions than in general income growth regressions, these variables may be thought of as micro-level incidences of such tradeoffs.

4.72 The first column of Table 4 shows the results from regressing growth equality on the RHS variables. As expected given the results so far, educational attainment appears with a highly significant negative coefficient. For the period 1981-98, improvements in education across the Brazilian states seem to have benefited the population as a whole more than they have benefited the poor. On the other hand, industrial employment appears with a significantly "better" positive coefficient than employment in either agriculture or services. Over the whole period industrial

[76] The definition of poor in this section for the purposes of calculating income growth is the same as that used in the previous section, namely the poorest quartile of individuals in the data.

employment was significantly correlated with income growth (Table 3), and moreover its differential effects relative to agriculture and services have been greater among the poor. There is also a small but significant effect of policy stability on the income distribution. Finally, the quality of public administration seems also to have had a slightly inequitable incidence on growth, though the point estimate of this effect is very small.

4.73 The corresponding results restricting to the later period of 1989-98 are reported in Table 4, column II. The results are similar, suggesting that the effects reported in the last paragraph are not solely owing to the 1980s period in the data. In 1989-98, education again appears to have greater growth effects on average than among the poor. The main differences between the 1990s and the whole period lie in the sector and infrastructure effects. Services now appear with a significantly larger negative coefficient, that is, it appears that services income growth has not benefited the poor relative to the whole population. Finally the variable *trash*, proxying for local infrastructure, now appears with a significant negative coefficient.

Table 4.4
Coefficients (absolute Z-values) from Equality Equations

	I	II	III	IV
Period	**1981-98**	**1989-98**	**1981-98**	**1989-98**
Dependant Variable	***Equality***	***Equality***	***Relative Equality***	***Relative Equality***
Coefficients				
Educ	-0.114**	-0.135**	-0.113**	-0.144**
	(7.93)	(7.44)	(6.00)	(6.05)
Public Admin	-0.0052**	-0.0040	-0.0044*	-0.0051
	(2.62)	(1.59)	(1.86)	(1.60)
Political	0.0135	0.0136	-0.037	-0.0087
	(0.65)	(0.65)	(1.01)	(0.24)
Policy	0.0117**	0.0059	-0.015**	-0.0008
	(2.21)	(0.48)	(2.00)	(0.05)
Electric	-0.151	-0.131	-0.129	0.052
	(1.62)	(1.15)	(1.08)	(0.29)
Trash	-0.124	-0.281**	-0.271*	-0.590**
	(1.21)	(2.17)	(1.85)	(2.74)
Industry	-0.118	-0.358*	-0.145	-0.312
	(1.31)	(1.72)	(1.05)	(1.23)
Agriculture	-0.299**	-0.469**	-0.667**	-0.887**
	(3.46)	(3.35)	(4.25)	(3.44)
Services	-0.313**	-0.559**	-0.431**	-0.608**
	(2.78)	(3.71)	(3.09)	(3.04)
Urban	-0.068	0.093	-0.309*	-0.110
	(0.50)	(0.46)	(1.65)	(0.42)
Formal	-0.066	-0.059	-0.063	-0.129
	(0.58)	(0.34)	(0.38)	(0.52)
Lagged depvar	0.170**	0.168**	0.139**	0.214**
	(4.60)	(3.93)	(3.13)	(3.93)
R squared from OLS	0.28	0.26	0.24	0.23
Number of obs.	2707	1685	2707	1685
Number of groups	171	171	171	171
Mean no. periods	15.8	9.9	15.8	9.9

The "Relative Poor"

4.74 Columns III and IV of Table 4 explore a further concept of income distribution: that of the equality of growth interpreted as its incidence among the poorest 25 percent *within each state*. This changes the emphasis from the income distribution at a national level to the distribution at the level of the individual states. The person at the 25 percent point of the income distribution in São Paulo, for example, is above the extreme poverty line used for this and other studies.[77] On the other hand, much more than 25 percent of the population of, say, Ceará fall below this poverty line (indeed more than half do). As a convenient shorthand for this state-level concept of income distribution, we shall label people falling within the poorest quartile of their state as the "relative poor" as opposed to the "absolute poor" whom we define nationally. It is worthwhile to check whether the same broad results hold if one interprets poverty as "relative" rather than "absolute" in this sense.

4.75 The answer seems to be that the results do not change very much, with two exceptions. As column III (Table 4) shows, for the whole period 1981-98, the policy uncertainty variable now appears with a significant negative coefficient. Also, relative to column I, agricultural employment was significantly less pro-poor (in our newly relative terms) than was industry.

4.76 For the period 1989-98 the picture is not dissimilar, even if the coefficients alter somewhat. Education and infrastructure (through garbage collection as opposed to electrification) again appear with negative coefficients. Agricultural employment again seems to be the precursor of inequitable growth, with an even higher negative coefficient than for the whole period.

Distinguishing between Levels of Education

4.77 Since the results regarding education of the analysis so far are robust and also important from a policy perspective, we now proceed to assess differences by education level. Table 5 reports coefficients from equations that included measures of the development of different levels of the education system (primary, lower secondary, high school, and college). Since we are mainly interested in the *differential* effects of the various levels of education, the coefficients we report are the differences between the effects of secondary, high school, and college attendance measures and those related to no education or just some primary school attendance. Moreover, for digestibility we restrict to the period 1989-98 and omit mention of all the other coefficients. The results for the other coefficients are anyway very similar to those reported in Tables 3 and 4, and we wish to concentrate the remainder of this section on the analysis pertaining to education.

4.78 Column I reports the results of the general income equation estimation, while column II restricts to the (absolute) poor. Column III then reports the point estimates of the effects of the different levels of education on our measure of equality. Column IV (analogous to columns III and IV of Table 4) investigates the notion of relative equality defined above.

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[77] The poverty line is defined in absolute terms at R$65 (measured in São Paulo in 1997), and adjusted for regional price variations (Azzoni and Menezes-Filho, 2000). Since the poverty rate measured this way varies a great deal across states, there is a significant difference between the concepts of absolute and relative poverty as defined in the text.

4.79 Where the results are significant, they are what one might expect. College enrollments, despite their positive (though statistically insignificant) effect on income growth, increase subsequent income inequality in these data. This may not seem surprising, but taking the data at face value nonetheless reinforces the message that policy makers be aware of the distributive consequences of investments in tertiary education.

4.80 Beyond this, the results of splitting education by levels are quite clear. Upper primary education enrollments correlate with subsequent improvements in the income distribution (the coefficients are relative to the omitted category of primary education enrollment). Secondary and tertiary enrollments correlate with subsequent deterioration in the income distribution, whether measured according to a national or a state-relative definition. There is a general pattern from positive distributive impacts towards negative as one moves up through the levels, as one would expect.

Table 4.5
Analyzing Levels of Education

°	I	II	III	IV
Period	**1989-98**	**1989-98**	**1989-98**	**1989-98**
Dependant Variable	***Delta***	***Delta25***	***Quality***	***"Relative" Equality***
Coefficients				
Secondary	-0.018 (0.46)	-0.031 (0.68)	0.241** (1.97)	0.219 (1.39)
High school	-0.023 (0.36)	-0.0059 (0.08)	-0.391** (3.49)	-0.291** (2.39)
College	0.160 (0.80)	-0.143 (0.83)	-0.396* (1.68)	-0.278 (1.11)
... other coefficients not reported				
R squared (OLS-FD)	0.47	0.42	0.18	0.17
Number of obs.	1845	1845	1685	1685
Number of groups	190	190	171	171
Mean no. periods	9.7	9.8	9.9	9.9

Location and International Trade

Augmenting the Model with State-Fixed Variables: Quasi-First Differences

4.81 This section addresses three more of the hypotheses enumerated at the beginning of the paper. These concern trade, migration, and geographical location (climate, latitude, and altitude).

4.82 Since these variables are fixed in time, or are so for practical purposes because they are only available for certain years in our data, the estimation strategy of the previous section, which relies on taking first differences of the data in consecutive years to control for all state-fixed effects (which simultaneously rules out identifying them), is inapplicable. However, following the approach of Holtz-Eakin, Newey and Rosen (1988), a workable alternative is at hand. The main element is that by allowing state-fixed effects to be non-stationary (time-variant), the model is generalized to encompass the state-fixed effects model as a testable restricted form. This more general specification is known as Quasi-First Difference estimation (QFD). If the restricted stationary fixed

effects form is rejected (as it is in our data), this allows the effects of other time-invariant variables (such as geographical location) to be identified by the estimation.

4.83 Table 6 gives the coefficients from a QFD specification including location and trade variables. Rather than repeat the list of all coefficients, we focus here on those variables that this specification is designed to identify. Column I shows the estimation of average income, column II average income among the poor, column III the difference-in-differences definition of the "equality" of growth. The period of estimation is 1984-98 owing to the use of lags of the variables as instruments in the estimation. Columns IV, V, and VI show the equivalent results restricting to the 1990s (1989-98).

Table 4.6
Coefficients (absolute t-statistics) from QFD Growth Equations

	I	II	III	IV	V	VI
Period	**1984-98**	**1984-98**	**1984-98**	**1989-98**	**1989-98**	**1989-98**
Dep. Variable	***Delta***	***Delta25***	***Equality***	***Delta***	***Delta25***	***Equality***
Coefficients						
Temp	0.116 (0.66)	0.0157 (0.94)	-0.0142 (0.85)	-0.0048 (0.16)	-0.0231 (0.86)	-0.0470 (1.60)
Rain	-0.0017 (0.10)	0.0018 (0.10)	0.0080 (0.48)	0.0545* (1.66)	0.0645* (1.71)	0.0074 (0.17)
Latitude	0.0133 (0.83)	0.0006 (0.03)	-0.0043 (0.31)	0.038 (1.31)	0.0455 (1.57)	0.0044 (0.15)
Altitude	0.0005 (0.10)	0.0010 (0.21)	-0.0073 (1.39)	0.0057 (0.74)	-0.0033 (0.48)	-0.0165* (1.82)
Distance from the sea	-0.0072* (1.77)	-0.0016 (0.41)	0.0103** (2.61)	-0.0187** (2.96)	0.0001 (0.01)	0.0281** (3.53)
Number of obs.	2550	2550	2550	1695	1695	1695
Number of groups	171	171	171	171	171	171
Mean no. periods	14.9	14.9	14.9	9.9	9.9	9.9

4.84 There is evidence of trade and climate effects in income growth overall, though not among the poor. Most noticeable is the negative effect of distance from the sea on income growth, an effect that became more marked in the 1990s. We interpret this effect as possibly one of international trade, and it suggests that the importance of trade for income growth has increased for Brazil, a result that is intuitive given the lowering of tariff barriers in the early 1990s. However, the incomes of the poor do not show sensitivity to trade access, giving some succor to the view that opening to trade has not helped the poor. The result is confirmed in the inequality regressions (columns III and VI): the positive coefficient on distance in our interpretation implies that access to markets has increased inequality in Brazilian household income, with the effect larger and more significant in the 1990s. These conclusions are highly tentative and will form the focus of further investigation, since distance from the sea in Brazil may be capturing factors other than access to foreign markets, given the proximity of all the main metropolitan centers to the coast.

4.85 There is a weak effect of rainfall on income in the 1990s (column IV), in the direction one might expect (higher rainfall raises income growth). This effect is approximately equal for poor and

non-poor alike (columns IV and V), reflected in the absence of any relation between rainfall and inequality (column VI). Turning this around, this suggests that low rainfall hurts the poor proportionately (or even a little more than the average if one uses the point estimates, although the difference between them is not at all statistically significant), justifying public interventions in times of drought on the equity grounds. We would not make too much of this result: it probably did not require sophisticated econometrics to draw this conclusion.

Migration

4.86 Estimates of the effect of migration in these data suffer from two problems. First, migration figures have only been calculated for two years of the data, so much of the time variation in this variable remains unobserved. Second, as a consequence, it is not possible to structure a convincing specification that sorts out the particularly severe problems of endogeneity that this variable poses. Migration is clearly a choice that is made in response to incentives, part of which are the relative expected economic opportunities offered by point of departure and destination. This induces correlation between future economic activity and inward migration, even in the absence of a causal effect running from migration to subsequent growth.

4.87 We nevertheless ran one specification of the regressions including the migration variable, and found that migration into a state is not correlated with subsequent growth in average household per capita income in the period.

IV. Policy Implications

A Return to the Hypotheses

4.88 Let us now return to the policy hypotheses we listed at the beginning of this paper. How strongly have they been supported by the empirical analysis presented in the last section? Part of the aim of the present study is to attempt to offer some priorities in terms of public action, so we impose our own interpretation on the extent to which the evidence on each question is convincing in this context.

Education Constraints: Strong Evidence

4.89 Education is playing a large role in the story of present-day Brazilian growth. The pattern of growth in the 1960s and 1970s, based upon industrialization and urbanization, may have allowed for growth without education, but all the evidence is that those days are gone.

4.90 The strongest effect found in the data is for upper primary education. Primary enrollment is now nearly universal in Brazil, so the strongest implication of the education results is for states to concentrate on keeping primary school children in school longer. This will probably entail increasing the quality of primary education while expanding access to upper primary and secondary. Importantly, the analysis of poor-income growth suggests that this will be one of the only ways of increasing the pro-poor pattern of growth and reducing the growth-inequality tradeoff that has been apparent in Brazil for most of the last two decades.

The Investment Climate: Strong Evidence

4.91 The coefficient on policy uncertainty has been robustly significant, as has that on the educational level of public employees. The policy conclusions to draw from such evidence are a little less obvious than in the case of education. It would be unhelpful to suggest that policies never be changed. And there are obviously limits to the educational levels one would expect to find at certain levels of local government.

4.92 Nonetheless, the evidence accords so strongly with what investors and entrepreneurs actually say, that it is hard to avoid the conclusion that uncertainty and public governance are serious issues. Other recent work has examined issues of public governance in relation to private sector activity, and here we defer to these authors for a detailed assessment of Brazil's policies (see Soh, 2001, and Foreign Investment Advisory Service, 2001).

Infrastructure Bottlenecks: Strong Evidence

4.93 Our data are not ideally suited to identifying infrastructure growth effects, since the measures of infrastructure we might expect to have the strongest growth effects—roads, ports, agricultural irrigation—are absent. Nonetheless, electrification does seem to have a strong impact on subsequent household income growth, an impact that is at least larger on the income of the poor than on the whole population. Trash collection also has a strong positive impact, though in the case of this variable the effect is lower on poor-income growth than on average.

Labor Rigidities: No Evidence

4.94 The interpretation of the coefficients on our *formal* variable is anyway problematic, as we discussed in the earlier section on hypotheses, but since this variable does not seem to play a significant role in determining subsequent income growth, we shall not dwell on the matter. Brazil's labor code is the subject of much debate, and will probably also be modified in the years to come. It may affect Brazil at a national level. But variation between income growth rates across states do not reveal any effect at the state level.

Climatic Constraints: Weak Evidence

4.95 A long strand of economic literature posits that some countries are geographically doomed to lower growth rates owing to climatic conditions that impede economic activity. The most common evidence cited is the negative coefficient on "tropical" dummy variables in cross country growth regressions. We therefore investigate whether rainfall, latitude or altitude are associated with differences in income growth rates.

4.96 There is also evidence of the effect of rainfall on economic growth. This is not surprising: rainfall affects the Brazilian economy through its large agricultural sector (and more recently through the availability of hydroelectric energy, although this effect was probably absent in the period covered by our analysis). Rainfall effects are equally or even slightly more strongly felt among the poor than on average.

Domestic Interstate Trade: No Evidence

4.97 The volume of trade with other Brazilian states showed no relation with subsequent income growth in our data. Since barriers to trade between states are not great, this would not seem to be a concern for policy makers.

International Trade and Access to Markets: Weak Evidence

4.98 Brazil's economy, despite lowered tariffs in the 1990s, remains relatively closed. There is also variation in the distance to major markets among the states. If integration were constraining growth, we would expect to see those states furthest from markets, and those trading least, growing more slowly (*ceteris paribus*). In the data we use distance from the sea as a proxy for market access to attempt to test for the effects of trade.[78]

4.99 Distance from the sea is significantly associated with lower economic growth on average, though not among the poor. Thus, if one accepts the plausibility of distance from the sea as a proxy for market access, one is left with the plausible if worrying conclusion that trade promotes economic growth in Brazil, but that the poor tend not to benefit from the growth so generated. This would suggest that arguments favoring trade liberalization are right, as are concerns about protecting those whose economic activities suffer rather than benefit from increased openness, paying attention to social safety nets, etc.

4.100 These tests are clearly not perfect, however, and we would be unwilling to emphasize policy conclusions based only on one regression result. There is, however, a wealth of other evidence on this question both worldwide and for Brazil, with perhaps the most convincing to be found in Moreira and Correa (1998). Cohen (2001) also suggests that increased trade openness in the absence of flexible labor markets increases inequality.

Agglomeration and Spatial Factors: Weak Evidence

4.101 A principal finding of our research is of slow but significant unconditional convergence between Brazilian states in the late 1990s. Our first-order results therefore do not support the notion that spatial poverty traps are an inescapable fact in Brazil.

4.102 Within states, there is of course considerable variation in local conditions, and here our results, discussed above, for infrastructure variables may be seen as evidence of spatial poverty traps (in the spirit of Jalan and Ravallion, 2000). However, we prefer to interpret these results as supporting infrastructure provision per se, rather than emphasizing the spatial interpretation of these coefficients.

4.103 Finally, in the 1990s there has been a negative relationship between the level of urbanization (the number of households classified in the PNAD as in urban areas) and the rate of economic growth. Combined with empirical evidence that migration to Brazil's largest metropolitan poles is subsiding (Fiess and Verner, 2001), this evidence accords with the notion that urban

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[78] We also experimented with interstate trading volumes as a proxy for integration into the national economy, but there was no evidence that this played a significant role in growth.

problems—considerations of security and congestion in particular—are having a significant economic impact in today's Brazil. This, combined with the findings in favor of convergence (albeit not rapid), constitutes the opposite of the "agglomeration" result—higher economic growth in cities owing to network externalities—that we were expecting.

Sector Composition: No Evidence

4.104 Industrial growth has seemed to favor poor-income growth slightly more than growth in services and agriculture, although the effects are not very robust to the estimation specification used. Otherwise there were not systematic differences between growth rates associated with industry, services, or agriculture.

Migration: No Evidence

4.105 Brazil's economic miracle was founded upon urbanization, the transformation of the productive base from traditional industries towards manufacturing, and migration, particularly from the Northeast to the Southeast of the country (see Gordon, 2001). Recently these migratory flows have diminished and in some cases reversed (Fiess and Verner, 2001). It is an interesting question, though hard to answer convincingly, to what extent this has been a causal factor in Brazil's economic slowdown.

4.106 The question is hard to answer because opportunities for income growth cause and are caused by migration, and so most attempts to assess causality are doomed to ambiguity. We analyzed partial correlation between migration and income growth, without addressing causality. But the results show no correlation between migration into a state within a cohort and subsequent income growth for that cohort in the state. In the absence of such correlation, the question of causality is moot. The result casts doubt on any public policy that places too heavy a reliance on migration to alleviate the problems of the poor.

Main Messages

4.107 Policy recommendations should only follow from a greater body of evidence, of which the present study represents a small part. What follows can therefore be but suggestive.

4.108 Convergence has only occurred to an appreciable extent since stabilization. It is already fairly well accepted in Brazil that the eradication of inflation held great benefits for the poor, and this is a large part of the explanation for the stronger convergence during the years 1993-96 in the state data. The stable environment that followed has also led to steadier economic growth, and the data in all periods show that there is a clear correlation between income growth widely defined and the income growth of the poor.

4.109 Income growth among the poor is harder to explain than among the population at large. Whereas education, infrastructure, and political variables (in initial levels) are correlated with subsequent general income growth at the state-cohort level, the relationships are much harder to detect for the poor. This is not related to sample size, since the point estimates of the coefficients

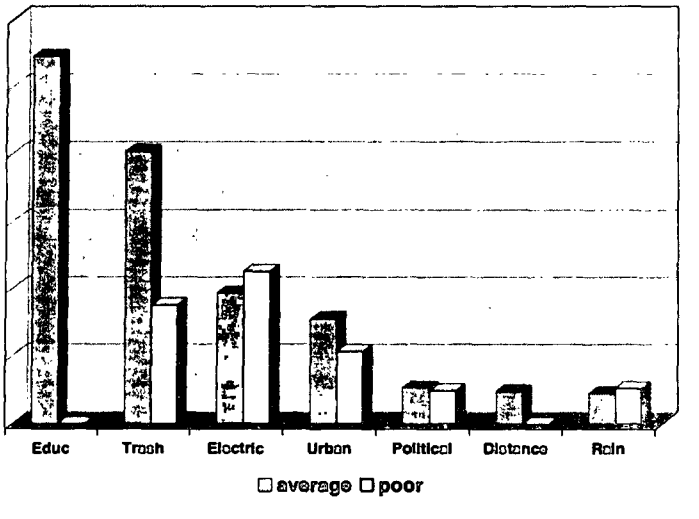
are lower in magnitude in the latter case, and averaging within cells implies that the two sets of regressions are run on sets of observations of very similar size.

4.110 The differences in coefficients in turn suggest that there may be policy tradeoffs between growth and equality. The tradeoff that stands out most in our data is that associated with investments in education. The education variable used for most of the analysis (average completed years) does not necessarily reflect the success or failure of public education policies to increase the human capital of the poor, since it may be responding more over time to changes in levels of schooling in the middle income brackets, at the national level. But the results suggest the need for vigilance to ensure that public efforts in education do not simply benefit the upper three-quarters of the income distribution. In particular, they suggest that making sure that the poor stay in school beyond the first few years of primary school is central for growth, the reduction of inequality, and the reduction of poverty. Other investments in education have so far had more inequitable effects.

4.111 Infrastructure investments are also important determinants of growth, and the two we have focused on in differ in their effects on the poor. Electrification has been a gradual process in rural areas, but its marginal effects appear to be as strong for the poor as for the average household. Trash collection also has positive growth effects, although these are less equitable. There is evidence that this source of inequity has become more acute in the 1990s, as growth has picked up. Certainly the conclusion should not be that Brazil lessen its commitment to extend basic infrastructure to its population. But again, vigilance may pay off in setting priorities if the most benign distributive effects are desired.

4.112 It bears repeating that some of the conclusions from the PNAD about economic growth over the period 1981-98 are extremely robust. The general level of education appears to have had a very strong relationship with subsequent economic growth. This relationship appears with the same broad magnitude regardless of the estimation technique or the period. Moreover, variables reflecting political and policy uncertainty or variability detract significantly from growth at the state level. This effect echoes arguments that are often made in policy discussions, but as far as we know there are not many such strong empirical confirmations of the effects.

Figure 4.10
Representation of Effects of RHS Variables
(Response of Income Growth to a One Standard Deviation Improvement in the Variable)



Closing Remarks

4.113 The approach used here is new in several ways. First, it isolates the effects of economic activity on labor income, the most important income source for the average citizen, rather than national income aggregates, which may correspond less closely with the welfare of individuals. Second, we have presented a deeper analysis of the distributional dimension of the growth process in Brazil than has been undertaken until now. This approach may be tailored in future work to address, for example, the concerns of individual states about their economic performance. It turns out that the income dynamics of the poor, though similar in the aggregate to those of the whole population, show distinct microeconomic effects (see Figure 10). This suggests that, while to a first approximation growth is good for all, there are tradeoffs in policy composition between growth and how "fair" that growth is perceived to be.

4.114 This said, these results should *inform* rather than *form* public policy in the absence of more detailed assessments of policies and experiences. The PNAD data have too many shortcomings, and econometric results do not imply policy recipes. Nonetheless, we believe that the analysis of the pro-poor incidence of income growth is an important step.

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PART II

POLICY FOCI

5. BRAZIL AND THE KNOWLEDGE ECONOMY

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I. INTRODUCTION

5.1 Growth in Brazil over the last two decades has been slower than the world average. Unlike Brazil, large economies like India and China, and most East Asian and Pacific developing economies have significantly increased their shares of global GDP (Table 5.1).[79] In trade, Brazil has lost market share in exports (Table 5.2),[80] and its export structure is based on commodities, while most the rest of the world's trade is primarily in manufactured products (Table 5.3).

5.2 Now that Brazil is regaining macroeconomic stability, its strategic focus is shifting to the longer term. This is important because the global context has changed in fundamental ways. We are in the midst of what could be called a "knowledge revolution," [81] with major implications for Brazil's strategy: these will be outlined in this chapter.

5.3 The next section lays out some trends of the knowledge revolution and their implications for Brazil. It argues that to make effective use of knowledge for its development, Brazil can make improvements in four inter-dependant areas: the economic incentive and institutional regime, education and skills, the information and communications infrastructure, and the innovation system. The third section analyses Brazil's innovation system in more detail. The fourth section examines the information and communication infrastructure.

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[79] Average GDP growth for East Asia and Pacific developing economies was 8.0 percent during 1980-1990 and 7.5 percent during 1990-1999.

[80] According to cross country ratings of competitiveness done annually by IMD, a management institute based in Switzerland, Brazil's rank varied between 33 and 37 during the past few years. In 2000 it was ranked in 34 among 47 countries, up from 37 in 1998 and 35 in 1999. See IMD, *The World Competitiveness Yearbook 2000.*

[81] The terms "new economy", "digital economy" and "knowledge economy" are currently used interchangeably, and usually focus on the creation and use of ICTs. We have chosen a broad definition of the knowledge-based economy that includes not only ICTs and industries dependent on R&D, but also covers the use of technical, policy, and social knowledge for economic activities. However, this not as broad as other definitions, for example, that of the "knowledge society," which includes spiritual, social, intellectual and philosophical knowledge.

Table 5.1
Growth of Gross Domestic Product, Brazil versus other Countries 1980-1999

	1980-1990	1990-1999
Low Income	4.7	3.2
India	5.8	6.0
Lower Middle Income	4.2	3.4
China	4.2	7.2
Upper Middle Income	2.6	3.6
Brazil	2.7	3.0
High Income	3.4	2.3
USA	3.6	3.3
World	3.4	2.5

Source: WDI 2001, Table 4.1, pp.194-6.

Table 5. 2
Brazil's Share of World Markets: 1980-1996

Products	1980	1984	1990	1996
Basic	6.1	6.9	5.4	5.1
Industrialized	0.81	1.21	0.80	0.79
Total	1.3	1.7	1.1	1.0

Source: Horta e Souza (2000) cited in Frischtak 2001, p. 5.

Table 5.3
Composition of Merchandise Exports, Brazil and other Countries 1999

	Food	Agricultural Primary Products	Fuels	Ores and Minerals	Manufactured Goods
Low Income	15	3	20	3	52
India	17	2	0	2	76
Lower Middle Income	9	2	15	5	62
China	6	1	2	2	88
Upper Middle Income	10	2	10	4	73
Brazil	29	5	1	10	54
High Income	7	2	3	2	82
US	8	2	5	3	79
WORLD	8	2	5	3	79

Source: WDI 2001, Table 4.5, pp. 210-212

II. Brazil and the Knowledge Revolution

The Knowledge Revolution and Global Competition

5.4 A new consideration for policy makers is the speed of changes in production and dissemination of knowledge made possible by increasing scientific understanding and advances in information and communications technologies (ICT). The cost of voice transmission circuits has dropped by a factor of 10,000 over the last 20 years and computing power per dollar invested has risen by a factor of 10,000 over the same period. The ICT revolution, in turn, is increasing the power of electronic networks as research tools, permitting a larger set of new technologies. This is also having a major impact on business and social interactions.

5.5 The rapid development and spread of knowledge facilitated by technical progress and the ICT revolution is creating a more competitive and interdependent world. The share of world trade (exports and imports) in world GDP increased from 28 percent in 1970 to 52 percent in 1999 (World Bank, 2001).[82] Beyond trade, there is greater interdependency and competition through foreign direct investment (FDI). Sales in 1999 by foreign affiliates of transnational corporations were estimated at $13.6 trillion, roughly twice the $6.9 trillion of world exports. Globalization is even higher when account is taken of international sourcing of production inputs and inter-firm alliances, including the internationalization of R&D and technology licensing activities. Globalization is largely being driven by investments in R&D made by transnational companies. Estimates are that between 75 percent and 80 percent of all global R&D is being made by transnational corporations.

5.6 The knowledge revolution also requires large investments in intangibles such as marketing, design, and distribution. It is estimated that in advanced OECD countries, investments in intangibles, including R&D (about 2.2 percent of GDP) plus patents and licensing, design, marketing, education, training, and software may represent as much as measured GDI.[83]

5.7 Even in industries characterized as low- or medium-technology, technical knowledge and the associated organizational changes increasingly provide the edge in productivity and product differentiation. Traditional industries, such as textiles, cement and steel now use new technical knowledge and information systems to improve design and quality, production processes, and the efficiency of marketing and distribution. Likewise, in agriculture, better understanding of plant reproduction and growth, genetic engineering, and techniques for harvesting, storing, transporting and distribution affect the value of plant and animal products. Transportation, distribution, finance, insurance, health and education themselves are becoming increasingly knowledge intensive. What matters more than technology creation is the effective use of technology and knowledge throughout the economy.

5.8 While, in principle, the globalization of trade, finance, and information flows may make it easier to narrow knowledge gaps across countries, the accelerating pace of change and the difficulties of many developing countries in getting started may bring about the opposite—a widening "knowledge divide." Capital and other resources could flow to those countries with stronger knowledge bases, reinforcing inequality (World Bank, 1999c). Brazil's challenge is to develop a strategy that maximizes the potential benefits and minimizes the risks.

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[82] The direct role of technology in this process is reflected in changing patterns of trade. Between 1976 and 1996, the share of high- and medium-technology products increased from 33 percent to 54 percent of total goods traded. The share of primary commodities fell from 34 percent to just 13 percent, while that of resource-based products remained constant. These trends have major implications for developing countries, which are primarily exporters of primary commodities. Both the share and the prices of their exports have been falling for five decades.

[83] For the OECD as a whole, investments in a subset of these intangibles—R&D, public education, and software—is 7.9 percent of GDP: comparable with average investment in plant and equipment (8.6 percent of GDP).

Key Elements of the Knowledge-Based Economy

5.9 The effective use of knowledge and information is becoming the most important factor for productivity, the creation of wealth, and the improvement of social welfare.[84] This does not imply that a country such as Brazil must simply rush to develop ICTs and high technology. We define a knowledge-based economy as one that encourages its organizations and people to acquire, create, disseminate, and use knowledge more effectively for greater economic and social development. The fundamental pillars of a knowledge-based economy are:

- An economic and institutional regime that provides incentives for the efficient use of existing knowledge, the creation of new knowledge, and entrepreneurship;
- An educated and skilled population that can create and use knowledge;
- A dynamic information infrastructure that facilitates the communication, dissemination, and processing of information;
- An effective innovation system centered on firms, and comprising a network of research centers, universities, think tanks, consultants, and other organizations that tap the stock of global knowledge, assimilate and adapt it to local needs, and create new knowledge and technology.

5.10 These elements are interdependent. It is not enough just to improve domestic research and development (R&D), or education, or the information and communication infrastructure without also improving the overall system of economic incentives and institutions. These affect the efficiency with which resources are put to use, the extent to which the country draws on expanding stocks of global knowledge, and the overall flexibility of the economy to restructure, both to take advantage of new knowledge and to improve performance in traditional sectors.

An Overview of Brazil's Situation

5.11 This section presents a preliminary assessment of Brazil's situation using a benchmarking tool developed by WBI with indicators for the various elements of the framework. Annex 1A explains the benchmarking tool and the indicators, which are available for 92 countries and 66 indicators. To give the assessment some country specificity, Brazil's position is compared not only to that of the US (perhaps the leading knowledge-based economy) but also to that of three other Latin American countries (Argentina, Chile and Mexico), as well as to two other large developing economies (China and India).[85]

5.12 Brazil is behind the US in almost all indicators except the flexibility of its people. But it may surprise some readers that on many variables Brazil is also behind the Latin American countries,

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[84] All economies are knowledge-based. What has emerged recently, however, is that rapidly growing economies are becoming increasingly dependent on the effective creation, acquisition, distribution, and use of knowledge.

[85] The analysis relies on the standard 15-variable scorecards presented in Annex IE as well as the more detailed scorecards on each pillar of the knowledge economy, as highlighted in Annex 1F that compare Brazil with other Latin American economies such as Argentina, Chile and Mexico, as well as with China, India and the US.

and that in some variables it lags China and India, much poorer countries. For Brazil to take advantage of the knowledge revolution it will need to develop a comprehensive strategy.

Updating the Economic Incentive and Institutional Regime

5.13 Clearly one of Brazil's weaknesses has been macroeconomic instability. This appears to have been brought under control in the last decade, so Brazil can now focus on the structural and incentive issues that constrain its potential to use knowledge more effectively.

5.14 A striking characteristic of Brazil is that it is a relatively closed economy. The ratio of exports plus imports to GDP is one of the lowest among all countries. In 1999 this ratio was 22 percent in Brazil, less than half the world average of 52 percent. Brazil is not well integrated into the global knowledge economy, and this is not just because of its size. This ratio is much higher in larger economies such as Germany (57 percent,) the UK (53 percent), France (50), China (41 percent), and even India (27 percent).[86] Besides not having a large traded sector, Brazil still has relatively high tariff and non-tariff barriers, reducing pressure from international competition. According to some qualitative indices, domestic competition is quite high, implying that the main issue in the overall economic regime seems to be low exposure to international competition: Brazilian firms do not face as much pressure as those in other countries to improve their technology and productivity to keep up with the rapidly changing international environment.

5.15 Brazil ranks in the mid-range on the soundness of its banks and adequate regulations and supervision of financial institutions, and is better than other large developing countries such as China and India. Saving and investment rates are also mid-range, but interest rates are high, which constrains the financing of enterprises. On protection of intellectual property, the legislative regime in Brazil appears to be above average. However, as will be seen below, there are significant issues regarding their implementation and enforcement.

5.16 On institutional variables such as the regulatory framework, rule of law, government effectiveness, and corruption Brazil also falls in the mid- or lower mid-range. A stronger rating appears in voice and accountability as compared to say, Mexico or Argentina and even more than China or India, a tribute to the resurgence of its democratic tradition.

Upgrading Education and Skills

5.17 Besides the relative isolation of the economy from the global economy, a second weakness of Brazil's knowledge structure is the low educational attainment and skill level of the population. For an economy at its per capita income, Brazil's literacy rate is low (at 85 percent of the population aged over 15 years). More striking is Brazil's secondary enrollment rate, just 62 percent. This compares poorly, for example, with China, a country with less than one fifth of Brazil's per capita income, but where secondary enrollment is already 70 percent. Progress has been made in recent years in Brazil, with a doubling of graduates—a trend that reflects both increased enrolments and reduced dropouts.

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[86] The only major country with a lower ratio than Brazil is Japan, with just 19 percent. The ratio for the US is 24 percent.

5.18 Brazilian enrollment rates in tertiary education are satisfactory and higher even than in China, although China is fast expanding tertiary education and may catch up with Brazil in less than five years. One way China has been able to expand its higher education so rapidly is because it now covers one third of the costs of higher education through student tuition fees. The article in Brazil's constitution mandating free public higher education obviously makes it difficult to expand higher education. In addition, the system is highly regressive in that as a rule the children of the more well-to-do gain access. Brazil's relative spending patterns in primary, secondary, and tertiary education are shown in Table 5.4. Brazil is not getting the best from its tertiary education sector.

Table 5.4
Expenditures per Student – Brazil and Comparison Countries [a/]

In PPP US$	Brazil	Chile	South Korea	OECD
Primary	859 (12.6)	2115 (4.1)	3308 (2.1)	3769 (2.9)
Secondary	1002 (10.8)	2292 (3.8)	3518 (1.9)	5507 (2.0)
University	10791	8775	6844	10893

Source: C. Haddad, *op.cit.*, and OECD " Education at a Glance", 2000. a/ ratios between university, secondary and primary public expenditures in parenthesis, from Frischtak, 2001, p. 25.[87]

5.19 Brazil's great strength among the indicators on this component of the framework is the flexibility of people to adjust to new challenges. However, without a strong education and skill base, the effects of this asset will be limited. The country thus faces a major challenge in developing an efficient and equitable secondary and higher education strategy.

5.20 Brazil needs a greater share of professional and technical workers in the population (currently a lower share than in Chile or Mexico). But to do this it will have to devise ways to use private sources of finance. This may imply a greater focus on the provision of basic education through to secondary level. The financial constraints embodied in the constitution represent the main challenge in tertiary education. Improving tertiary quality means not only expanding the public system by tapping private and corporate resources, but also encouraging the expansion of private universities. This will involve a heightened public role of quality control over the overall system.[88] A further option is to explore the potential of using ICT more actively in the provision of education, not just for teacher training, which appears to be the main area of current focus, but also for higher education, as is being done in OECD countries and in China, Mexico, and India. Greater use of ICT may permit expansion of access while maintaining quality. With greater private finance and provision, the government could focus more on the provision of grants and loans for poor students.

5.21 Regarding financing, public expenditure on education is higher as a percentage of GDP in Brazil than in other Latin American countries such as Argentina, Chile and Mexico, as well as that

[87] Frischtak notes that Brazilian spending on higher education may be biased upwards by costs of hospitals and personnel associated with universities. However, this may also be true for some comparison countries.

[88] The government has made major strides to improve the quality of tertiary education through several means: a large national comparative exam for graduates, an institutional evaluation program and an annual national tertiary education census. These measures add up, making Brazil a leader in tertiary education quality assurance, not just among developing countries. See "Higher Education in Brazil: Challenges and Options," Human Development Department, Latin America and the Caribbean Region, The World Bank, August 17, 2001.

of large developing countries such as China and India, and equal to that of the US. Another positive feature is that its national culture seems to be more open to foreign influence than these countries, with the exception of Chile.

Improving the Innovation System

5.22 As can be seen from the scorecards in Annex 1E, the Brazilian innovation system is weak in virtually all areas, with the exception of entrepreneurship, in spite of government efforts. Brazil spends 0.8 percent of GDP on R&D (2.2 percent for OECD countries). It is striking that Brazil has fewer scientists and engineers engaged in R&D per million population than Chile and Mexico, and fewer also than China. Moreover, in Brazil, most R&D is performed in public institutes and state owned enterprises, and relatively little is done by the private sector. This is in contrast with Korea, for example, where private firms do 80 percent of R&D.

5.23 As pointed out by Frischtak (2001), there are some large government programs in aeronautics (Embraer), satellites (CBERS), deep-water oil exploration (Petrobras), tropical agriculture (Embrapa), and biotechnology (Genoma), distinguished by world-class technology development. By and large, however, private firms have not developed or adapted knowledge intensively, despite the strong entrepreneurial capability in Brazil.

5.24 R&D output is also low when measured in terms of patents or technical publications, compared with Argentina, Chile, China or India (though higher than Mexico). This suggests that the efficiency of the domestic R&D efforts could improve.

5.25 One way in which Brazil has obtained access to global knowledge has been through FDI, and until the 1990s, Brazil was the largest FDI host among developing countries. China's opening has now made it more successful in attracting FDI relative to the size of its economy. Large FDI inflows have been one of the drivers of China's modernization (Dahlman and Aubert, 2001).

5.26 Finally, the venture capital market is also not as well developed as in Chile, or indeed China or India, which limits the start-up of new companies, especially high technology companies without a track record or many assets for collateral.

5.27 Thus, whilst Brazil could improve the management and efficiency of its R&D effort, the main issues seem to link back to the broader policy regime that does not put sufficient pressure on firms to keep up with global best practices and new knowledge. Efforts may also be needed in the near future to attract "high-quality" (export-oriented) FDI to help access global knowledge.

Expanding the Information Infrastructure

5.28 Brazil has accomplished considerable progress in developing its information infrastructure in recent years with the privatization of *Telebras* and the liberalization strategy orchestrated by the National Telecommunications Agency (*Anatel*). "Teledensity" remains lower than in advanced economies (fixed line teledensity—23.1 lines per 100 inhabitants—is one third of US and half of Spain, while mobile service density reached 14 accesses per 100 people in 2000). Brazil has fewer internet hosts per 10,000 persons than Argentina or Mexico. The Internet is thus still out of reach for the majority of the population—less than 10 percent of the population has access to it—owing

to a series of factors: lack of infrastructure, high prices, and low educational levels. Promoting universal access to telecommunications—through infrastructure development and tariff lowering—requires appropriate deregulation, intensified competition and the attraction of foreign investors.

5.29 Computer penetration is also lower in Brazil than in Argentina, Chile or Mexico, but higher than that of China and India. The ICT skills of the population could be developed, which may also increase internet content. In terms of the percentage of companies that use the internet for e-commerce, Brazil ranks lower than Argentina and Mexico and slightly higher than Chile.

II. BRAZIL'S INNOVATION SYSTEM AND POLICY[89]

5.30 The contribution of innovation and technology to Brazilian economic development has been limited. Competitiveness has declined slightly over the last two decades. Overall productivity is low compared to other major developing economies and the innovation system contains serious gaps. Brazil does not take advantage of the entrepreneurship of its population, nor from significant investments in its science base. Improvement requires a multi-pronged, long-term effort. University-industry interactions need to be improved by various means. Appropriate financial and technical support should be provided to enterprise—particularly to SMEs—to stimulate its innovation and R&D efforts. Incentives of various forms (export promotion, competition, standards), as well as the intellectual property regime, could be strengthened. More generally, the technical culture of the population could be raised in the context of a comprehensive education policy.

Technology and Economic Performance

5.31 The position of Brazil in international trade has declined slightly over the past two decades. After an improvement in the early eighties, there was a decline in the second part of the eighties and stagnation since then (Table 5.2). Brazil has shifted its export composition away from basic products towards industrialized goods, a trend that is consistent with world trade. However, its comparative advantage has been accentuated in resource-based sectors, while there has been a loss of competitiveness in technology intensive sectors. Falls in market shares are noticeable in electronics, textiles and transport equipment, as well as in processed agricultural products. Gains in market shares were in steel, non-ferrous metals, chemicals and petrochemicals (Table 5.5).

5.32 There has been a moderate contribution of technology to competitiveness, insufficient to keep up with international trends, judging by international benchmarks. Brazil appears to have low overall productivity and low labor productivity, regardless of sector (agriculture, manufacturing, and services).[90]

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[89] This section is largely based on the information provided at the WBI *Knowledge for Development* Policy Forum for Brazil, China and India (Wilton Park, U.K. March 2001), and notably by Frischtak (2001).

[90] World Competitiveness Report, IMD, 2000. Out of the 47 countries listed in the report, Brazil's rankings are 41 for the overall productivity, 38 for labor productivity, and respectively 37, 38, and 38 for agriculture, manufacturing and services (related GDP (PPP) per person employed.

Table 5.5
World Market Shares of Brazilian Exports
Major Product Groups

	1980	1996
Basic Products	**6.1**	**5.1**
Agriculture and livestock	6.2	3.9
Mining	6.1	8.3
Soybeans and related products	5.9	4.8
Industrialized Products	**0.81**	**0.79**
Non-metallic minerals	0.6	0.8
Steel	1.3	3.5
Non-ferrous metal	0.4	1.4
Mechanical Products	0.6	0.6
Electric products/electronics	0.5	0.2
Transport material	0.8	0.7
Wood and Furniture	0.9	1.1
Pulp and Paper	1.2	1.5
Rubber	0.9	1.5
Chemicals	0.3	0.6
Petrochemicals	0.4	0.6
Pharmaceuticals	0.5	0.4
Textiles	1.2	0.8
Food Products	2.8	2.6
Cut and Processed Meat	1.6	1.5
Other	0.3	0.3
Total	**1.3**	**1.0**

Source: same as Table 5.2

The Innovation System

5.33 Brazil's investment in science and technology, dating from prior to the Second World War, is not large measured in percent of GDP, but it is substantial in absolute terms. Total S&T expenditures reached $10.7 billion in 1997 (versus $6.2 billion in 1993). Overall R&D spending—at about 35 percent to 40 percent of total S&T expenditures—is 0.8 percent of GDP.[91] International comparisons of R&D efforts per capita are given below (Table 5.6).

[91] Brazilian statistics in science and technology do not follow OECD standards. Overall S&T investment figures are available (of which the content varies from one country to another). Then estimations are made for R&D that vary depending on the source. There is some convergence around the figure of 0.8 percent of GDP. There are also problems in the estimation of R&D personnel: there are no credible figures for "Full Time Equivalent" (FTE) researchers. IMD's figure of 21,500 (2001) appears low, though many R&D personnel work in the university sector and therefore devote much of their time to teaching.

Table 5.6
R&D Expenditures and Personnel per Capita, 1998
Total Expenditures

	Value	Rankings
US	842.5	4
Japan	969.9	3
China	5.3	40
Brazil	37.2	31
India	2.4	43

Business Expenditures

	Value	Rankings
US	807.92	1
Japan	698.76	3
China	2.38	40
Brazil	14.89	28
India	0.47	43

Total R&D personnel nationwide per capita (per 1000 people)

	Value	Rankings
US	3.73	18
Japan	7.09	3
China	0.60	33
Brazil	0.137	41
India	0.135	42

Total R&D personnel in Business per capita (per 1000 people)

	Value	Rankings
US	2,962	9
Japan	4.65	3
China	0.25	22
Brazil	0.04	40
India	0.038	41

Source: IMD, 2000

5.34 The total number of scientists and engineers working in R&D is estimated to be 48,800. The number appears to be considerably lower when counted in full time equivalent (FTE): 21,500 (Table 5.6). Two other issues deserve mention. First, there is a strong regional concentration of S&T potential in a few areas, notably São Paulo, which concentrates about 50 percent of total S&T expenditures and personnel. Second, business contributes modestly to the overall R&D effort. About 30 percent is funded by business, the rest by the government. Of concern is the very low number of researchers in the business sector (6,800 in FTE). Seventy percent of the S&T workforce is in the university and public sector.

5.35 At the same time, Brazil benefits from the most entrepreneurial population in the world, according to a recently compiled index of entrepreneurial activity (Table 5.7), combining data of business creation—Brazil being first in the world with one adult out of eight creating his or her own business—and data of adult employees working in firms with less than 42 months of existence—Brazil being third behind Korea and the US. Even more surprising is that this dynamism is taking place in a climate that is not very favorable to business creation and development (issues of regulatory burden, tax overload, etc.—see chapter 7).

Table 5.7
Index of Entrepreneurial Activity

Brazil	Korea	US	Australia	Canada	Norway	Argentina	India	Italy	U.K.	Germany	Spain
16	13.6	12.6	10.9	7.9	7.9	7.7	6.3	5.6	5.1	4.7	4.5

Source: Global Entrepreneurship Monitor 2000.

5.36 However, the links between S&T investment and entrepreneurial capability are not well established. Brazil neither takes full advantage of its investments in science, nor of its entrepreneurial capability. The innovation system thus presents definite strengths and gaps.

5.37 Some innovation successes—of worldwide significance—are noticeable, notably in heavy engineering (aviation and oil offshore exploration), and in agriculture. In all cases the public sector has played a crucial role. The state owned enterprises—*Embraer* and *Petrobras*—have been the main engineers of successful developments in aeronautics and oil exploration. In the agriculture sector, *Embrapa,* the public research institute, has been the key platform. Promising developments in life sciences (genetic research) are also noticeable, though they have yet to be transformed into commercial successes.

5.38 As a whole, these successes remain isolated. The inventive performance of the country, measured in terms of patents deposited in international offices such as the USPTO or WIPO, remains mediocre (though increasing), and is not commensurate with S&T investments (Table 5.8).

Table 5.8
Patent Requests to WIPO, 2000, Number and Percent

US	Germ.	Jap.	U.K.	France	Swed.	Holland	Switz.	Austr.	Can.	Korea	China	Brazil
38171	12039	9402	5538	3601	3071	2587	1701	1627	1600	1514	579	161
42.0	13.2	10.3	6.1	4.0	3.4	2.8	1.9	1.8	1.8	1.7	0.64	0.18

Source: WIPO, cited by Frischtak

5.39 The relatively low effort of the business sector in R&D affects the innovative capacity of the economy. Problematic is the low number of R&D personnel employed by enterprises. This can be explained by several factors. First, hyperinflation did not encourage such long-term investment, and these effects persist in Brazil's financial system today. Secondly, the specialization of Brazilian industry tends to be concentrated in intermediate products of relatively low technological content. Thirdly, low recruitment of qualified scientists and engineers seems due to the domestic orientation of most enterprises. Exports represent only 5 percent of domestic firms' sales and 12.5 percent of the turnover of foreign-owned firms.

5.40 Nevertheless, innovation surveys made in the Sao Paulo area[92]—the most dynamic part of the economy—show that many firms innovate (about 25 percent have introduced technologically

[92] "Technological Innovation in Brazilian Industry: An assessment Based on the Sao Paulo Innovation Survey," Ruy Quadros et al. *International Journal of Technological Forecasting and Social Change*, vol. 67, no. 2, May 2001. The survey is made on bases comparable to those implemented in the EU, following the methodologies of the OECD and Eurostat.

modified products or processes over the period 1996-98).[93] There is a concentration of the innovation effort in intermediate goods (e.g. chemicals) and conventional engineering sectors. A large proportion of innovations are driven by demands and ideas coming from suppliers and clients rather than by science and research activities (a feature observable in advanced economies too, though in a lower proportion).

5.41 There are signs that a dynamic small and medium enterprise (SME) segment is emerging in the Brazilian economy. A stock of over 10,000 "high productivity" firms in the range of 20 to 500 employees have been identified,[94] and the number of exporting companies has been increasing regularly over the years in all size categories (although 450 firms were responsible for nearly three quarters of manufactured exports). They benefit from a number of export and SME supporting programs, the latter spearheaded by *Sebrae*— the well-funded Brazilian Service for Support of SMEs—in conjunction with private actors and social organizations. They also take advantage of 45 industry-funded National Centers of Technology (*Cenatecs*) and of a number of services provided by universities, which have spread in recent years (such as "dial technology" offices).

5.42 Incubators—to support "techno-entrepreneurs"—are also spreading. More than 135 structures have been established in 17 states. They have so far attracted a limited number of enterprises (1,100), contributing modestly to employment creation. Although future prospects are encouraging (200 incubators are expected to be established at the end of 2001), this illustrates one issue affecting Brazil's innovation capability: the inadequacy of technical culture among the population. On one hand, the majority of entrepreneurs do not pursue technical ventures. On the other, the scientists do not manifest the same entrepreneurial spirit as the population. Only 462 PhDs were working in business incubators at the end of 2000, less than 1.7 percent of a pool of some 27,700 PhDs located in university departments and research institutions.[95]

5.43 Some of these incubators are part of larger, complex structures such as technology parks, (e.g. in Rio de Janeiro, Pernambuco, Rio Grande do Sul, Ceará and Brasília). Most are incipient, but a first cluster of S&T parks is beginning to consolidate around the city of Campinas in the State of São Paulo, where 13 research universities and research institutions are responsible for 16 percent of the country's scientific output, and generate 9 percent of the national GDP.

5.44 Traditionally MNCs have been the main vector of technological and managerial modernization of the Brazilian economy. Despite the growth in FDI flows and continuing investor confidence, the potential for FDI to operate as a knowledge precursor seems to be receding.[96] In particular, FDI is increasingly directed to services and other non-tradable goods, where competitive pressures are smaller, where the knowledge gap not as pronounced as in the manufacturing sector, and where competitive advantage centers on inexpensive cost of capital. Cumulative FDI flows in 1996-99 were 19.2 percent for industry and 79.2 percent for services. There are significant obstacles that discourage high-quality FDI, including a restrictive regime on technology transfer

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[93] A lower proportion than in advanced economies (50 percent in average)

[94] See "Valor", December 21, 2000, data generated by the Ministry of Finance (cited by Frischtak).

[95] As noted by Frischtak, op cit.

[96] See Frischtak (2001).

(systematically requiring government licenses), and mediocre protection of property rights.[97] A well functioning IPR regime, fully in line with TRIPS agreements, would significantly increase FDI.[98]

5.45 A problematic intellectual property rights regime affects the innovation climate in Brazil. Laws in the concerned areas (inventions, industrial designs, trade marks, software, etc) are, in general, in compliance with international standards. But the conditions governing their application are inadequate, e.g. the patent approval process is slow (five years on average). Their enforcement is also mediocre, due to judicial back-logs and a dearth of judges adequately trained in intellectual property law.[99] As for foreign patents, the Brazilian law permits the issuance of compulsory licenses in cases where patent holders choose to supply the Brazilian market through imports rather than local production.[100] Moreover, there are no incentives to stimulate inventions coming from R&D work performed in universities or in businesses funded by the federal government to encourage innovation (incentives such as the Bayh-Dole act in the US, which allows benefiting entities to retain title to inventions under federally-funded research programs and encourages their commercialization, notably through SMES).

Government Policies

5.46 Over the years, the government has put in place a series of schemes, some with the support of the World Bank (PADCT I and II, which invested a total of US$ 470 million in 4,500 projects over the period 1986-97), which have been strongly science-oriented (focused on building research infrastructure and training of scientific personnel), rather than technology-oriented. They have contributed to the development of important programs and institutions (such as the National Council of S&T Development, CNPq, and the Fund for study and projects, FINEP). Meanwhile some state governments have taken similar initiatives, principally São Paulo with the establishment of a science foundation (FAPESP). The impact on the scientific potential of the country has been substantial. For instance the number of PhDs amounted to 2,200 per year in 2000 versus about 500 in 1980. Brazil has nearly tripled its share of world publications (from 0.44 percent in 1981 to 1.2 percent in 2000).

5.47 In the late 1990s, a new series of more technology-oriented measures were put in place with the support of PADCT. A reform and investment program was implemented with a total planned expenditure of some $360 million for the period 1997-2001. The program included a series of schemes to support R&D cooperative projects (between the government/university sector and the business sector), basic technological research and various "sectoral" services (metrology and standards, IPR regime, evaluation and monitoring, etc). These measures, if effectively implemented, should begin bearing fruit.

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[97] As noted in the FIAS report (2001). The report indicates that, in a recent survey, 40 percent of foreign companies said they did not use their most advanced technology or processes in their Brazilian-based operations.

[98] The potential increase would be 7.4% of current FDI flows according to a recent econometric study. See the World Bank report on Global Economic Prospects 2002, chapter 5 (July 2001).

[99] See FIAS (2001), notably pp. 187 to 199.

[100] Although the most aggressive use of the law has been in pharmaceuticals (and is estimated to have helped fight AIDS), the law refers to all patents, whatever sector is considered. See GEP 2002, op. cit. (box 5.2).

5.48 To spur the innovative capability of the economy, the government has recently decided to establish seven sector funds (using resources brought about by a tax on services provided by recently privatized enterprises), though the conditions of use and management of such funds remain unclear. The decision has also been taken to establish a public venture capital fund. In order to reinforce the strategic capacity of the government, a Strategic Study Center has also been created in the Ministry of Science and Technology.

Policy Guidelines

5.49 A series of well-targeted and vigorous measures are needed to improve Brazil's innovation climate. A first priority would be to act on those elements of the incentive regime that affect the innovation climate. In particular, it is recommended to:

- Improve the IPR regime by strengthening enforcement and accelerating the approval process. This requires increased resources for INPI (the national institute in charge of intellectual property), as well as a transformation of the review procedures (e.g. systematically involving foreign partners concerning foreign technology applications).

- Further reduce obstacles to firm creation (bureaucracy, regulations, tax burden, etc) particularly for new technology-based companies, and obstacles to the availability of long term finance. This is a key area for improvement (see the 2000 World Competitiveness Report), and is crucial for innovation ventures, which are by nature uncertain and only have a long-term pay off.

- Stimulate exports and encourage enterprises to improve their product scopes and quality. In particular, technical norms and standards should be reviewed and made more demanding, placing them on par with international competition. The establishment of a permanent commission at the Federal level for this purpose is a possibility, which would work in close contact with State authorities to reduce tariff and non-tariff barriers.

- Eliminate regulatory obstacles that prevent adequate use of foreign investments and related technology transfer (by suppressing all government licenses and authorizations as has been done in Chile).

5.50 A second set of measures should address the interaction between the university and public research sector on the one hand, and the business sector on the other. Three actions are recommended:

- Establish a powerful IPR-related incentive instrument along the lines of the US Bayh-Dole act. In addition, the conditions of licensing by the university and public sector of their inventions to the private sector should be adapted.

- Consider financial measures to facilitate—for the benefit of SMEs—the recruitment of researchers, as well as the contracting of R&D work to universities and other research institutions. These schemes have proven to be useful and efficient in

advanced economies (cf. French, German, and Dutch experiences). They consist of subsidizing a proportion of the cost of salaries of researchers recruited by the SMEs, or of the cost of contracts of SMEs with university or public laboratories. The subsidy can take the form of a tax deduction.

- Establish industrial R&D PhD programs that are jointly developed by the university and business sectors (as done in several OECD countries—see for example the Danish experience, which allows the granting of PhDs to individuals pursuing full time research work in enterprises).

5.51 It is important to design the new sector funds under MCT efficiently (these will pertain to technologies and industries of the Brazilian economy, such as oil, biotechnology, etc.). The scope of these funds—which will become a major renewable source of public funding for technology development—is not yet clear; they range from the support of basic research to technical research of a more applied nature (although at the pre-competitive stage). The lessons of international experience can be brought into the design and implementation of these incentives. In particular, a clear distinction should be made between the support of basic research, which should be based on "excellence" criteria, and the support of technical/industrial research, to be based on "relevance" criteria (patent prospects, potential profits, etc).

5.52 Finally, there is the possibility of expanding schemes for technical (and commercial) assistance, information, and training that address the needs of SMEs: the number of supporting structures (such as *Cenatecs*) is small. This could be done at the local and regional level and the government could encourage states to provide funding. Mechanisms adopted in a number of countries (Germany, France, Spain) consist of developing programs jointly with local authorities and associations of entrepreneurs and engineers, on the principle that local authorities match the funding provided by the central government.

5.53 It is clear that improving the overall innovative capability of the economy will take time and will not bear significant results before a decade or so. A number of measures must be taken in close coordination between the Federal and State governments. Finally, as is usual with knowledge and innovation policies, there is need for inter-ministerial action. For these reasons, the establishment of an appropriate coordinating body at the top level of the government could help catalyze and oversee policies.

IV. The ICT Sector in Brazil

Recent Reforms and Privatization and Liberalization Developments

5.54 The Brazilian telecom sector was a state monopoly until July 1998, when the privatization of *Telebras* occurred. Until this date the market was characterized by a lack of investment, poor quality of service, and high costs.[101] The plan announced by Brazilian regulator Anatel (*Agência*

[101] Prior to 1972, there were more than 900 telecommunications companies scattered across Brazil. By 1975, Telebras and its operating subsidiaries (collectively known as the "Telebras system") had acquired the vast majority of these companies, creating a monopoly in telecom services. The Telebras monopoly lasted until 1975, when the Brazilian government proposed a reform of the regulatory system. In 1995, Congress approved Constitutional

Nacional de Telecomunicações) in September 1998, for the implementation of the final stages of privatization, paved the way for a deep transformation of the country's telecom sector. The first stage of *Anatel*'s liberalization strategy is to permit competition through a number of "mirror" companies by allowing a new service provider in each of the service areas dominated by the former *Telebras* companies. This will be followed up by full competition in 2002, when there will be no geographical or service restrictions.

Efficient Instruments and Clear Goals

It was the introduction of the "The General Law of Telecommunications" (*Lei Geral de Telecomunicações* LGT) in 1997 that provided for both competition and the privatization of Telebras. The administratively independent and financially autonomous regulator *Anatel* was the instrument to guide Brazil towards telecommunications reform. In addition to *Anatel*, The Ministry of Communications determines overall policies to be followed and CADE ensures fair competition within all business sectors in Brazil.

Anatel's fundamental job is to regulate, grant concessions and oversee telecommunication services in Brazil. All procedural steps, proposals and decisions are submitted to widespread scrutiny, aimed at reconciling the public interest with the particular interests of the private sector and other segments of society.

With regard to services, *Anatel's* goal is to ensure universal access to the population, with mandatory expansion and quality goals. LGT classifies telecom services according to the judicial status under which they are provided, public or private. This classification was implemented so that the government could ensure that operators providing services under the public regime fulfilled their universalization and continuity obligations

5.55 The success of liberalization of the telecom sector and the privatization of Telebras is visible today in the explosion of new services available. In July 1998, when 27 state-owned telephone companies were privatized, there were 20.2 million hard-line telephone accesses. The 34 hard-line telephone operators have since installed (up to December of 1999) 7.6 million new lines, an expansion of more than 37 percent in a year and a half. Likewise, the number of public telephones, during this same period, rose from 547,000 to 740,000. Quality also improved during this period, such as the network digitalization index, the average time to get a dial tone, the local and long-distance phone rates and the number of orders placed for repair services per 100 public telephones. More than 271,000 phones purchased through expansion plans that had not been delivered in December of 1998 were installed by May of 1999.

5.56 In the area of wireless phone service, the evolution has also been considerable. The launch of prepaid services increased demand, and increased competition is driving down costs. In 1994, 800,000 people owned cell phones, 5.6 million were in use in July of 1998, and by December 1999 15 million cell phones were in operation in Brazil. An increasing proportion of the Brazilian population is benefiting from access to telecom resources. Fixed-line teledensity in 2000 was 23.1 lines per 100 inhabitants, approximately half of Spain's and one-third of the USA's, and is expected to reach 32.6 by 2005, while mobile service density, after experiencing an extremely fast

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Amendment No. 8 ending the monopoly of the state-controlled telecom companies and representing the first step toward profound reforms. In 1998, the cellular interests of Telebras were broken up into separate companies. Eight cellular providers were formed, each operating in one of eight cellular regions, along with three fixed-line service providers. The government completed the privatization of *Telebras* in July 1998.

expansion, is projected to grow from 14 to 32.6 accesses per 100 people between 2000 and 2005 (Table 5.9 below)[102].

Table 5.9
Brazil: "Teledensity" 1995-2005 a/

Accesses per 100 people	1995	1998	2000	2005 b/	G1	G2
Fixed Line	9.3	13.6	23.1	32.6	20.0	7.1
Mobile	0.9	4.5	14.0	32.6	73.1	18.4

Source: "Infrastructure and Universalization of Telecommunications Services," presentation to the Policy Forum on Using Knowledge for Development, Wilton Park, March, 2001.
a/G1 and G2 - average annual rates of growth between 1995-2000 and 1998-2005.
b/Ministry of communications projections.

Limited Access to the Internet

5.57 Informational constraints affect most people in the country. In view of the revolutionary nature of the internet—and its capacity to subsume most media—when it comes to accessing and exchanging information, as well as the far more limited informational content of the widely disseminated open TV (and radio), most discussion around the issue of access centers on the use of internet resources by the population.[103]

5.58 The internet remains outside the reach of most people in Brazil. Though estimates vary, partly due to definitional issues, approximately 9-10 million people may be considered "connected" to the internet, that is 54-60 people per 1000 population, which compares unfavorably with Mexico (95 per 1000), Chile (156/1000) or Argentina (174/1000).[104] Considering there are some 129 million people aged 10 and above, 7–8 percent of the population has access to broad informational resources. *Ibope*, a public opinion research institute which tracks internet use in the country, concluded that 84 percent of users are in the A/B socio-economic category (upper and middle class), 14 percent in lower middle class (class C), and only 4 percent in classes D and E, which make up most of the population. According to these data, the internet is still overwhelmingly an elite instrument in Brazil, the potential of which could and most likely is being used to reinforce existing concentration of income and wealth.

5.59 A combination of lack of (quality) infrastructure, high prices of critical services and equipment (particularly relative to families' disposable income), and low educational levels which impede the use of the internet, are restrictive factors explaining why less than 10 percent of the "eligible" population is connected.

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[102] See "Infrastructure and Universalization of Telecommunications Services," presentation at the Wilton Park seminar, and *Sociedade da Informação no Brasil – Livro Verde* (2000), chapter 3. It is worth noting that total telecom access paths per 100 inhabitants—37.1 in 2000—was still little over one-half the average for OECD countries in 1988 (72.1). See OECD (2001).

[103] As noted in the paper by Frischtak, op cit., from which the data are extracted.

[104] See Eric Portero (2000), except for Brazil.

5.60 Despite these limitations, Brazil is Latin America's largest Internet market, representing over 50 percent of all Internet users and nearly 80 percent of all e-commerce activities in the region. These statistics, combined with the fact that the Brazilian internet market is growing at over 50 percent a year, present a lucrative proposition to many international operators. Explosive demand is also taking its toll on Brazilian Internet Service Providers (ISPs), not only in terms of catering adequately, but also in making adequate provision for increased bandwidth requirements. The advent of free subscriptions, introduced by banks and e-commerce companies in January 2000, threatens to fuel the fire. Today there are seven backbone networks in Brazil that have been constructed by private entities. In addition, *Embratel* has built a commercial backbone linking several of Brazil's largest cities.

5.61 In terms of e-commerce, 27 percent of the Brazilian Internet users currently make purchases on line. This figure represents 80 percent of the entire Latin American region's e-Commerce activity. Recent surveys suggest that over the next few years, the Latin American e-commerce market will explode, and more than 50 percent of Brazilian users will make purchases online. Conversely, a number of barriers will affect the future prospects of e-commerce in Brazil. These include low-PC penetration, low-credit card ownership, and poor product fulfillment infrastructure.

High Potential and Investment

5.62 The new regulatory conditions, coupled with the sheer size of the country, presents unrivalled opportunities in the country's telecom sector. Brazil is an enormous market. Brazil is among the largest telecom markets in the world. With its rapid economic growth, Brazilian telecom has great potential for development: it is estimated that telecom revenues in Brazil could reach US$78 billion in 2010.[105] Commercial activities in Brazil that use the Internet are expanding considerably, to the point that they now make up more than half of the Latin American market, in terms of users and in volume of transactions. Investments, which in 1998 alone exceeded $13 billion, coupled with the arrival of new technologies, equipment, and information services, have placed Brazil at the leading edge of the production, storage, use, and dissemination of voice, data, text, sound, and image formation. Increased investment has had a positive impact on prices, quality of service, and the range of services readily available. The projected magnitude of investments in this sector for the next 5 years is shown in Table 5.10.

Table 5.10
Investment Projections through 2005 (US$ billion)

Services	2000	2001	2002	2003	2004	2005	Total
Fixed	6.7	5.7	5	4.4	4.1	3.9	29.8
Mobile	2.4	3.1	3.7	4	4.2	4.5	21.9
Mass Communications	1.7	2.1	2	2.2	2.2	2.2	12.4
Total	10.9	10.9	10.7	10.6	10.6	10.6	64.1

Source: Anatel 2000

[105] Pyramid Research, 2000.

5.63 In the Internet area, booming corporate and consumer use is attracting some of the world's largest ISPs, along with several Latin American providers with financial backing from US investors. Among the foreign companies are AOL, which is investing heavily in the launch of a number of local web sites in Brazil, and *Telefónica*, which recently purchased *Nutec*, Brazil's second largest ISP (for about US$500 million).

Instruments to Stimulate R&D

5.64 In comparison with the rest of Latin America, Brazil does have a small sophisticated technological base and a contingent of qualified human resources. The Secretariat of Computer and Automation Policies (*Secretaria de Políticas em Informâtica e Automação*—SEPIN) of the Ministry of Science and Technology (MCT) is in charge of managing all aspects related to the Law of Fiscal Incentives in Computer Technology (Law 8248). A close evaluation reveals that, during the period of 1993 to 1999, the results obtained with the incentives provided by this Law are quite remarkable: In 1999, 183 requests for fiscal incentives were approved, filed by 263 companies. Investments in R&D also rose significantly—a total of R$600 million was spent in 1999 in this area by companies taking advantage of the incentives available through legislation. Of this total, R$225 million was spent in partnerships of private corporations with universities and research centers. In the same year, R$15 million resulted from the payment of charges established through the Computer Technology Law. With this money, the government was able to strengthen projects for the qualification and development of human resources in the area of R&D, to expand the national Research Network and bolster the exportation of software.

5.65 There are some challenges:

- There is a shortage of researchers;
- In terms of distribution, the Brazilian scientific community is concentrated, in large part, in universities and research centers—only 20-30 percent work in industry.
- Technology transfer from academic circles to the Brazilian industrial sector is low;
- Brazil's education system and skills bottlenecks will, over the longer term, present the largest threat to the future of the ICT development.

Table 5.11
ICT Trade Balance 1996-98 (US$ million)

	1996	1997	1998
Imports	**4126**	**5357**	**5008**
Computer and peripherals	2662	3070	3015
Telecommunication	1464	2287	1993
Exports	**382**	**553**	**592**
Computer and peripherals	289	329	337
Telecommunication	93	224	255
Deficit	**-3744**	**-4804**	**-4416**

Source: SEPIN/MCT Shortage of Engineers and Scientists

Industrial Policy and Regulatory Issues

5.66 The Brazilian telecom regulator *Anatel* has enhanced the competitive environment in the course of sector reform. However, some operators have noted that the pace of *Anatel*'s regulation process is too slow to keep pace with the demands of the market. Both fixed and mobile operators find that *Anatel*'s regulation, which is targeted to protect consumers' interest, does not consider investors' business reality and hence hinders private investment. Cable operators have stated that *Anatel*'s upcoming regulations on bi-directional services have lagged the market's needs.[106] Specific regulatory issues include the following areas.

Failure of C-Band and D-Band Licensing

5.67 On February 2nd, 2001, due to a lack of bidders, Anatel postponed the upcoming C-band PCS license auction, which promises efficient Internet and data transmission over cellular phones. Having suffered a number of delays due to lawsuits and injunctions, the failure of the C-band PCS auction will postpone the entrance of a third competitor in Brazil's major markets until January 2002. Anatel's failure to assess market reality and existing service penetration levels contributed to the lack of interest in the C-band license auction. Following an extensive consultation period on everything except pricing, Anatel determined the value of each license using a formula that failed to take into account several market factors, decreasing the attractiveness of the investment at Anatel's minimum established prices.

5.68 The latest wireless (D-band) auctions failed to attract new market players. Telecom Italia (TI) was the only multinational company to participate, bidding in all three regions and winning two of them (including São Paulo state). The absence of new investors has more to do with global investors' recent loss of faith in high-technology shares than in a lack of interest. However, *Anatel* has also raised service-quality standards, including tough customer-satisfaction targets (measured by complaint volume). These factors, along with high prices for the concessions in general, make it harder for companies to enter the Brazilian market.

Interconnection Rates

5.69 Interconnection rates in Brazil do not reflect costs: they represent approximately 50 percent of the user tariffs, although for certain distances and times, the interconnection rates are higher than the user tariffs. The regulation of interconnection rates by Anatel tends to limit abusive rates. However, the absence of competition in the local access market limits negotiation of rates. These factors represent a limitation for the development of the telecom market.

Fines

5.70 Fines are up to R$50 Million for violation of Universal Service Obligation; R$50 Million for jeopardizing competition; R$50 Million for violation of Quality Obligations; R$50 Million for violation

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[106] Anatel's imminent decision to allow bi-directional Internet services over coaxial cable systems will enable Brazil to offer a variety of access technologies: traditional copper, TDM, broad-band wireless, coaxial cable and fiber optics.

of User Rights. The fines only have caps and the caps are too high. There are no clear definitions of violations and rules to determine the amount of fines according to the degree of the violation.

Government versus Private Sector

5.71 Since its privatization in 1998, Brazil's telecom infrastructure has been modernizing quickly. Heavy investments have served as stimuli for the development of the Internet and related industries. However, companies are beginning to worry that government may introduce new taxation on the sector. The concern has been widely shared by e-business executives regarding the authorities' intention to introduce a new form of taxation on electronic transactions. The levy could be similar to the existing 0.3 percent financial-transactions tax and assessed at the clearing stage of payments. The city of Rio de Janeiro is already charging telecom firms R$1 for each kilometer of fiber-optic network installed. This, coming on top of an already heavy corporate tax burden, could damage business prospects associated with e-commerce.

The Future of Information Infrastructure: Main Challenges

Equipment Cost

5.72 Equipment costs have been traditionally one of the binding constraints to web connection. More recently, entry of new producers (Compaq and Dell, among others), with gains in scale and productivity (and continuing competition from gray market producers/imports, which supply an estimated 50-60 percent of demand) has led to a fall in prices. Nonetheless the cost and availability of credit and the income distribution both limit demand. As a result, the rate of PC penetration was still low at 26.3 per 1000 habitants in 1999.[107]

5.73 Equally important, with few national backbones, the connection costs to the IP network charged by the dominant provider (the privatized *Embratel*, which controls an estimated 70-80 percent of the internet traffic) costs a multiple of equivalent services in other countries, where competition is more intense (Table 5.13).

Table 5.12
Product and Services Price Comparison: Brazil versus USA (US$)

Services/products	Brazil	USA	Difference (%)
Fixed line subscription a/	10.20	16.00	-36.3
Minute in mobile b/	0.23	0.35	-34.0
Pentium 3/800 Mhz/64 mega memory	1008	924	17
Printer HP deskjet 640 C	152	99	54
Microsoft Office 2000 standard	438	468	-6.4
Connection of 1 Mbps to IP c/	7200	700-1200	500-900

Source: "Valor", 12-14 January 2001. Notes: a/ in the US all local calls are included, whereas in Brazil, each additional call is charged above a certain number, which implies a significantly higher total price than the US; b/ average tariff for Telesp Celular, in S.Paulo; c/ prices for UUNet in the US, and for Embratel, according to Brazilian providers (for Embratel, the price ratio is 2.5 to 3.0).

[107] By comparison, Mexico's penetration rate was 37.3; Argentina's 39.2; Chile, 54.1; Spain's 22.1; and the US, 406.7. See Ministry of Science and Technology (September 2000).

Backboning and Access

5.74 High-speed communications depends increasingly more on the utilization of fiber optic infrastructure. The infrastructure in the North and Northeast regions of Brazil is not readily available. This vast area will still depend, for some time, on satellite-based means of communication, either geostationary or low orbiting, to meet their communication needs (including voice telephone). With taxes on local calls currently averaging 28.6 percent, the average cost for local calls in Brazil remains among the region's highest (see Table 5.13), and dedicated connections are prohibitively expensive. Without the adoption of alternative tariff plans (such as unlimited local calls or byte-based rates) for internet usage, dial-up Internet access, which is currently the dominant mode of accessing the Internet, will remain too costly to most consumers.

Table 5.13
Telephone Tariffs in Selected Countries of the Americas Region, 1998 (US$)

	Residential		Business			Subscription as a fraction of GDP per capita
	Connection	Monthly Subscription	Connection	Monthly Subscription	Local call	
Argentina	150	12.8	150	36.4	0.1	1.9
Brazil	**43**	**6.7**	**43**	**11.6**	**0.09**	**1.7**
Canada	42	13.2	58	37.8	..	0.8
Chile	159	16.3	159	16.3	0.12	4.2
Peru	151	14.8	151	16.2	0.08	7.3
United States	44	19.9	70	41.3	0.09	0.8
Central America	121	6	159	9.9	0.06	4.4
South America	186	7	247	12.3	0.07	2.8
Caribbean	51	9.2	65	19.8	0.07	3.7
Americas	107	8.3	145	16.4	0.07	3.3

Source: Americas Telecommunication Indicators 2000, ITU

5.75 On Brazil's current trajectory, its low-income households and less developed regions will be left behind. It will take a great deal of government-support funding to bring affordable community Internet access centers and to provide basic education/training on how to use the Internet.

Policy & Regulation

5.76 Continued growth in consumer and business adoption of e-commerce depends on several factors: online user privacy, electronic contracts legitimacy, industry-specific insurance provision and antitrust regulations (limiting mergers and acquisitions among telecom and internet service providers). With the liberalization of various market segments and the change in the nature of services offered, there is a need for transparent policy and rules on these issues.

Lack of Content in Portuguese

5.77 The volume of information available in networks is an indicator of a nation's knowledge capacity. In Brazil, despite emerging local content, the internet remains a predominantly English-speaking medium and, therefore, places content restrictions on the vast majority of Brazilians.

V. CONCLUSIONS

5.78 Growth in Brazil over the last two decades has been slower than the world average. In order to catch up, Brazil could make effective use of knowledge for development. This does not just imply that Brazil must simply rush to develop ICTs and high technology. It could, however, make improvements in four key areas: *the economic incentive and institutional regime, education and skills, the information and communications infrastructure, and the innovation system.*

5.79 These elements are interdependent. It is not enough to improve domestic R&D, or education, or the information and communication infrastructure, without also improving the overall system of economic incentives and institutions. These affect the efficiency with which resources are put to use, the extent to which the country draws on expanding stocks of global knowledge, and the flexibility of the economy to restructure. For Brazil to take advantage of the knowledge revolution to accelerate its rate of growth and to increase its welfare it will need to develop a comprehensive strategy encompassing reforms in all four pillars of the knowledge economy.

Updating the Economic Incentive and Institutional Regime

5.80 Brazil is not very well integrated into the global knowledge economy, and this is not just because of its size. Besides having a small traded sector, Brazil still has relatively high tariff and non-tariff barriers, and this reduces pressure from international competition. The main issue in the overall economic regime thus seems to be low exposure to international competition: Brazilian firms do not face as much pressure as those in other countries to improve their technology and productivity to keep up with the rapidly changing international environment.

5.81 Brazil ranks in the mid-range on the soundness of its banks, has adequate regulations and supervision of financial institutions, and is better than other large developing countries such as China and India. Savings and investment rates are also in the mid-range, but interest rates are high which constrains the financing of enterprises. On protection of intellectual property, the legislative regime in Brazil appears to be above average. However, there are significant issues regarding their implementation and enforcement.

Upgrading Education and Skills

5.82 Another feature of Brazil's knowledge structure is the low educational attainment and skill level of the population, especially at the secondary level. On the other hand, Brazilian enrollment rates in tertiary education are satisfactory when compared to that of large developing countries. Brazil's great strength is the flexibility of its people to adjust to new challenges. However, without a strong education and skill base, the effects of this asset will be limited. The country thus faces a major challenge in furthering the reforms already undertaken and in developing an efficient and equitable secondary and higher education strategy.

Improving the Innovation System

5.83 Brazil could improve its innovation system to take advantage of the tremendous entrepreneurial spirit of its population. It spends 0.8 percent of GDP on R&D, average for middle-

income countries but lower than the average of 2.2 percent for OECD countries. The output of the domestic R&D system is low when measured in terms of patents or technical publications, compared to other countries in the region. The export performance in R&D intensive sectors is deteriorating. There are some large government programs such as aeronautics, deep-water oil exploration, tropical agriculture, and biotechnology, that are distinguished by world-class technology development. By and large, private firms have not developed or adapted knowledge intensively, despite the strong entrepreneurial capability in Brazil.

5.84 Thus while Brazil could improve the management and efficiency of its R&D effort, the main issues seem to link back to the broader policy regime (trade, competition etc.) that does not put sufficient pressure on firms to keep up with rapidly evolving global practices and new knowledge. Efforts may also be needed in the near future to attract high quality FDI to help access global knowledge. (Until the 1990s, Brazil was the largest FDI host among developing countries, although its position has been eroded recently by China). For this, as well as to stimulate domestic innovation efforts, the Intellectual Property Rights regime could be improved and better enforced. Measures to stimulate university-industry interactions would also improve the innovation climate.

Expanding the Information Infrastructure

5.85 Brazil has made considerable progress in developing its information infrastructure in recent years, with the privatization of *Telebras* and the liberalization strategy orchestrated by the National Telecommunications Agency (*Anatel*). "Teledensity" remains lower than in advanced economies. Brazil also has lower internet host levels than Argentina or Mexico, and computer penetration is also low. The Internet is thus still out of reach for the majority of the population--less than 10 percent of the population have access to it—owing to a series of factors: lack of infrastructure, high prices for connection, critical services and equipment, and low educational levels. Promoting universal access to telecommunications—through further infrastructure development and tariff lowering—requires appropriate deregulation, intensified competition, and renewed attraction of foreign investors. At the same time, the ICT skills of the population could also be developed.

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ANNEXES

Annex 1A: Knowledge Assessment Methodology

WBI's program on *Knowledge for Development* uses a knowledge assessment methodology (KAM) which consists of a set of 66 structural and qualitative variables that benchmark how an economy compares with its neighbors, competitors, or countries it wishes to emulate. It helps to identify the problems and opportunities that a country faces, and where it may need to focus policy attention or future investments. The comparison for the 66 variables is undertaken for a group of 92 countries, which includes most of the developed OECD economies and about 60 developing economies. A list of these countries is presented in Annex 1B.

The set of 66 variables serve as proxies for the four areas that are critical in the development of a knowledge-based economy, namely:

- An economic and institutional regime to provide incentives for the efficient use of existing and new knowledge and the flourishing of entrepreneurship.
- An educated and skilled population to create, share and use knowledge.
- A dynamic information infrastructure to facilitate the effective communication, dissemination, and processing of information.
- An efficient innovation system of firms, research centers, universities, consultants and other organizations to tap into the growing stock of global knowledge, assimilate and adapt it to local needs, and create new technology.

In addition, the KAM includes several variables that track the overall performance of the economy. These variables help to illustrate how well an economy is actually using knowledge for its overall economic and social development.

The team has also developed an *interactive Internet-based KAM exercise* which can facilitate comparison of a particular country with (a) all countries in the sample (in this case 92 countries); (b) all countries within a particular range of human development; and (c) other countries in the Region. In addition, regional comparisons can also be undertaken to see how a particular region compares to another. The exercise also includes a "help" feature (on the upper right corner of the screen) that is useful in navigating through the exercise *(http://www1.worldbank.org/gdln/kam.htm).*

Knowledge Assessment Scorecards and the Interactive KAM

As a large set of variables is unwieldy, simplified "knowledge assessment scorecards" consisting of 15 variables have been developed. In the interactive KAM exercise, the 15 variable scorecards are referred to as the "standard" scorecards. However, participants are not just limited to the 15 variables that are used in the standard scorecards, but can choose other variables from the 66-variable data set and create their own scorecards. Annex 1C presents a list of variables used in the standard scorecards; Annex ID presents the rest of the variables used in the KAM exercise. Annex 1E presents the standard 15-variable scorecards; Annex 1F presents the scorecards by each pillar of the knowledge economy. Annex 1G provides the data used for the scorecards.

The 15-variable standard scorecards presented in Annex 1E represent the four pillars of the knowledge-based economy (economic incentive and institutional regime, education, innovation system, and information infrastructure), and include some performance variables as well. Thus, these scorecards attempt to capture the essence of a country's preparedness for the knowledge-based economy.

Each of the variables used in the scorecards is normalized on a scale of zero to 10, so that the highest value is rated 10 and the lowest, zero. An economy should not necessarily aim for a score of 10 on all variables. Some variables reflect performance; others reflect trade-offs that characterize different development strategies. Still others reflect the particular structural characteristics of an economy. The normalized variables are put on star diagrams to graphically illustrate and facilitate comparisons among countries.

Annex 1B: Country Selection

Countries selected for the Knowledge Assessment Scorecards

G7	Europe	East Asia	South Asia	Transition Economies
Canada	Denmark	China	Bangladesh	Belarus
France	Finland	Hong Kong	Bhutan	Bulgaria
Germany	Ireland	Indonesia	India	Czech Republic
Italy	Netherlands	Korea	Nepal	Estonia
Japan	Norway	Malaysia	Pakistan	Hungary
UK	Spain	Mongolia	Sri Lanka	Kazakhstan
USA	Sweden	Philippines		Latvia
		Singapore		Lithuania
		Taiwan		Poland
		Thailand		Romania
		Vietnam		Russia
				Slovakia
				Slovenia
				Turkey
				Ukraine
				Uzbekistan
7	**7**	**11**	**6**	**16**

Latin America and Caribbean	Middle East	North Africa	Sub-Saharan Africa
Argentina	Bahrain	Algeria	Botswana
Barbados	Egypt	Morocco	Cameroon
Bolivia	Iran	Tunisia	Djibouti
Brazil	Jordan		Eritrea
Chile	Kuwait		Ethiopia
Colombia	Lebanon		Ghana
Costa Rica	Oman		Kenya
Dominican Rep.	Qatar		Madagascar
El Salvador	Saudi Arabia		Mauritania
Jamaica	Syria		Mauritius
México	UAE		Mozambique
Paraguay	Yemen		Nigeria
Peru			South Africa
Uruguay			Tanzania
			Uganda
			Zimbabwe
14	**12**	**3**	**16**

Total: 92 countries

Annex IC: Variables Used in the Standard 15-variable Scorecards

Performance Indicators

1. Average annual GDP growth 1990-99 (%) (World Development Indicators, 2001)
2. Human development index 1999 (Human Development Report, UNDP, 2001)

Economic Incentives

3. Gross capital formation as a % of GDP (Annual Average Growth, 1990-1999) (World Development Indicators, 2001)
4. Tariff and non-tariff barriers 2001 (Heritage Foundation, 2001)

Institutional Regime

5. Rule of law (World Bank Institute, 1999)
6. Control of corruption (World Bank Institute, 1999)

Innovation System

10. FDI as percentage of GDP 1990-99 (SIMA database 2001)
11. Total expenditure for R&D as a percentage of GNI 1987-1997 (World Development Indicators, 2001)
12. High technology exports as a percentage of manufactured exports 1999 (World Development Indicators, 2001)

Education and Human Resources

7. Adult literacy rate (% age 15 and above) 1999 (Human Development Report, UNDP, 2001)
8. Secondary enrolment 1997 (World Development Indicators, 2001)
9. Tertiary enrolment 1997 (World Development Indicators, 2001)

Information Infrastructure

13. Telephone per 1,000 persons, 1999 (telephone mainlines + mobile phones) (International Telecommunication Union, 2000)
14. Computers per 1,000 persons, 1999 (International Telecommunication Union, 2000)
15. Internet hosts per 10,000 persons, 2000 (International Telecommunication Union, 2000)

Annex ID: Other Variables Available in the KAM

Performance Indicators

1. Gender development index 1999 (Human Development Report, UNDP, 2001)
2. Poverty index 1999 (Human Development Report, UNDP, 2001)
3. Composite ICRG risk rating 2000 (World Development Indicators, 2001)
4. Unemployment rate, % of total labor force 1996-98 (World Development Indicators, 2001)
5. Productivity growth (% change of GDP per person employed) 2000 (IMD World Competitiveness Yearbook, 2001)

Economic Incentives

6. Overall central government budget deficit as % of GDP, 1998 (World Development Indicators, 2001)
7. Trade as % of GDP, 1999 (World Development Indicators, 2001)
8. Intellectual Property is well protected (WEF Global Competitiveness Report, 2000)
9. Soundness of banks (WEF Global Competitiveness Report, 2000)
10. Adequate regulations & supervision of financial institutions (IMD World Competitiveness Yearbook, 2001)
11. Local competition (WEF Global Competitiveness Report, 2000)
12. Protection of property rights (WEF Global Competitiveness Report, 2000)

Institutional Regime

13. Regulatory framework (WBI, 1999)
14. Government Effectiveness WBI, 1999)
15. Voice and accountability (WBI, 1999)
16. Political stability (WBI, 1999)
17. Press freedom 2001 (Freedom House, 2001)

Innovation System

18. Technology Assessment Index (Human Development Report, UNDP, 2001)
19. Royalty and license fees payments (millions) (1999) (World Development Indicators, 2001)
20. Scientists and engineers in R&D per million 1987-97 (World Development Indicators, 2001)
21. Research collaboration between companies and universities (WEF Global Competitiveness Report, 2000)
22. Entrepreneurship among managers (IMD World Competitiveness Yearbook, 2001)
23. Easy to start a new business (WEF Global Competitiveness Report, 2000)
24. Availability of venture capital (WEF Global Competitiveness Report, 2000)
25. Number of technical papers per million people 1997 (World Development Indicators, 2001)
26. Patent Applications granted by the USPTO (per million pop.) 2000 (USPTO)
27. Private sector spending on R&D (WEF Global Competitiveness Report, 2000)

Human Resources

28. Primary Pupil-teacher ratio, pupils per teacher,1998 (2001 SIMA database)
29. Life expectancy at birth, years, 1999 (2001 SIMA database)
30. Management/worker relations (WEF Global Competitiveness Report, 2000)
31. Flexibility of people to adapt to new challenges (IMD World Competitiveness Yearbook, 2001)
32. Public spending on education as % of GDP 1999 (World Development Indicators, 2001)
33. Professional and technical workers as % of the labor force 1999 (ILO, 2000)
34. 8th grade achievement in mathematics (TIMMS 1999)
35. 8th grade achievement in science (TIMMS 1999)
36. National culture is open to foreign influence (IMD World Competitiveness Yearbook, 2001)
37. Companies invest heavily to attract, motivate and retain staff (WEF Global Competitiveness Report, 2000)
38. Management education is locally available in first class business schools (WEF Global Competitiveness Report, 2000)
39. Well educated people do not emigrate abroad (IMD World Competitiveness Yearbook, 2001)
40. University education meets the needs of a competitive economy (IMD World Competitiveness Yearbook, 2001)

Information Infrastructure

41. Telephones per 1,000 people, 1999 (International Telecommunication Union, 2000)
42. Mobile phones per 1,000 people, 1999 (International Telecommunication Union, 2000)
43. TV Sets per 1,000 people, 1999 (World Development Indicators, 2001)
44. Radios per 1,000 people, 1999 (World Development Indicators, 2001)
45. Daily newspapers per 1,000 people, 1996 (World Development Indicators, 2001)
46. Investment in telecom as % of GDP 1998 (IMD World Competitiveness Yearbook, 2001)
47. Rating of computer processing power as % of total worldwide MIPS 1998 (IMD World Competitiveness Yearbook, 2001)
48. International telecommunications: cost of call to US in $ per 3 minutes, 1999 (World Development Indicators, 2001)
49. Information Society Index 2000 (IDC 2000)
50. Percentage of Companies that use the Internet for electronic commerce (WEF Global Competitiveness Report, 2000)
51. ICT Expenditures as a % of GDP 1999 (World Development Indicators, 2001)

Annex 1E: Knowledge Assessment Scorecards

Standard 15-variable Scorecards

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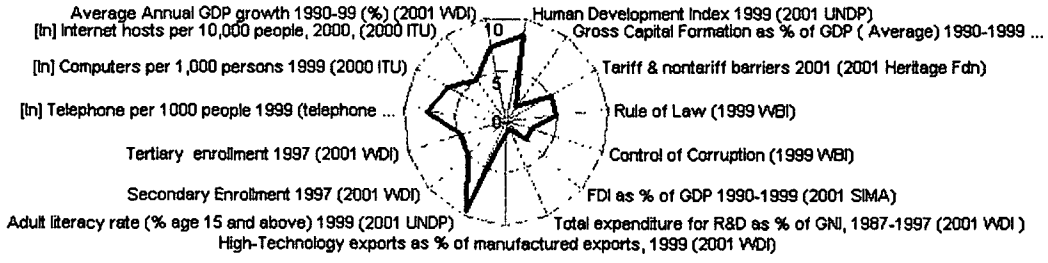

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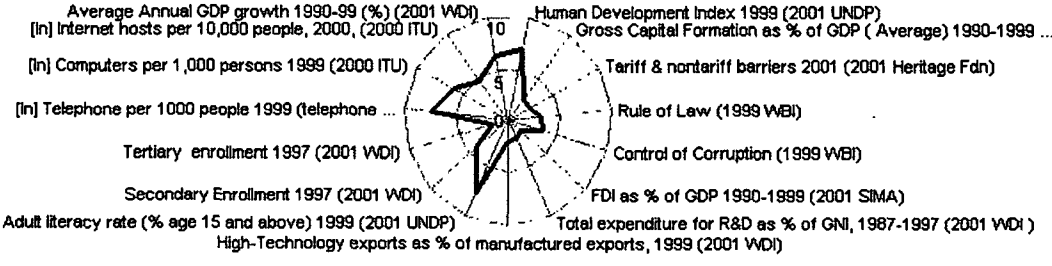

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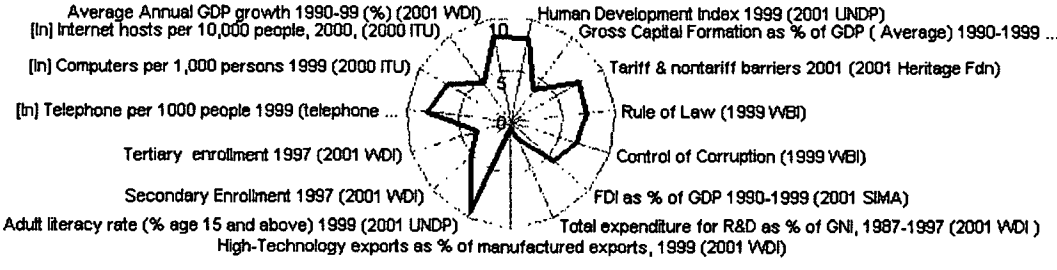

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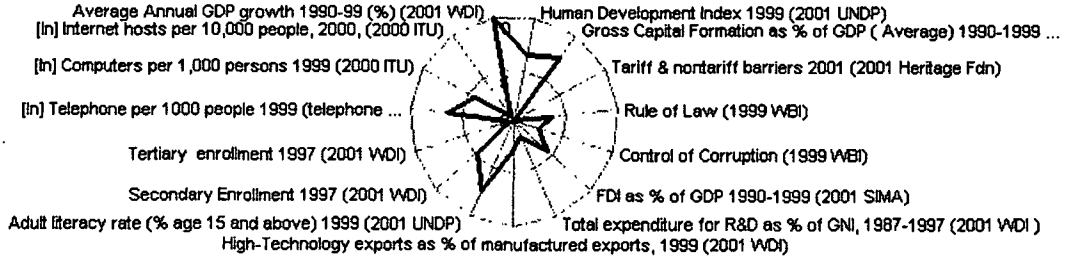

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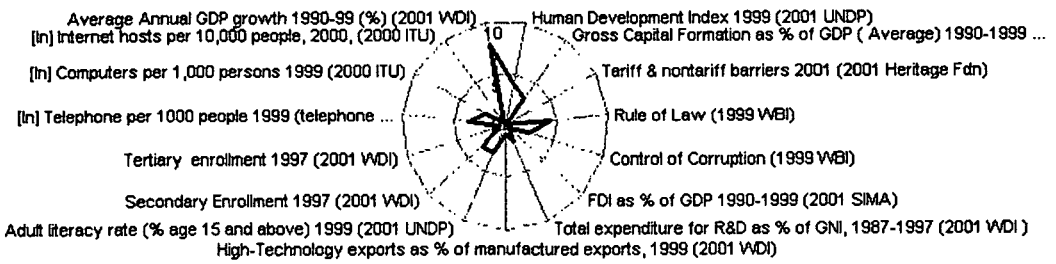

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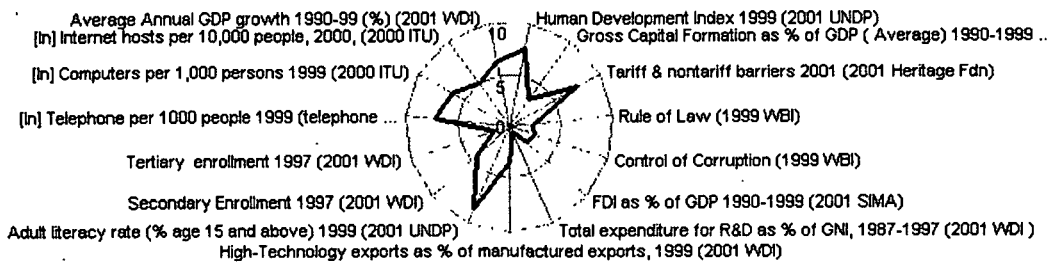

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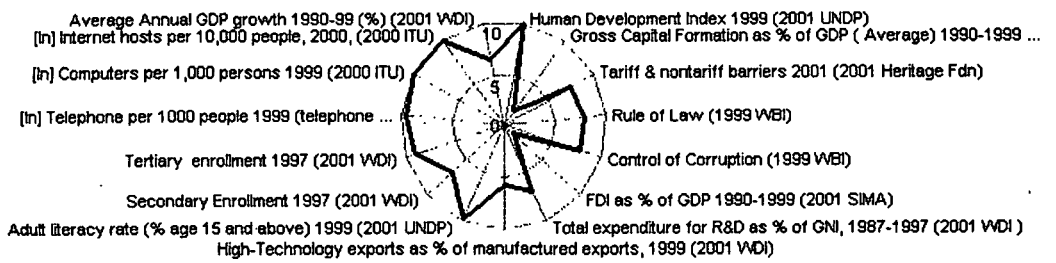

Annex 1F: More Detailed Scorecards

Economic Incentive and Institutional Scorecards

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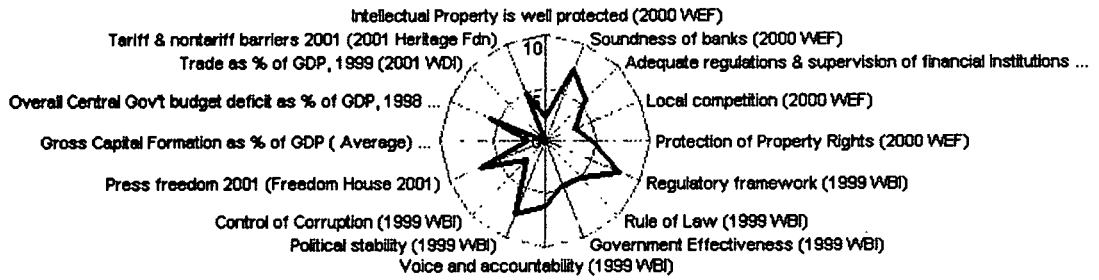

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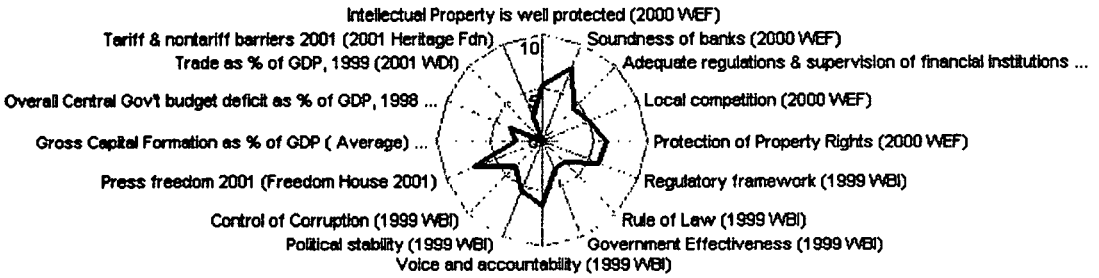

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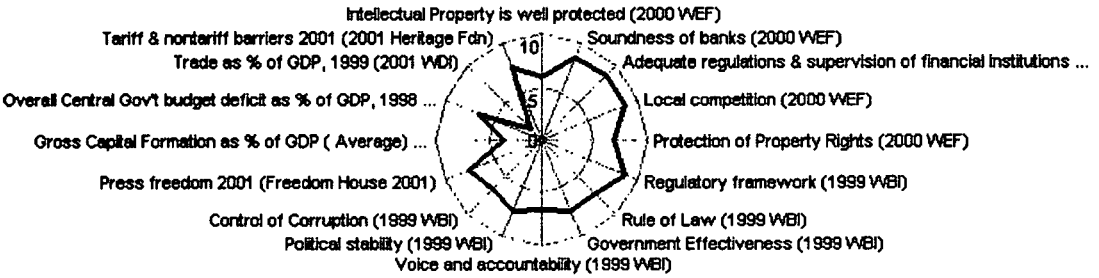

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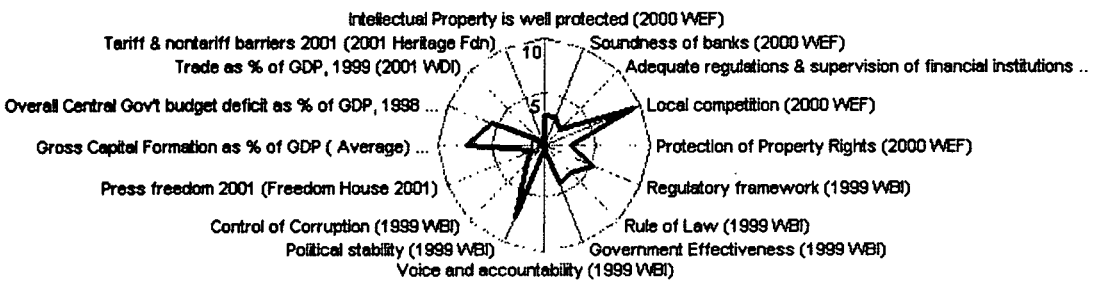

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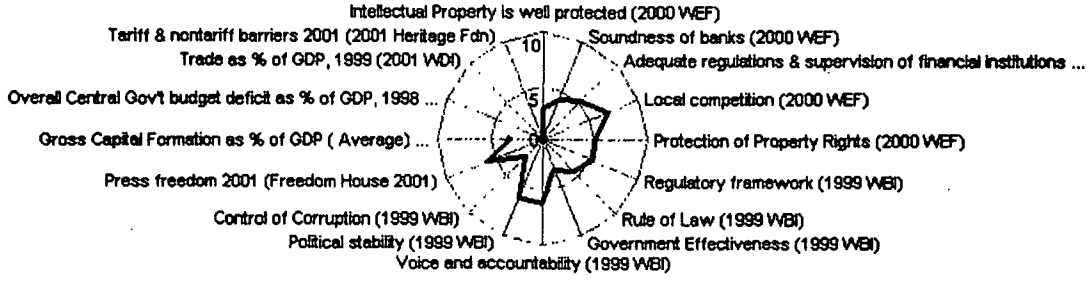

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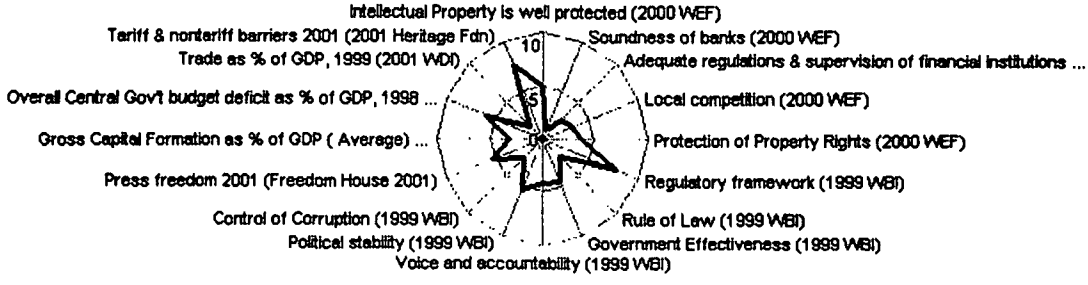

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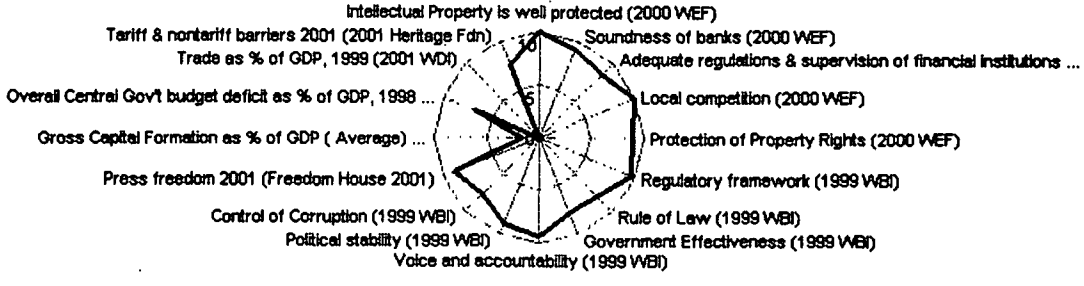
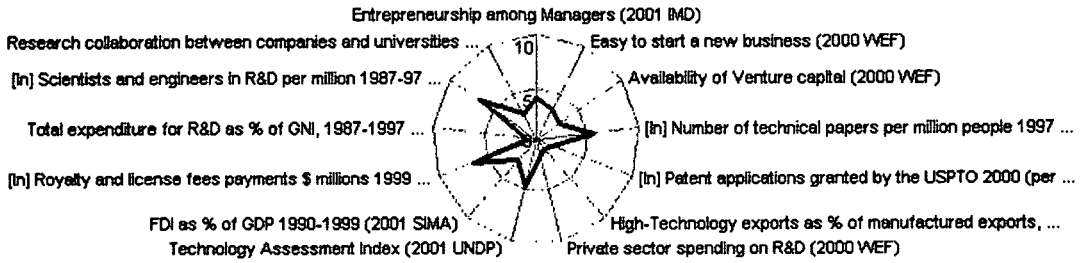


Innovation System Scorecards

Argentina



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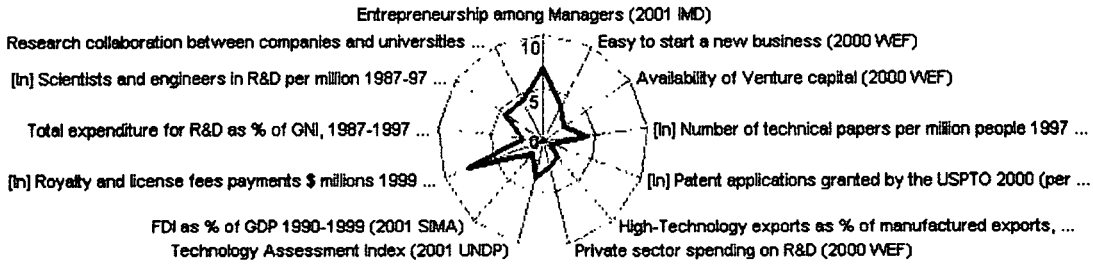

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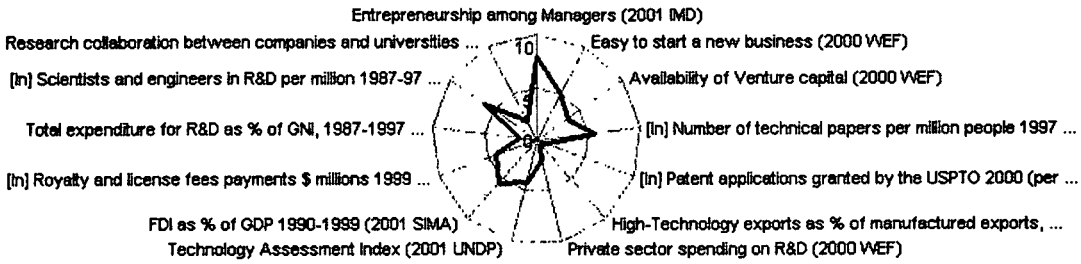

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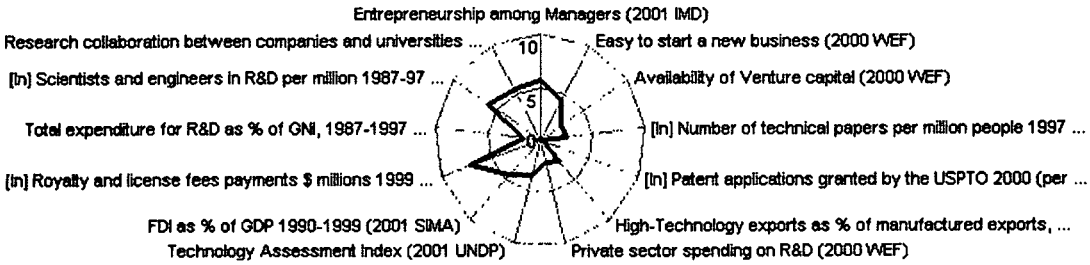

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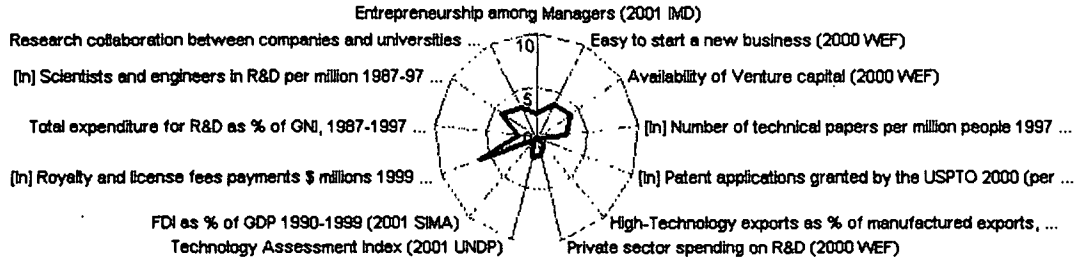

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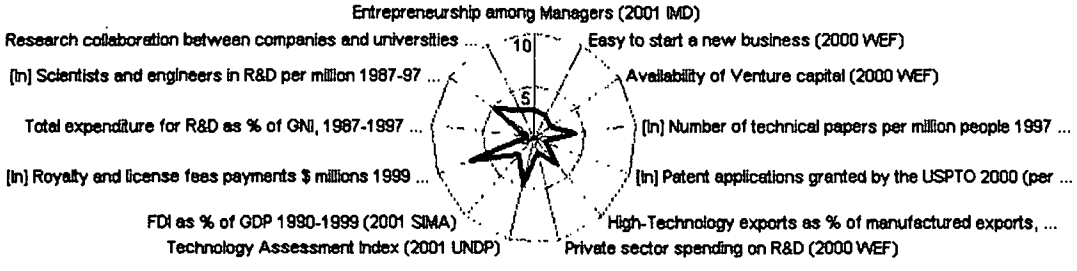

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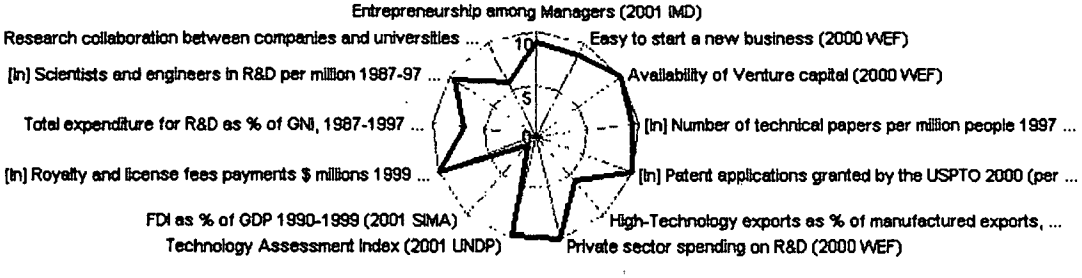
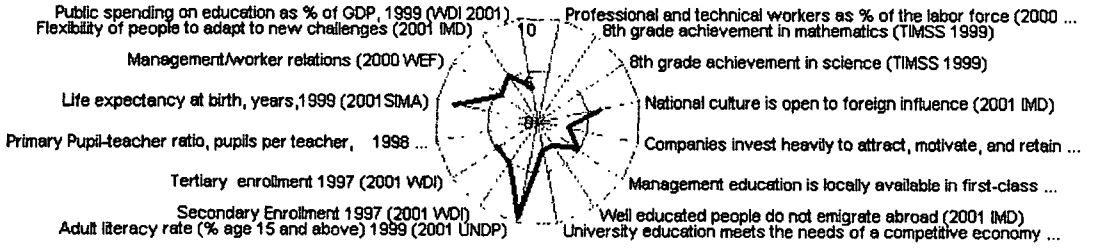


Education Scorecards

Argentina



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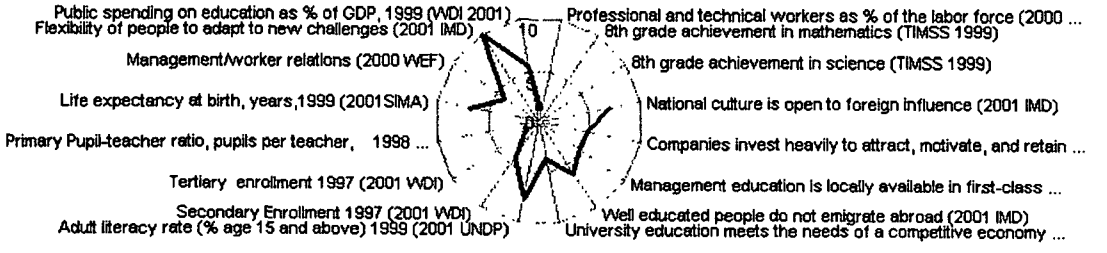

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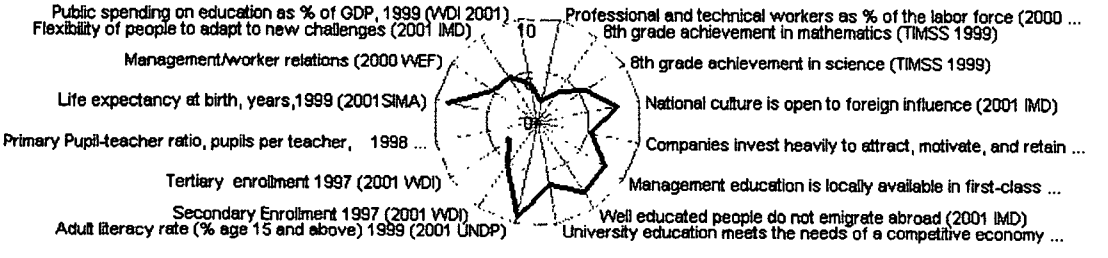

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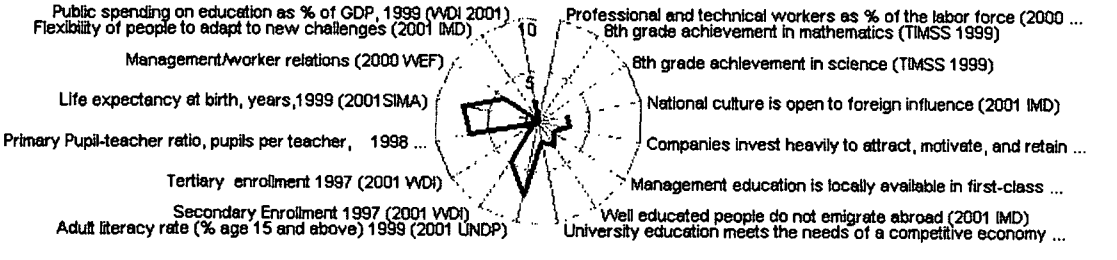

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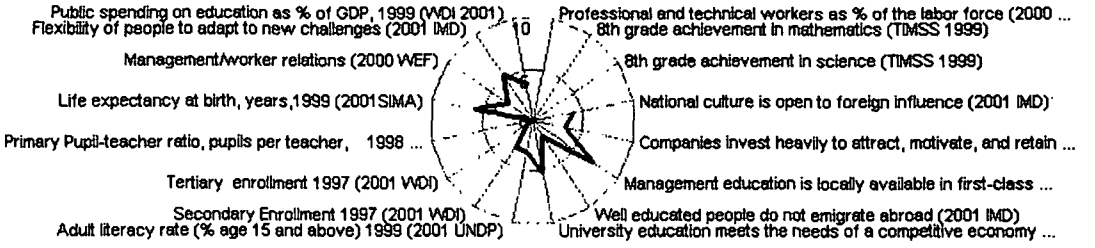

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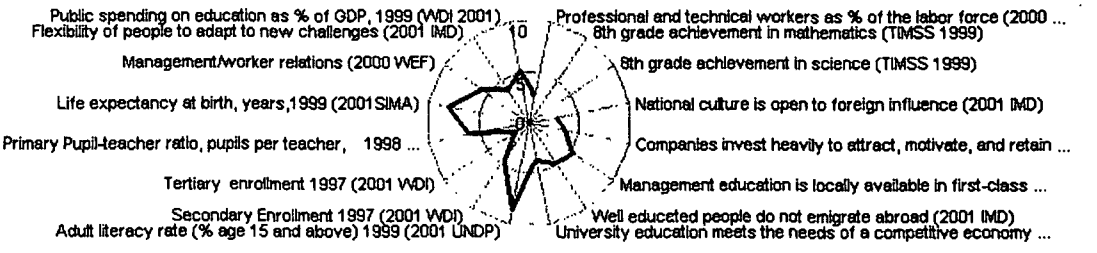

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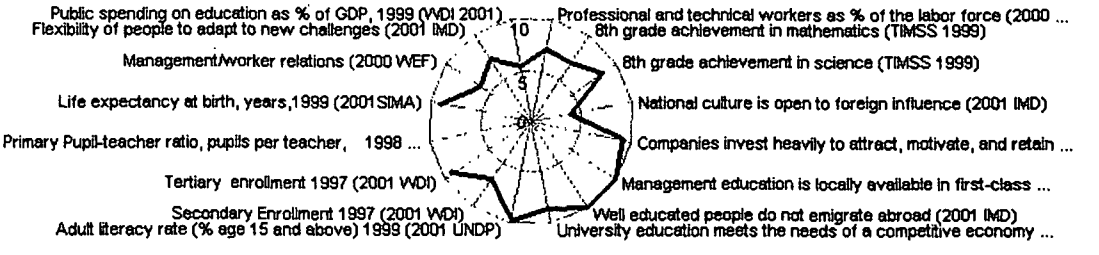
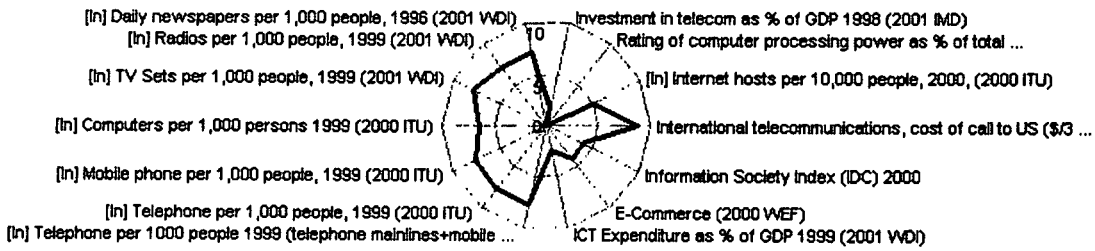


Information Infrastructure Scorecards

Argentina



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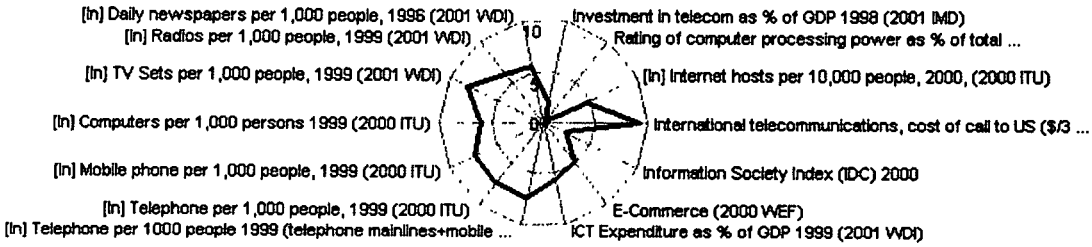

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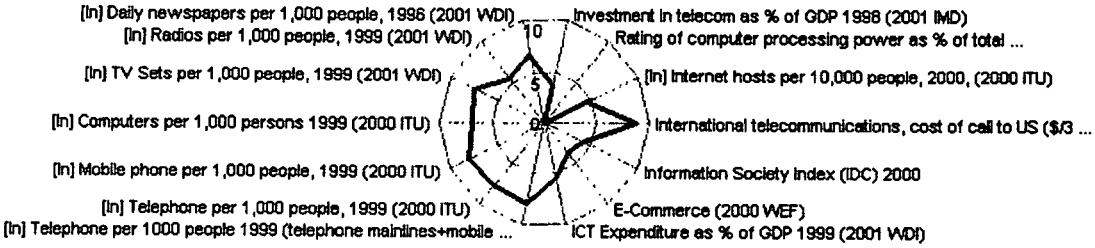

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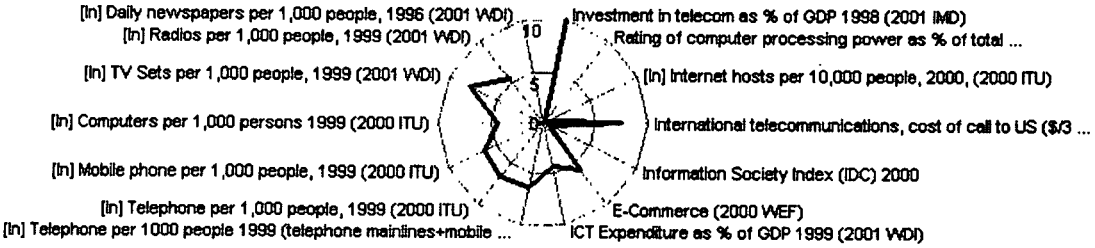

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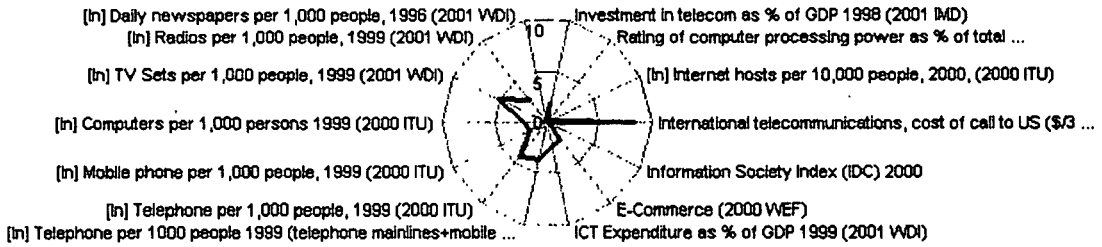
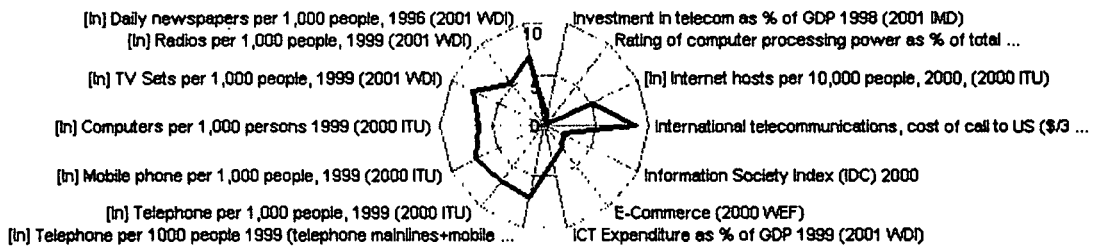
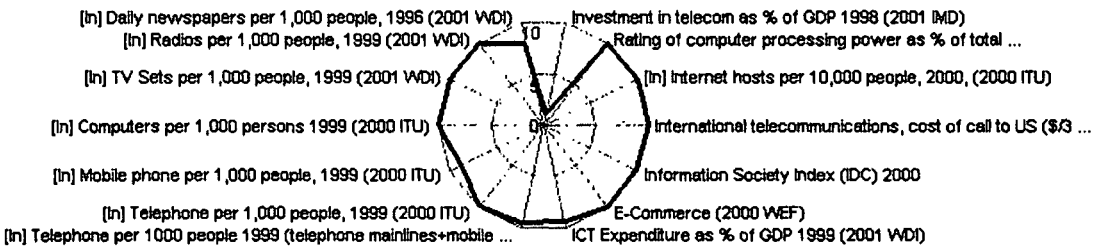


Mexico



USA



Annex 1G: Data for the Knowledge Assessment Methodology

KAM Data in Standard 15 Variable Scorecard

Countries	Average Annual GDP growth 1980-98 (%)	Human Development Index 1999	Gross Capital Formation as % of GDP (Average) 1990-1999	Tariff & nontariff barriers	Rule of Law (1999 WBI)	Control of Corruption	FDI as % of GDP 1990-1999	Total expenditure for R&D as % of GNI, 1987-1997	High-Technology exports as % of manufactured exports, 1999	Adult literacy rate (% age 15 and above) 1999	Secondary Enrollment 1997	Tertiary enrollment 1997	[ln] Telephone per 1000 people 1999 (telephone mainlines+mobile phones)	[ln] Computers per 1,000 persons 1999	[ln] Internet hosts per 10,000 people, 2000
Argentina	4.9	0.842	17.753	6	0.319	-0.275	2.515	0.36	8	96.7	73	42	5.931	3.696	3.678
Brazil	3	0.75	20.739	4	-0.222	0.056	1.491	0.61	13	84.9	62	15	5.782	3.582	3.688
Chile	7.2	0.825	24.943	8	1.086	1.029	5.221	0.68	4	95.6	75	31	6.096	4.199	3.549
China	10.7	0.718	38.375	2	-0.04	-0.269	4.092	0.68	17	83.5	70	6	5.153	2.501	0.525
India	6	0.571	23.319	2	0.16	-0.306	0.392	0.73	6	56.5	49	7	3.570	1.194	0.278
Mexico	2.7	0.79	22.593	6	-0.474	-0.277	2.186	0.33	21	91.1	64	16	5.567	3.769	3.944
USA	3.3	0.934	17.951	6	1.254	1.407	1.133	2.63	35	99	97	81	6.970	6.235	7.792

KAM Data Corresponding to Economic Incentive and Institutional Regime

Countries	Intellectual Property is well protected	Soundness of banks	Adequate regulations & supervision of financial institutions	Local competition	Protection of Property Rights	Regulatory framework	Rule of Law	Government Effectiveness	Voice and accountability	Political stability	Control of Corruption	Press freedom 2001	Gross Capital Formation as % of GDP (Average) 1990-1999	Overall Central Gov't budget deficit as % of GDP, 1998	Trade as % of GDP, 1999
Argentina	3.4	5.5	6.5	4.4	4.5	0.668	0.319	0.262	0.482	0.507	-0.275	33	17.753	-1.6	21
Brazil	4.5	5.6	5.929	4.8	5.2	0.134	-0.222	-0.22	0.552	-0.323	0.056	31	20.739	-7.3	22
Chile	4.8	6.1	8.056	5.6	5.5	0.896	1.086	1.166	0.615	0.451	1.029	27	24.943	0.4	56
China	3.6	3.4	4.911	5.7	3.7	-0.07	-0.04	0.016	-1.296	0.483	-0.269	80	38.375	-2.2	41
India	3.8	4	6.306	5.2	4.7	-0.04	0.16	-0.264	0.496	-0.037	-0.306	42	23.319	n/a	27
Mexico	4.4	2.5	5.091	4.4	4.2	0.608	-0.474	0.179	-0.108	-0.352	-0.277	46	22.593	-1.4	63
USA	6.3	6.4	7.864	5.9	6.4	1.135	1.254	1.366	1.505	1.096	1.407	15	17.951	0.8	24

KAM Data Corresponding to Education

Countries	Adult literacy rate (% age 15 and above) 1999	Secondary Enrollment 1997	Tertiary enrollment 1997	Primary Pupil-teacher ratio, pupils per teacher, 1998	Life expectancy at birth, years,1999	Management/worker relations	Flexibility of people to adapt to new challenges	Public spending on education as % of GDP, 1999	Professional and technical workers as % of the labor force	8th grade achievement in mathematics	8th grade achievement in science	National culture is open to foreign influence	Companies invest heavily to attract, motivate, and retain staff	Management education is locally available in first class business schools	Well educated people do not emigrate abroad
Argentina	96.7	73	42	n/a	73.6	4.6	6.553	3.1	n/a	n/a	n/a	7.263	3.5	5.3	3.73
Brazil	84.9	62	15	n/a	67.2	4.5	8.643	4.7	6.343	n/a	n/a	7.5	4.1	5.3	5.93
Chile	95.6	75	31	n/a	75.5	4.9	6.466	3.3	10.248	392	420	7.771	4.3	6.1	7.32
China	83.5	70	6	24.059	70.1	4.5	4.267	2	n/a	n/a	n/a	6.22	3.5	4.5	3.78
India	56.5	49	7	58.124	63.2	4.2	6.605	3.3	n/a	n/a	n/a	6.626	3.6	5.9	3.15
Mexico	91.1	64	16	27.565	72.1	5	5.948	4.4	13.195	n/a	n/a	6.234	3.7	5.4	5.14
USA	99	97	81	n/a	76.9	5.1	7.438	4.7	28.500	502	515	6.579	5.7	6.7	8.55

KAM Data Corresponding to Innovation Systems

Countries	Entrepreneurship among Managers	Easy to start a new business	Availability of Venture capital	[ln] Number of technical papers per million people 1997	[ln] Patent applications granted by the USPTO 2000 (per million pop.)	High-Technology exports as % of manufactured exports, 1999	Private sector spending on R&D	Technology Assessment Index	FDI as % of GDP 1990-1999	[ln] Royalty and license fees payments $ millions 1999	Total expenditure for R&D as % of GNI, 1987-1997	[ln] Scientists and engineers in R&D per million 1987-97	Research collaboration between companies and universities
Argentina	5.36	3.8	3.2	4.065	0.994	8	2.6	0.381	2.515	6.094	0.38	6.492	3.4
Brazil	6.357	4	3.1	3.189	0.614	13	2.9	0.311	1.491	7.158	0.81	6.124	3.9
Chile	6.704	4.5	3.6	4.055	0.726	4	2.7	0.357	5.221	3.951	0.68	6.096	3.2
China	5.934	4.2	3.1	2.109	0.122	17	2.8	0.299	4.092	6.676	0.66	6.118	4.3
India	4.782	4	3.8	2.247	0.123	6	2.6	0.201	0.392	5.756	0.73	5.004	3.6
Mexico	4.683	3.5	2.9	3.032	0.708	21	2.5	0.389	2.186	6.319	0.33	5.366	3.5
USA	7.107	5.9	6.4	6.399	5.858	35	5.5	0.733	1.133	9.494	2.63	8.210	4.4

KAM Data Corresponding to Information Infrastructure

Countries	[ln] Telephone per 1000 people 1999 (telephone mainlines+mobile phones) 2000 ITU	[ln] Telephone per 1,000 people, 1999 (2000 ITU)	[ln] Mobile phone per 1,000 people, 1999	[ln] Computers per 1,000 persons 1999	[ln] TV Sets per 1,000 people, 1999	[ln] Radios per 1,000 people, 1999	[ln] Daily newspapers per 1,000 people, 1998	Investment in telecom as % of GDP 1998	Rating of computer processing power as % of total worldwide MIPS 1998	[ln] Internet hosts per 10,000 people, 2000	International telecommunications, cost of call to US ($/3 min) 1999	Information Society Index (IDC) 2000	E-Commerce	ICT Expenditure as % of GDP 1999
Argentina	5.931	5.362	5.096	3.896	5.680	6.524	4.812	0.545	0.39	3.878	2.8	33	41.7	3.41
Brazil	5.762	5.203	4.915	3.592	5.808	6.096	3.689	0.561	1.01	3.688	1.8	42	48.1	5.82
Chile	6.098	5.399	5.410	4.199	5.481	5.872	4.585	0.861	0.15	3.549	2.9	32	38.9	5.74
China	5.153	4.711	4.187	2.501	5.677	5.811	n/a	1.916	1.83	0.525	6.7	51	52.9	4.88
India	3.570	3.466	1.253	1.194	4.317	4.796	n/a	0.534	0.69	0.278	4.2	54	27.4	3.48
Mexico	5.587	4.826	4.958	3.789	5.587	5.784	4.575	0.377	1.02	3.944	3	44	31.5	4.2
USA	6.970	6.551	5.899	6.235	6.738	7.671	5.371	0.413	35.63	7.792	-	2	62.2	6.87

6. HUMAN CAPITAL POLICIES FOR GROWTH

The Implications of Theory and Evidence for Brazil

Prepared by Indermit S. Gill and Harry A. Patrinos [108]

I. INTRODUCTION

6.1 Pick up any report by international development agencies and it is difficult to escape strong pronouncements on the importance of one or another aspect of "human capital"—the generic term used for the skills and energies of humans—especially education. Here is a sample:

> *"Investment in education is a key to sustained growth, not only because it contributes directly through productivity, but because it also reduces income inequality."* [109]
>
> *"I am not for a moment suggesting that primary education and secondary education are not at the very essence of development ... [but that is] not enough. .... If you are going to advance the issue of poverty and development in developing countries .... the key ... is higher education...".* [110]
>
> *"Higher education has never been more important to the future of the developing world as it is right now. It cannot guarantee rapid economic development – but sustained progress is impossible without it."* [111]
>
> *"Today, more than ever before in human history, the wealth – or poverty – of nations depends on the quality of higher education."* [112]

6.2 Some months ago, we set out to study what human capital policies are most needed in Brazil, especially the issue of the relative emphases on pre-primary, primary, secondary and tertiary education. Based on the last three assertions, we might have reasoned that if higher education is the key for even a low-income country, it definitely should be the highest priority for an upper-middle income country such as Brazil. We might then have checked whether Brazil fares

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[108] We would like to thank Avani Parekh for research assistance, and Andreas Blom, Norbert Fiess and Mark Thomas for useful inputs and comments.

[109] Nancy Birdsall et al. (1997): Chapter 4 in Pathways to Growth: Comparing East Asia and Latin America, Inter-American Development Bank.

[110] James Wolfensohn, President of the World Bank, cited in Chapter 5 of World Bank (2001): Constructing Knowledge Societies: New Challenges for Tertiary Education.

[111] World Bank and UNESCO (2000): A Report of the Task Force on Higher Education and Society.

[112] Malcolm Gillis, President of Rice University, 12 February 1999; quoted in World Bank and UNESCO (2000): A Report of the Task Force on Higher Education and Society.

badly relative to other Latin American countries in tertiary enrollment and found that it does; besides, some of these countries—such as Peru and Ecuador—actually are much poorer. We could then have concluded that today, more than ever before, the key for improving the lot of Brazil's people—especially its poor—is increased access to and quality of higher education.

6.3 We would almost certainly have been wrong. What we did instead was to examine the evidence. We examined the literature on economic growth and human capital, and studied the experience of countries such as the US and South Korea that have followed generally effective education and training policies and have also grown rapidly, conditional upon attained per capita income levels or resource endowments. We then juxtaposed the lessons learned from these and other countries against Brazil's current state of affairs—high debt levels that constrain government spending, a high level of income inequality, looking to grow its way out of trouble—and came to a different conclusion. We conclude instead that to increase economic growth, the *highest priority for Brazil over the next decade may be to rapidly expand secondary education (grades 5-11) of acceptable quality*—subsidizing training any more is not likely to help much, and the time for greater subsidies for higher education will come later. This paper explains why we reach these conclusions.

What is "Human Capital"?

6.4 For some purposes, human capital can usefully be classified into *tangible* and *intangible* components, following the taxonomy adopted by David (2001). Tangible human capital are the more directly observable traits, such as health, longevity and physiological condition such as strength and eyesight. Much of the discussion of the relationship between human capital and growth, however, generally concerns intangible human capital whose formation, through study, training and work, is costly. This intangible human capital can be subdivided further into psycho-motor capability, cognitive capability, and procedural capability.[113]

6.5 During the last half-century the importance of intangible forms of capital has increased relative to tangible forms of capital, both human and physical. In the US, for example, the ratio of intangible to tangible capital stock increased from 0.5 in 1930 to more than 1 by the end of the century (David, 2001). Of the intangible stock, human capital formed through education and training investments is believed to now represent about three-fourths of the total non-tangible stock. We can surmise that intangible human capital stocks are both smaller and relatively less important in middle and low income countries such as Brazil and India, but also that their importance grows rapidly with economic growth.

6.6 This paper therefore is mostly devoted to a discussion of these intangible aspects of human capital. That is, we focus in this paper on education and—to a lesser extent—on post-school investments in human capital. Therefore, this paper shares the bias of much of the existing literature on economic growth in treating human capital as synonymous with the intangible attributes acquired by people through study, training and experience. But this bias does not make this effort hopelessly flawed as a policy discourse on Brazil. One can reasonably make the

[113] David (2001) further subdivides procedural capabilities into four categories: flexibility and retrainability, problem-solving skills and leadership, creativity and innovativeness, and social capability.

argument that over the last half-century Brazil has done somewhat better in the more tangible areas of health and longevity—though it remains behind on male health and survivability—than it has in fostering the formation of intangible human capital most needed by a middle-income country.

What are "Human Capital Policies"?

6.7 Given the breadth of the definition of "human capital", it is difficult to find policies that do not influence the acquisition or formation of human capital, and hence be excluded from the set of "human capital policies". David (2001, page 67) suggests a practical solution, defining human capital policies as "those which are introduced with the explicit intention of affecting the levels, diversity and relative availability of human capabilities". In this regard, a previously underemphasized point stressed by Heckman (1999), David (2001) and other economists is that the human capital formation effects of the general fiscal system (how taxes are raised, how subsidies are structured) should definitely be considered an important part of human capital policies. The other components are more obvious: government policies to promote health and longevity, measures to foster education and training at all levels and for all age groups, and regulations and interventions to promote acquisition of skills as a by-product of work. We do not directly address government incentives for research and development in this paper.

6.8 The aim of this paper is to identify what a government that faces a fairly tight budget constraint and with similarly limited administrative capabilities can do to ensure that the country's human resources (at least) not act to dampen economic growth and preferably provide a boost to economic growth. We recognize that this is rather confining: there may be good reasons to improve education and health levels in their own right, or for non-economic reasons such as national pride or social welfare, regardless of their growth effects. In this paper, we restrict the discussion to economic reasons for promoting human capital formation mainly for tractability reasons, but also because economic growth is and should be an important policy objective of poorer nations.[114]

6.9 Our main interest here is therefore on human capital policies that promote growth. This paper is written with Brazil in mind, though much of what we write may also be applicable in other middle-income countries. Being economists, we use the only method we know to address this question, viz., an economic approach. This paper may indeed be summarized as "lessons from the dismal science for human capital policies in Brazil and middle-income countries."

The Plan of this Paper and Main Conclusions

6.10 In the sections that follow, we zigzag between the lessons of international experience on the one side and findings for Brazil on the other. In the next section, we briefly describe some human capital indicators in Brazil and the health, education and training systems. Section 3 then summarizes the theoretical characterization of human capital in the economic growth literature, and presents the main findings from empirical investigations using cross-country data. Note here that much of the estimations of the relationship between human capital and growth is correlative in nature, but what is required for policy is evidence on whether and which human capital investments

[114] Those who need convincing should read Easterly (2001).

lead to higher growth. Section 4 zigs back to a quick look at long-term time-series evidence for Brazil based on a short paper by Fiess and Gill (2001) that attempts to decipher the direction of causation. Section 5 then studies the relevant aspects of education policies in three countries—the US, South Korea and India—during the last century. Based on the findings of the previous three sections. In section 6, pulling together the policy lessons learned in sections 3-5 and relying on the additional insights provided in David (2001), Heckman (1999) and Heckman and Klenow (1997), we conclude with some policy guidance for fostering human capital formation and economic growth in Brazil.

6.11 Because this is a long paper, we will not withhold the main messages till the end. But we state them here only briefly and perhaps more forcefully than the evidence warrants, in the hope of encouraging or even provoking the reader to take a look at the rest of the paper. Essentially, our trek through the theory, international evidence, and assessment of Brazil's condition over the last decade or so leaves us with the following conclusions—

- *On the benefits of rapidly increasing human capital investments.* The evidence that human capital investments rapidly lead to economic growth is weak at best. Put another way, there is little in the way of evidence from cross-country analysis and country studies that increased flows lead to higher growth rates. From a policy point of view, this means that massive investments in education, training, and health would probably not raise economic growth rates quickly.

- *On the benefits of having large human capital stocks.* There is evidence that countries that have grown steadily and impressively have higher human capital stocks. Put another way, there is some evidence that countries with higher stocks of human capital—both tangible and intangible—grow faster. From a policy point of view, these two findings mean that countries should view human capital policies as instruments of long-term growth, not as devices for sparking economic growth spurts.

- *On Brazil's education levels and growth since the 1950s.* Simple econometric tests for Brazil's own experience seem to support these findings: That is, short-term correlations between human capital and economic growth are as weak as long-term associations are strong.

- *On the importance of investments in health versus education and training.* The pattern of human capital indicators for Brazil suggests while Brazil made the "epidemiological transition" during the 1980s, it still has to make what can analogously be termed a "pedagogical transition". Put differently, while Brazil made the transition to middle-income country status in its health-related achievements, it still has education-related indicators (such as secondary and tertiary enrollment ratios and the qualifications of teachers at all levels) that are more likely to be found in low-income countries. While Brazil's health levels can still improve—a lot in the case of adult male health, for example—the emphasis of human capital policies over the next decade should be on education.

- *On the potential for "leapfrogging" in human capital investment.* While countries can "leapfrog technologies", the experience of the US in the last century and South Korea during the last fifty years indicates that there is little choice for today's middle and low income countries but to build up human capital stocks in basically the same sequence as earlier developers—investing in primary education first, then in secondary education, and finally in tertiary education. Alternative strategies such as building a stock of workers with higher education (e.g., India's technology initiatives) do not stand up under closer scrutiny.

- *On investments in tertiary versus lower levels of education.* Again, while there is some evidence of knowledge- or R&D-related externalities (also called spillovers or leaks), there is little proof of growth-related externalities associated with higher education. Middle-income countries such as Brazil that face tight budget constraints should pursue human capital formation aggressively but not in a frenzied manner. It is doubtful that the unavailability of workers with higher education is a constraint on growth, so frenzied investments in colleges and universities are unlikely to unleash growth. Besides, at current levels of graduation from high school, public initiatives to expand higher education do not qualify as non-elitist.

- *On the importance of secondary school investments.* In Brazil, if there was just one thing the policymakers should do, it would be to focus their attention on expanding the access to secondary education of acceptable quality, starting with what we term "junior secondary schooling" (grades 5-10).

- *On gradually shifting resources from primary to "adjacent" levels.* Brazil has achieved remarkable progress in primary school enrollments over the last decade but now—like many middle-income countries—faces declining primary school enrollments because of demographic reasons (the fertility in 2000 was half its 1980 level of 4 births per woman). The challenge for countries such as Brazil where primary and secondary education are sub-national responsibilities is to shift resources from primary to secondary levels. New evidence from industrialized countries—corroborated by studies in Brazil—also points to high economic returns and equity-enhancing effects of pre-primary schooling or early childhood interventions, so some of the resources saved at the primary level can also be transferred to pre-primary interventions.

- *On school versus post-schooling investments in skills.* Job-specific training has a high rate of return when employers and workers determine where, when and for what workers should be trained. In sharp contrast to such private training, the rate of return to public training initiatives is essentially zero. To foster training that yields high returns, the two things middle-income country governments could do are: (a) raise education levels of the workforce, since education and private sector training are strongly correlated; and (b) properly regulate labor markets so that private sector incentives are not distorted.

II. BRAZIL: THE ANATOMY OF AN "INTANGIBLE CAPITAL" LAGGARD

6.12 In this section, we provide a brief description of long-term trends in national income and selected aspects of human capital in Brazil, especially education and health. One of the aims here is to identify episodes in the half-century since 1950 that are especially revealing of the relationship between economic growth and human capital formation in Brazil

Education

6.13 The Brazilian education system is divided into three levels: fundamental (grades 1-8), intermediate (grades 9-11) and higher. It has expanded quite rapidly over time. In 1964 there were about 10 million students in the system, by 2000 there were more than four times as many. In 1990, there were 4 million preschool students, about 30 million at the elementary level, about 4 million at the (senior) secondary level, and about 2 million at the tertiary level. The notable features of the Brazilian systems are high repetition and dropout at primary and secondary levels, low secondary enrollments (about 40 percent of the eligible population), and an over-subscription to higher education.

Table 1
Basic Characteristics of the Brazilian Education System

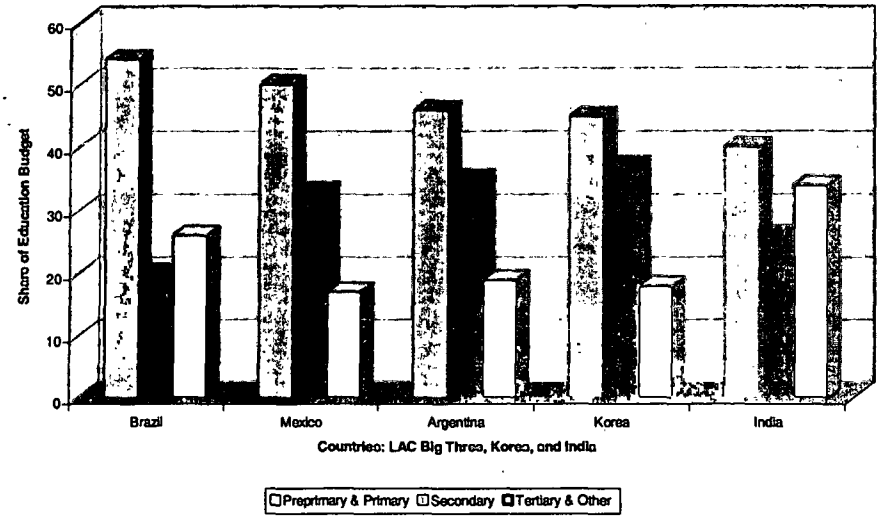
Brazilian structure	This paper's terminology	Grade	Length	Average No. of years to complete[1]	Estimated cost in RS per student /year	Legal responsibility
Ensino Fundamental	Primary Education	1-4	4	5.4	517	Municipality and State (shared)
	Lower Secondary Education	5-8	4	4.9	637	
Ensino médio	Upper Secondary Education	9-11	3	3.7	661	State
Supérior	Tertiary Education	12-17	4-6[4]	4.5	13,654	Federal

Source: Blom et al (2001). The above unit costs do not take into account the high rates of dropping out or repetition. Adjusting for these problems would especially increase unit cost for the lower levels of education. The cost for tertiary is calculated only for federal universities, which normally are considered to be the most expensive.

6.14 Brazil spent 5.1 percent of its GDP on education in 1995, considerably more than Argentina (3.5 percent), Mexico (4.9 percent), Korea (3.7 percent), and India (3.2 percent). By 2000, Brazil had increased this ratio to 5.5%. All public education is free, and some private education also receives public support. What stands out is the extraordinarily low priority given in the Brazilian budget to secondary education, and the high priority given to higher education (see Figure below).

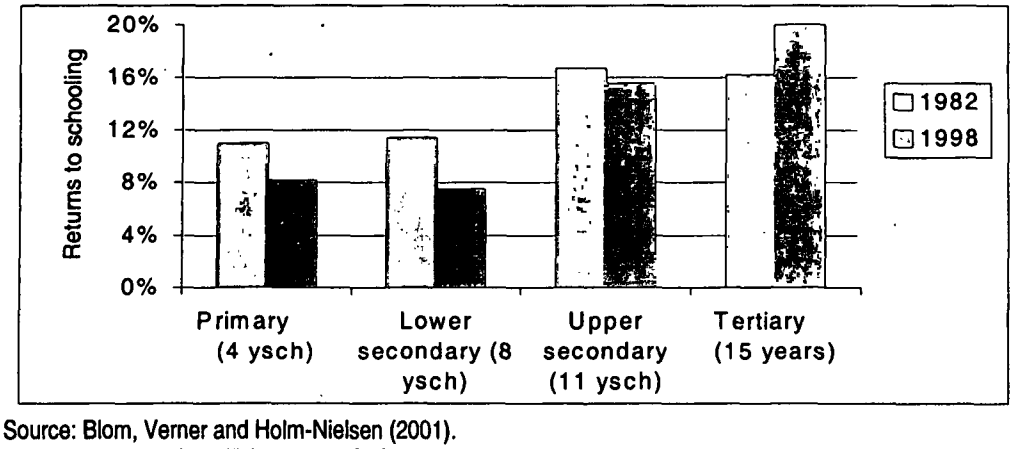
Figure 6.1

Brazil Spends a Small Fraction of Its Education Budget on Secondary Education



6.15 Given the findings in Blom, et al (2001)— reproduced below—that rates of return to secondary education have declined over the last two decades while those to higher education have fallen, it may seem that what Brazil most needs is an expansion of higher education funding. We will examine this issue in each of the subsequent sections. Here it should suffice to note that higher private rates of return to education do not by themselves constitute a case for a reallocation of public subsidies towards higher education, also noting that Blom et al (2001) do not make this assertion.

Figure 6.2
Brazil; Returns to Schooling in 1982 and 1998



Source: Blom, Verner and Holm-Nielsen (2001).
Note: The reported coefficient is the OLS-estimate of the return to one completed year of schooling at the indicated level. The wage regressions are based on wage earners only, and only in the six largest metropolitan areas, and include control variables. ysch stands for years of completed schooling

Health

6.16 Trends in health status in Brazil are encouraging, though the Brazilian people now are said to "have the misfortune to suffer from both the health problems of the industrialized First World and the preventable diseases of the Third World".[115] Children are healthier now than in the past and more of them are getting healthier faster, "because of improvements in purchasing power, maternal education, utilization of health services, community infrastructure and water supply, and individual behavior." (World Bank, 1998). Despite these recent improvements, sharp regional inequalities persist: child health, access to maternal education, health care and water are poorer in the Northeast, and worst in the rural Northeast. Endemic parasitic diseases continue to threaten rural and remote areas in all parts of Brazil.

Basic Indicators

6.17 Brazil has experienced a sharp decline in fertility over the last two decades, which "has in all likelihood reduced the prevalence of the factors associated with risks to childhood health.... Diarrhea among children declined sharply and diseases preventable through vaccination are largely under control in Brazil. An epidemiological transition is said to occur in a country when, as a result of modernization and development, infant mortality and fertility decline, life expectancy increases, and infectious and parasitic diseases are no longer the leading causes of death. As early as 1980, "post-transitional" conditions became the leading causes of death in every region of Brazil. By 1980, cardiovascular disease became, and remains till today, the leading cause of death in each major region and in almost all states.[116]

6.18 Brazil has also made progress in combating HIV/AIDS. The changes in incidence of AIDS in response to government initiatives shows the benefits of "intangible human capital": data from the Health Ministry indicates that while in 1984, 83 percent of AIDS sufferers were university graduates by 1994 almost 70 percent were illiterate or had at best completed primary school.

The Health System

6.19 Brazil's system meets the basic economic axiom of separating the financing from the provision of services." The government health care system, called the *Sistema Único de Saúde* (SUS), contracts out much of inpatient care and a substantial portion of outpatient services to a network of non-profit and private for-profit hospitals and clinics. The government manages and owns only 31 percent of the hospital beds it supports. Despite the efficient structure of the health system, under-financing of the public system is believed to result in regional inequality, arbitrary rationing, and a perceived decline in quality. These are not unusual problems for a middle-income country.

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[115] Director of Brazil's national center of epidemiology, Dr. Eduardo Levcovitz.

[116] These are not diseases of the rich alone. Indeed, both the prevalence of these diseases and of the risk factors associated with them, such as smoking, poor diet and lack of exercise, are generally higher among the poor, who are relatively uneducated and are less likely to be reached by information campaigns. There is also increasing incidence of tuberculosis and leprosy (World Bank, 1998).

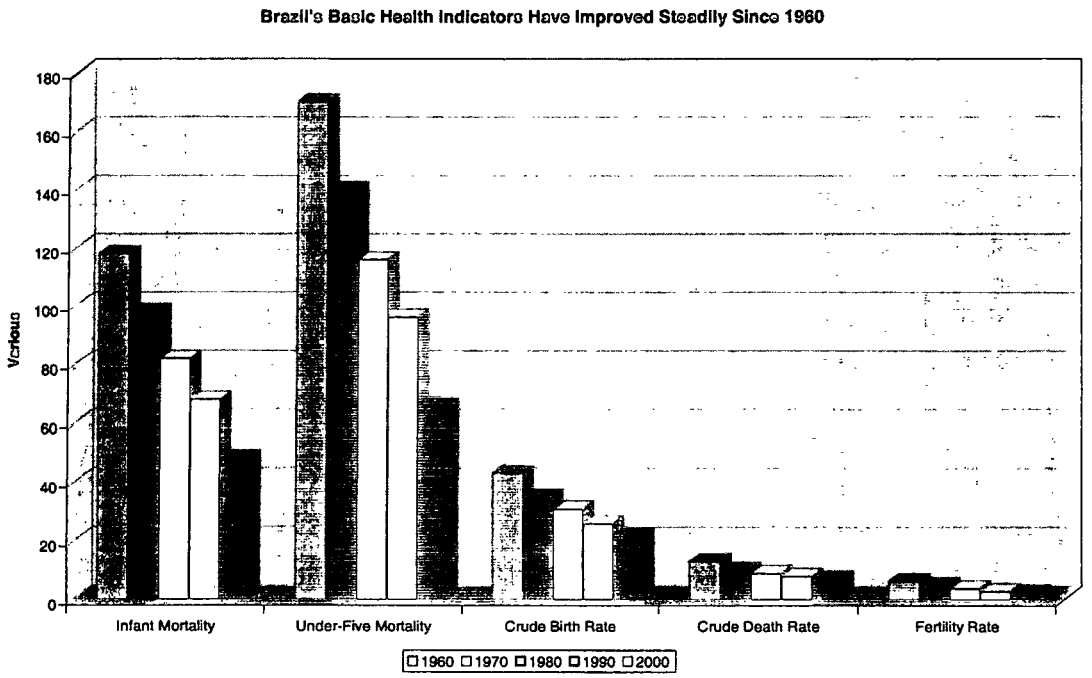

Figure 6.3

Brazil's Human Capital Scorecard

6.20 It is useful to compare Brazil's human capital performance with other countries in Latin America and the Caribbean. Overall, compared with other countries in Latin America and the Caribbean, Brazil still does poorly in human capital indicators.[117] But this underperformance is not uniform, and should be kept in mind while prioritizing investments.

- Child (under-five) mortality is marginally worse—Brazil under-performs by about 6 percent compared with the average Latin American country.
- Female health indicators (survival to 65 years, and years spent in poor health) are not much worse than the average—these are areas in which Brazil has made considerable progress over the last two decades.
- Brazilian males fare worse: longevity and quality of life indicators are about 10 percent worse than for Latin America as a whole.
- Brazil has caught up with Latin America in pre-primary and net primary education enrollments.
- By far the worst performance is for net secondary school enrollment—Brazil is a full 40 percent behind the average Latin American country.

[117] All numbers are from the 2001 *World Development Indicators* of the World Bank. This comparison is meaningful because Brazil's per capita income (adjusted for purchasing power) is roughly average for the region.

- Brazil also does poorly in higher education, lagging behind other countries by about 13 percent.

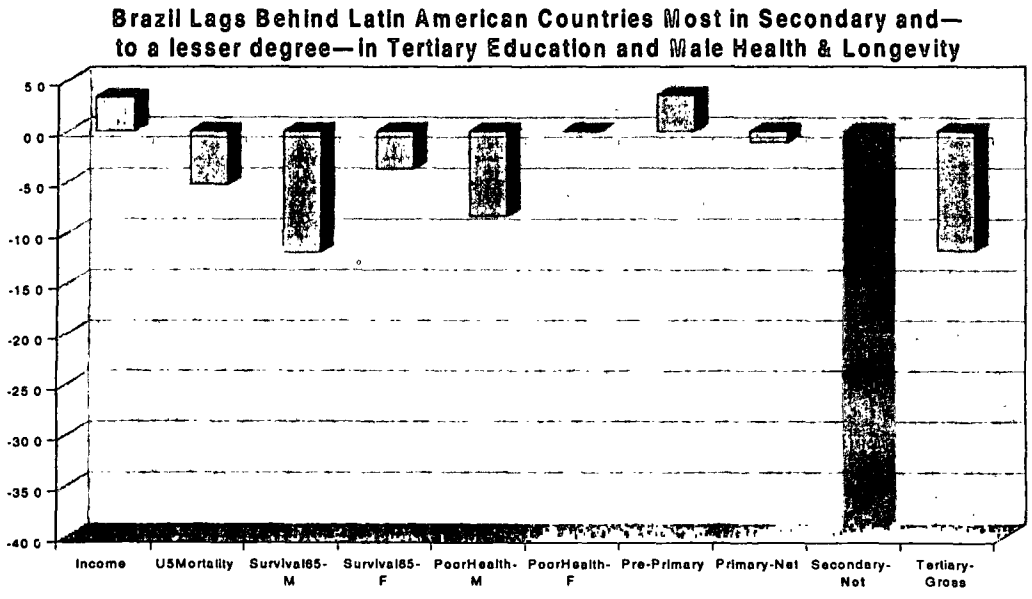

Figure 6.4

6.21 A one-line summary of this section would be that while Brazil made the epidemiological transition during the 1980s, it has yet to make the analogous transition in education. The aim of policymakers could then be to implement a set of policy measures that enable Brazil to make this "pedagogical transition" to middle-income country education levels during the next decade.

6.22 If this were a study of human development, the policy priorities would be somewhat obvious. But our aim here is to determine whether and which human capital investments would most likely help increase economic growth rates in Brazil. We examine what theory and the experience of other countries can tell us about the importance of human capital for growth, and the types of human capital investments that will be most effective in increasing growth in a middle income country such as Brazil. We turn to this next.

III. Lessons from the Literature

6.23 This section presents the result of a quick search through the heap of conjectures, arguments, hypotheses, models, statistics, and regression estimates generated by economists on the subject of economic growth in the hope of finding something on what all this implies for human capital policy. Compared with the researchers that have contributed to this body of work, who were often attempting to explain worldwide growth patterns, the question is somewhat narrower for us: the policymakers we assumed to be our readers were assumed to be from Brazil, a country that is no longer poor, that has sometimes grown rapidly, but has always lagged behind other middle-income countries in human capital development. What follows is the result of this search, organized to be of some help to policymakers in middle-income developing countries.

6.24 In this section, then, we first briefly survey the treatment of human capital in theories of economic growth developed in the last half-century, since the seminal papers on economic growth by Swan (1953) and Solow (1953), to the explicit recognition of human capital in influential papers by Uzawa (1965) and Lucas (1988), and more recent work by Romer (1989), Grossman and Helpman (1991), and others linking investments in human capital, R&D, knowledge externalities, and economic growth. Our aim here is not to comprehensively survey the treatment of human capital in this literature (for that we recommend Topel 1999 and Patrinos 2001). The objective here is to uncover the policy implications, viz., strong clues in the literature for defining a useful role for government. The main premise in the theory is a common sense one—that human capital is an important correlate of growth—and the main policy implication is that because social returns to investments in human capital exceed private returns, there is a case for subsidization of this form of investment because the competitive solution results in under-investment in human capital.

6.25 Later in this section we survey the empirical literature on human capital and growth that has followed these theoretical developments. Again, our aim here is to summarize the policy implications of this literature. This consists of some single-country estimations but mainly of a flood of multi-country growth regressions, which began with Barro (1991), Mankiw, Romer and Weil (1992) and others who found a significant correlation of education with growth. These findings were challenged by Benhabib and Spiegel (1994), Pritchett (1997) and others, and efforts also began to ensure consistency between these cross-country macroeconomic estimations and established within-country microeconomic findings on the rates of return to human capital (see, e.g., Bils and Klenow, 2000). This debate continues unabated even as we write this. But there may be some light at the end of this decade-long tunnel: initiated by Wolff and Gittleman (1993) and others, developed further by Baumol and Wolff (1997) and others, and helpfully summarized by Krueger and Lindahl (1998), Topel (1999), Wolff (2000) and Temple (2001), this line of thinking may be now at a state of knowledge that could yield reliable clues for policy formulation.

Human Capital in the Theory of Economic Growth

6.26 Influential ideas often have deceptively humble origins. Modern growth economics had a simple but surprising start. Solow (1953), in an attempt to understand the determinants of US growth, developed a simple model of the economy in which output depended on capital and labor. When he tested how well the model fit the data, however, Solow found that the growth of measured

capital and labor accounted for only a fraction of the growth in output. The rest was unexplained or captured by the "residual". The efforts of growth economists for the last fifty years can be summarized as theoretical and statistical attempts to chip away at this residual so that the explanatory power of economic theory is improved to a point that economists are no longer embarrassed by their ignorance about the most basic economic issue: the growth of income (see Easterly, 2001, for an enjoyable and insightful account of this "quest").

6.27 Economists began work on the effort to explain the Solow residual right away. To simplify somewhat, the work basically headed in two directions. The first priority was a relative no-brainer even for economists to determine and so started right away: capital and labor inputs were obviously not as well-measured as output, so better measures had to be found. Perhaps this would explain more or even all of the growth of nations. The quality of labor—not just its quantity measured in hours worked—clearly mattered. More educated or better trained workers produced more, and produced for longer as they became healthier and longer-lived. Human capital had made its entrance. Education played a central role, in large part because it was much easier to measure than other forms of human capital.[118] So, as we will see in more detail in the next section, education became a favorite of *empirical* growth economists.

6.28 The second strand was related but more subtle, and hence took longer to gather steam. The main implication of this formulation was that beyond a point, people can not be made better off just by giving them more machines to work with or by making them work harder. This could only be done by organizing production better, so that more could be produced with the same amount of capital, labor and other inputs (such as energy). That is, technological progress had to occur to make economies grow over long periods. The question economists began to grapple with was whether and how technical change could be speeded up. Concepts such as knowledge, innovation, R&D, and patents swirled around this body of work. Knowledge was central here—education obviously mattered too but played a supportive rather than central role. The concepts lent themselves better to theorizing than measurement, and so, not coincidentally, knowledge and innovation became the favorites of *theoretical* growth economists.

6.29 After Uzawa (1965) who recognized the possibility of technological progress being determined "within the system" rather than being fate, the progress in growth theory essentially halted for two decades. Then Romer (1986), Lucas (1988) and others sparked a revival, motivated in large part by the failure of standard neoclassical growth theory to explain the failure poorer economies to catch up to the richer ones. The main culprit—according to these theorists—was the characterization of technical change in standard growth theory as largely exogenous to the country's own efforts, when in fact it depended on factors that could be influenced or were endogenous. By the early 1990s, "new growth theory" was in full bloom.[119]

6.30 The neoclassical view of economic growth is that as physical and human capital are accumulated, their incremental contribution to output diminishes. The implication for developing countries is that since they have smaller endowments of physical and human capital, they will grow

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[118] A decade or so later Becker (1973) and Mincer (1974) would argue that post-school investments in human capital—proxied by years of experience—were perhaps a larger fraction of human capital than education.

[119] Comprehensive reviews of new growth theory are provided elsewhere (Amable and Guellec 1992; Brander 1992; Behrman 1990; Verspagen 1992; Sala-i-Martin 1990; Klenow and Rodriquez-Clare 1997; Temple 1999b).

faster than rich countries for the same level of investment in physical and human capital assets. Eventually, poor economies will catch up with rich economies and per capita incomes will converge. While a central element of economic growth theories is technological change, basic neo-classical theory assumed that it is *exogenous* to the economic process (Solow 1956, 1957, 1970). The newer growth theories that emerged in the late 1980s are differentiated from each other by the accumulated factor which acts as the source of growth, for example: physical capital (with learning by doing or complementarities); technology (research and development); human capital; infrastructure; and public services. Thus, long-run growth is still determined by technological change, but it is *endogenously-driven.* This in turn may be brought about by a variety of reasons, such as learning-by-doing (Romer 1986), external effects of human capital formation (Lucas 1988), production externalities of public expenditures (Barro 1990) and quality improvements through the invention of new products (Grossman and Helpman 1991).

6.31 New growth theories underscore the distinction between capital-based models and ideas-based models (Romer 1993a, 1993b). Capital-based models assert that growth is the result of capital accumulation. Ideas-based models give emphasis to a factor that opens up new investment opportunities, alternatively known as innovation, invention or technological change. Ideas drive both growth in income and capital accumulation. The discovery of ideas is treated as being endogenous rather than exogenous in the new theories. Ideas are not the same as physical or human capital. But unlike neo-classical theory, ideas are something other than freely available public goods. In industrialized countries they come about as a result of intentional attempts to make discoveries. Ideas arrive in developing countries as a result of attempts to transfer them, to the extent that this is encouraged by market incentives.

6.32 In an equilibrium growth model of endogenous technological change, long-run growth is driven primarily by the accumulation of knowledge (Romer, 1986). This theory postulates a positive externality in the production of knowledge because knowledge is assumed not to be perfectly patentable or kept secret. The major new assumption of this theory is that knowledge grows without bound. One adaptation adds human capital with externalities in the sense that the average level of human capital affects a worker's productivity in addition to the effect of her own human capital (Lucas 1988). In this sense human capital is "twice blessed;" because of its inherent productivity and because interactions among well-educated people further increases their efficiency.[120] But, in any case, the distinction between education-related and knowledge externalities is an important one for policy and should be kept in mind.

6.33 Other theorists emphasized labor-augmenting spillovers from human capital investments. Once a given level of knowledge is achieved, it is much easier to acquire further knowledge or a sharp change in production possibilities is induced so that there is a critical mass in human capital attainment. As a result of such threshold externalities, countries with high human capital investment relative to their per capita incomes can experience periods of high-sustained growth.

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[120] In "old" neo-classical theory, the production function is Y = F (K, L), where output (Y) is a function of capital (K) and labor (L). In "new" neo-classical theory, models have been developed from the following basic formulation: Y = f (T, L, **T**), where L is a conventional production factor such as labor, T represents the stock of investment in technological change, and the bold **T** indicates a general volume that is available to all firms in the economy. In Romer (1986), for example, it indicates the sum of all individual *T*s, while in Lucas (1988) it is the average level of human capital (Verspagen 1992).

Therefore, there could be high payoffs in terms of growth to human capital investments at higher levels (Azariadis and Drazen 1990). Developing countries may experience low growth rates until a crucial (perhaps human capital level) threshold is passed (Tallman and Wang 1992).

6.34 In addition to the role of increasing returns to scale, new growth theory emphasizes the learning by doing effects of human capital in the production of technology-intensive products and the dynamic spillover effects of the growth of the export sector, which acts as a leading sector in the diffusion of modern technology across other sectors and industries. Growth theorists also distinguish between *education*, especially at primary and secondary levels, and *knowledge*, acquired through work, production, research, and education.

Table 6.2
Policy Implications in New Growth Theory

Author	Component	Policy Implication
Romer (1986)	learning-by-doing	Invest in R&D
Lucas (1988)	external effects (spillovers)	Invest in human capital
Azariadis and Drazen (1990)	threshold levels	Invest in human capital
Barro (1990)	production externalities	Public expenditures
Young (1991)	invention	Research/production experience
Grossman and Helpman (1991)	innovation	Trade, openness, encourage knowledge flows

6.35 Different roles for the market and the government are specified in the new growth models. The need for government intervention is justified and a role for monopoly power to promote innovation is provided. Amable and Guellec's (1992) review of new growth theory shows that most models provide a basis for public intervention in order to reach the optimal equilibrium. The implication from Lucas' model is that human capital investments are likely to be below the socially optimal level unless there is market intervention in the form of a subsidy for accumulating additional human capital (Tallman and Wang 1992). Individuals do not take external effects into account, making subsidies for human capital accumulation necessary. Tallman and Wang (1992) argue that this may help explain the rapid development of the Newly Industrialized Countries.

Single Country Estimations

Human Capital Matters, But Not So Much

6.36 Most of the empirical work conducted to validate new growth theory thus far has relied on cross-country evidence (which we survey next).[121] These cross-country studies, however, are often plagued by the measurement problems associated with the use of such data (Tallman and Wang 1992). In many cases it is not known how the data was collected, how reliable it is, or how consistent it may be. A more intensive examination of specific case studies may be a promising path toward understanding the role of human capital in economic development. Some interesting

[121] See, e.g., Romer 1989, 1990; Barro 1991; Lau, Jamison and Louat 1991; Scott 1991; Benhabib and Spiegel 1992; Barro and Lee 1993; Gundlach 1993; Knight, Loayza and Villanueva 1993; Baffes and Shah 1993).

work using new growth theory has examined the determinants of the within-country economic growth (which we now examine), though this work has not got the same attention as cross-country work.

6.37 As noted earlier, just as the relatively amorphous concept of *knowledge* was the favorite of new growth theorists, *education* has been the favorite component of human capital for empirical investigators, presumably because of data availability reasons. Attempts to determine the contribution of education to economic growth began in the 1960s. Denison (1967) tried to identify the contribution of different factors of production to the growth of national income or gross national product of the United States between 1910 and 1960. Increases in the quantity of labor and physical capital did not explain the increase in gross national product. There was a large "residual factor." Denison (1967) suggested that improvements in the quality of the labor force, including increased education, were important, and Denison (1985) found that changes in schooling accounted for almost 30% of the change in per capita income between 1929 and 1980. Several more efforts were made to refine or update Denison's estimates. And indeed the refinement continues till today: Recently, for example, Jorgenson and Stiroh (2000) estimated that labor quality growth accounted for nearly 15 percent of labor productivity growth for the 1959-1998 period in the United States.

6.38 A case study of Singapore and Hong Kong by Young (1992) and a later paper by Young (1994) that expanded this exercise to include the other two East Asian fast-growers—Taiwan and South Korea—also used educational attainments to account for labor quality changes. Singapore and Hong Kong is used to develop some insights into the growth process and to evaluate the empirical validity of existing models of endogenous growth (Young 1992). The study finds that both capital and human capital-adjusted labor have grown considerably faster in Singapore, and that while technical change has contributed substantially to economic growth in Hong Kong, its contribution to growth in Singapore is next to nil. The difference in initial conditions is also important: Hong Kong had a better-educated labor force and industrial elite, and this is significant in explaining subsequent differences in the performance of the two economies. Hong Kong's superior labor force in terms of education and higher rate of TFP growth, supports endogenous technical change models which emphasize the supply of human capital as determining the ability of an economy to absorb new technologies.

6.39 An examination of the growth process using new growth theory in South Korea between 1967 and 1986 indicated that the growth of human capital and the diffusion of skills—which are emphasized in new growth models—seem to have been important for growth in Korea (Sengupta 1991). In the case of Indonesia, evidence for 1971-1990 shows that primary and secondary schooling has very important effects on overall growth: a one percent increase in the ratio between enrollment in secondary school to total enrollment (primary and secondary schools) would contribute to the increase in real GDP per capita by 0.5 percent (Juoro 1993).[122] Using data for Taiwan for the period 1965 to 1986, Tallman and Wang (1990) investigate an open economy

[122] In an influential paper, Murphy, Shleifer and Vishny (1991) show that countries with higher proportions of engineering college majors grow faster than countries with a higher proportion of law majors. Jouro (1993) also verifies that engineering graduates influence growth positively in Indonesia, while law graduates have a negative effect.

model with endogenous growth through human capital accumulation. The evidence supports the theoretical suggestion that the inclusion of a human capital measure in the labor input variable increases its importance considerably. In an analysis of industrial growth in Coastal China, Wang and Mody (1993) examine the external effects of human capital. They argue that foreign investment and exposure to foreign knowledge has stimulated industrial growth in coastal China. Education is shown to have an important impact, although more so in tandem with knowledge acquired through international links (see also Chen and Feng, 2000).

Table 6.3
Human Capital In New Growth Theory: Single Country Estimates

Country	Theoretical Concept	Empirical Result	Study
Austria	External effects of human capital	Consistent	Winter-Ebmer (1992)
Brazil	Threshold levels of education	Consistent	Lau, Jamison, Liu and Rivkin (1993)
China	External effects of human capital	Consistent	Wang and Mody (1993)
Guatemala	External effects of human capital	Somewhat consistent	Sakellariou (1995)
Israel	Knowledge	Consistent	Bregman and Marom (1993)
South Korea	Spillovers of human capital	Consistent	Sengupta (1991)
South Korea and Taiwan	Product variety	Somewhat consistent	Feenstra, Madani, Yang and Liang (1999)
Taiwan	Endogenous technological growth	Consistent	Tallman and Wang (1990)
Taiwan	Endogenous growth (education and exports)	Consistent	Chuang 2000

6.40 The endogenous growth theory literature is used to specify a model of economic growth for Israel (Bregman and Marom 1993). The empirical analysis goes beyond neo-classical models to include physical infrastructure, human capital and the degree of openness of the economy. The returns to physical infrastructure (54-63 percent) and human capital (15-24 percent) are found to be greater than the returns to business capital (14 percent). Also, greater openness to foreign trade leads to a positive contribution to productivity. Openness in foreign trade is hypothesized to lead to greater growth because of increased competition, enhanced efficiency, and the exchange of ideas and technology, thus promoting the accumulation of knowledge and human capital. Using Lucas' (1988) model of the external effects of human capital formation, Winter-Ebmer (1992) examines the impact of human capital on wages in Austria. In the Lucas model the human capital investment of an individual has external benefits for his co-workers in the form of higher productivity, which should in turn have an impact on wages. The results are not inconsistent with the Lucas model. Estimating a number of different regressions, the author finds that the only consistently significant variable explaining industry wage premiums is average years of schooling.[123]

[123] A microeconomic approach is used in order to test Lucas' basic assumption of the external effects of human capital. External effects are specific microeconomic phenomena and cannot easily be tested using cross-sections or time-series of countries. This procedure obviously has the advantage that – especially relevant for the study of human capital effects – years of schooling are comparable across industries within one country but not across different countries all over the world (see below). The approach is two-step: internal effects of human capital on pay are controlled for using wage regressions for individual data. External effects on pay are present if the

6.41 Finally, an examination of economic growth over time in Brazil using state-level information for the 1970s and early 1980s—a period of rapid growth—estimated that education explains about 20 percent of this "miracle" growth (Lau *et al.* 1993). Among the reasons put forward to explain such a high contribution is that there is a threshold level of minimum average education somewhere between three and four years of schooling in order for education to begin to have an impact, and Brazil crossed this threshold some years before this growth spurt.[124] In more technical terms, there is a range where there are sharply increasing returns to intangible capital as proposed by Romer (1989). The authors caution, however, that it may be a long time before education has an effect on output (Lau *et al.* 1993).

Cross-Country Estimations

Human Capital Stocks Matter, Flows Seem Not to

6.42 Getting human capital data for a panel of countries puts an additional strain on researchers: the numbers have to be comparable across countries. The result is that most cross-country regressions use schooling enrollment data to proxy intangible human capital investments, education levels to measure the stock-equivalents, and life expectancy data to proxy tangible human capital stocks.

6.43 There is considerable confusion about what the results of cross-country analysis are. Take a look at three assessments of the "consensus" from the literature, all circa 1997:

> *"In the burgeoning literature on the determinants of growth rates across countries, the importance of education is a robust factor, proving relatively insensitive to changes in either specification or sample composition."*[125]
>
> *"..... rather jarring is the repeated finding, in these international data, that changes in the estimated levels of schooling or human capital do not contribute positively to growth, at least measured over the 1965-85 period."*[126]
>
> *"Cross national data show no association between the increases in human capital attributable to rising educational attainment of the labor force and the rate of growth of output per worker. This*

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average amount of human capital of a reference group (say, industries) is determining average wages in this group (or more precisely interindustry wage differentials) over and above the effect of individual characteristics on individual pay. In the first step internal effects of education are filtered out using wage functions for individuals. In the second step the resulting industry wage premiums are regressed on industry-specific characteristics and, above all, on average human capital in the industry to account for external effects of human capital. The author tries to separate internal returns to education from external ones.

[124] Lau, Jamison and Louat (1991) also find that a threshold of four years of primary schooling has a noticeable effect on economic growth, using cross-country data.

[125] Birdsall, Ross, and Sabot (1997).

[126] Griliches 1997, "Education, Human Capital and Growth: A Personal Perspective", *Journal of Labor Economics* 15, S330-342.

implies the association of educational capital growth with conventional measures of TFP is large ... and negative." [127]

6.44 Empirical studies by Romer (1989), Azariadis and Drazen (1990), and Barro (1991) were among the first to attempt to bring cross-country evidence to bear upon the implications generated by externality-based models of economic growth. The main findings of these studies was that economic growth in a broad cross-section of countries over the period 1960-1985 depends positively upon measures that are claimed to represent initial levels of human capital. Mankiw, Romer, and Weil (1992), in another influential paper, found that investments in human capital contribute towards explaining growth in an analysis of cross-country differences in growth.

6.45 The initial results confirming education's favorable impact on economic growth were soon questioned. Benhabib and Spiegel (1994) found little impact of education on economic growth, and the results were confirmed by Wolff (1996) and Baumol and Wolff (1997). Pritchett (1997) also found that in cross-national data there is no association between increases in human capital attributable to rising educational attainment, of the labor force and the rate of growth of output per worker.[128] Wolff (2000) estimated three models on the role of education in economic growth and found, for the most part, that educational levels, the growth in educational attainment, and interaction effects between schooling and R&D, are not significant determinants of country labor productivity growth.[129]

6.46 The pendulum appears to be swinging back towards the initial result—that increases in education are correlated with increases in economic growth—recently. A positive correlation between economic growth and increases in educational attainment is estimated by Temple (1999a), who argues that this effect was always in the data, but is hidden by unrepresentative observations. His correction for measurement error is to remove outliers from the dataset. Then, using the same data as Benhabib and Spiegel (1994) but applying "least trimmed squares" and successively eliminating 14 outliers, he finds that human capital is significantly correlated with growth. Most recently, Barro (2001) again looks at the impact of education on growth, distinguishing between the quantity of education (measured by years of school attainment) and

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[127] Pritchett 2000, revised version of a 1997 paper.

[128] Nevertheless, Pritchett argues that the impact of education varies by country, going on to postulate various reasons for this finding. First, institutional/governance can be significantly perverse so that educational capital accumulation lowered economic growth. Second, perhaps the marginal returns to education fell rapidly as the supply expanded while demand for educated labor was stagnant. Third, educational quality could have been so low that years of schooling have created no human capital.

[29] Wolff (2000) concludes with a review of possible reasons for this finding. Poor quality of education data—based on compilations of country responses to UNESCO questionnaires—is dismissed as the reason. The second possible reason is comparability across nations, but this is not viewed as seriously biasing the results. A third possibility is specification errors, but several different specifications yield the same results. The fourth is that the causal relation between productivity and schooling may be the reverse of the one assumed – that is, schooling might respond to income levels rather than productivity growth to educational levels. This may account for some of the results, especially given the fact that some countries have developed elite systems where education is more of a luxury good. The fifth possibility is the one that Wolff believes is correct: formal education *per se* may not have much relevance to productivity growth among advanced industrial countries. Rather, it may be the case that only some forms of schooling and training are related to growth.

quality of education (measured by scores on internationally comparable examinations). His model is applied to one hundred countries, estimating the determination of the growth rate of real per capita GDP, measured over three ten-year periods between 1965 and 1995. On the effects of education, Barro (2001) finds that the quantity of schooling, measured as the school attainment of males at secondary and higher levels, has a positive and statistically significant relationship with growth.[130] On the quality of education, Barro (2001) finds that science scores have a statistically significant positive effect on growth. The implication is that a one-standard-deviation increase in scores would raise growth rate on impact by 1.0 percent a year. By contrast, a one-standard-deviation increase in school attainment would increase growth rate by 0.2 percent a year. Thus, he concludes that quality and quantity of education matter, but quality matters a lot more.

6.47 Finally, on what level of education matters, Wolff and Gittleman (1993) report while generally that the data seem to be consistent with the proposition that increases in higher education increase growth rates in high-income countries (but the effect diminishes over time), increases in secondary education for middle-income countries, and increases in primary school performance for low income countries. They conclude that for "developing countries, it appears that primary emphasis should be given to improvement of both the quality and quantity of primary and secondary education. These two levels are likely to be the main ingredients in promoting their economic growth for the foreseeable future."

6.48 When one stands back and considers these findings, they seem unsurprising. What seems more surprising is that it has taken economists two decades to learn this (and some are still not sure).

Other Issues

Reconciling Macro- and Micro-economic Evidence, Externalities, and Causality

Reconciling the evidence

6.49 All of the above was confirmation at an essentially qualitative level that education matters for output growth. What the cross-country estimates tell us is different from what microeconomic studies have shown to be the case in many countries. The rate of return to a year schooling, for example, is about 10 percent, and even higher in low-income countries where these rates of return can reach 20 percent.

6.50 In a recent review of the literature, with a special focus on labor markets, Topel (1999) highlights the difficulties with establishing a relationship between education and economic growth. He documents the limitations of the macro approach to this question, suggesting that beyond establishing the premise that education matters, the channels through which education affects

[130] The implication is that an additional year of schooling raises the growth rate by 0.44 percent a year, implying a social rate of return to male secondary and higher education of 7 percent. Female attainment at the secondary level is statistically insignificant. Male primary schooling is insignificant, but primary is a pre-requisite for secondary education, so it remains important. Female primary schooling is positive but statistically insignificant; however, when fertility is held constant, it becomes significant. Hence, female primary schooling promotes growth, at least indirectly.

growth are not touched upon. His estimations find significant "social" returns to education that are as large or larger than private returns. Using within-country changes in education and productivity, he finds that a one-year increase in the average years of schooling for a country's labor force raises output per worker by between 5 and 15 percent. Since the macro literature offers few clues about policies to pursue that will allow human capital accumulation to contribute to economic growth, Topel (1999) suggests that policies that artificially compress wage differentials also reduce the returns to post-schooling investment. That is, low returns to schooling deter investments in human capital. The implication is that supporters of greater educational investments should be pleased, not perturbed, to see high and increasing rates of return to schooling.

6.51 In an unpublished paper, Mamuneas, Savvides and Stengos (2000) try to reconcile the evidence between cross-country growth results and micro estimates, using total factor productivity estimates to construct estimates of the elasticity of output with respect to human capital. They find that for many developing countries, years of schooling have no effect on aggregate output. Constructing an estimate of the social rate of return to human capital from aggregate data on output and inputs, they find substantial differences in rates of return according to a country's stage of economic development. High-income countries have the highest rates while those for low and middle income are frequently insignificant and even negative. Their estimates of the social rate of return for developed economies are consistent with those from micro studies (private rate of return) while those for developing economies are lower than private rates of return.

6.52 Krueger and Lindahl (1998) also offer evidence to suggest that the impact of education on economic growth is as high as the returns to education estimated in microeconomic studies. They argue that evidence finding no relation between education and economic growth is a spurious result, coming about because of a high degree of measurement error in education data. They account for the error and find that the effect of changes in educational attainment – as opposed to the initial level of education, as is used in most of the macro growth literature – on income growth in cross-country data is at least as great as microeconomic estimates of the rate of return to years of schooling.

Externalities

6.53 It has been difficult to estimate externalities associated with human capital, which would provide a rationale for subsidization of human capital investment and hence a role for public policy.

6.54 Heckman and Klenow (1997) estimate the externality by comparing the schooling coefficient from cross-country Mincer regressions with those from cross-individual Mincer regressions. When they take into account differences in technology, social returns are similar to private returns. Rauch (1993) examines the effect of average education on wages and finds significant externalities. Other attempts to estimate social returns include Krueger and Lindahl (2000), Bils and Klenow (1997), Wolfe and Zuvekas 1997 and Haveman and Wolfe (1984). But previous estimates show that social goals can be at least partially achieved via education and its external effects. The total annual value of the non-marketed effects of schooling are about the same as the annual, marketed earnings-based effects of one more year of schooling; i.e., the annual value of incremental schooling reported in standard human capital estimates might capture only about one-half of the total value of an additional year of schooling (Haveman and Wolfe 1984;). Lochner (1999)

estimates the social benefits of high school graduation through reduced crime amount to almost 20 percent of the private return.

6.55 A recent review by Venniker (2000) finds that evidence is scarce and inconclusive, providing support for human capital externalities that is neither strong nor undisputed. Studies that estimate externalities in the form of individual's human capital enhancing the productivity of other factors of production through channels that are not internalized by the individual (similar to Lucas, 1998) provide evidence that is ambiguous. Some estimates give negative values, others give high estimates. One way to summarize this may be that while there is anecdotal evidence of large *knowledge* spillovers through production (see, e.g., Easterly, 2001), the spillovers from education *per se* may be small. But there is no obvious policy implication that can be drawn.

6.56 Patrinos and Psacharopoulos (2001) provide evidence that if these externalities are not considered, social returns to all levels of education are considerably lower than private returns. The most noteworthy result is that while private returns to secondary schooling are lower than returns to higher education, this order is reversed when these returns are deflated by public costs of education (see Figure 5). [131]

Causality

6.57 Much of what has been discussed relates to the correlation between human capital and growth. Some researchers attempt to determine causality—the distinction between initial human capital and concurrent investments in human capital in part addresses this weakness. But there have been more concerted efforts, a notable one being Bils and Klenow (2001). They find that higher initial levels of schooling enrollment is associated with faster subsequent growth in GDP per capita or worker for a broad cross-section of countries between 1960 and 1990. Then, constraining the cross-country estimations to be consistent with microeconomic evidence on rates of return to schooling and experience for individuals in 52 countries, they attempt to determine whether the data are more consistent with schooling causing growth, or with growth causing schooling. The conclusion is that the causation is more from growth—especially *expected* growth—to schooling than the other way round.

[131] Additionally, for policy purposes it is important to determine at what level externalities are greatest. Psacharopoulos (1994) asks whether the externalities at lower or higher schooling levels are more important for economic development: "Can one weigh two very elusive items: (a) the positive externalities associated with a university graduate discovering a new vaccine; and (b) the negative externalities associated with 30 percent of the population being illiterate for their entire lifetimes?"

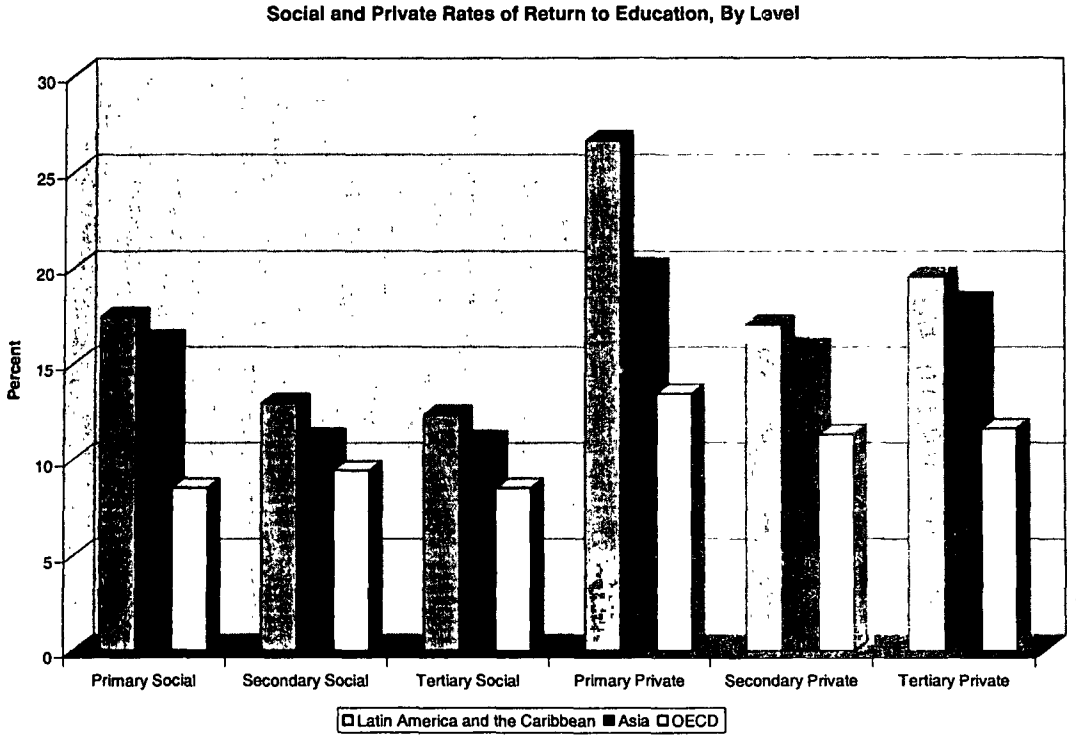


Figure 5

Where do we go from here?

6.58 Perhaps a fair one-line summary of the results of dozens of such studies is that higher initial human capital stocks raise subsequent growth rates, but current investments in human capital appear not to have a significant growth-enhancing effect immediately or in the near future.[132] This is not very different from the results of Lau et al (1993) for Brazil during its growth spurt in the 1970s and is essentially the same conclusion reached through time series analysis of Brazilian data for 1951-1999 by Fiess and Gill (2001) that is discussed in the next section.

6.59 Solow (2000) and others who have followed this debate for more than a decade advise that—for both theoretical reasons such as the assumptions regarding technical progress and practical considerations such as the dubious quality of aggregate data on human capital—these cross-country estimations should be augmented by within-country empirical investigations. So we now examine what time series macroeconomic data from Brazil can tell us about the relationship between education (the best measured component of human capital) and economic growth.

[132] Though Krueger and Lindahl (1998) claim to find the opposite for OECD countries, they get this result only when they consider 10 to 20 year lags. This is in fact similar in spirit to the finding that "stocks matter, not flows".

IV. SCHOOLING AND GROWTH IN BRAZIL[133]

Brazilian schooling and GDP during the last half-century

6.60 School attainment is measured as the average years of completed schooling of 20 year-olds in any year. Growth is measured as annual increments in real GDP; real GDP figures are from IBGE, the Brazilian Institute of Geography and Statistics. Since we do not have schooling data as far back as 1950, we construct a the time series on schooling using household survey data from stacked household surveys for 1998 and 1999.[134] We impute schooling for each year between 1950 and 1999 from these data. The exercise assumes that individuals complete their school education by the age of 20. Thus, the average schooling level of a persons aged 69 years in the 1999 survey is used to approximate the average schooling level of people who were 20 year-olds in 1950, school attainments of a person aged 68 (67) in 1999 (1998) are equivalent to the school attainments of a 20 years old in 1951, and so on. The two series are displayed in Figure 6.

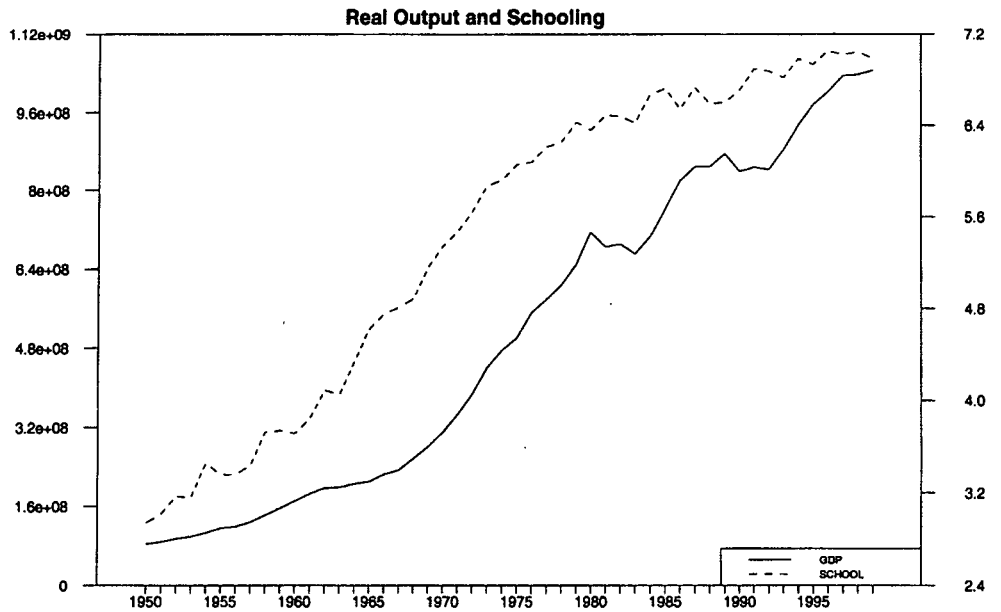


Figure 6.6

[133] This section is based entirely on a note by Fiess and Gill (2001).

[134] The PNAD (*Pesquisa Nacional por Amostra de Domicilios*) is the Brazilian annual National Household Survey. PNAD data come from annual national household surveys of about 100,000 households, performed in the third quarter of each year. The survey is conducted by IBGE. It began at national level in 1971 and underwent major revision between 1990 and 1992. This revision makes it difficult to obtain fully compatible data before and after 1992, and since we do compare across decades this is important to keep in mind. The survey contains extensive information on personal characteristics, including information on income, labor force participation, and educational attainment and attendance.

Some Econometrics[135]

6.61 We use a bivariate time series model to assess the causality between school attainment and growth in Brazil between 1950 and 1999. The econometric technique used here is called a Granger causality test, which essentially examines whether changes in schooling levels and GDP (a) are correlated with each other; and (b) display causality, e.g., increases in schooling levels systematically precede increases in GDP—in which case schooling is said to "Granger cause" economic growth.

6.62 Since we find strong evidence that schooling and real GDP are non-stationary, we test for Granger causality within an error correction framework, i.e., we first determine the order of cointegration between the two series following Johansen (1988) and then augment short-run dynamic equations for changes in school attainment and growth with the derived error correction terms from the cointegration regressions. The VAR models for the cointegration analysis includes a constant in the cointegration space and 3 lags for school attainment and GDP. This specification proves sufficient to produce random errors.[136] The λ_{trace} test indicates one significant cointegrating vector (Table 4).

Table 6.4[137]

Null Hypothesis H_0: rank = r	Alternative Hypothesis	Lag: 4 With Constant	95% Critical Value	90% Critical Value
λ_{trace} test				
r = 0	r > 0	23.84*	20.17	17.79
r ≤ 1	r > 1	6.56	9.10	7.50

*Rejection at the 5% level of significance

6.63 Normalizing the cointegration vectors on the 1st element yields the following estimates for β and α (Table 5):

[135] This section can be skipped without prejudice to understanding the rest of the paper.

[136] The model specification is in the Appendix along with tests for long-run exclusion, stationarity and weak exogeneity. Both variables appear to be non-stationary and the diagnostics on the residuals of the system show the absence of autocorrelation and indicate normality. A sensitivity analysis for different lag lengths. There is some evidence for weak exogeneity of school attainment.

[137] This result comes about by starting at the top of Table 1 and moving downwards until H_0 cannot be rejected. As this is the case in the second row, the analysis maintains the H_0 of one or less cointegrating vectors; this implies the existence of exactly one cointegrating vector in the data.

Table 6.5

	β (1)		α (2)	t-stat.
School	1.000	Δ school	0.209	1.955
GDP	-1.866	Δ GDP	0.112	4.446
Constant	31.755			

Note: Δ indicates a variable in first differences.

6.64 The adjustment coefficient of Δ *school* is borderline significant and a formal test indicates that weak exogeneity for school attainment cannot be ruled out. (The LR test is: $\chi^2(1) = 2.40$, p-value = 0.12.). This indicates that in the long-run school attainment is driving growth and growth is the only variable adjusting to disturbances in the long-run equilibrium.

6.65 To assess Granger causality while taking account of cointegration between school attainment and real output, we estimate a short-run dynamic equation for growth and changes in school attainment, augmented with the lagged error correction terms from Table 5, column 1. The choice of a lag length of 2 for the short-run models is determined by the specification of the VAR model for the long-run analysis. The findings are reported in Table 6.

Table 6.6

	$\sum_{n=1}^{2} \Delta \text{School}_{t-n}$	$\sum_{n=1}^{2} \Delta \text{GDP}_{t-n}$	ecm_{t-1}
Δ School$_t$	F-test: F(2,41) =1.34, p = 0.27	F-test: F(2,41) = 0.32, p = 0.73	t-test: 1.10, p = 0.27
Δ GDP$_t$	F-test: F(2,41) = 0.69, p = 0.51	F-test: F(2,26) = 2.40, p = 0.11	t-test: 3.91, p = 0.00

Note: A variable x_t is said to Granger cause a variable y_t if either its lagged Values (Δx_{t-1}) or the error correction term, ecm_{t-1}, enter significantly the short-equation for Δy_t.

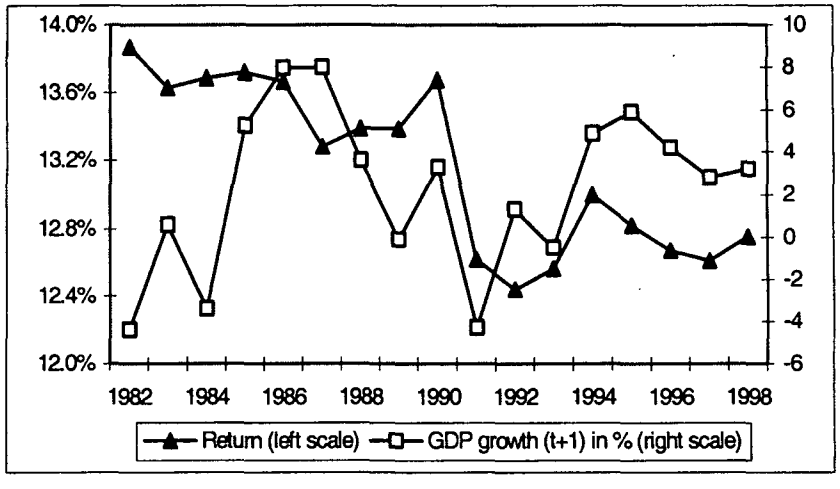
6.66 We find no short-run causality between school attainment and growth. Since the error correction term is only significant and positive (coefficient: 0.11) in the growth equation, we conclude that school attainment causes growth in the long run, but growth does not cause school attainment, either in the short or the long run.

Schooling seems to help, but only in the long-term

6.67 Time series data for Brazil over the last fifty years appear to be consistent with the main result of cross-country data analysis: countries with higher levels of education, other things being equal, seem to grow faster; but increases in education levels do not result in higher growth rates. There is an apparent inconsistency here—how can stocks and flows of the same variable (education) have such different effects on growth. The paradox can be resolved by bringing in the time dimension of this relationship. The international evidence seems to indicate that human capital—proxied often by schooling levels—pays rewards in terms of higher growth rates only over long time horizons. Today's flows are tomorrow's "initial conditions" or stocks.

6.68 The results reported for Brazil in this section suggest (the data do not allow a stronger statement) that higher investments in education do raise growth rates over the long run. But schooling increases do not translate into immediate increases in growth rates; if anything, higher growth rates—by raising the returns to schooling and hence encouraging greater private investments in schooling or by enabling governments to spend more on education—appear to raise schooling levels (see Figure from Blom et al, 2001[138]). The policy lesson here may be that Brazil should maintain steady investments in education and other complementary forms of human capital, and not expect immediate or short-term growth dividends from such investments. Over longer periods, when combined with other pro-growth policies, these human capital investments will pay off. When it comes to human capital, patience seems to be the watchword. Lau et. al (1993) come to a similar conclusion from their study of Brazilian growth during the 1970s (see section 3).

Metropolitan Brazil: The Returns to Schooling and GDP growth



Source: Blom et al (2001), based on PME-data and for GDP-growth: World Bank database SIMA.
Note: The returns to schooling are given by the coefficient to years of schooling in an earnings regression with control variables.

Figure 6.7

6.69 Once again, however, we should stress the unreliability of such exercises as evidence on their own. But these results appear to be generally supported by analysis from cross-country data. Even if we take these results seriously, however, these findings are not enough to inform policy. For example, it is less than obvious at what level policy efforts should be focused—education levels increase if some people acquire a lot more education, or if many people acquire a little more education. It is to these questions that we now turn. Human capital formation before, during, and after reasonably long periods of economic growth may be especially instructive for determining

[138] Blom et al (2001) find that a relationship between GDP growth and returns to schooling is discernible, but only after 1986. The simple correlation between the two is 0 for the whole period 1982-1998, but 0.5 for the period after 1986. After 1986, GDP-growth seems to be related to the average returns to schooling in the subsequent year. That is, GDP-growth, ceteris paribus, increases the reward to human capital.

policy. The call for the study of "growth episodes" by Romer (2001) actually conforms closely to the policy practice of providing "good practice" cases in economic reports, and this is what we turn to next.

V. EVIDENCE FROM THREE "EPISODES"

6.70 In this section, we study three "episodes" of remarkable growth in per capita GDP: the United States (henceforth US) between 1901 and 2000, the Republic of Korea (henceforth Korea) between 1951 and 2000, and India between 1976 and 2000. The emphasis is on verifying or qualifying the policy conclusions drawn from the previous two sections, and not on describing or analyzing the growth episodes in more general terms.

6.71 The choice of countries for closer study is deliberate, and the periods chosen are deliberately long as well—100 years, 50 years and 25 years respectively. We have chosen to contrast currently democratic countries at various stages of economic growth, from the US at a per capita income of about $30,000 and Korea at $10,000, to Brazil at $4,500 and India at $450 (see table below). More interestingly, the choice conforms with "best practice" defined using a criterion that economic growth analysts may find interesting: these are countries exhibiting high economic growth during the last two decades or more, conditional on levels of output of or inputs to growth (along the lines of Hanushek and Kimko, 2000). Since 1980,

- The US was one of the fastest growers conditional upon initial per capita income levels,
- Korea was a fast grower conditional upon initial natural resources per capita,
- India was a fast grower conditional upon initial physical and infrastructure capital per capita and human capital, and

6.72 We contrast these conditionally fast growers countries with Brazil, which was a fast grower conditional upon initial human capital endowments.[139]

[139] For support for this selection see, e.g., Hanushek and Kimko (2000), figures 2 and 3, page 1203. The countries are first ranked according to their average annual growth rates of real GDP between 1960-1990, and then re-ranked by conditional growth rates allowing for initial income and initial human capital. India and the US jump from the 25-50 percentile group to 75-90 percentile group, Brazil also moves up more than 20 percentage points from the 50-75 percentile group to the 75-90 percentile group, and South Korea stays in the 90-100 percentile group. Another country that moves up strongly in ranking is Mexico; examples of countries that move the other way are Germany, Japan, Israel, and Panama.

Table 6.7
Growth Episodes and Human Capital Formation in Four Countries, 1970-2000

	World	USA	Korea	Brazil	India	Unit
Real GDP, 1999	30220	8710	405	750	445	Current $ Billions
Real GDP/Capita, 1999	5055	31915	8685	4470	450	Current $
Growth of Real GDP						Annual %
1971-1980	3.6	2.8	7.6	8.5	3.0	
1981-1990	3.0	3.2	7.7	1.5	5.9	
1991-2000	2.4	3.2	6.1	2.6	5.8	
Growth of GDP/Capita						Annual %
1971-1980	1.7	1.8	5.7	5.9	0.7	
1981-1990	1.3	2.2	6.4	-0.4	3.6	
1991-2000	1.3	2.2	5.0	1.2	3.9	
Education Level						Years
1960		8.7				
1970		10.1				
1980		11.9				
1990						
1995		12.2	10.1	4.3	4.2	

Note: Shaded area indicates recent period of sustained GDP growth
Sources: World Bank staff estimates for GDP, Barro and Lee (2000) for education

United States, 1901-2000: America's "Human Capital Century"

6.73 At the beginning of the 20th century, the leading European countries such as Germany, France, and the UK, and the US all had secondary school enrollment ratios that were around 20-25 percent, not too different from Brazil's own net enrollment ratio at the beginning of the 21st century. Barely 10 percent of US youth were high school graduates in 1910. Shaped by what Goldin (2001) and others have termed a "Republican ideology" and facilitated by new world endowments, the US devised an education system that made it the leader in post-elementary education within three decades. By the late-1930s, the US was three or four decades ahead of Britain and France in post-elementary education, and these gaps persisted until even after the 1950s (see Graph and Goldin, 2001). By the mid-1930s, "the median youth had a high school diploma" (Goldin, 1999) so that public initiatives to expand access to higher education—such as the GI Bills for returning soldiers in the 1940s and 1950s—can safely be classified as non-elitist, at least outside USA's deep South. While post-World War II Europe struggled to expand secondary enrollments, the US was well on its way to ensuring robust *tertiary* education enrollments.

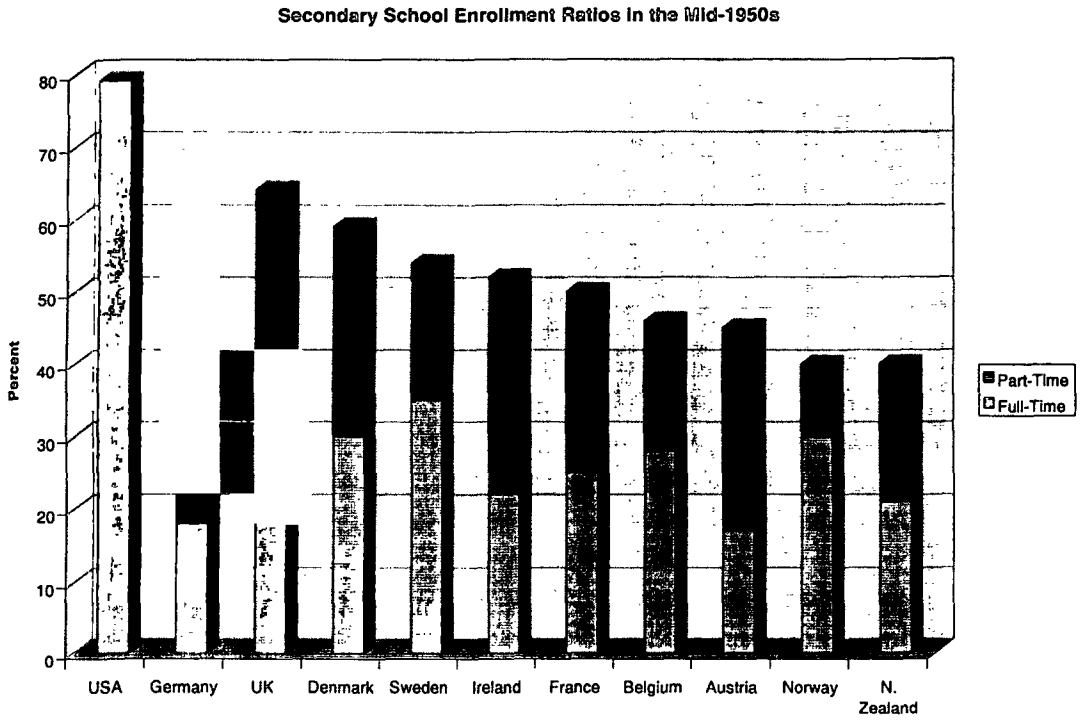


Figure 6.8

6.74 By 1970, many countries had caught up with the US secondary enrollment levels, but it took some of them another three decades to achieve the gross tertiary enrollment ratio of more than 70 percent that the US had attained by the end of the century. The 20th century has been nicknamed the "American century"—for some of the same reasons, it is also the "human capital century" as in Goldin (2001). Since 1950, the US economy has undoubtedly benefited from increases in both educational attainment and research intensity: one growth accounting exercise (Jones, 2000) concluded that 30 percent of US growth between 1950 and 1993 was due to the rise in educational attainment and 50 percent to the rise in research intensity, facilitated undoubtedly by the high educational stocks in the US.[140]

6.75 What distinguished the US secondary education system from its European counterpart was that it "was open, infinitely forgiving, lacking universal standards, and academic yet practical," while the European system "was closed, unforgiving, with uniform standards, and academic for some and industrial for others. One was egalitarian, the other was elite." (Goldin, 2001). Another distinguishing feature was decentralization. The high school expansion in the US was not led by the federal government, and even state compulsory education laws were a secondary factor.

6.76 The pattern of the rates of return to education in the US is also instructive. The relative wages of more skilled workers have over time fallen, with three periods during which they fell

[140] Labor quantity is responsible for the remainder.

sharply: between the late 1910s and early 1920s, during the 1940s and—for college graduates only—during the 1970s (Goldin and Katz, 2001). But education levels increased even during these periods.

Current issues in the US—quality and equality

6.77 The attention to secondary education quality—or "universal standards"—in the US is a relatively modern phenomenon, and by some measures the US appears to have traded quantity for quality. US students are stereotyped as doing considerably worse in international tests than their European and East Asian counterparts (Franciosi, 2001). This may be one aspect in which a virtue of the US system handicaps it: the forgiving and egalitarian nature of secondary education in the US implies that a relatively large population of disadvantaged youth take the test in the US than in other countries (Berliner and Biddle, 1995). This should imply that US students do as well as students in less egalitarian systems at lower grades, and this difference should increase for higher grades. In fact, this appears to be true. Franciosi (2001) reports that at age 10, fewer than one-third of countries outperforms the US students in math and science tests, by age 14, this ratio is close to half, and by the last year of high school, this ratio is more than two-thirds. In any case, standardized test scores seem to be a poor predictor of the outcomes that matter. Heckman (1999) cites evidence that the link between test scores, especially in early years of schooling, and later outcomes is at best weak.

6.78 After attaining high levels of primary, secondary and tertiary enrollment rates, motivated by equality concerns and spurred studies showing the effectiveness of early childhood interventions, the US has launched pre-primary programs such as Head Start for disadvantaged children. The beneficial effects are estimated to be high and lasting (Heckman, 1999): Treated when they were 4-5 years old, disadvantaged subnormal IQ youth assigned to the Perry Preschool program fared significantly better even 30 years later than comparable non-participants, returning about $7 in higher earnings and/or lower crime for every dollar spent. There are few public programs that have such high benefit-to-cost ratios. The US experience with Head Start also shows that such interventions have to be well funded to be successful, a strong argument for governments to be selective in where and how to intervene. Heckman (1999) reports positive results for interventions for primary school students, but the benefit-to-cost ratios are considerably lower. The downward trend continues with interventions for older youth—public training programs often fail to meet simple cost-benefit criteria.

6.79 The third issue is competition at the primary and secondary level, motivated again by equality of opportunity considerations, and spurred by the example of US higher education, which is widely regarded as the world's best. The US primary and secondary education system is decentralized down to the district level. Since the rich are more mobile, they can move to districts that have better schools (which tend also to have higher house prices and rents). There is thus a concern that the US system of education does not serve the poorest sections of society well. Greater competition between school districts is suggested as a solution, but such reforms are opposed by public teachers' unions. Hoxby (1998) reports large gains in costs, parental involvement and student performance when public schools face greater competition from private religious and non-religious schools—higher levels of achievement are produced at lower cost. Countries such as Brazil that have decentralized education systems can benefit from the US experience.

Table 6.8: Effects of competition among US school districts

Costs – Per pupil spending	17% decrease
Public school costs – Public schools' per pupil spending	0% change
Student achievement – Test scores	3 percentile point increase
Student achievement – Wages	4% increase
Student achievement – Educational attainment	0.4 additional years
Public school student achievement – Test scores	8 percentile point increase
Public school student achievement – Wages	12% increase
Public school student achievement – Educational attainment	12% increase in college graduation
Parental involvement – Parent's visits to schools	30% increase

Korea, 1951-2000: A Hundred Years in Fifty?

6.80 In the last half-century, South Korea has grown faster than any other country. Without attributing causation, it is also remarkable that during this time the average education level in Korea has increased from less than four years to more than ten, and is now higher than some West European countries.[141] In three decades, it achieved almost universal primary and secondary education coverage, and now has a tertiary education sector that is as large as those in many developed countries (Kim, 2001). Korea's unprecedented growth in education is not just an outcome of economic growth itself but, rather, can be attributed to special features of the Korean growth strategies that were pursued with both equity and outward-orientation. In turn, Korea's economic growth has benefited from the education level of its human resources, which have played a key role in absorbing advanced technology from the developed countries.[142]

6.81 The noteworthy features of Korean education are (a) accelerated pace of expansion, (b) egalitarianism; and (c) "conservative sequencing" in that primary enrollment levels were high before a massive secondary education initiative was undertaken, and secondary enrollment rates were high before a massive tertiary education expansion. In the second two aspects, one could

[141] There have been many studies on how Korea achieved high, sustained economic growth. Factors including high savings and investment ratios, a well-educated labor force and well-directed export-oriented development strategies have been cited as responsible for Korea's success. Several attempts to investigate the ingredients of Korea's economic growth have followed the growth accounting approach, which, by decomposing the growth of output into a variety of inputs, gives a measure of human capital's contribution to output growth. In general, the growth accounting estimates show that the contribution to growth of human capital as a productive factor has been small in the Korean economy: one study finds that the increase in human capital explains 0.7 percent of the annual growth rate during 1963-82, or less than 10 percent of total growth. But this may be an underestimate because growth accounting does not explain where the growth of inputs and, especially, total factor productivity come from.

[142] On the other hand, human development itself has undoubtedly benefited from the strong demand for education triggered by the growth of income. However, Korea's unprecedented growth of education indicates that the accomplishment in human development is not just an outcome of economic growth itself but, rather, can be attributed to special features of the Korean growth strategies that were pursued with both equity and outward-orientation.

argue that South Korea's experience was uncannily similar to that of the US during the last century.[143]

Accelerated expansion, not "leapfrogging"

6.82 The 1950s and 1960s were a period of emphasis on primary education in Korea, with policy efforts concentrated on expanding basic education opportunities. The rapid pace of expansion necessitated that much of education be "low cost"—double shifts, large class size, and growing public discontent marked this phase. By the mid 1960s, the shift to better quality primary and a rapid expansion of (vocational) secondary education had begun, but the big increase in the number of high schools did not occur until 1975-1980 (when high schools increased by almost 300 and enrollment by half a million—see Kim 2001). In the mid 1970s, the government started to pay attention to access to colleges by all groups, especially through improved quality of instruction in secondary schools for all income classes. By the late 1980s, despite concerns of a possible "over-education" of Koreans, the pace of educational progress has not slowed down.

6.83 It is almost tautological that a country cannot have higher enrollment ratios at the secondary school level than at the primary level, and similarly, greater ratios at the tertiary level than at the secondary level. What is exceptional about Korea is how quickly the gains in enrollment were attained: Korea accomplished in about three decades (1950-1980) what took the US six decades after 1900. Even more remarkable, perhaps, is the careful sequencing. Rapid expansion at the secondary school level occurred between 1970 and 1990, *after* achieving (between 1950 and 1970) universal enrollment at the primary school level. Again, the big push at the tertiary education level occurred between 1990 and 2000, *after* near-universal secondary enrollment had been achieved and—using the criteria suggested by Goldin (2001) for the US—public initiatives to encourage higher education enrollments could safely be classified as "non-elitist".[144] While this does not mean that *no* expansion took place at the higher levels before universal enrollment was attained at the lower levels; the point is that *public policy* aimed at a sequenced expansion.

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[143] The main difference was in the degree of decentralization, the Korean approach being considerably more centralized than that of the US.

[144] A combination of high growth and equitable income distribution is another factor in Korea's progress in human capital. Korea has had relatively equal income distribution, which has enabled the majority of the people to access private education.

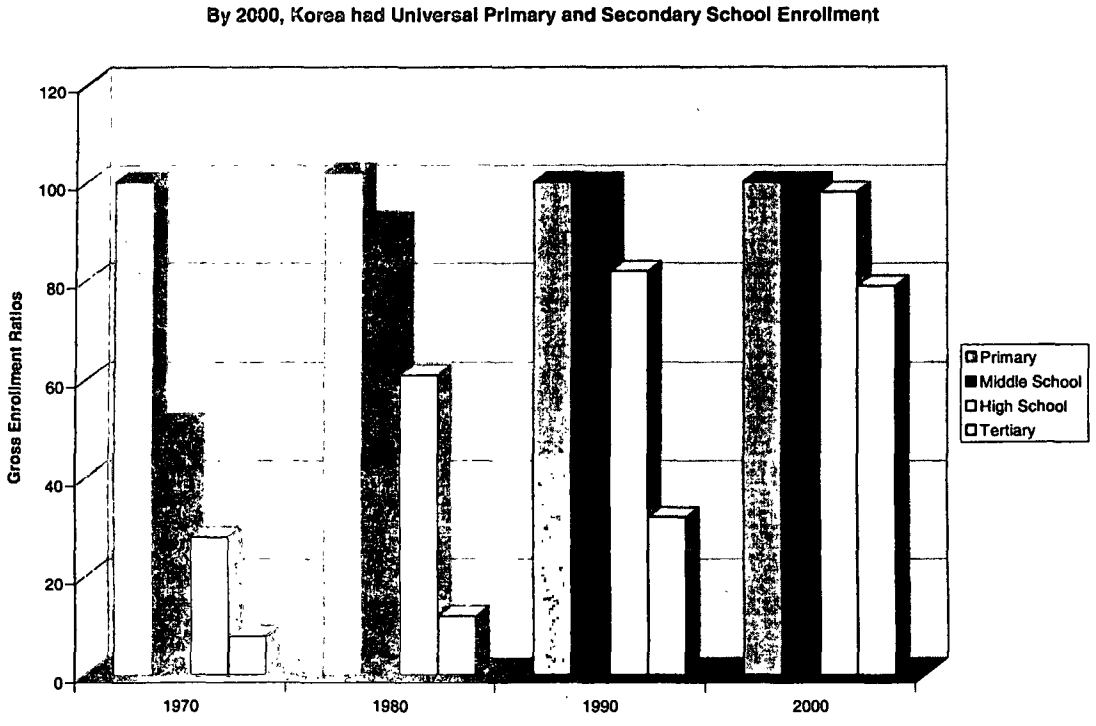

Figure 6.9

Authoritarian, but egalitarian

6.84 Between 1950 and 1970, the share of primary education (grades 1-6) remained at about 70-75% of the budget, starting to decline to about 50% in the 1970s, only after universal primary enrollment had been achieved. At this time (in 1968), entrance restrictions to middle schools were also abolished to make access universal and a system of random allocation of students to middle and high schools was instituted to make the system more egalitarian. The pattern still remains egalitarian in its most basic features: over the last three decades, the share of public school enrollments has remained high and even increased at the primary level and middle school levels, but the share of private institutions in enrollment has increased at the tertiary level (see Figure 10).

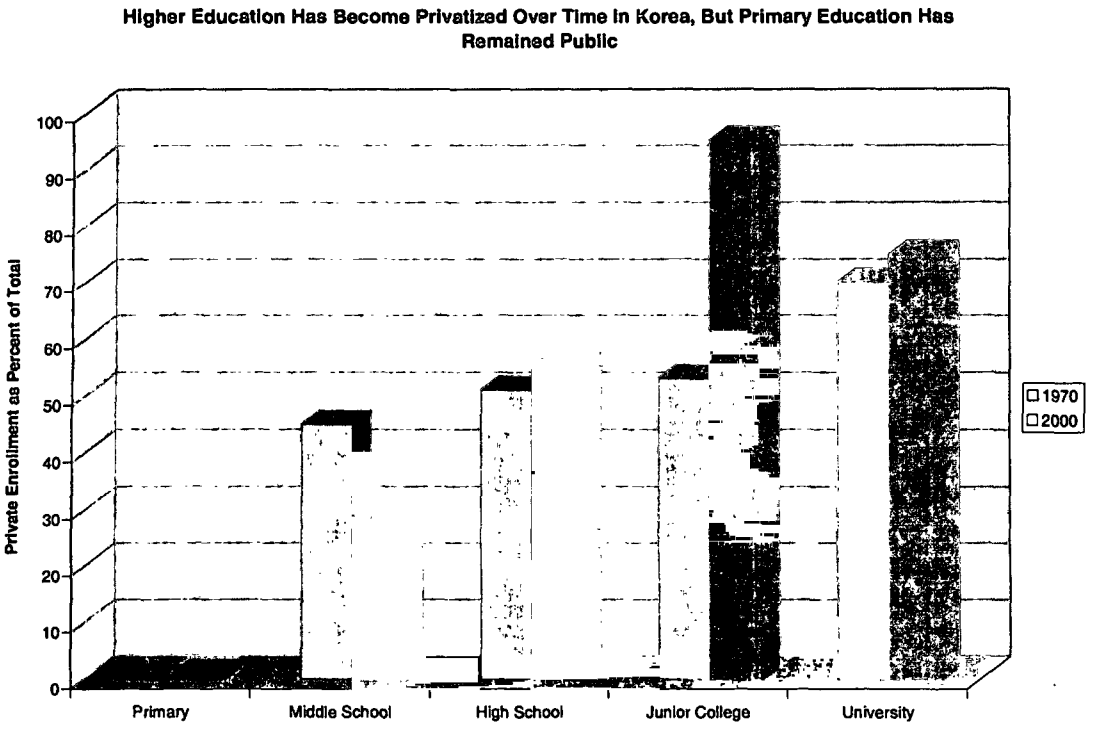

Figure 6.10

India 1976-2000: Growth and Higher Education Investments Amidst Illiteracy

6.85 India is sometimes held up as a counter-example to the advice given by economists to developing countries that they move sequentially from an emphasis on primary education to one on secondary education, and only then on higher education. After all, ignoring this advice, India spent a large chunk of its public money on higher education, especially on technical institutes, and—if the popular press is to be believed—is the better for it. India, it is said, has become a technology leader in the world; never mind that almost half of India is still illiterate.[145] Cities like Bangalore and Hyderabad are touted as the Silicon Valleys of tomorrow; India has a new growth engine in information technology, and will be pulled by it to higher and higher levels of living standards.

6.86 To determine if this is indeed the case, we surveyed the evidence on the premier public technology institutes, focusing on the Indian Institutes of Technology, and on India's rapidly growing information technology sector, especially in and around Bangalore.

Indian Institutes of Technology—human capital investments for other countries?

6.87 In 1946, India's Ministry of Education convened a special committee to find a way to train bright young Indians in engineering. The Sarkar Committee recommended that four institutions be

[145] Illiteracy rates in India for adult males and females (aged 15 and over) in 1997 were 33 percent and 61 percent respectively.

built, one each in the north, south, east and west of the country. The schools were intended, in the words of future Prime Minister Nehru, to "provide scientists and technologists of the highest caliber who would engage in research, design, and development to help build the nation towards self-reliance in her technological needs." The planners drew on Massachusetts Institute of Technology as a model and on UNESCO for funds to build the first campus near Calcutta. Five other campuses followed, in Kanpur, Delhi, Bombay, Madras and, most recently, Guwahati. At various times, the United States, Britain, the former Soviet Union and Germany have provided financial backing and technical support.

Table 6.9
India's Institutes of Technology

IIT Campus	Established	Undergraduates	Graduates	PhDs	Links
Kharagpur, West Bengal	1951	2700 students total			http://www.iitkg.ernet.in/
Kanpur , Uttar Pradesh	1959	1250	850	58	http://www.iitk.ac.in/
Bombay, Maharashtra	1959	450	711	203	http://www.iitb.ernet.in/
Madras, Tamil Nadu	1959	no info available			http://www.iitm.ernet.in/
Delhi	1961	1501	1040	488	http://www.iitd.ac.in/
Guhawati, Assam	1995	no info available			http://www.iitg.ernet.in/
Location to be decided	Na	na	na	na	na

6.88 The IITs have also been teaming up with industry on development. IIT-Kharagpur patents a dozen new products each year. Companies such as Intel and Philips Electronics, which are big recruiters at the IITs, have funded endowments and scholarships. They have even bankrolled computer and electronics laboratories in order to maintain standards. IBM opened a research center on the campus of IIT-Delhi in 1998—and with sponsored projects that are collaborations between IIT faculty and industry. The Indian government pays most of the $3,000—six times the annual per capita income of the country—it costs annually to educate each student. One view has it that India has been able to produce world-class universities at surprisingly little cost, and by nurturing the schools, the country will reap huge rewards as the graduates invest in India and draw it further into the circle of global trade and prosperity.

6.89 This cost advantage has been a significant cause of brain drain. About 40 percent of IIT graduates are believed leave the country and not return. In 1998, Indian engineers were running more than 775 technology companies in California's Silicon Valley that accounted for $3.6 billion in sales and 16,600 jobs (Saxenian, 2000). Further, it is estimated that 40 percent of Silicon Valley start-ups are Indian-spawned, and of those, half are by IIT graduates. It is hoped that at least some of these will return to India or at least bring business to India. But the connections between these non-resident Indians and their home country rarely extend beyond holiday visits. But, it is said, despite the fact that many graduates never return to India, the IITs spawn an interest in investing in India both by IIT alumni and by companies interested in the IT phenomenon in India. Bangalore, a city in Southern India, has attracted a lot of this business.

The Lore of Bangalore

6.90 Prior to 1984, the Indian software industry operated within the framework of a highly regulated, autarkic model of import substitution-led industrialization (ISI) and the ideology of self-reliance that guided the Indian economy. This policy regime stifled entrepreneurs and isolated the India from the global economy. As a result, efforts to promote software exports during the period never took off. Policies that permitted the import of state-of-the-art computers in exchange for a guarantee to export a certain amount of software were not enthusiastically received. Import procedures were cumbersome, duties were high and obtaining foreign exchange for business expenses was difficult.

6.91 The post-1984 policy changes were crucial to the growth of the Indian software industry because they allowed domestic producers to exploit domestic resources in global markets. India's greatest asset is a large, educated, English-speaking workforce that is willing to work at relatively low wages. In spite of widespread illiteracy, India boasts thousands of educated engineers who have remained either under-employed or unemployed for decades. Few countries can match India's combination of low-wage, high-skill workers. In 1994, wages for software programmers and systems analysts in India were less than one-tenth of those for their United States counterparts, and lower even than other developing countries like Mexico.[146]

6.92 The performance of India's IT industry during the 1990s has been impressive, particularly compared with other sectors of the Indian economy. The sector's compound annual growth rate for 1994-1999 exceeded 40 percent, compared with 6.6 percent for the economy as a whole. This strong growth was led by the software industry, which in 1999 accounted for 65 percent of India's total IT revenues. Total software revenues of $3.9 billion in 1999 were close to four times those of IT hardware manufacturing and grew more than 55 percent per year in the late 1990s. Moreover, the software industry's growth was driven primarily by exports. While the domestic market for software has grown in absolute terms, software exports account for a large and increasing share of total industry revenue. This export success is particularly striking for an industry that remained peripheral to world markets throughout most of the 1980s. A report by McKinsey & Co. has forecast that by 2008, India's IT industry will generate $87 billion in annual revenues, $225 billion in market value, and 2.2 million jobs.

6.93 One may never really know it because of the hype, but Bangalore and other technology centers are still just small oases in India's human capital desert. The total employment in the Bangalore software industry, for example, is about 200,000, a miniscule 0.05 percent of India's labor force of 440 million, and less than the number of Indians granted temporary worker visas in the US in the last decade (see Figure 11). India's software revenues are less than 1 percent of an estimated world software market of some $300-$500 billion. In spite of the sector's rapid export

[146] Programmers in India are increasingly aware of the global demand for their skills and the higher compensation available in developed economies. Many aspire to work for foreign companies for opportunities for overseas jobs. The United States has been a major beneficiary. A recent study of the H-1B visa program, which grants temporary work authorization to skilled foreign persons, reports that Indian H-1Bs grew steadily from 1989, becoming the largest category in 1994, doubling in size by 1996 and quintupling by 1999. Indians accounted for 47% of all visas issued in 1999, implying 55,000 Indian workers in 1999 alone, and a total of almost 200,000 between 1989 and 1999. The next largest groups of H-1 visa holders were from the UK and China, but each was 6% or less of total visas granted.

expansion between 1985 and 1995, from $28 million to $480 million, India's share of total world IT exports has remained only 0.5 percent. Moreover, India's 0.5 percent share of world IT exports in 1995 was less the country's 0.6 percent share of world *aggregate* exports in the same year. In spite of the evidence that a handful of Indian software companies are gradually moving up the value chain and gaining international recognition for their quality and performance, the industry as a whole remains significantly less productive than its global competitors. The annual revenue per employee in India was $15,000-20,000, a fraction of the $100,000 per employee in other software producers such as Israel and Ireland. Such numbers suggest that policy lessons from India's IT experience should be drawn with caution (Saxenian, 2000).

Despite the Press, India's Information Technology Sector Is Still Miniscule

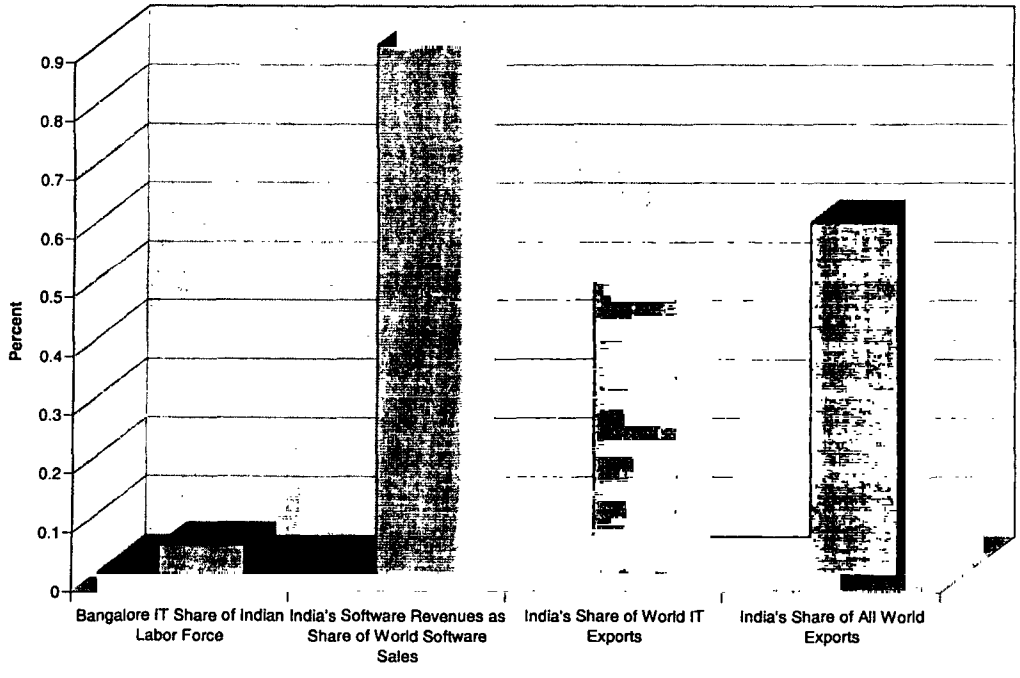

Figure 6.11

Lessons from India for other developing countries

6.94 The lessons for other low- and middle-income countries from India's investments in the IITs are difficult to determine. In attempting to learn lessons, three points are relevant. First, while the growth and outcomes of the IITs are impressive, it is important to note that the IITs are not leading "research centers"—not a bad thing for a country with a per capita income of $500 that is considerably behind the world's technology frontiers. Second, the IITs were developed in close collaboration with institutions in countries that are (or were) the world's technology leaders, and have maintained these links over the years. Finally, luck was on India's side—the timing of these investments in human capital happened to be just right. IIT graduates were able to benefit from the telecommunications revolution and now—by facilitating links between US and Indian firms—may be able to repay India for the large subsidies they have privately benefited from.

6.95 The lessons from the Indian high technology "miracle" are somewhat easier to draw. First, one should be realistic "about the limits of software as a development strategy for India. Bangalore is not Silicon Valley and IT is not going to solve all of India's problems. IT is still a very small piece of the Indian output and exports...." (Saxenian, 2000). Second, the success of Bangalore almost certainly owes as much to good fortune as to good government. While the central government did lower import duties on computer software and hardware and adopt a policy of export development in the mid-1980s, the government's noninterference may have also been responsible for the rapid growth of software exports than interventions. Some observers believe that had the government officials interfered too much, they may have prevented the provision of labor-intensive, low value-added programming services provided on-site to Western firms by Indian contractors—called "bodyshopping"—which later could be shifted offshore to places like Bangalore and Hyderabad. Finally, at least in the beginning, private initiatives (e.g., Texas Instruments' telecommunications center) overcame the main obstacle to growth of this offshore industry—lack of adequate telecommunications infrastructure. Sen (1994) observes that "until 1991-92, there was virtually no policy support at all for the software sector." It was only later (in the early 1990s) that government-aided technology parks—akin to export-processing zones—were set up that combined telecommunications infrastructure with tax incentives for software exports.

VI. Policy Implications for Brazil

6.96 Over the last two decades, Brazil has made extraordinarily rapid progress in some aspects of human capital—notably in expanding access to primary education and improving its quality, and in dealing with some threatening healthcare issues such as HIV/AIDS. By sheer coincidence—it is certainly just that—these have also been years of poor and erratic economic growth. Even if it were not a coincidence, this would not be a strong argument for slowing down investments in human capital: a healthier, longer-lived, more educated citizenry is a goal in itself, at par if not higher than the objective of higher incomes and greater wealth. In fact, the evidence summarized in this paper—that human capital investments do not generally lead to economic growth spurts, that there may in fact be evidence that growth spurts lead to greater human capital accumulation, but there is reason to believe that sustained accumulation of human capital leads to higher growth over longer periods—is consistent with a close relationship between human capital and growth in Brazil since the 1960s (see Figure from Blom et al below). Even if economic growth were Brazil's only objective, these experiences call for a strengthened human capital effort.

6.97 But over the next decade, Brazil will be hobbled by its debt service obligations. It should take these obligations seriously—paying down its public debt is more likely to help in jump-starting growth than even large and well-conceived investments in human capital. Paying off public debt will, however, leave little fiscal room for investment, in human or non-human capital, which means that Brazil has to be more selective than other countries in picking these investments. Based on the experience of some other countries and on Brazil's own experience, this paper suggests actions most likely to pay off in terms of economic growth while improving income distribution (or at least not exacerbating inequality). ***For public investment, these are to maintain efforts to provide quality primary education, an increased effort to improve access and quality of junior secondary education for everyone, and selected pre-primary interventions to improve health and learning outcomes of the relatively disadvantaged.*** The aim of regulatory reform should be to provide stronger incentives for Brazilian individuals and firms to invest in human

capital and for the private sector to shoulder more responsibility in its finance and provision. ***Regulatory reform priorities are labor policy changes to encourage private training initiatives and the reform of the higher education system to ease restrictions to entry by private providers—including foreign institutions—and greater autonomy for all institutions so they strengthen links with industry.*** We discuss these in more detail now.

More Attention to Secondary—Especially Junior Secondary—Education

6.98 Perhaps the most important recommendation of this paper is that Brazil should dedicate the next decade to improving junior secondary or middle school education. There is some ambiguity regarding the definition of "secondary schooling": for Brazil, this should roughly be interpreted as grades 5-11, i.e., the second cycle of *ensino fundamental* (grades 5-8) and all of the *ensino médio* (grades 9-11). The most important rule is that the government initiative be "non-elitist": the majority of people should already be qualified to benefit from it. This is what disqualifies higher education from being a candidate for a large increase in public investment. The net secondary enrollment rate in Brazil is less than 40 percent, so it is likely—because of high dropout and repetition rates—that less than a quarter of Brazilian youth have high school diplomas. The reasons for this recommendation are:

- Brazil's net secondary enrollment ratio in 2000 is roughly the same as the US level in the 1920s. Brazil lags behind the average Latin American country by about 40 percent in net enrollment ratios: that is, while the LAC average is about 50 percent, Brazil net ratio is 35 percent. Of all human capital indicators, this is by far the largest shortfall.

- Brazil spends relatively less on secondary education than countries such as Argentina, Mexico and South Korea, and relatively more than these countries on higher education.

- There is some evidence from cross-country data that improvements in secondary education access and quality yield the greatest payoff for the average middle-income country (e.g., Wolff and Gittleman, 1993). Since Brazil's secondary education performance has been worse than middle-income countries on average, this could mean that the effort should initially be focused at the junior secondary level.

- While improvements in secondary education will not lead to immediate increases in economic growth, econometric evidence indicates that it is unlikely that any investment in human capital—e.g., higher education—will do so. So Brazil may as well be patient and egalitarian, instead of being impatient and elitist. It will probably not suffer a loss in short-term growth performance, and will almost certainly earn a premium over the long term.

- Besides, there is little evidence of significant positive externalities associated with higher education (e.g., Heckman, 1999). The high and rising private returns to university education observed in Brazil call for measures to facilitate greater private provision and financing, and not to allocate scarce public funds to higher

education. The immediate goal should be to shift resources from tertiary levels to junior secondary education.

- Due to a sharp drop in fertility in Brazil during the last two decades, enrollments in primary education (grades 1-4) have begun to gradually decline. In a few years, resources will have to be shifted out of primary education. It is important that a large part of these resources be shifted then to secondary education, including grades 9-11.

6.99 Even if Brazil did not have a heavy fiscal burden, it should encourage the private sector to share the responsibility for this expansion of secondary education. As it turns out, Brazil already has a vibrant private sector (see box below)—it should not be crowded out by the public effort. The secondary education shortfall is so large, and the benefits of competition so well established, that a strong private secondary education sector will improve both access and quality of education.

Private Post-elementary Education in Brazil

Brazil already has a sizable and vibrant private sector in education. In Sao Paulo state alone, the private education sector caters for approximately 15% of all students—with nearly 20% at high school level. The largest school chain in Brazil is UNIP/Objetivo, which caters for more than 500,000 students. Many private schools operate more than one "unit," frequently vertically integrating into other levels of schooling, including kindergarten, or taking over other schools that are not so successful. The Pitágoras school chain, for example, a private educational institution, is based in Belo Horizonte, Minas Gerais State, in southeast Brazil. It was established in 1966. Pitágoras enrolls more than 85,000 students in 190 schools located all across the country. The COC – "Curso Oswaldo Cruz" – school chain has three schools, 63 franchises and 26,000 students. (Tooley, 2000)

Private schools and universities do not receive any direct subsidy from government. However, they are offered a number of tax incentives, which together amount to an indirect subsidy. If institutions are not-for-profit, then they are not required to pay taxes. According to the Education Ministry, however, the most significant 'indirect subsidy' comes from the possibility of families deducting expenses from taxation in terms of tutoring, and companies deducting from taxation their expenses putting employers through courses, and also if they fund scholarships to private schools. (Tooley) Nevertheless, a 1997 survey by GRUPO – the São Paulo State Private Schools Association – showed that 90% of its schools are established as limited companies, while only 10% are not-for-profit foundations and philanthropic entities (Tooley, 2000).

There is small, but growing tendency, for private schools to seek funds from overseas investors. These include schools in Sao Paulo State such as Porto Seguro, (investment from Germany), Miguel Cervantes, (Spain), and Dante Alighieri, (Italy). These are known as very good schools with a large number of students. These potentially provide some role models of external investment in Brazilian education. (Tooley, 2000)

Maintain Attention to Early Childhood—Especially Preprimary—Interventions

6.100 Given Brazil's debt servicing burden and tight budget constraints, it has to be especially picky in deciding in whom to invest public money. Early childhood interventions qualify as investments with the highest returns:

- Evaluations in the US suggest that early childhood interventions may have among the highest payoffs in terms of greater student achievement, higher earnings and lower crime rates. The experience of the US indicates that pre-school interventions have been successful in altering the social skills and motivation of children

- Assessments from Brazil indicate that preschool attendance has significant beneficial effects in terms of learning and earnings(World Bank, 2000), even controlling for family background and other factors. Two years of preschool increase schooling attainment by about one year, with some evidence that this effect is greater for poorer households. Two years of preschool reduces grade repetition by 6-10% (greater for poorer households), thus increasing the efficiency of education expenditures. Two years of preschool increase male earnings by between 4 and 12 percent, again with some indication of a higher increase for poorer families.

- The benefits of these investments for growth and poverty reduction will obviously be felt over the long term but, again, it is unlikely that there are any human capital investments, which will raise economic growth in the short term.

Improve Regulatory Framework—But Reduce Public Spending—for Higher Education

6.101 This third area is a difficult political issue—as explained in Schwartzman (1998)—but it has to be tackled if Brazil is to put its scarce public resources to good use. The reason why this reform is difficult is that it would be best for the country, over the short to medium term, to reduce public funding for higher education. This should naturally be preceded by institutional reform to allow even greater private participation in tertiary, especially university, education. The rising rates of return to higher education are at once discouraging---because it means that the supply of higher education has not kept pace with demand—and encouraging, because it means that there is likely to be considerable willingness to pay for it. But one thing is clear: Brazil's higher education system may be the most elitist government program in existence.

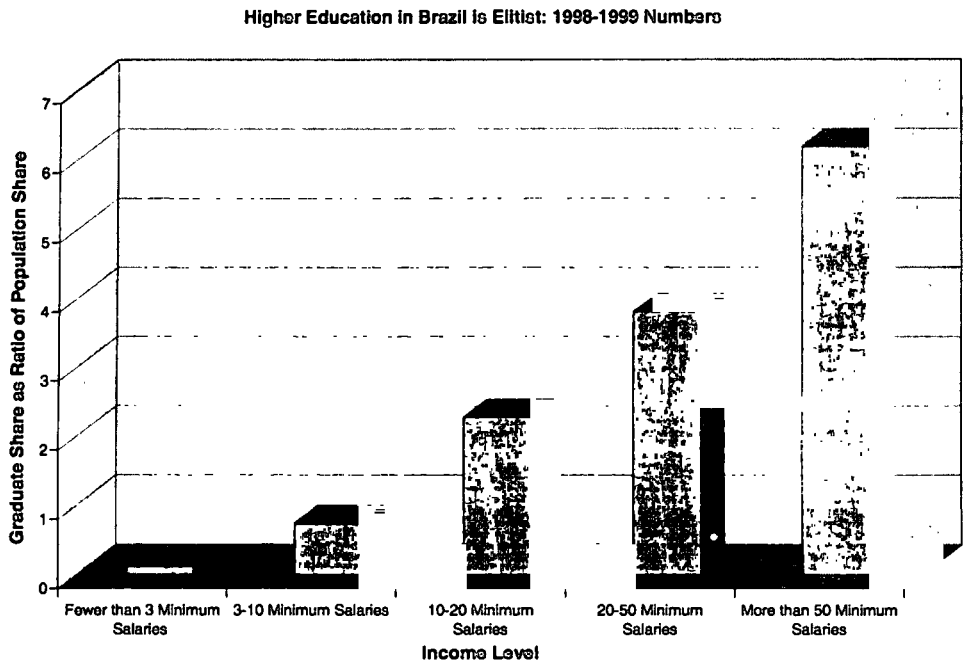

Figure 6.12

6.102 The priorities for reform for the Brazilian Higher Education Sector, detailed in World Bank (1999) are:

- Removal of the constitutional mandate that all publicly provided education must be free of charge. In most other countries, the rule appears to be that schooling that is legislated as compulsory also be provided free of charge by the government.

- Changing the funding formula for tertiary education to encourage competition among universities, and to increase the incentives to tap other revenue sources including current students, industry and alumni.

- Streamlining the procedures for starting and running private institutions of higher learning, including universities. See Table 10 for a contrast between Spain and Chile, which demonstrates that countries can choose to promote private activity or they can make it more difficult. Chile has decided to regulate the private university system lightly, while Spain takes a more heavy-handed approach. The Chilean system seeks to instill innovation and competition in the system. Other countries provide further incentives, such as subsidized loans, concessions on land, and student financing support.

- A reduction in the share of the education budget spent on higher education for the next decade or so, so as to allow an increase in secondary education funding without increasing the fiscal burden of public education.

Table 6.10
Establishment of Private Universities: The Cases of Spain and Chile

Spain: Stringent regulations	Chile: Liberal System
Curriculum requirements for higher education considered in establishment/recognition of universities	Curriculum requirements for higher education are not considered
A new university must have educational structure needed to provide at minimum instruction leading to eight degrees at least three in second cycle with one in experimental sciences or technical studies	A new university must have the educational structure needed to provide instruction leading to a professional career chosen from among 12 prescribed by law
Before beginning its operations it must elaborate prospectus defining areas of research activities	It may begin operations and continue to function without undertaking research activities of any kind
Total number of teachers in each university cannot be less than that required to maintain ratio of 1:25 with respect to the number of students	There is no minimum
In first cycle 30% of teachers must hold doctoral degrees; in second cycle 70%; in third 100%	There is no minimum
In no case may number of teachers holding doctorates be less than 50% of total teaching staff	There is no minimum
60% of teachers must be employed full time	There is no requirement to employ full-time personnel
Teachers in private universities may not belong to the active teaching staff of any public university	There is no incompatibility
Full and effective compliance with the principle of academic freedom must be guaranteed	There is no requirement in this regard
Formal commitment must be made to keep university and each division in operation for minimum period of time to allow students to complete studies	There is no requirement in this regard
Inauguration of new university authorized by competent education administration after it ascertains all commitments fulfilled and Government accredits official degrees to be conferred	New universities begin to function automatically, once the approval formalities for their plans and programs are completed by an examining university.
Report on teaching and research activities carried out in context of university's multi-year program must be submitted annually to administration and Board of Universities	They have no reporting obligations. The 1990 amendments to the law on universities established reporting obligations only for universities that opt for the public accreditation system
Public authorities shall periodically inspect compliance by private universities with the standards that apply to them	Plans and programs of new universities subject to approval; students and graduates must be examined by traditional university for number of years

Source: ECLAC-UNESCO (1992), *Education and Knowledge: Basic Pillars of Changing Production Patterns with Social Equity* (Santiago, Chile)

Maintain current taxation policies—especially the deductibility of training and education expenses

6.103 The reasons for this recommendation are:

- Taxes on physical capital actually reduce human capital investment decisions. The level of human capital investment declines when the (net of tax) interest rate increases, so lowering the tax on interest income can have a beneficial effect on human capital accumulation. But it is unlikely that this will be popular recommendation since it will be seen as a move favoring capital and hence rich people.

- The current tax system favors human capital accumulation on the job versus pre-employment schooling since training expenses by employers are *fully* deductible in Brazil but those by individuals are not. But there is a prevailing belief that Brazilian firms do not sponsor enough on-the-job training, so this bias towards training is probably best left unaltered.

- While a progressive tax on earnings like the one Brazil has discourages human capital accumulation, it would be unpopular—and, in the short term, inequality-increasing—to replace it with a flat rate consumption tax.

- Changes in tax policy involve complex federal-state issues that are best left untouched.

VII. Summary and Conclusions

6.104 To conclude, the main findings and policy implications of this paper are:

- The evidence on the effects of human capital formation on economic growth is far from overwhelming; accordingly—despite claims to the contrary—policies to increase investments in human capital formation should not be regarded as the silver bullet for increasing economic growth rates; *investments in human capital are for the long-term*.

- Part of the problem is measurement related—human capital is difficult to measure, even when proxied only by education, its major component.

- Human capital formation requires complementary inputs to pay off in terms of economic output. A key piece of evidence in this regard is that the coefficient for human capital falls when capital accumulation is controlled for. It also falls when initial technology and policy effects are controlled for. This is what one should expect, because human capital is strongly correlated with both capital and unmeasured/unspecified inputs.

6.105 Sustained and stable economic growth appears to be an important determinant of rapid human capital formation, rather than the other way round. For Brazil, just as recent stabilization efforts were aimed at "breaking the back of inflationary expectations", this finding means that efforts to strengthen "expectations of growth" through steady and sustained—even if modest—economic growth will increase human capital formation.

- Cross-country evidence and analysis of growth episodes indicates that the causality between human capital and economic growth runs both ways, with evidence of economic growth encouraging human capital formation in the short and medium term somewhat stronger than the evidence for human capital formation "causing" economic growth.

- Some of the cross-country evidence and the experience of countries like the US, Korea, and India indicates that episodes of strong human capital formation have

followed—not accompanied or preceded—periods of steady, sustained, economic growth. An important catalyst for human capital formation may be the reduction of volatility of real GDP growth.

6.106 Brazil has done better in improving health-related outcomes than education and training related indicators. The thrust of human capital policies should be to aggressively improve these "intangible" components of human capital in Brazil.

- Health outcomes have improved quickly since the 1960s, and Brazil made the epidemiological transition in the 1980s. This progress permits a generalization: while progress in some areas—such as adult male health—is still needed, the problems of the "median Brazilian" are more those of upper-middle and high income countries than those afflicting people in low-income countries.

- On the other hand, many education outcomes continue to lag even the average Latin American country, and in some cases (e.g., net secondary school enrollment rates) are as poor as some lower-middle-income and low-income countries.

6.107 The main thrust of Brazilian education policy over the next decade should be on access and quality of non-elitist post-elementary education, roughly grades 5-11.

- While the literature on human capital and growth has dwelt on the contribution of human capital relative to other factors such as capital accumulation and technical change, the question of policy interest in most countries is what level of education—elementary, secondary, and tertiary—governments should subsidize at the margin.

- Adapting the successful American model of non-elitist post-elementary schooling to Brazil to determine good practice in public education for economic growth implies that tertiary education enrollment expansion will not qualify as "non-elitist" in aggregate terms at current secondary school enrollment ratios.

- The evidence for middle-income countries (including the cross-state analysis for Brazil reported in Chapter 4) appears to indicate that access to non-elitist post-elementary schooling is most likely to foster long-term economic growth without exacerbating inequality seriously. Therefore, despite the increasing private rates of return to university education in urban Brazil, the appropriate level for closest government attention should be secondary education (consistent with the argument in World Bank, 1999).

6.108 Policies to encourage post-schooling human capital formation, principally those by firms investing in job-specific skills of workers, may be as or more important—especially over the short-term—than initiatives to increase schooling enrollments.

- Post-schooling investment in human capital is generally ignored by the empirical literature because of severe measurement problems. This may not be a fatal flaw,

since education levels and on-the-job training are net complements for many workers (e.g., firms spend more on the training of more educated workers).

- In any case, anecdotal evidence indicates that post-schooling investments in human capital earnings functions are lower in Brazil compared with countries such as the US and Korea. If it is confirmed that post-school human capital formation rates are lower, then Brazil should examine how labor market reforms may increase these investments.

6.109 Policies to encourage growth of the Brazilian "innovation sector" include reform of the financing of higher level science and technology education in Brazil to encourage closer university-industry linkages, along the lines urged in World Bank, 2000b. The argument is not for overwhelmingly private higher education in Brazil, but one for greater autonomy and competition that encourages cost-sharing with students and firms.

- The evidence that leads to this conclusion comes in part from the study of the growth episode in the US after the Bayh-Dole Act of 1980 that allowed individuals and institutions to patent inventions made with public support, some comparisons with the less formal industry-university linkages in Japan, and Japan's passage of the Technology Transfer Act in 1998 in an effort to mimic the strong incentives for R&D inherent in the US system.

- The distinctive features of the higher education system of the US are decentralization, competition, regionalism, and the coupling of research and graduate education. But given the state of pre-university education in Brazil relative to the US, the case for large-scale subsidization of tertiary education are much weaker in Brazil until far-reaching reforms are carried out for university financing, and secondary education enrollment increases to a majority of the relevant population group.

Summary Table of Human Capital Policy Recommendations

Policy Area	Evidence	Policy Recommendation
Pre-primary Education and Health Interventions	Large benefits of well-funded public early childhood programs in US and Brazil, especially for disadvantaged children: schooling attainment up, grade repetition down, earnings up and crime down. Benefit-to-cost ratios of 5 to 8 in the US	Maintain attention to early childhood programs. Increase funding for targeted early childhood—especially preschool— programs for disadvantaged children
Primary Education	Increased primary net enrollment ratios during the last two decades—Brazil now does not lag behind other countries in the region	Continue policies in place since the early 1990s; prepare to reallocate expenditures away from primary education as demographic transition occurs over the next decade
Secondary Education	Brazil underspends on secondary schooling and has low net enrollment ratio relative to Latin America average, expansion will be non-elitist given near universal primary school enrollment since 1995, evidence indicates junior secondary education has greatest (long-term) effect on growth in Brazil	Increase effort to improve secondary education outcomes over the next decade, starting with junior secondary education, until net secondary enrollment ratios reach 100 percent. Careful sequencing is recommended, not leapfrogging.
Higher Education	Brazil overspends on higher education but has low enrollment relative to Latin America average, increasing private returns to tertiary education over the last decade, more government spending will be elitist given low high school completion ratios.	Aggressive reforms to facilitate private sector involvement. Increase financial autonomy for public universities and reduce public spending, with saving diverted to junior secondary education. Encourage foreign investment in for-profit postsecondary education.
Enterprise-based training	When financed and provided by the private sector, training has among the highest return of all forms of human capital investments. When financed and provided by the public sector, the returns are close to zero.	Identify and change labor regulations (e.g., severance laws) that create perverse incentives for firms and workers to keep employment relationships short. Limit public training programs to disadvantaged workers.
Research and post-graduate study	Institutional autonomy for research universities, public funding for research with a liberal intellectual property rights law such as the Bayh-Dole Act in the US promotes profitable university-industry links.	Institutional autonomy for universities, and a law allowing private researchers to profit from inventions/innovations made using public research funds
Maternal and Child Health	High rates of return to public programs	Continue policies in place.
Adult Male Health	Brazil lags being other Latin American countries in male longevity and morbidity	Investigate if special attention to this is needed
Tax Policy	Progressivity in income taxes discourages human capital accumulation	Continue policies in place for the next decade—the only major cost of human capital investment that is not tax deductible is college tuition

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7. THE INVESTMENT CLIMATE IN INTERNATIONAL PERSPECTIVE

Prepared by Hoon Sahib Soh

I. INTRODUCTION

7.1 This paper analyzes the relationship between public governance and investment in Brazil. The first section evaluates the quality of public governance in Brazil, focusing on measurements that are relevant to private sector business activities. It describes the available governance measurements, compares Brazil's ratings with other countries, and suggests priority areas for improvement. The next two sections analyze the impact of governance on entrepreneurial investment and foreign direct investment, respectively. The section on entrepreneurial investment evaluates the regulatory burden faced by entrepreneurs starting up a new business in Brazil. The section on foreign direct investment analyzes the impact of FDI inflow for Brazil and how the quality of governance has affected this flow. We concentrate on these two aspects for two reasons. First, these are areas that are particularly important for productivity gains through innovation. Second, these are areas where it is possible, through surveys and quantitative methodology, to measure the impact of regulations on businesses.

7.2 Public governance has been defined as the "exercise of authority through formal and informal traditions and institutions for the common good."[147] This broad definition encompasses concepts such as transparency and accountability of public institutions, quality of policy making and public service provision, and effectiveness of legal and regulatory systems. Such concepts are inherently difficult to measure. Surveys, based on interviewees' assessments of governance, have traditionally been the common method, with their obvious drawback of subjectivity.

7.3 A more objective method is to measure the underlying variables that determine overall governance quality. These variables include government processes and institutional arrangements: examples are civil service pay and the size of government expenditure. Such variables have the advantage of providing policymakers with information on which they can directly target policies, and they are more conducive to objective as opposed to subjective methods of measurement. Their disadvantage is that interpreting the policy implications of these variables can be unclear. Decreases in court case delays can result from decreased demand owing to deteriorating judicial services or from improved efficiency of the court system. The policy implications are very different depending on the interpretation.

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[147] Thomas, Vinod et al., "The Quality of Growth," World Bank and Oxford University Press, 2000.

7.4 Tables A1 and A2 (Annex) provide a list of currently available public governance measurements, which are organized into the two aforementioned groups, overall measures and measures of underlying determinants of governance quality. If a data set has a mixture of both types of measurements, then it is included in table 1A but marked by an asterisk. The tables also list data sets that measure public governance variables only for Brazil.

II. Overall Public Governance Measures

7.5 This section analyzes overall governance measurements, and compares Brazil to other countries. Governance measurement for Brazil focuses on three broad dimensions: the legal system, the regulatory system, and government bureaucracy. All three areas affect the quality of policies, public service provision, and the overall investment climate. Table 1 summarizes the main results from the most widely used rating agencies.

Table 7.1
Governance Ratings for Brazil

	Legal	Regulatory	Bureaucracy / Public Institutions
GCR	Average compared to similar LAC countries Surveys judicial independence, likelihood of out of court settlement, litigation cost, corruption	Poor ratings for general regulatory burden but average for others Surveys time spent dealing with government bureaucracy, regulatory burden, private property rights, stringency of regulatory standards	Average compared to similar LAC countries Surveys independence of policy, institutional stability, police protection, pervasiveness of irregular payments Chile has high ratings
ICRG	Poor rule of law, which assesses the law and order tradition of the country	N/A	Poor bureaucratic quality, lowest among compared countries
BERI	Poor contract enforceability; lowest rating among compared countries	Poor policy enforceability; lowest rating among compared countries	Poor bureaucratic quality; lowest rating among compared countries

7.6 The Global Competitiveness Report (GCR) evaluates the general business environment of each country, where business environment is determined by legal, regulatory, and bureaucratic dimensions, as well as physical infrastructure, education and technology, and financial market development. Brazil ranks 32 among 57 developed and developing countries for its business environment. Similar upper middle income countries[148] are ranked as follows : 24 for Chile; 44 for Argentina, 43 for Mexico, 28 for S. Korea, 30 for Malaysia, 31 for Hungary, 34 for Czech Republic, and 42 for Poland. Brazil's business environment ranking is average compared to other countries with similar per capita income. Chile has a relatively high ranking within this group: this country could be a good benchmark for Brazil.

7.7 Figure A1 (Annex) presents GCR measurements of legal system quality: judicial independence, the likelihood of disputes being settled out of court, litigation cost, and corruption in

[148] Using the guidelines in World Development Report 2000, upper middle income is defined as 1998 GNP per capita between $3,031 and $9,360, where exchange rate is calculated using the World Bank Atlas method.

the legal system. Brazil compares fairly well with other Latin American countries as well as the East Asian countries represented by Korea and Malaysia. In particular, Brazil has measurements similar to Chile, and both countries have better measurements than Argentina and Mexico. The GCR data thus do not support the perception that the legal burden in Brazil is severe. Given that cost of litigation includes both the duration of the legal process as well as attorney fees, the perception that the court system in Brazil is beset by long delays is not supported by the GCR survey results, unless one assumes that such problems are just as prevalent in Chile or Korea.

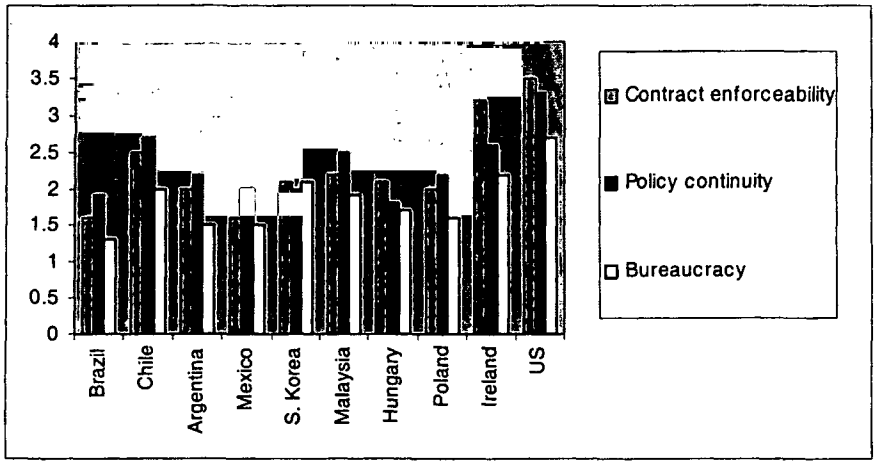
7.8 Figure A2 (Annex) presents the GCR results for the regulatory system: time spent dealing with government bureaucracy, general burden of regulation, clear delineation and enforcement of private property rights, and stringency of regulatory standards. As with the legal system, the regulatory system measurements suggest that Brazil has regulatory quality comparable to similar countries, with one important exception. Among the countries compared, Brazil has the poorest rating for the *general burden of regulations*. In this respect, its rating is similar to the ratings of much poorer countries such as India and Mauritius.

7.9 The public institutions variables, as shown by figure A3 (Annex), indicate that Brazil received similar ratings to the other Latin American countries except for Chile. These measurements consist of independence of policy, institutional stability, police protection, and pervasiveness of irregular payments. Brazil has poorer ratings on all four of these measurements than Chile. Indeed, Chile has public institutions that are also higher in quality than those of East Asian and East European countries.

7.10 Figure A4 (Annex) presents three areas of public governance rated by ICRG: rule of law, bureaucratic quality, and corruption. Again, Chile received relatively high ratings, while Brazil generally received ratings lower than similar East Asian and East European countries. The rule of law variable suggests that Brazil has a poor legal and regulatory environment overall: its rating is substantially lower than all the other countries except for Mexico. Furthermore, the bureaucratic quality variable for Brazil is the lowest in the group.

7.11 Figure 7.1 presents three measurements of public governance by BERI: contract enforceability, policy enforceability, and bureaucratic quality. Again, Brazil has poor ratings for these measurements, while Chile generally received ratings higher than similar middle-income countries. Indeed, Brazil has the lowest rating on these measurements in the group. As in the ICRG survey, Brazil's bureaucratic quality is the lowest of the group.

Figure 7.1: BERI Public Governance Measurements



7.12 Other agencies provide similar evaluations. Price-Waterhouse-Coopers (PWC) publishes country governance ratings based on interviews of firms, equity analysts, banks, and PWC employees. The overall rating, shown in Figure A6, is based on five categories: corruption; legal system; government macroeconomic and fiscal policies; accounting standards and practices (including corporate governance and information release); and regulatory regime. The rating is aggregated from the five categories with equal weights, where lower scores indicate higher quality. According to PWC, the quality of governance in Brazil is similar to Argentina but poorer than Mexico and Chile, and similar to the representative East Asian and East European countries. PWC's assessment is similar to GCR ratings presented above. Both studies suggest that the overall business environment of Brazil is comparable to similar countries. Again, Chile stands out as having a high quality of public governance, with ratings similar to the United States.

7.13 Given that the overall rating is an aggregation of the ratings on five different subcategories, it is of interest to examine the subcategories. Figure A presents these for Brazil and other Latin American countries. For all five subcategories, Brazil has ratings similar to Argentina but lower than Mexico and Chile. In particular, Brazil has a much lower rating for the fourth category, accounting standards and practices, corporate governance and information releases. This paper will not delve into issues specific to accounting standards and corporate governance, but these issues are intricately related to public governance. For example, enforcement of shareholder rights depends on the quality of the legal and regulatory system, and the independence of firm activity from government interference will depend on transparent corporate governance structure.[149]

7.14 The main conclusions from the various public governance assessments can be summarized as follows:

[149] Refer to "Reforming Public Institutions and Strengthening Governance," page 14.

- The evidence is mixed regarding the quality of Brazil's governance compared to similar middle-income countries, but Brazil consistently received ratings lower than the developed countries.
  - Compared to Latin American and other middle-income countries, Brazil received poor ratings from BERI and ICRG, but ratings from poor to average from GCR. BERI and ICRG survey experts, whereas GCR surveys business people and government officials.
- Among the three subcategories, Brazil received a particularly low rating on its regulatory system.
  - The high regulatory burden is a theme repeated throughout the rest of this chapter, where evidence is presented to indicate that the regulatory burden acts as a major barrier to both entrepreneurial and foreign investment activities. It should be noted that this conclusion is mainly derived from the GCR results.
- Among the middle-income countries, Chile stands out for high-quality public governance.
  - Chile's ratings from PWC were similar to the ratings for United States. Similarly, Chile received high ratings for all categories from BERI and ICRG, and for bureaucracy and public institutions from GCR. Lessons drawn from Chile's public sector reforms might prove useful for Brazil (Box 1): these reforms reduced the discretionary power and increased the transparency of the public sector.

III. Measurements of Underlying Determinants

7.15 The above provide a direct assessment of public governance. On the other hand, these indicators do not provide clear policy implications, as they measure broad phenomena affected by many factors. The problem remains to assess these underlying institutional factors directly.

7.16 One possible strategy is to use more finely disaggregated subjective assessments. The GCR, as described in the previous section, implements such a strategy. For example, instead of a single "rule of law" index, GCR provides multiple measurements such as judiciary independence, use of alternative dispute resolution mechanisms, litigation cost, and corruption in the court system.

7.17 An alternative strategy is directly to measure presumed determinants of governance quality. One must form hypotheses about the relationship between a particular legal, regulatory, or institutional arrangement and governance quality. Because governance reform policies target these underlying arrangements, such measurements can more easily result in policy implications. If the hypothesis is accepted, these measurements also allow one to verify reform progress.

7.18 The following subsections presents two cross-country data sets that measure such determinants. The first data set measures court performance; the second measures regulatory burden for start-up entrepreneurs.

Box 7.1: Chile's Public Sector Reforms[150]

It can be argued that the quality of its public institutions is a major reason why Chile consistently receives high marks for its governance. The public institutions have been shaped by the reforms carried out by the military regimes during the 1970s and 1980s and the democratic administrations of the 1990s. These reforms resulted in a public sector characterized by institutional stability, independence of policies, and a relative lack of corruption.

One of the key achievements of the reforms has been the reduction of discretionary power within the public sphere. In one sense, these reforms were based on a preference for fostering the "credibility" as opposed to the "flexibility" of the public institutions. The discretionary power of the state was reduced by implementing a uniform tariff which limited private sector lobbying for import protection, banning nontariff barriers, privatizing social security and consolidating the budget procedures in order to limit the amount of lobbying on fiscal matters, and institutionalizing the independence of the Central Bank in order to end the influence of private sector interests on credit policies.[151] Institutional mechanisms were installed which made it difficult to reverse the reforms, some requiring a three-fifths majority in Congress for amendments. Changes would have to be discussed openly in Congress, thereby reducing the scope for lobbying and backroom political deals.

The budget process was centralized in the Ministry of Finance, which took precedence over the sectoral ministries in the formulation and execution of the budget, and the executive branch rather than the legislature had the last word in the approval process. Congress could only reduce items of expenditure proposed by the administration, and were prohibited from altering revenue calculations, increasing expenditures, or reallocating resources between programs. Strict limits were placed on the time allocated to congressional discussion of the budget. Congress had only 60 days to agree on the amendments to the budget bill once received, after which the executive's proposal was automatically approved.[152] The highly hierarchical and centralized nature of Chile's budgetary institution limited opportunities for discretionary influences on the budget process.

Along with reductions in opportunities for discretionary influences, efforts were made to increase institutional accountability and transparency by increasing the emphasis on results and performance. Starting with a pilot program launched in 1993, public services produced specific goals and management targets based on strategic planning. Indicators were developed which allowed for effective internal and external monitoring of the institution's operations, and the performance indicators were eventually incorporated into the budgetary process. All public services were required to prepare an annual performance report indicating the degree to which budget, program, and management targets have been met.[153]

Transparency was also maintained during the democratic period through constant consultations with the business community. Although never institutionalized, major business associations had frequent access to the Ministries. Policymakers and business leaders would often negotiate on draft legislation, where the business association would make comments based on their own technical evaluations. Identification with any single conglomerate, which could result in lobbying opportunities, was avoided by consulting with business associations that represented the interests of a broader spectrum of the business community. The drawback of this arrangement was that labor interest was clearly subordinated to business interest.[154]

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[150] Marcel (1999), Foxley T. and Sapelli (1999), and Silva (1997).

[151] Foxley T. and Sapelli (1999), page 414.

[152] Alesina et al. (1995) showed that Chile's budgetary institution had one of the most clearly established lines of authority and responsibility in Latin America.

[153] Marcel (1999), page 318.

[154] Silva (1997), pages 173-179.

Court Performance

7.19 The Legal Department of the World Bank has conducted a cross-country analysis of the performance of courts by measuring the determinants of the quality such as court delays and legal costs.[155] The project reviewed the efficiency of courts in twelve developing and industrial countries. Efficiency was analyzed by measuring clearance rate, caseload, backlogs, and cost of supplying court services. Cost includes not only operational cost but also capital expenditure and opportunity cost.

7.20 Clearance rate, which is the percentage of filed cases that are resolved, measures the productivity of courts and judges. Figure A8 presents the data. The two industrialized countries in the sample have a clearance rate above 97 percent, while the figure for Brazil at around 90 percent is lower than Chile, Peru, and Singapore. The clearance rate of the Brazil court system is on the lower end of the range among similar countries but is higher than several countries, including Colombia, Hungary, Ukraine, and Ecuador.

7.21 The determinants of the clearance rate were analyzed using regression analysis. Increased capital spending, increased use of technology, and decreasing the proportion of time that judges spend on administrative tasks have positive and significant affects on the clearance rate. By contrast, the salary level of judicial personnel and the number of court staff do not have a significant effect on the clearance rate. These results raise concerns about the effectiveness of traditional legal reform policies focusing on salary and staff. Instead, legal reforms should focus on increasing capital spending, technology, and administrative support for judges.

7.22 The time required to resolve cases is another factor in the quality of the court system, particularly for developing countries where delays in the legal process are often cited as a major problem.[156] Unfortunately, a cross country data set of the time required to resolve cases is not available. On the other hand, the number of pending cases affects the time it takes to resolve a case. Figure A9 presents data for the number of pending cases per judge for Brazil and other countries of similar and higher income levels. Along with Chile, Brazil clearly has substantially higher number of pending cases relative to countries in other regions. In particular, Peru has a low figure, which could have resulted from experiments with major legal reforms, including the use of temporary judges to resolve backlogged cases.

7.23 Another indirect measurement of the time required to resolve cases is the "backlog index." The backlog index is the number of cases pending at the start of the year divided by the number of cases resolved during the year.[157] A higher ratio implies longer civil case processing time. Figure

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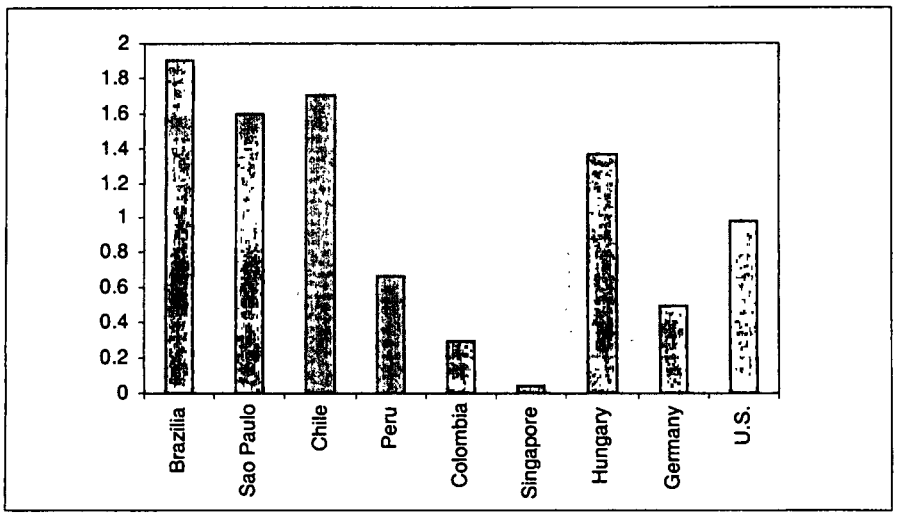
[155] Dakolias (1999a, 1999b); The project chooses to focus on measurements of efficiency of the legal system because it provides a quantifiable means of comparing courts worldwide, but this does not mean that other dimensions of legal system, such as judicial independence and procedural transparency, are not important determinant the overall quality of the judicial system. Hence, if the study determines that certain variables are deemed insignificant determinants of judicial system efficiency, policymakers should keep in mind that such variables might still have significant affects on other aspects of judicial quality.

[156] Pinheiro (1999), and Buscaglia and Dakolias (1996)

[157] National Center for State Courts, Examining Court Delay, The Pace of Litigation in 26 Urban Trial Courts (1987) in Dakolias (1999b)

7.2 presents the data. Among the compared countries, the court systems in Brasilia and São Paolo have the highest and third highest figures. Both the number of pending cases per judge and the backlog index indicate that court delays in Brazil are comparatively serious.

Figure 7.2
World Bank Legal Department Backlog Index



7.24 The World Bank Legal Department also analyzed the backlog as the dependent variable of a regression. The results indicate that the capital budget, technology, managerial activism, and cost per case are significant determinants of case processing time, while the number of court staff, salaries, and the level of training do not appear to be significant. In a related analysis, the results indicate that the more judges rely on managerial activism, the greater the capacity of budgetary resources to increase the supply of court services. Court systems with larger capital budgets and greater use of information technology have shorter expected duration of cases. Again, the study raises issues about the effectiveness of traditional legal reform policies that focuses on salary and staff numbers.

Regulatory Burden for Start-up Entrepreneurs

7.25 As with the legal system, measurements of the quality of regulatory systems have relied mostly on subjective assessments, but a recent joint study by Djankov, La Porta, Lopez-de-Silanes, and Shleifer focuses on objective measurements. The study analyzed the entry of start-up firms in 75 countries, including Brazil, and collected data on required procedures, official time, and official cost. The advantage of relying on official figures is that the variables are easily measured but maintain objectivity; the disadvantage is that the actual regulatory burden faced by firms could differ from official figures.

7.26 The data suggests that the official cost of entry is high in most countries, and that countries with heavier regulation of entry have higher corruption and larger unofficial economies. Compared to other countries, Brazil requires a large number of days in order to complete the start-up procedures. A more detailed analysis of the cost of entry will be presented in the following section.

7.27 In summary, the cross-country analysis of the determinants of governance quality reveals:

- Court delays are a serious problem in Brazil where, compared to other countries, the court system requires substantially higher number of days to resolve cases.
- The capital budget, technology, managerial activism, and cost per case are significant determinants of case processing time, while the number of court staff, salaries, and the level of training do not appear to be significant.
- The time required to complete regulatory procedures relating to business investments in Brazil is much higher than in other countries.

7.28 So far this chapter has analyzed governance as it pertains to private-sector activity on a general level, without focusing on any particular aspect of the Brazilian economy. We now turn to a more detailed analysis of the last point above—the impact of governance on investment activities—and focus on two types of investment that are particularly important for Brazil: entrepreneurial investment and foreign direct investment.

IV. Governance and Entrepreneurship

7.29 This section first presents survey results from two sources, the World Business Environment Survey (WBES) and the GCR. The section then presents an analysis of the data set collect by Djankov et al. (2000).

7.30 The World Bank conducts an on-going cross-country survey of the general business environment called the World Business Environment Survey (WBES). The project surveys at least 100 firms for each country and surveyed 200 in the state of São Paulo. In particular, the WBES asks firms' managers about the relative importance of various constraints to the operation and growth of their businesses. Figure A11 summarizes the survey results. Taxes and regulations, and political instability were considered the most serious obstacles to conducting business in Brazil. Other governance related measurements such as the judiciary system, corruption, and crime receive ratings received lower ratings. The results suggest that regulatory burden is one of the most problematic constraints for business operations, but remains inconclusive because the survey combines the categories tax and regulatory burden.

7.31 Figure A12 presents the same survey data for Brazil versus other middle-income Latin-American countries. Tax and regulatory burden are cited as the most problematic constraint for Argentina as well, whereas political instability and inflation are cited as the most problematic for Chile and Mexico, respectively. Tax and regulatory burden for Brazil received the highest rating among all countries and across all categories. In the remaining survey results, the most striking difference between Brazil and non-Latin American countries is the high degree of importance assigned to political instability by Brazilian respondents.

7.32 The annual GCR survey includes questions concerning business environment constraints for new businesses. It asks for an assessment of the degree to which unfavorable economic and financial conditions, burdensome administrative procedures, and lack of legal protection are obstacles for new businesses. Figure A13 presents the results. Higher ratings are better. Brazil is

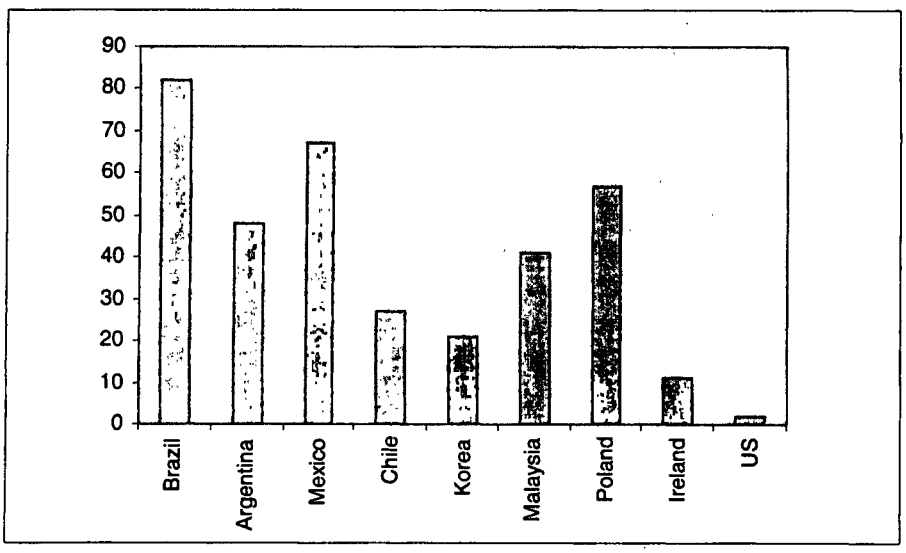
similar to other Latin American countries except for Chile, which in general has higher ratings. An interesting observation is that a lack of legal protection is considered by far the least important obstacle to starting up a new business in all the countries. Also, regulatory burden, measured by administrative procedures, is as much of an obstacle as the economic and financial conditions.

7.33 In general, these two firm level surveys fail to provide conclusive evidences on the importance of regulatory obstacles to starting up a new business in Brazil, although they hint at its importance. By contrast, the new data set collected by Djankov et al. (2000) on the regulatory burden for business start-ups in 75 countries strongly indicates that the official cost of entry for Brazil is high.[158]

7.34 Figures A14 through A16 (Annex) present the cross-country data on the number of procedures, business days to complete the procedures, and cost of completing the procedures, to start up a new business. Brazil's official number of procedures, at 11, is approximately average compared to other large, middle-income Latin-American countries. Chile has the lowest number of procedures. For the two representative Asian countries in our sample, Korea has the same number of procedures as Brazil, whereas Malaysia with 7 has a lower number. Developed countries, represented by Ireland (chosen for its recent dynamism) and the US, require only 3 procedures.

7.35 The cost of starting up a new business is standardized for comparative purposes by dividing by per capita GDP. Figure A15 presents these figures. The figures ranges from a low of 0.5% for the US to a high of 55.5% for Mexico, although the next highest is 26.5% for Malaysia. Brazil at 13.4% has cost comparable to Argentina, Chile, Korea, and Ireland. The official cost of starting up a business in Brazil is similar to even the higher growth countries such as Korea and Ireland.

Figure 7.3
Number of Days to Complete Procedures for New Businesses[159]



[158] The data set was kindly made available by Mr. Djankov.

[159] Djankov et al. (2000).

7.36 Brazil compares most poorly with respect to the number of business days required to start up new businesses. Figure 7.3 presents the figures. With 82 total official days required to start up a new business, Brazil has the highest figure compared to all the other countries in our sample. Excluding Brazil, the other three Latin American countries have an average of 47 days, where Chile at 27 days has the lowest requirement. Korea requires 21 days and Malaysia requires 41 days, both substantially lower than Brazil. Ireland requires 11 days, while the US requires 2 days.

7.37 Summarizing, the analysis of the regulation of entry data indicates that more than the cost of procedures or the number of procedures, Brazilian entrepreneurs are most burdened by the *time* required to comply with government regulatory procedures concerning start-up businesses.

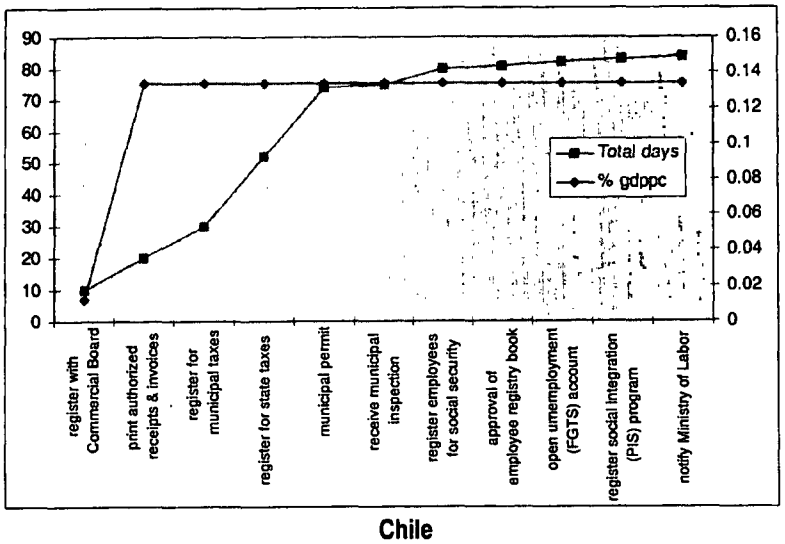
7.38 The source of the differences in the required procedures can be analyzed using Figure 7.4. These figures show the detailed start up procedures for Brazil, Chile, and Ireland, respectively. Chile, as is often the case with many governance measurements, has the least obstructive procedure among the middle income Latin American countries, while Ireland is presented in order to show how procedures in a developed countries enjoying high growth differs from Brazil.

7.39 Focusing first on the time component, the figure for Brazil shows that most of the time required to start up a new business comes from the earlier half of the procedures. In fact, steps four and five alone, each requiring 22 business days, comprise 52% of the total number of days. Step four consists of registering with the state tax authorities, the *coletoria estadual da fazenda*, where registration is done at three different offices. Step five consists of registering with the municipality and receiving an operations permit, an *Alvará de Funcionamento*. Besides steps four and five, steps one through three each requires 10 business days. Step one consists of registering with the state commercial board, step two consists of ordering receipts and invoices from authorized printing companies, and step three consists of registering with the municipal taxpayers registry, and receiving approval for the authorized receipts and invoices.

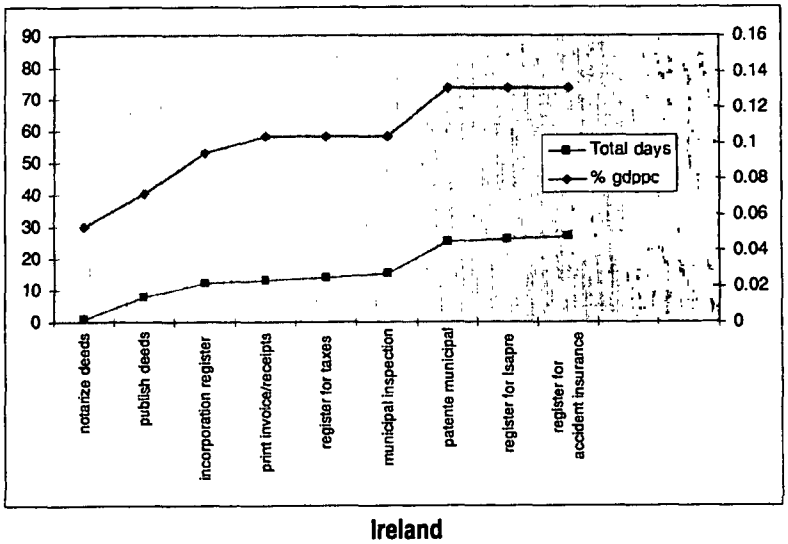
7.40 In contrast to Brazil, none of the steps in the start up process for Chile requires more than 10 days. Step seven, obtaining an operations license from the municipality, requires 10 business days, while step two, publishing the deed in the official gazette, requires 4 days, and step three, registering in the commercial state registry, requires 4 business days. All the other steps require only 1 business day each. The contrast with Ireland is even more striking. The entire process requires only three steps. The first step, filing necessary documents such as the article of association with the Registrar of Companies, takes 10 business days, while the other two steps take 1 day each. Actually, the last step consisting of registering income, social insurance, and VAT with the Revenue Commissioner is performed online and hence takes less than a day.

Figure 7.4: Business Start-up Processes

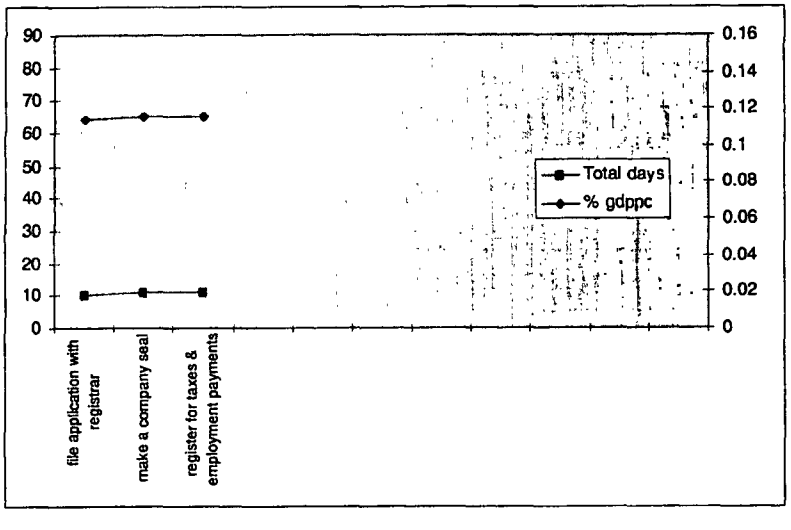
Brazil



Chile



Ireland



7.41 The comparative analysis suggests some specific ways of reducing the regulatory burden for Brazilian entrepreneurs starting up businesses.

- In general, the start-up process should be streamlined and centralized, including through the use of online services.
  - For example, entrepreneurs in Brazil have to deal with up to 6 government agencies. In comparison, entrepreneurs in Ireland deal with 2 agencies, where one of the agencies is accessed through the internet.
- Efforts to streamline the regulations governing the start-up process will no doubt be hindered by Brazil's multi-layered government organization. The fact that entrepreneurs have to deal with multiple agencies spread throughout various national and subnational governments clearly increases regulatory burden. In the United States, where the government is also organized according to a fiscal federalism structure, consistently requires the least amount of regulatory burden in the start-up process. Hence, it would seem that the process can be improved in Brazil despite its multi-layered government structure.
- The tax registration process should be better integrated into the rest of the start-up regulatory process.
  - The time required to register for municipal and state taxes in Brazil, combining for 32 business days, is a burden that is disproportionately large compared to the situation in Chile and Ireland. In Chile, entrepreneurs register at the Single Tax Register (*Rol Único Tributário*), which requires 1 business day, while in Ireland tax registration is performed online.

7.42 The results from the Djankov study are generally corroborated by a recent study[160] conducted by the Foreign Investment Advisory Service (FIAS).[161] The FIAS study similarly argues that the lengthy registration process characterized by multiple procedural requirements is a major impediment for the private sector in Brazil. It recommends establishing a single contact point for business registration by combining all company registration in one authority, merging the company and tax registration process, streamlining information exchange procedures among involved authorities in order to reduce unnecessary duplicative efforts by firms, and reducing excessive documentation requirements.

7.43 In the previous section, it was noted that delays in the court system was often cited by experts as the most significant shortcoming of the legal system. The present section documented the delays caused by the regulatory system. These delays are symptoms of a governance structure unable to support quick resolution of business activities, thereby adding cost, uncertainty, and suppressing entrepreneurship. The inefficiency of the regulatory and legal system not only

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[160] "Legal, policy, and administrative barriers to investment in Brazil," FIAS, May 2001, chapter III, sections A and B.

[161] FIAS is a unit of the World Bank Group.

dampens domestic private sector activities, but it also hinders domestic firms from effectively competing in the international markets.

7.44 One caveat is that the figures from the Djankov study are official figures, and therefore the actual regulatory burden for Brazil relative to other countries could be different. On the other hand, given that irregular payments for licenses and permits are considered more common in Brazil compared to developed countries, as indicated by the GCR data, the actual regulatory burden for Brazil relative to developed countries is likely to be even greater than the official figures.

V. GOVERNANCE AND FOREIGN DIRECT INVESTMENT

7.45 The World Bank's *Global Development Finance* presents some general statements concerning the relationship between capital flows and investment. They are listed below and may serve as useful starting points:[162]

- Long term capital flows are significantly associated with domestic investment, whereas the relationship between short term flows and investment is considerably weaker
- FDI is clearly associated with increases in investment compared to portfolio flows [163]
- In the short term, FDI through mergers and acquisitions may have less of an impact on domestic investment than "Greenfield" FDI, but the long term comparisons are ambiguous [164]
- Domestic structural factors such as governance, combined with others such as the level and quality of education, quality of physical infrastructure, and financial market development determine the host country's absorptive capacity, or the ability to convert the foreign capital into productive investments.

7.46 The evidence presented in this section shows that FDI is closely associated with domestic investment and that the quality of governance affects the amount of FDI inflow as well as its impact on domestic investment. The section first describes and analyzes the FDI inflow data for Brazil, then presents various qualitative and quantitative observations that support the existence of a positive relationship among governance, FDI, and investment, then concludes with some policy implications.

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[162] Refer to World Bank's Global Development Finance 2001, chapter 3.

[163] Bosworth and Collins (1999) finds that FDI and bank lending has a strong impact on domestic investment, where portfolio flows has a positive but insignificant impact.

[164] The relationship between FDI and domestic investment has weakened in countries where the proportion of M&A has risen, such as countries in East Asia and Latin America. However, M&A might significantly increase long term productivity.

The Size of FDI Inflows

7.47 Worldwide foreign direct investment increased substantially over the recent years, but the share of FDI flowing to developing countries decreased from 35 percent in 1994 to 16 percent in 2000, reflecting a more competitive environment as well as the completion of many large scale privatization projects in developing countries. The ownership form of foreign investment has changed as well in the late 1990s, as M&A activities grew rapidly in both Latin America and Asia, and especially in Brazil.

7.48 Cross-border M&As, including the privatization of state-owned enterprises, rather than "Greenfield" investments have been the main driving force behind the latest rise in FDI. Although it is impossible to measure cross-border M&A's share of FDI inflow precisely because of measurement incompatibilities,[165] if we assume that all cross-border M&As are financed through FDI, then the share reached over 80 percent in 1999. For developing countries, where "Greenfield" foreign investment is still dominant, the share is lower than the world average. Among the developing countries, the Latin American and Caribbean countries, especially Brazil and Argentina, dominate cross-border M&A sales.

7.49 For Brazil, FDI has increased significantly over recent years, as shown by Figure A19. In contrast, international portfolio equity flows have remained stagnant, raising speculation that weaknesses in the corporate governance system in Brazil have held back development of domestic equity markets. Brazil has been successful in attracting non-portfolio FDI, but these flows' sustainability remains unproven, and we turn to this in the next section.

7.50 In addition to the size of FDI, the host country's degree of involvement in international production is another indicator of FDI performance. A comparatively low level of involvement in international production would indicate that the host country lags other countries in its ability to benefit from the international production system, which in turn indirectly indicates low levels of FDI. UNCTAD publishes a Transnationality Index, which measures the extent of a country's involvement in international production.[166] The index is an average of the following four measurements: FDI inflows as a percentage of gross fixed capital formation between 1995 and 1997; FDI inward stock as a percentage of GDP in 1997; value added of foreign affiliates as a percentage of GDP in 1997; and employment of foreign affiliates as a percentage of total employment in 1997. Among 30 developing countries, Brazil, at approximately 7 percent, ranks 25th, well below the average of 14 percent. Chile is ranked 7th at 17.5 percent, Mexico is ranked 16th at 11 percent, Argentina is ranked 18th at 10 percent, and China is ranked 14th at 12 percent.

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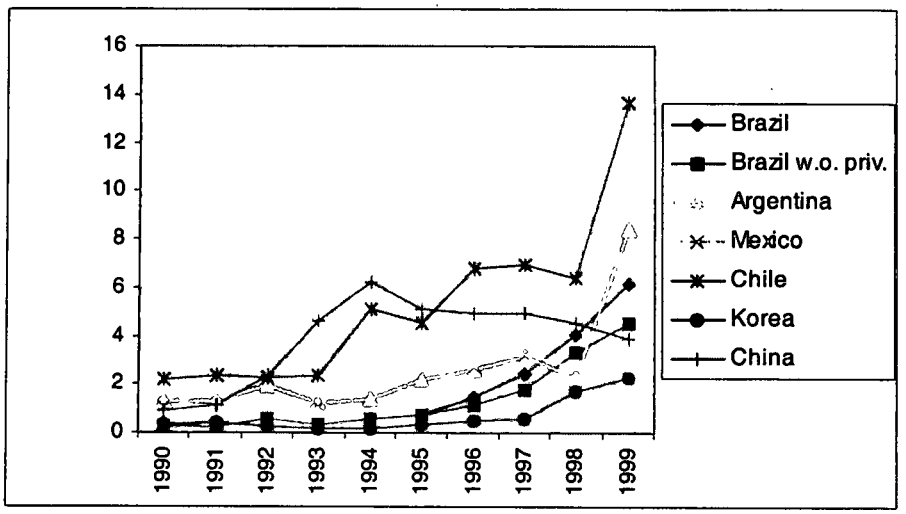
[165] Refer to World Investment Report, page 10, and Global Development Finance 2001. M&As financed locally or through the international capital market is not included in FDI data. FDI is reported on a net basis while M&A is reported on a gross basis. The total amount of an M&A transaction phased over several years is recorded in the first year in the FDI data.

[166] UNCTAD, World Investment Report, 2000.

The Sustainability of FDI

7.51 Figure 7.5 shows that Brazil's recent strong FDI performance. It plots FDI inflow, as a percentage of GDP, during the 1990s for Brazil and comparable Latin American and Asian countries. The figure makes it clear that for most of the decade, compared to the size of its economy, Brazil lagged behind the other countries except for South Korea. The ratio of FDI to GDP for Brazil surpassed Mexico and Argentina only in 1998, then outpaced China in 1999. In particular, for the second half of the decade, Chile outpaces Brazil as well as other comparable countries in its ability to attract FDI.[167] The ratio of FDI to gross fixed capital formation paints a similar picture, and shows that Brazil lagged other comparable countries until the late 1990s.

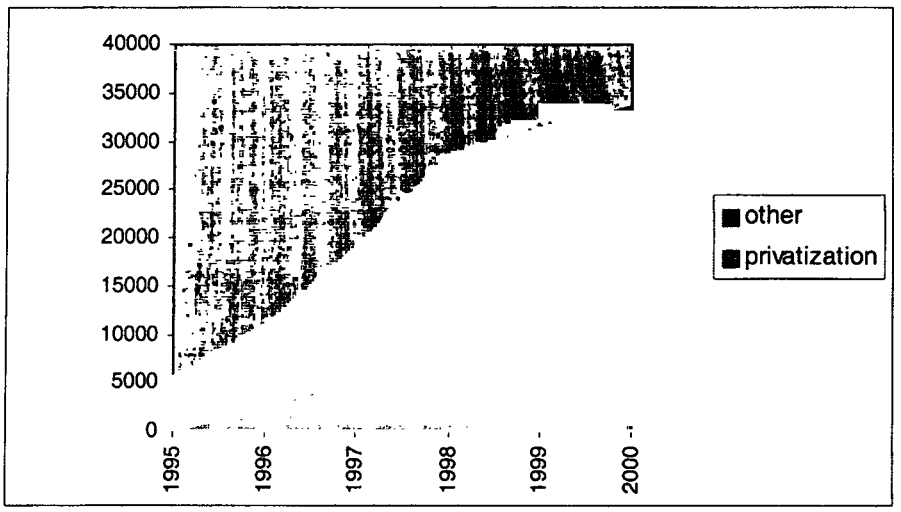
Figure 7.5
FDI as percentage of GDP



7.52 One of the issues that affects FDI sustainability is the degree to which Brazil's FDI relies on privatization. The recent increase in FDI coincided with the massive privatization program, as illustrated by Figure 7.6.

[167] Chile's ability to attract proportionately more FDI could be the result of policies that specifically deal with foreign investors as well as the high quality of its broader regulatory, legal, and institutional environment, but the fact that a large proportion of its FDI targeted the mining and, in 1999, the utility sector suggest that the recent increases might not be sustainable. The figures for 2000 indicates a sizable decrease in the FDI inflow, although as a percentage of GDP the figure is still at the upper range among comparable developing countries.

Figure 7.6
Brazil FDI Inflow

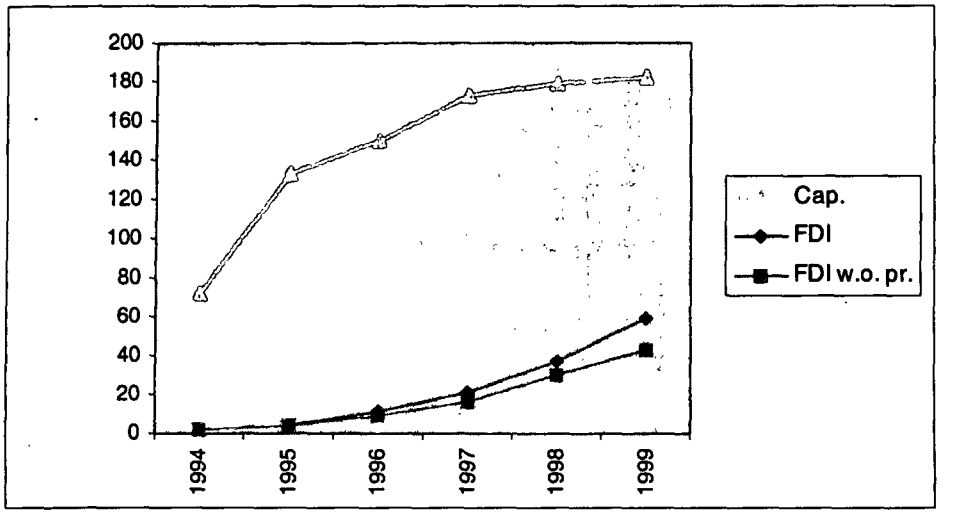


7.53 On the other hand, the figure also shows that FDI unrelated to privatization has increased at a faster rate than FDI resulting from privatization. Privatization related FDI accounted for an average of approximately a quarter of the total FDI inflow during the second half of 1990s. While privatization related FDI decreased in 2000, non-privatization FDI increased unabated. It indicates that the recent increase in FDI inflow into Brazil was not merely the result of privatization of state owned enterprises, although it clearly benefited from the privatization program. It provides hope that the recent high levels of FDI could be maintained despite the inevitable decrease of privatization related FDI.

7.54 Regardless of its sustainability, it is clear that FDI has increased substantially over the recent years. Then the relevant question is whether this increase has been matched by a similar increase in domestic investment. Figure 7.7 plots FDI and gross fixed capital formation for Brazil over the 1990s. As before, the figure shows that FDI increased substantially over the recent years, while gross fixed capital formation increased at a decreasing rate, eventually almost flattening out over the last three years. During this period, gross fixed capital formation as a proportion of GDP steadily decreased, from a peak of 20.75 % in 1994 to 18.92 % in 1999. Hence, whether in absolute amount or proportionate to the size of the economy, investment as measured by gross fixed capital formation has not increased as much as the increase in FDI.

7.55 There are three possible explanations for the lack of growth in domestic investment in response to the increase in FDI: (1) FDI attracted by the privatization programs have largely been used to finance government consumption; (2) FDI has largely been financed through mergers and acquisitions which bring less resources to the host country compared to "Greenfield" FDI; (3) demand for investment funds is inelastic with respect to the cost of funds, and therefore an increase in supply of investment funds caused by an increase in FDI led to a relatively large decrease of the cost but a small increase in investment volume. In another words, investors are not price sensitive.

Figure 7.7
Domestic Investment and FDI



7.56 The first hypothesis, although plausible, cannot by itself explain for the less than expected increase in domestic investment because, as discussed previously, privatization accounts for only a quarter of Brazil's total FDI inflow.

7.57 The second hypothesis could possibly account for the lack of response in domestic investment. If we assume that cross-border M&A results in small additions to the capital stock, then FDI composed largely of mergers and acquisitions would result in less than expected increases in domestic investment. Although FDI and cross-border M&A data are not completely compatible, Figure A23 suggests that a large proportion of FDI has been financed through M&As. On the other hand, even if Brazil's FDI inflow has been mostly accounted for by M&As, the explanatory power of the second hypothesis hinges on the assumption that FDI through M&A results in small additions to the capital stock. This assumption depends on two factors: the time horizon and the response of the seller in the cross-border M&A transaction.

7.58 Time horizon matters in the following sense. Even if cross-border M&A initially results in a change of ownership accompanied by only a small initial increase in the domestic capital stock, the longer run impact on investment is unknown. The acquiring foreign agent in a cross-border M&A transaction often follows up the initial investment with a series of additional investments. The assumption that cross-border M&A results in only a small increase in the capital stock compared to "Greenfield" FDI, could be valid in the short run but invalid in the long run.[168] Hence, this delay in impact could explain why FDI has increased without a corresponding increase in domestic investment.

[168] For the present argument, the comparison of the two modes of FDI entry focuses on increases in domestic investment while ignoring other effects on areas such as employment, technology transfer, and domestic competition. In the long run, the differences in these other areas could have a greater impact on the host country's economy than increases in the domestic fixed capital formation.

7.59 The response of the domestic seller also determines FDI's impact on domestic investment. The domestic seller can use the proceeds from the transaction in several ways. If we assume that the domestic seller reinvests all the proceeds in the domestic economy in such a way that adds to the capital stock, then FDI would result in an equally large increase in domestic investment.

7.60 The third hypothesis is based on assumptions regarding how domestic investors would respond to exogenous increases in the supply of investment funds. In the extreme case where the demand for capital is perfectly inelastic, an increase in FDI inflow would be exactly matched by a decrease in the supply of domestic investment capital, resulting in a "crowding out" effect. If the objective of the policymaker is to increase domestic investment, then the proper policy response would depend on one's beliefs regarding the determinants of the elasticity of the domestic demand for investment funds. The policymaker would need to know the factors that increase the sensitivity of investors to the cost of capital.

The Sector Distribution of FDI

7.61 Figure A24 shows the distribution of Brazil's FDI inflow into different sectors. For the latter half of 1990s, the service sector received approximately 80 percent of the total FDI inflow. By contrast, the stock of FDI in 1995 was 43 percent in the service sector, 55 percent in the manufacturing sector, and 2 percent in the agriculture and mining sector. The FDI share of the service sector is a more recent phenomenon. The services sectors in Argentina and Chile also receive a much larger share of FDI, whereas the service and manufacturing sectors in Korea receive approximately equal amounts, and the manufacturing sector in Thailand receives 70 percent of FDI.

7.62 The rapid increase of FDI inflow into the service sector was driven mainly by only two industries. By 2000, the telecommunications industry received 45 percent and the financial intermediation industry received 26 percent of all service sector FDI.

7.63 The fact that the manufacturing sector receives a much smaller share of FDI is a matter of concern for policymakers who are interested in export promotion. Although services are becoming increasingly more tradable, manufacturing has been the traditional engine of export growth for developing countries. In addition, many services still require proximity to the customers, limiting their capacity to contribute to exports. Finally, developing countries usually lack the higher levels of skill and technology necessary for export of services. The rapid growth of the NIEs (Newly Industrialized Economies) of East Asia and China are recent examples of manufacturing export based economic growth. In particular, China has enjoyed sustained high rates of growth based on surging foreign investment in its manufacturing export industries (Box 2). The experience of China seems particularly relevant for Brazil given that China also has a large domestic market and yet chose to pursue a growth strategy based on manufacturing export, with foreign firms playing a major role in the export manufacturing industries.

Box 7.2: FDI in China's domestic manufacturing export industries[169]

Foreign investment in its manufacturing export industries has been one of the most important factors behind China's sustained high rates of growth in the recent years. China's economy grew at an average of approximately 10% in the 1990s, as it became the world's ninth largest exporter in 1999, up from twelfth in 1990. The sector composition of China's exports consists mostly of manufacturing products such as general and electrical machinery and textile products.

The Chinese industrial development process has been characterized by the heavy involvement of foreign direct investment. Subsidiaries of foreign affiliates accounted for 46% of its exports, 52% of its imports, and 12% of its fixed capital formation in 1999. In addition to direct contributions to trade and investment, the economic integration of the foreign affiliates in the local economy has resulted in backward and forward linkages and the creation of industrial clusters. Foreign processing and assembly industries have led to the formation of local parts companies. Clusters of such companies have led processing industries to form similar clusters nearby, leading to a virtuous cycle.

The large-scale involvement of foreign firms in the domestic export industry has been accompanied by continued efforts to improve the investment and trade environment. The average tariff rates have decreased from nearly 40% in 1988 to below 20% since 1998, import quotas and import licenses for items such as heavy machinery, electrical machinery, and optical instruments were eliminated in 1997, and certain foreign banks were allowed to operate local currency businesses in Pudong, Shanghai in 1998. Although still far from a market-based economy, China's campaign for membership into the WTO will apply further pressure for institutional and structural reforms, including improved market access and protection of intellectual property rights for foreign investors.

7.64 The fact that foreign direct investors heavily favor the service over the manufacturing sector also indicates that foreign investors mainly view investing in Brazil as a means of reaching the large domestic market. Service sectors such as the telecommunication and finance industries witnessed large increases in FDI as changes in regulations and policies allowed and encouraged foreign investment. In addition, foreign investors wishing to conduct business in these industries have little choice but to directly invest in Brazil given that these industries are not easily tradable. Hence, investors in these industries have a relatively high tolerance for the poor investment climate in Brazil because they have little other alternative means of accessing the domestic market.

7.65 On the other hand, FDI inflow into the manufacturing sector remained stagnant, reflecting foreign manufacturers' reluctance to view Brazil as an attractive manufacturing base. International investors searching for a manufacturing export base have a lower tolerance for a country with a poor investment climate, given that they can always choose to invest in another country. They can access the domestic market of a country with a poor investment climate by exporting to the country as opposed to directly operating in the country. This is a choice not available in a non-tradable service sector. Hence, the level of FDI in the manufacturing sector is a better indictor of the host country's investment climate than the level of FDI in the service sector.

7.66 The fact that foreign firms in Brazil have a local market orientation is also suggested by another recent survey. AT Kearney surveyed senior executives from the world's largest multinational corporations in order to determine the reasons why they would invest in a given market. The survey indicated that domestic market access is a more important reason than low production costs for FDI in Brazil, whereas the two factors are similar in their importance for FDI in Mexico (Figure A25). Low production costs are cited by only 26% of survey respondents as

[169] METI (2001).

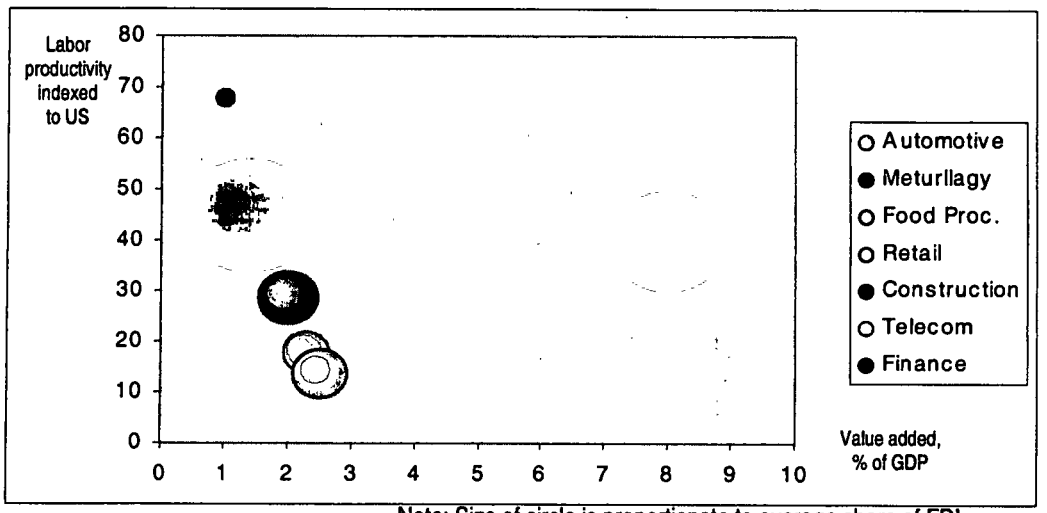
important factors for Brazil compared to 68% citing market size. For Mexico, 43% cited low production cost and 43% cited market size.

7.67 Finally, the large share of FDI in the service sector, in as far as it reflects the fact that foreign investors are local market-oriented, could explain why 40% of foreign firms in Brazil do not use their frontier technology. The figure was reported in a study by SOBEET, and cited in FIAS (2001). Using data on Asian subsidiaries of Japanese multinational firms in the electronics industry, Belderbos et al. (2000) showed that FDI with a local market orientation has a higher local content than export-oriented FDI. They conjecture that local market oriented FDI uses more mature and standardized low-cost components procured from locally established suppliers. This may explain why host market-oriented foreign firms in Brazil tend not to use sophisticated technologies.

The Industry Distribution of FDI

7.68 If one assumes that FDI benefits domestic industry both directly through investment and indirectly through competition and transfer of technology, then FDI can be a component of a country's industrial policy. Figure 7.8 shows the industrial distribution of Brazil's FDI inflow. The horizontal axis is the industry's value added as a percent of GDP in 1995, the vertical axis is the industry's labor productivity indexed to the US in 1995, and the size of the circle reflects the industry's average share of FDI over the second half of the 1990s. The industries included in the figure are limited to those included in McKinsey (1998).

Figure 7.7
Sector breakdown of FDI



Note: Size of circle is proportionate to average share of FDI
Source: McKinsev(1998). World Bank SIMA

7.69 Industries with low productivity, large GDP share, and currently low levels of FDI are industries with the highest potential for increased FDI to have the greatest impact on overall economic growth. In the figure, the industries represented by small circles located nearest to the bottom, right-hand corner most closely satisfy these criteria. Although there are no industries that satisfy all three criteria, the three most promising candidates are retail, food processing, and construction industries. The retail and food processing industries have relatively low productivity

but also small GDP shares, while the construction industry has a relatively large GDP share but a high productivity. The retail industry at 14 percent and the food processing industry at 18 percent have much lower labor productivity compared to their US counterparts. As indicated by the size of the circles, all three industries received on average a relatively small share of the FDI inflow between 1995 and 2000, capturing 3.37, 2.57, 0.44 percent of total FDI inflow, respectively.

7.70 Increased FDI into these lagging industries can stimulate higher domestic investment and greater competition, as evidenced by the Korea's experience with increased FDI into its retail industry (Box 3). In the case of Brazil, although the share of total FDI is still small, international investment in the retail sector has been present and growing as the sector restructures. Five out of the seven largest hypermarkets are at least partially foreign owned, although the next largest thirteen are domestic firms. Still, there are areas that can be improved as the retail sector remains relatively highly fragmented and the infrastructure for delivery services remains poor.[170]

Box 7.3

Foreign Direct Investment in the Korean retailing industry[171]

In January of 1996, the Republic of Korea lifted most of the previous legal restrictions on foreign investment in the retail and distribution industry, leading to the entrance of multinational firms and substantial changes in the market structure and the level of competition. Regulation that restricted the number and size of foreign retail stores was abolished, and limits on foreign ownership of commercial real estate were substantially eased.

Starting with the Anglo-Dutch company Makro, which opened an innovative membership-only warehouse discount store through a joint venture, major foreign retailers such as Costco, Wal-Mart, Carrefour, Tesco, and Promodes have become active in the Korean domestic market since 1996, mainly focusing on the large volume and low price discount sales concept. The investment entry mode has changed over time as well: recent foreign entries have opted for greenfield investments, shifting away from previously favored schemes such as joint ventures and technical collaborations.

Competition has increased as a result. Domestic competitors simultaneously reduced the prices of 200 to 400 items by an average of 2 to 3 percent in response the opening of the Makro store. The number of competitors has so rapidly increased that major foreign retail firms now operate 22 megastores in the Korean market. By contrast, the domestic discount chain leader, E-Mart, operates 18 outlets throughout the country. Partly in response to heightened foreign competition, domestic conglomerates such as Samsung aggressively expanded their shopping malls and hypermarkets in an effort to capture economies of scale. Direct and indirect technology transfers have benefited the domestic firms as well. Joint ventures and technical collaborations with existing local firms have been the preferred mode of entry for many of the earlier foreign entries, and local competitors such as E-mart have openly admitted to adapting Price Club's advanced management techniques.

Foreign entries have forced domestic firms to improve their scale and operational efficiency, ultimately benefiting the consumers. Some domestic firms have managed to withstand the foreign competition and continue to maintain a competitive edge over foreign rivals. Foreign discounters still lag E-Mart in sales performance and efficiency, although major domestic distribution firms are under heavy competitive pressure from foreign competitors who have a edge in low financing cost. Small and medium sized domestic retailers with weak financing capabilities are especially vulnerable.

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[170] Fabiana Borges da Fonseca, "Brazil Retail Food Sector Report 2000," USDA GAIN Report #BR0026, 2000; American Chamber of Commerce 2001.

[171] World Investment Report 1997; *Business Korea*, December 1999; and *Business Korea* February 1997.

7.71 In summary, the following statements can be made based on our analysis of the data:

- FDI inflow for Brazil increased substantially over recent years, but whether such levels are sustainable is questionable.
  - The current slowdown in the world economy could lead to a reduction in the total supply of foreign investment, reducing. FDI in Brazil, unless Brazil is able to increase its relative attractiveness as a host country for FDI. The data do not indicate that the recent increase in FDI is mainly based on government privatization programs, although there has been a reliance on a small number of service industries.
- The fact that the recent upsurge in FDI inflow has mainly benefited the non-tradable service sector while mostly bypassing the manufacturing sector suggests that the investment climate in Brazil still does not compare favorably with other countries.
  - It indicates that Brazil is a country where foreign investors mainly invest in order to gain access to the large domestic market, as opposed to a country where an internationally competitive investment climate attracts investors seeking to establish a manufacturing export base. The current sector mix of Brazil's FDI raises concern given that typical country examples of export-based growth have often been based on exports of manufactured goods, and foreign firms can often play a major role in exports. In addition, foreign firms which are host market-oriented typically use more outdated technology.
- The retail and food processing industries are characterized by low productivity and a small share of FDI inflow, suggesting that increased FDI can result in a relatively large impact on growth.
  - Increased FDI promotes growth in the industry not only through increased direct investment, but also through increased competition and transfer of technology.

7.72 The conclusion that the investment climate discourages FDI inflow into the manufacturing sector in Brazil is supported by the data. The next section presents the available research regarding the relationship between public governance, a major determinant of the investment climate, and the inflow of FDI. Given that cheap labor, tax benefits and a large domestic market are often cited as important determinants of FDI, the challenge is to identify the governance effect apart from the effects of these other variables.

Research on Governance and FDI

7.73 The general business environment is one of many factors that influences inflow of foreign direct investment. Past research, including a survey conducted by UNCTAD of senior executives of multinational corporations with affiliates in Brazil, suggests that the following three issues are the most important determinants of FDI:[172] size of the internal market; growth of the market; and the

[172] UNCTC 1992, UNCTAD 2000.

stability of the business environment. Business environment mainly refers to the macroeconomic policy regime, and the social and political environment. These three factors are interrelated. For instance, a large domestic market alone might not be a sufficient enough incentive for certain foreign investors. Lack of freedom to operate internally with a minimum of bureaucratic interference could deter foreign investment regardless of the size of the market. The important point to take away from the survey is that governance is as important a factor as host country market size and growth for foreign investors.

7.74 The survey results from UNCTAD can be compared to the survey conducted by AT Kearney. The survey shows that Brazil is among the top five destination of choice for global corporations, and the outlook for Brazil has improved since the currency devaluation. The survey provides insight into the factors that lead multinationals to invest in Latin America in general and Brazil specifically. Figure A28 shows that macroeconomic stabilization is by far the most important factor behind investment decisions in Latin America, but it also shows that improved rule of law is a significant factor in encouraging foreign investment, where its importance is comparable to the free trade agreement and the strengthening of Mercosur.

7.75 Both the UNCTAD and AT Kearney surveys suggest that governance has an important influence on foreign investment. This conclusion is supported by the data presented in World Bank's *Global Development Finance* (GDF, 2001). Using sources such as the European Round Table of Industrialists 2000 and the UNCTAD (1999), GDF 2001 presents evidences that the investment climate and governance are positively related to FDI. Figure A29 presents the evidence. The first panel shows that improvements in the investment climate are associated with higher FDI growth. The investment climate index ranges from 1 to 6, and the GDF estimates are based on European Round Table of Industrialists 2000. The second panel shows a plot of the FDI growth rate against a governance indicator. The governance indicator is an aggregated indicator from a World Bank study conducted by Kaufmann, Kraay, and Zoido-Lobotan (1999). It aggregates governance measurements of voice and accountability, political stability, government effectiveness, regulatory framework, rule of law, and corruption. Again, the data indicates that there is a positive relationship between public governance and the FDI growth rate.

7.76 Given that the surveys of business executives indicate that governance is a major concern in their foreign investment decisions, it is not surprising that some multinationals explicitly account for governance quality in their foreign investment decision making process. For example, a positive assessment of the country's political and economic system was a major element of Intel's decision to construct a $300 million semiconductor plant in Costa Rica. Intel gave high marks to Costa Rica for its stable and supportive government and its transparent legal system (Box 4).

Box 7.4: Intel's investment in Costa Rica[173]

The US semiconductor manufacturer Intel, with annual revenues of more than $25 billion, announced in November of 1996 plans to construct a $300 million assembly and testing plant in Costa Rica, a plant with up to 2000 (mostly Costa Rican) employees, over alternative sites in Brazil, Chile, Indonesia and Mexico. The decision by the large multinational corporation to invest in a relatively small country with limited domestic electronics and other high technology sectors attracted much attention in the foreign investment community. The Intel decision was notable because Costa Rica did not enter into a bidding war with other potential locations and offered little special subsidies other than the standard incentives available to other foreign firms that operate in the country's EPZs. This contrasts Brazil's subsidies to foreign automobile manufacturers which some have criticized as lowering national welfare.[174]

The governance quality of the country was a major factor in Intel's decision to make a large investment in Costa Rica. Costa Rica was a stable and democratic country committed to economic openness and which actively encouraged foreign investment, and the legal system was relatively transparent. The willingness of the president of Costa Rica to meet with Intel officials in order to pledge full support readily made it apparent the government's commitment.

Intel officials met with representatives from international accounting firms KPMG, Peat Marwick, Price Waterhouse, and Ernst and Young as well as Citibank to assess the transparency and reliability of the country's legal and financial institutions. Meetings were held with DSC Communications, the largest US electronics firm operating in Costa Rica, and several other foreign manufacturers in order to discuss the country's business climate as well as regulations regarding foreign transactions of US dollars.

7.77 Research also suggests that FDI is more sensitive to the governance quality when compared to other forms of capital flow. Hoekman and Saggi (1999) cite corruption, unnecessary regulatory requirements, complicated or nontransparent administrative procedures, and insufficient protection of physical and intellectual property rights as substantial obstacles to investment. Their study indicates that corruption has a greater impact on FDI than on debt or portfolio equity investment. One explanation for the greater sensitivity is that FDI requires a more direct interaction with local officials, suppliers, competitors, and clients. This section now turns to the existing research on the estimated size of this impact.

7.78 The Opacity Index, a governance rating system constructed by Price-Waterhouse-Coopers (PWC), was described in a previous section, "Measurement of the Determinants of Governance Quality." PWC uses the Opacity Index in their recent analysis of the effect of governance on foreign direct investment (PWC, 2001). The study implements a regression analysis based on Wei (2000a). The dependent variable is the log of FDI, and the independent variables include the Opacity Index in addition to other variables controlling for tax rate, size of economy, and labor cost. Based on these estimates, the results indicate that Brazil can increase the annual inflow of FDI by 141%, or $40.3 billion, if it improved its governance to US standards. The magnitude of the impact is clearly very large.

7.79 An interesting feature of this study is the inclusion of two independent variables indicating the presence of FDI incentive and restriction policies, respectively. The FDI incentive variable indicates the existence of policies such as tax concessions and export processing zones designed to promote foreign investment, while the FDI restriction variable indicates policies such as the

[173] Spar (1998), also MIGA Investment Promotion Toolkit.

[174] Hanson (2001)

presence of restrictions on foreign ownership and policies that excluded foreign firms in certain strategic sectors. The variables were constructed based on information from country reports published by the company, and each variable takes on a value from zero to four. The FDI incentive indicator variable was a significant determinant of FDI, while the restrictions indicator variables was insignificant. More importantly for the purpose of this report, the opacity variable was still statistically significant even with the inclusion of the incentive and restriction variables in the regression. The overall governance quality is a significant determinant of FDI even when specific FDI policies are taken into account.

7.80 Empirical studies assessing the quantitative impact of public governance quality on FDI flows (Wei 2000, Harms 2000, Lehmann 1999, Drabek and Payne 2000, Gastanaga et al. 1998, and Lee and Mansfield 1996) generally estimate a significant effect. Gastanaga et. al (1998) found that FDI was lower in countries with greater bureaucratic delay and higher nationalization risk, while Lee and Mansfield (1996) found that perceptions concerning the strength of intellectual property rights affected both the volume and composition of US foreign direct investment.

7.81 Wei (2000b) conducted a study comparing the effect of corruption on FDI, comparing its effect with cheap labor and tax benefits. The study uses GCR variables measuring corruption and regulatory burden as independent variables in the regressions on FDI. The results indicate that China could increase its FDI by 218% if it reduced corruption and red tape to Singapore's levels.

7.82 Drabek and Payne (2000) examined the impact of transparency on FDI inflows. The transparency variable is a country ranking based on a composite index constructed from the International Country Risk Guide (ICRG), where the underlying variables are the level of corruption, law and order, bureaucratic quality, contract viability, and the risk of government expropriation of private assets. The ranking ranges from 8.5 to 38. Using data from 52 developed and developing countries over the period 1991 to 1995, the study found that a one-point increase in the level of transparency was associated with an average of 40 percent increase in FDI inflows, although the expected increase varies widely among the countries. Unfortunately, the sample does not include Brazil, but the results indicate that Argentina could increase its FDI by 51%, Indonesia by 12%, and Chile by 7% if their rankings were increased by one point.

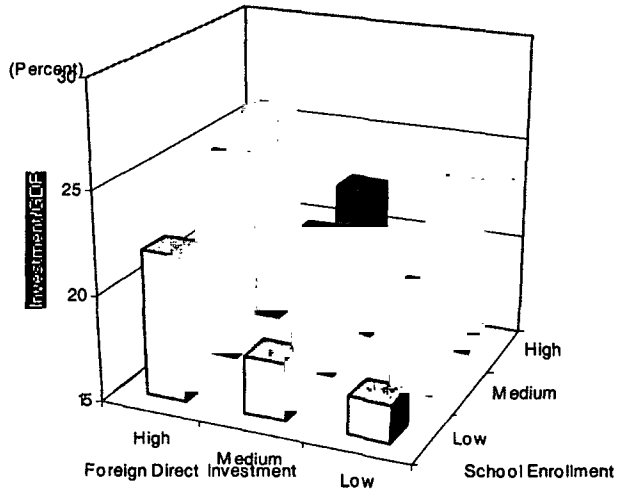
7.83 Of course, these numbers are merely illustrative, and comparison of the impact across the studies is difficult due to differences in definition and measurement methodology. Nevertheless, together the studies indicate that improving governance quality has a large impact on FDI inflows.

7.84 Governance also has an effect on the degree to which FDI is transformed into productive investment as opposed to consumption or an outflow of capital. The relationship between FDI and investment depends on the country's absorptive capacity. The absorptive capacity depends on factors among which public governance is a major component. The World Bank's *Global Development Finance* (GDF) 2001 cites political stability, health of the financial system, efficiency of government services, and the degree of corruption as well as the macroeconomic policy framework as factors which determines absorptive capacity.

7.85 Empirical researchers have only begun to explore this relationship. Borensztein, De Gregorio, and Lee (1998) finds that FDI's positive effect on investment increases with the stock of

human capital. GDF 2001 illustrates this relationship with a plot of foreign direct investment and school enrollment against investment-GDP ratio. The figure is reproduced as Figure 7.8.

Figure 7.8
FDI, School Enrollment, and Investment



7.86 Domestic investment is higher when FDI is greater and also when education levels are higher. When education levels are low, foreign direct investment has the least impact on domestic investment. The study indicates that the effectiveness of FDI at low levels of schooling maybe be close to zero.

7.87 Research suggests that the level of education could also have an impact on the extent of technological spillovers from foreign direct investment. Urata and Kawai (2000), using data on Japanese FDI to the rest of the world, found that the educational level of the host country was a significant explanatory variable for intra-firm technology transfer between parent firms and overseas affiliates. The level of education seems to be a key determinant of the host country's capacity to absorb technologies from the foreign firms.

7.88 In a similar manner, quality of governance is likely to affect the extent to which the host country benefits from technological spillovers from foreign firms. Studies indicate that the quality of governance affects general technological deepening in developing countries. Clarke (2000) showed that the quality of governance, as measured by the risk of expropriation and the rule of law, is correlated with R&D expenditures. Hence, improving the quality of governance would increase the capacity of the host country to absorb foreign technology. Increased R&D expenditure and increased educational attainment both reflect an upgrading of skills and knowledge of the local population.

7.89 The benefits that can be accrued from FDI also depend on its mode of entry. Previous sections have described the growing importance of cross-border M&A as an investment vehicle for foreign direct investors. Furthermore, it was suggested that greenfield investments could have a

larger impact on domestic investment compared to M&As in the short run. In addition, FDI dominated by M&A could adversely affect the level of competition by increasing the concentration of market power, leading to abuse of market power and lower consumer welfare. For example, studies based on developing and developed countries indicate that multinational corporation activity and the concentration of producers in host country industries are positively correlated.[175]. On the other hand, the relationship between FDI and market concentration depends on several post-entry effects. And there is no consensus on how increased market power concentration would affect the level of investment. Nevertheless, the strengthening of competition policy is considered a key component of any FDI liberalization policy.

7.90 In summary, we have made the following arguments based on the available research:

- Both survey and empirical research indicate that overall governance quality is a significant determinant of foreign direct investment in Brazil.
    - This relationship holds even when specific FDI policies and regulations are taken into account. Furthermore, compared to other forms of capital flow such as debt and portfolio investment, FDI seems to be more sensitive to the quality of governance.
- Governance affects not only the amount of FDI but also the impact of FDI on domestic investment through its affect on domestic absorptive capacity.
    - Factors which determine the host country's business climate, such as its political stability, the health of the financial system, the efficiency of government services, the degree of corruption, and the macroeconomic policy framework, seem to effect its absorptive capacity. The education level is one variable for which the data shows a clear relationship to absorptive capacity. FDI has the least impact on domestic investment when the level of education is lowest. In addition, the quality of governance affects the extent of technological spillovers from foreign firms.
- There is no consensus on how FDI affects market concentration in the host country, nor on how this affects aggregate investment, in comparison to cross-border M&A.

VI. Policy Implications

7.91 Governance, FDI, and domestic investment interact in a complex manner over the long run. Nonetheless, governance is a significant determinant of the other two variables. Policies to improve the quality of public governance should be an integral part of any country's strategy to promote FDI, domestic investment, and growth. This is especially for countries such as Brazil where key components of its governance trail other similar countries. Also, growing international competition for FDI means that foreign investors can choose from a growing number of potential investment locations. Countries can no longer afford to neglect improving their investment climate.

[175] World Investment Report, 1997, page 137. In particular, refer to Wilmore (1989) for a study of Brazil.

7.92 In addition to maintaining high levels of FDI, Brazil has an opportunity to maximize the benefits of FDI by improving its investment climate through its public governance policies. The evidence suggests that the benefits from FDI are small under a system characterized by regulatory and legal impediments to private economic activities, a poorly educated work force, and macroeconomic instability. In addition, governance should be improved in order to maximize the benefits of technological spillovers from foreign firms. The benefits of improving governance are of course not limited to its impact on FDI, as it will also improve the investment propensity and productivity of domestic private firms as well.

7.93 The recent FIAS report on Brazil offers policy recommendations for improving the investment climate for foreign investors.[176] In general, it recommends eliminating counter-productive red tape and streamlining administrative procedures in order to reduce investment cost, risk, and uncertainty. Some of the specific recommendations are to eliminate the excessive and redundant bureaucracy involved in site development, visas, and various permits and licenses, and to review and reform the corporate tax system in order to reduce its excessive complexity.

7.94 With regards to the form of FDI entry, given the lack of strong empirical evidence comparing greenfield and M&A FDI, the appropriate policy is to strengthen competition policy while avoiding policies which favors one form of entry over the other. On the other hand, countries such as Korea have implemented policies that favor greenfield over M&A forms of FDI.[177]

7.95 An important difference between Brazil and the manufacturing export-based economies of East Asia is the sector composition of FDI. Improved governance—more efficient courts, reduced administrative barriers—could encourage FDI in the manufacturing sector to form the basis for export growth in Brazil. As part of an overall industrial policy, FDI can also be an effective tool in developing inefficient industries such as non-tradable service industries, which are naturally protected from foreign competition. For Brazil, encouraging FDI in the retail and food processing industries could have a high impact on economic growth given the low productivity and low levels of FDI in these industries.

7.96 Improving the business climate will be crucial for developing countries to compete for FDI flows. The underlying macroeconomic stability and openness to trade will need to be maintained, but in addition Brazil will need to improve its regulatory framework, reduce corruption and bureaucratic constraints, and improve the legal and administrative system that supports the enforcement of contracts.

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[176] FIAS (2001), page xxiii.

[177] Refer to World Investment Report (2000), page 150. As a result of the Asian financial crisis in 1997, Korea changed its FDI and M&A policies in order to attract foreign investment in its troubled firms. Restrictions on foreign acquisition of domestic shares, M&As, and land were abolished. However, the new investment policy still slightly favors greenfield over M&A investment. Most of the newly introduced measures, such as the creation of foreign investment zones and tax incentives, are geared towards greenfield investment. The tax regime also favors greenfield over M&As by allowing reduction of taxes on corporate income, acquisitions, registration, and property and land.

7.97 The main conclusion is that the quality of public governance is a significant determinant of both private sector investment and FDI. Policies to improve the public governance, traditionally a somewhat neglected area in Brazil, must be given more attention.

7.98 Given its importance, measurements of governance that provide policymakers with greater objectivity and specificity assume an added importance. Measurements of the *determinants* of governance quality, based on the underlying government processes, are more effective in this manner as opposed to general governance quality measurements. For example, data on the number of court staff, salaries, and technology allowed the World Bank Legal Department to determine the key determinants of legal system inefficiency.

7.99 In addition, general governance quality measures are typically based on surveys, and are therefore difficult to assess because the results depend on the cultural background of respondents. Cross-state surveys may improve matters, as cultural differences across states within a country are generally less severe than between countries. Examples of such surveys are the World Bank FACS survey for India, and the IDESP survey of judiciary quality described in Pinheiro (1999).

7.100 Despite the potential shortcomings of survey methodology, the major international governance rating institutions consistently give Brazil a low rating for the quality of its regulatory system. The ratings on the legal system and government bureaucracy are mixed when compared to similar Latin American countries, but Brazil compares poorly against developed countries. Although there are obvious overlaps among the three categories, the survey results suggest that regulatory burden seems to be a particularly acute problem for Brazil.

7.101 The comparative measurements of the underlying legal and regulatory arrangements indicate that both court delays and the time required to complete the start-up regulatory procedures in Brazil are substantially higher than in other countries. Such delays not only represent a real cost to entrepreneurs, but since they occur before the outcome of processes is known, they also represent added uncertainty and thus financial risk, especially for those competing in the global markets. The more detailed analysis of Brazil's new business registration process showed that the delays were caused by the multiplicity of procedures required by the three levels of government.

7.102 Perhaps more so than domestic entrepreneurs, foreign direct investors, particularly when they are interested in establishing a manufacturing export base, are sensitive to the quality of the governance of the host country. The suspicion that foreign investors still do not consider Brazil's public governance to be a high enough quality is further corroborated by the fact that FDI inflow has been heavily skewed towards the non-tradable service sector, and by survey results.

7.103 With regards to the legal system, the capital budget, technology, and managerial activism are promising areas of policy intervention for reducing court delays, as opposed to the more traditional areas such as the number of court staff, salaries, and the level of training. With regards to the regulatory system, simplifying and centralizing the business start-up process and tax registration across levels of government should result in a reduction of regulatory burden.

7.104 Improving public governance should also be a policy priority for promoting exports given its potential to substantially increase the flow of FDI into the manufacturing sector. Meanwhile, promoting FDI into non-tradable service industries such as retail and food processing should have

a high impact given the low productivity and current low share of FDI of these industries. The current trend towards a stable and liberalized set of regulations regarding the repatriation of foreign capital and profit could be maintained. Particularly important in the context of these industries, the excessive bureaucracy involved in site development, visas, and various permits and licenses could be reduced, and the corporate tax system could be simplified.

7.105 There is need for further research, and one compelling choice would be to analyze the governance constraints faced by the informal sector. The sector is a substantial part of the Brazilian economy and suffers from low investment. One World Bank study has found that ineffective and discretionary administration of tax and regulations, weak rule of law, and corruption increases the size of the unofficial economy. In addition, the study shows that countries with larger unofficial economies tend to grow more slowly.[178] Hence, from a policy perspective, encouraging movement from the informal to the formal sector by lowering the cost imposed by an inefficient legal and regulatory system could have a significant impact on investment and economic growth.

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Annex

Table A1
Measurements of Overall Public Governance Quality

Data	Source	Variables (Partial List)	Methodology	Coverage	Brazil Data
Business Risk Service	Business Environment Risk Intelligence (BERI)	Bureaucratic delays, contract enforceability nationalization risk, policy stability	Survey of experts	50 mostly developed countries	Yes
International Country Risk Guide (ICRG)	Political Risk Services (PRS) Group	Government corruption, law and order tradition, bureaucratic quality	Survey of experts	140 developed and developing countries	Yes
Freedom in the World	Freedom House	Political freedom, civil liberty	Survey of experts	172 developed and developing countries	Yes
Global Competitiveness Survey	World Economic Forum	Independence of civil service from politics, competence of public sector personnel, tax evasion	Survey of businessmen, government officials	57 developed and developing countries	Yes
Country Risk Review	Standard and Poor's DRI / McGraw-Hill		Survey of experts	106 developed and developing countries	Yes
Central European Economic Review	Wall Street Journal		Survey of businessmen	27 transition economies	No
Transition Report	European Bank for Reconstruction and Development		Survey of experts	26 transition economies	No
Country Risk Service, Country Forecast	Economist Intelligence Unit		Survey of experts	114 developed and developing countries	Yes
Economic Freedom Index	Heritage Foundation / Wall Street Journal		Survey of experts	154 developed and developing countries	Yes
Asia Intelligence	Political Economic Risk Consultancy		Survey of experts	11 Asian countries	No
World Competitiveness Yearbook	Institute of Management Development		Survey of businessmen	46 primarily developed countries	
Private Sector Survey	World Bank (World Development Report 1997)	Policy and judicial unpredictability, quality of government services, corruption and red tape	Survey of businessmen		
Country Policy and Institutional Assessments	World Bank	Property rights and rule based governance, quality of budgetary management, transparency, corruption	Survey of experts		
Firm Analysis and Competitiveness Survey (FACS) *	World Bank	Number of visits by government official, business environment assessment	Survey of businessmen	3 countries (India, Bolivia, Morroco)	No
World Bank Economic Survey (WBES) *	World Bank	Time spent on regulation compliance, frequency of payments to public officials	Survey of businessmen		
Regulatory Cost Survey	World Bank	Assessment of regulatory burden, time required to register firm	Survey of businessmen	Ukraine	No
Quality of Brazil's judiciary system	IDESP (cited by Armenio Castelar Pinheiro (1999))	Slowness, fairness, and costs of courts	Survey of businessmen	Brazil only	Yes

Legal and regulatory environment	World Bank (Stone et al. (1992))	Time spent on regulation compliance, difficulty of regulation compliance	Survey of businessmen	Brazil and Chile	Yes
Opacity Index	Pricewaterhouse-Coopers	Corruption, legal system, regulatory regime	Survey of businessmen	35 countries	Yes
Corruption	World Bank (Pradhan et al. (2000))	Corruption that distorts formulation of laws and regulations	Survey of businessmen		
World Value Surveys	World Bank (cited by La Porta et al. (1997), Knack and Keefer (1997))	Degree of trust of others	Survey of individuals	30 countries	

* Contains both quality and determinants of quality measurements.

Table A2
Measurements of Determinants of Public Governance Quality

Data	Source	Variables (Partial List)	Methodology	Coverage	Brazil Data
Civil service employment and pay	Schiavo-Campo et al. (1997, 1997)	Number of government employees, average government wages	Collected by authors	80 to 100 countries	Yes
Weberian comparative state data project	Evans and Rauch (1999, 2000)	Index of meritocratic hiring, internal promotion index	Survey of experts	35 developing countries	Yes
Polity98 Project: Regime characteristics		Constraints on chief executives power, political participation			
Database of Political Institutions	World Bank (Beck et al. (2000))	Electoral rules, type of political system, party composition of the opposition and government coalitions		177 countries	Yes
Political Constraint Index	Henisz (2000)	Number veto power in government, party alignment across government branches	Collected by author	140 countries	Yes
Judicial Indicators	World Bank (Buscaglia et al., (1999))	Cases per judge, budget, clearance rate	Collected by department	11 countries	Yes
Regulation of entry	Djankov et al. (2000)	Number of procedures, official time, and official costs for starting up a business	Collected by authors	75 countries	Yes
Public expenditure management assessment	World Bank-IMF joint project	Budget formulation, execution, reporting	Collected by staff economists		
BNPP (Bank-Netherlands Partnership Program) Surveys	World Bank (Manning et al. (2000))	Rule credibility (ex., assessment of budget management guidelines), policy credibility, resource adequacy	Survey of public sector employees	8 developing countries and 6 in progress	No
Land titles	Alston et al. (1996)	Land titles, access to credit	Survey of landholders	Brazil	Yes

Figure A1. Global Competitiveness Report - Legal System

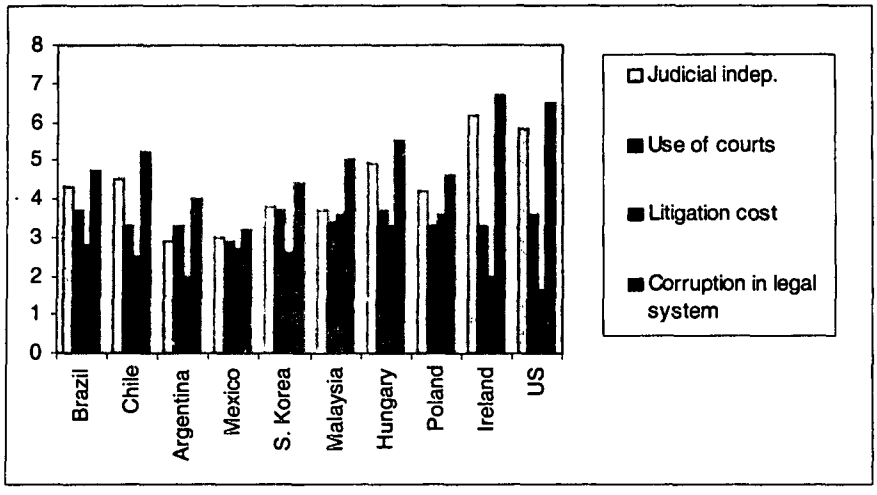


Figure A2. Global Competitiveness Report - Regulatory System

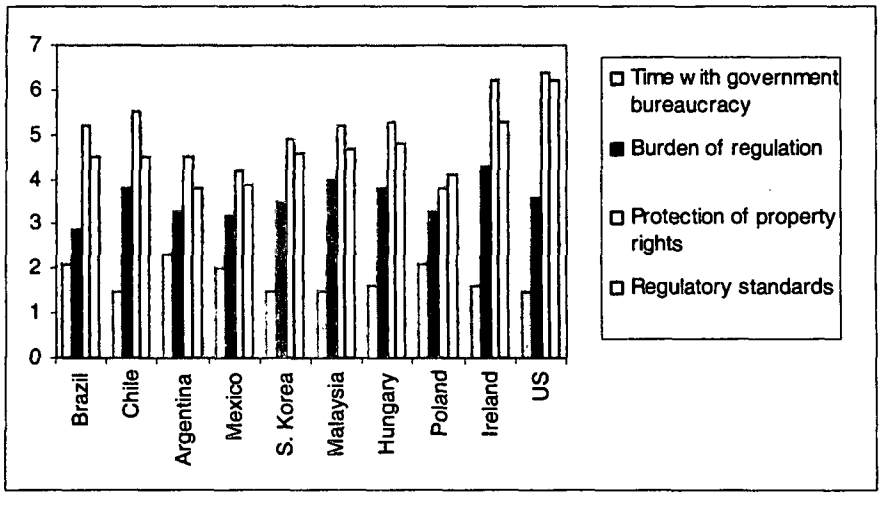


Figure A3. Global Competitiveness Report - Public Institutions

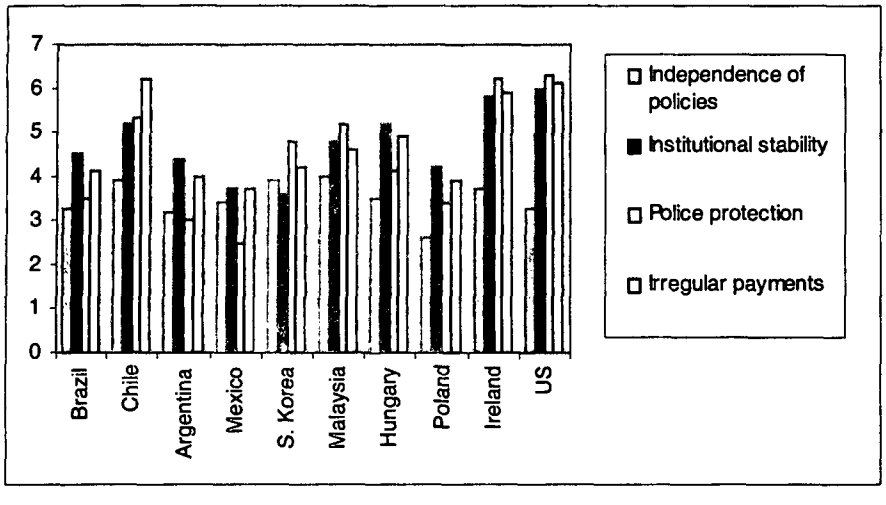


Figure A4. ICRG

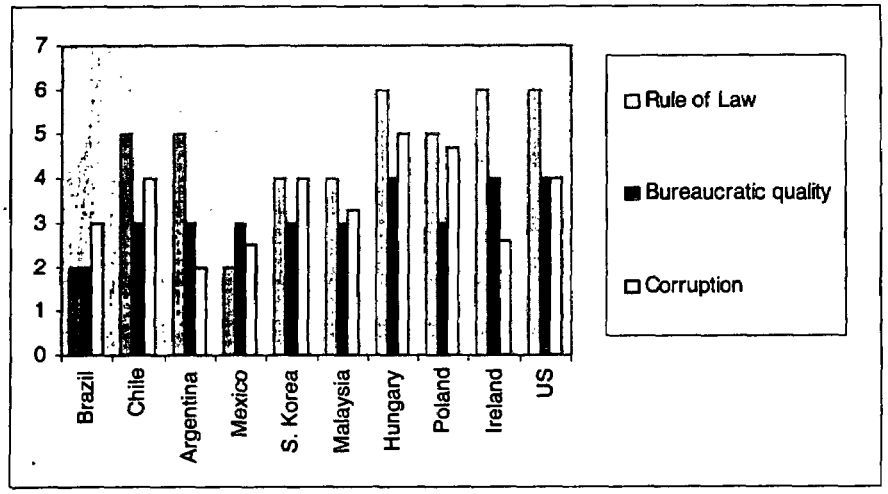


Figure A5. BERI

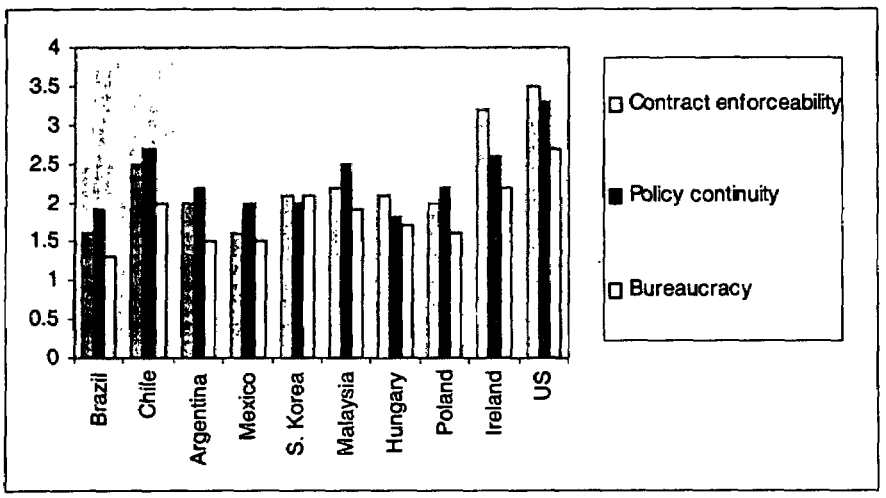


Figure A6. PricewaterhouseCoopers – Opacity Index

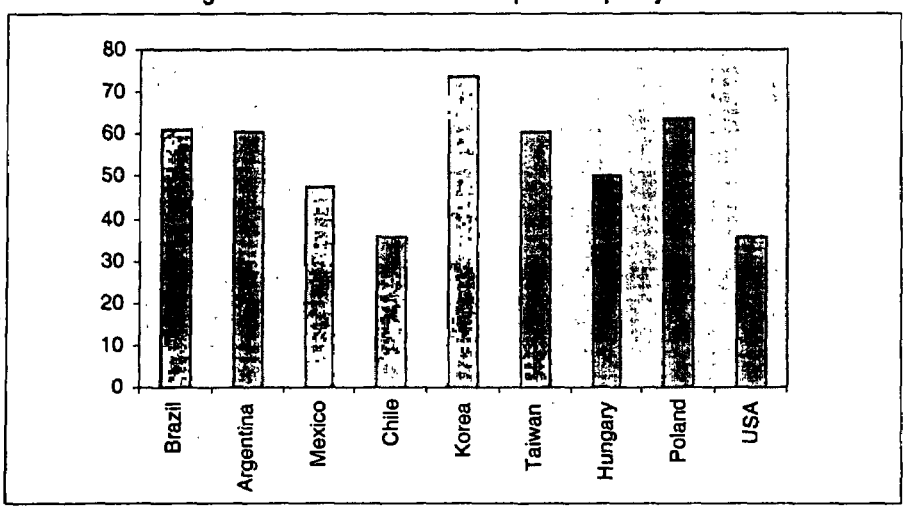


Figure A7. PricewaterhouseCoopers – Subcomponents of Opacity Index

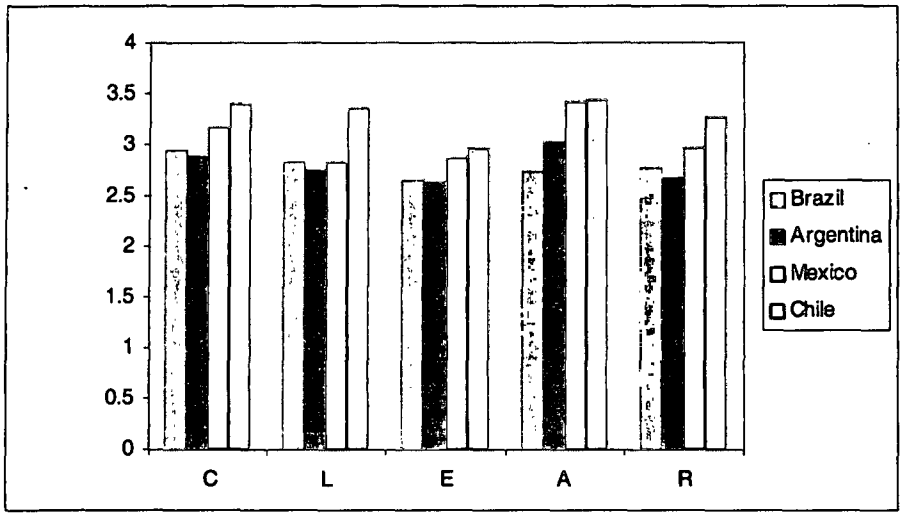


Figure A8. World Bank Legal Department – Clearance Rate

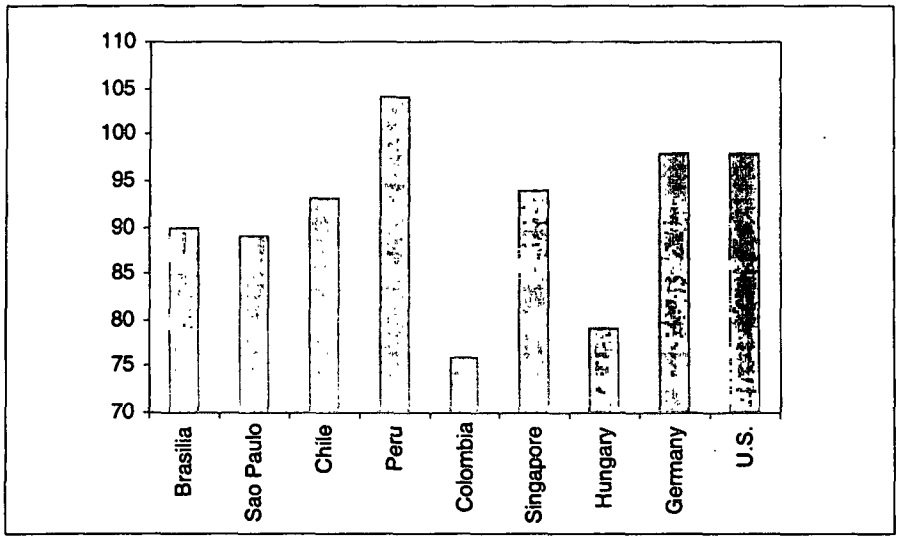


Figure A9. World Bank Legal Department – Pending Cases per Judge

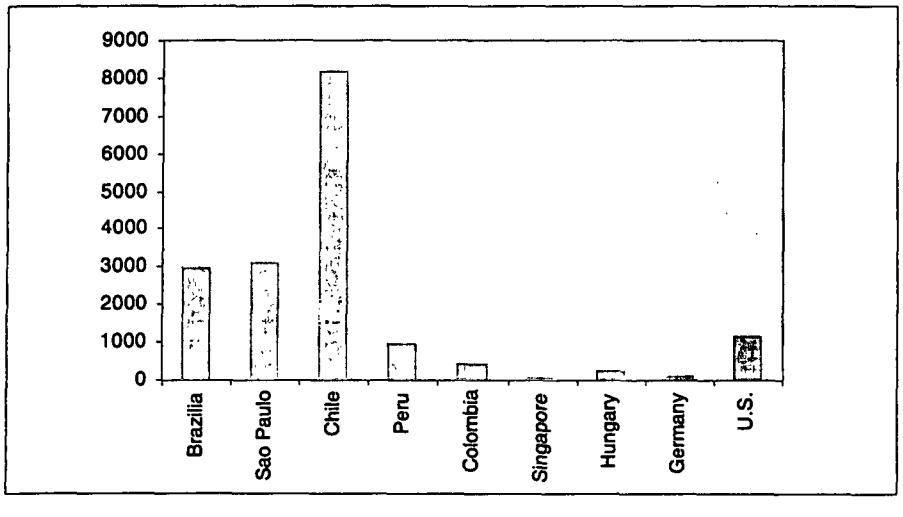


Figure A10 World Bank Legal Department – Backlog Index

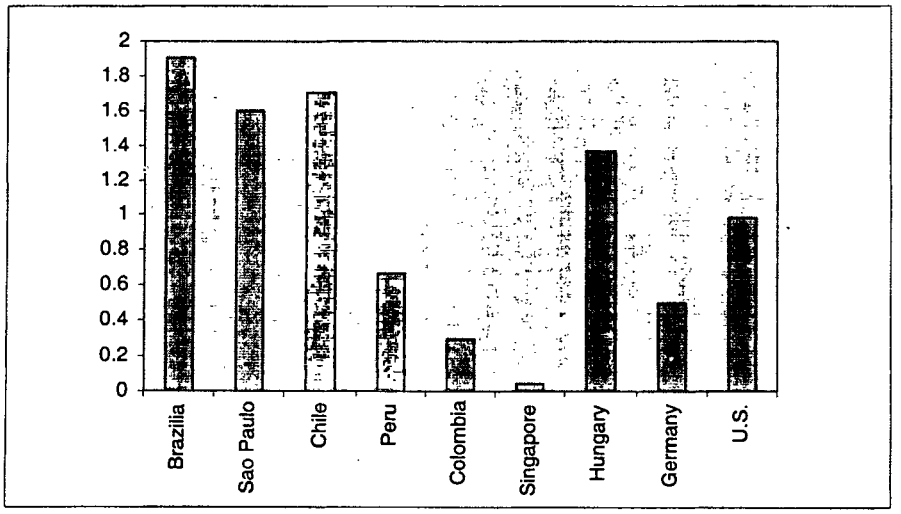


Figure A11. WBES – General Business Constraints, Brazil

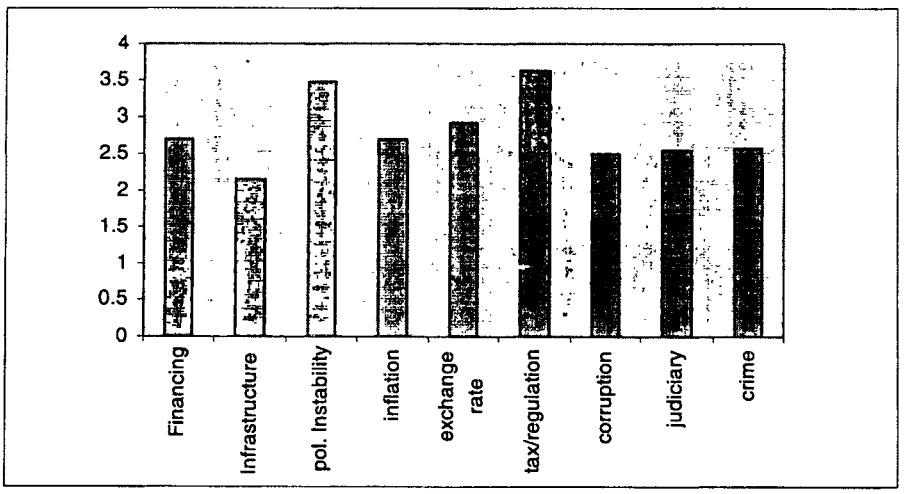


Figure A12. WBES – General Business Constraints, Brazil and LAC

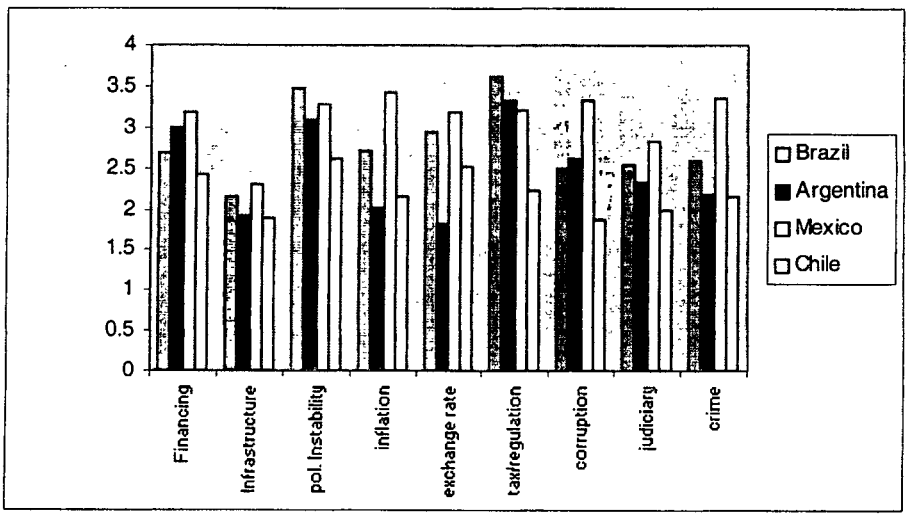


Figure A13. Global Competitiveness Report – Obstacles to New Businesses

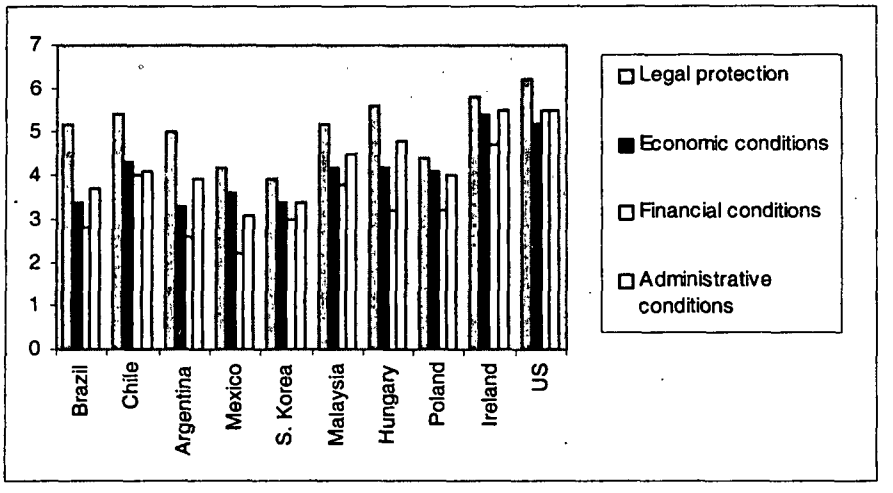


Figure A14. Djankov et al. (2000) - Number of Procedures for New Businesses

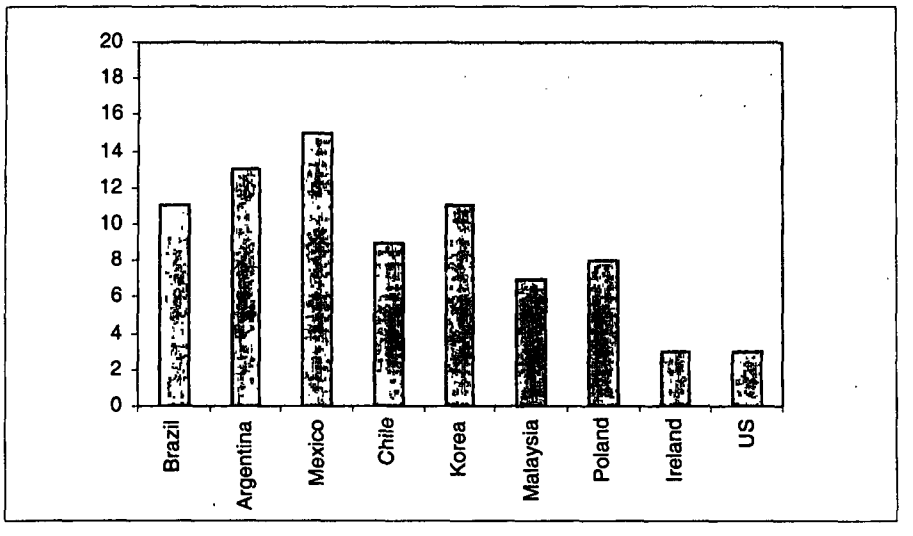


Figure A15. Djankov et al. (2000) - Direct Cost for New Businesses as Fraction of GDP Per Capita

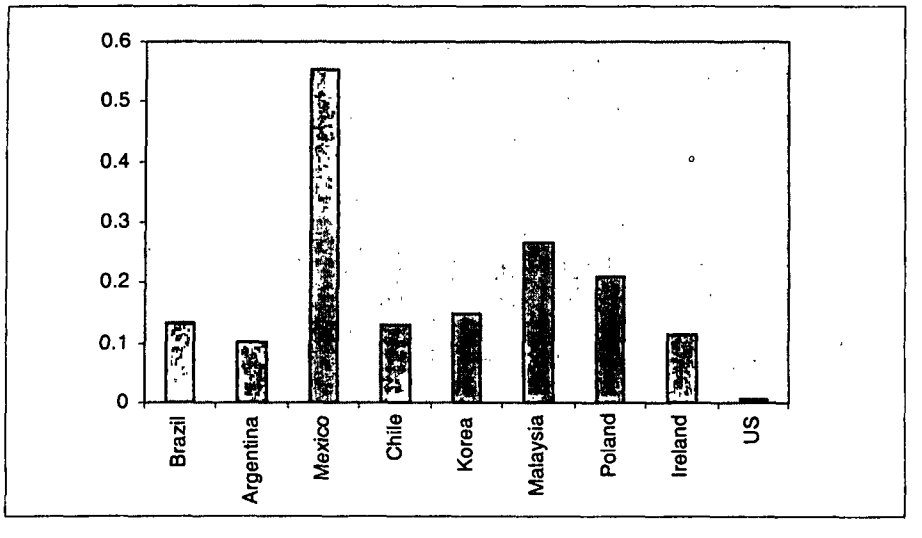


Figure A16. Djankov et al. (2000) - Number of Days to Complete Procedures for New Businesses

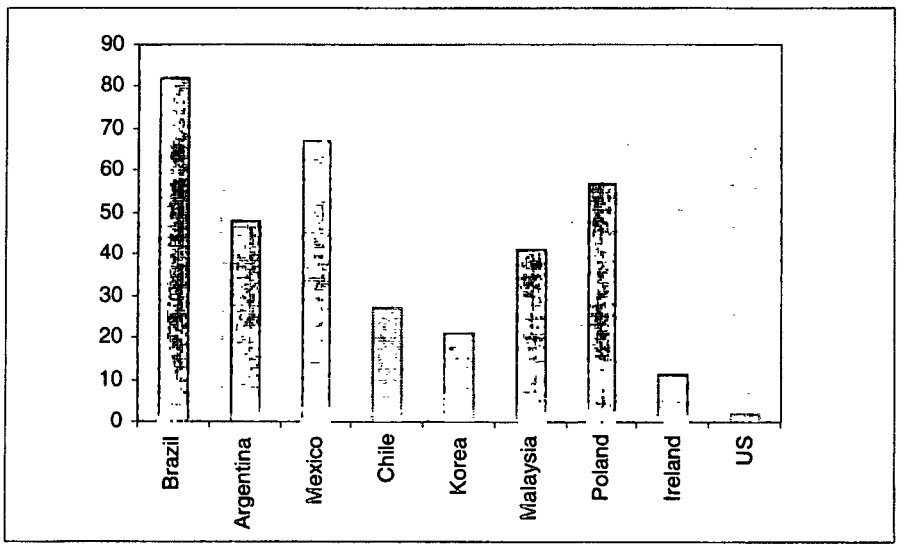


Figure A16. Brazil Business Start-up Process

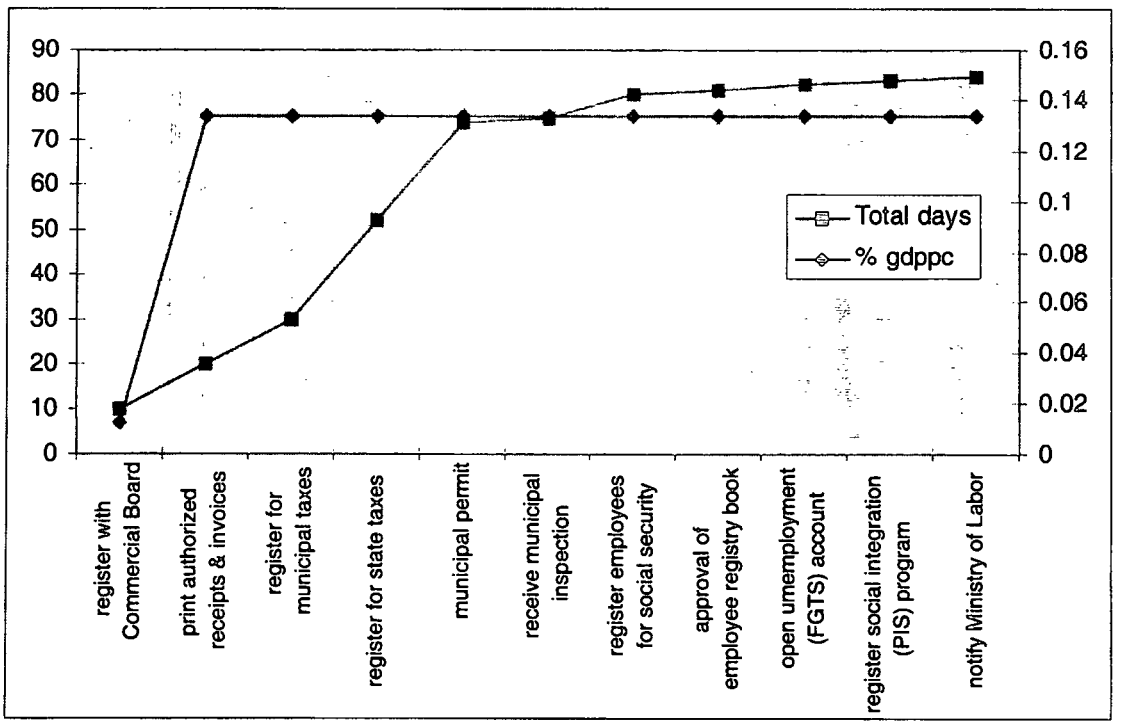


Figure A17. Chile Business Start-up Process

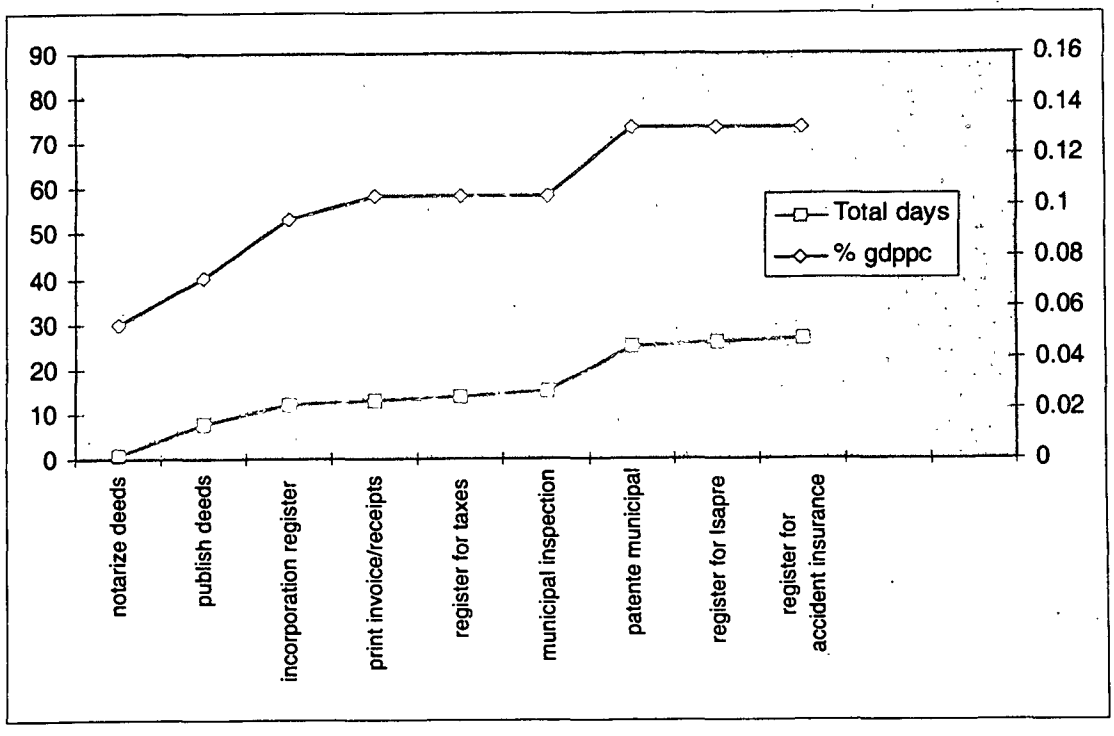


Figure A18. Ireland Business Start-up Process

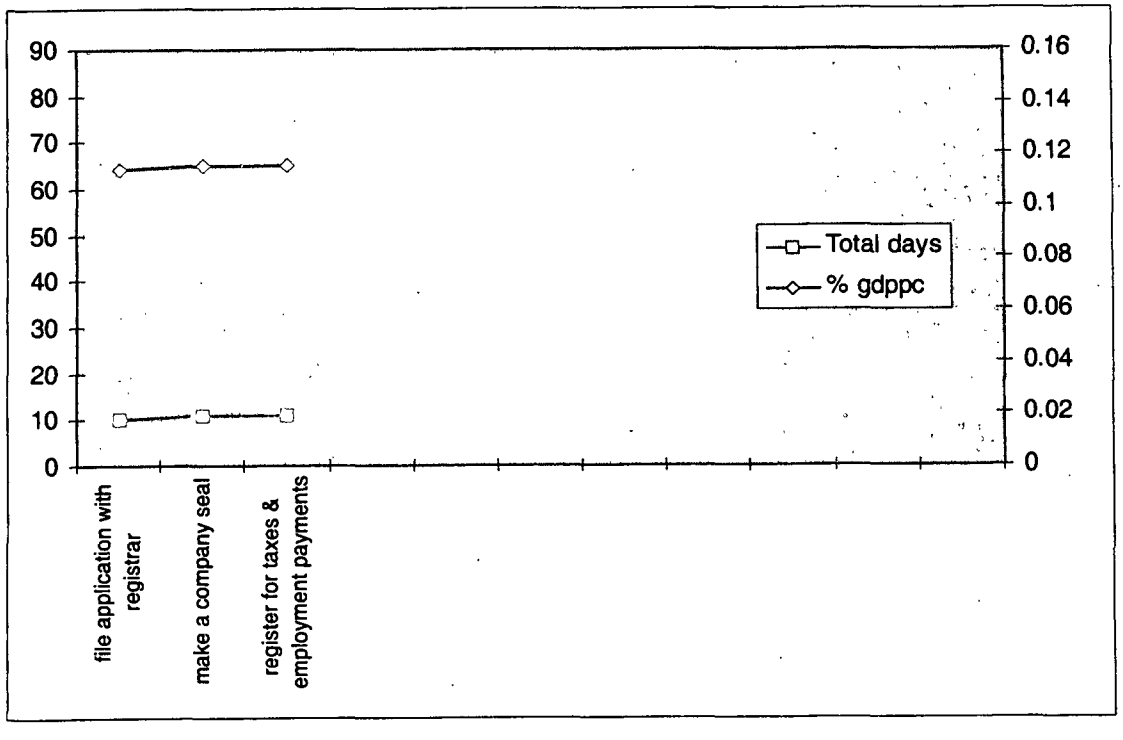


Figure A19. FDI and Portfolio Equity Flow

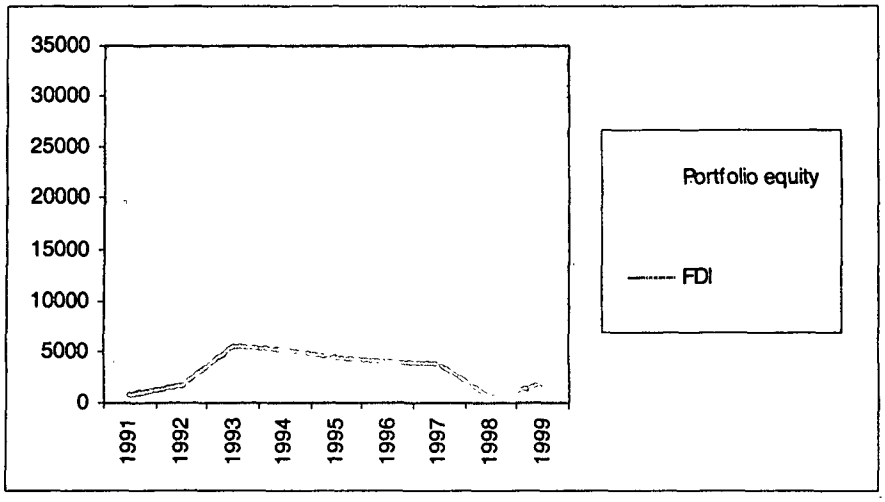


Figure A20. FDI as percentage of GDP

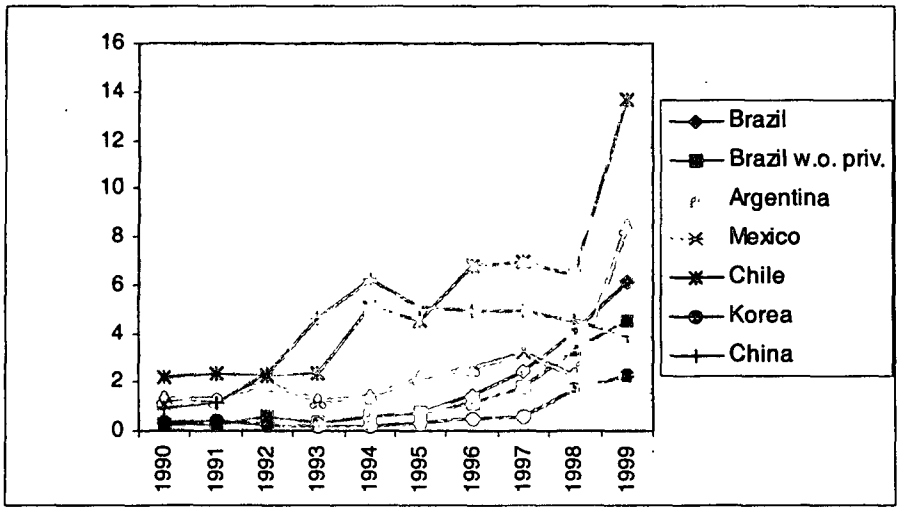


Figure A21. Brazil FDI Inflow

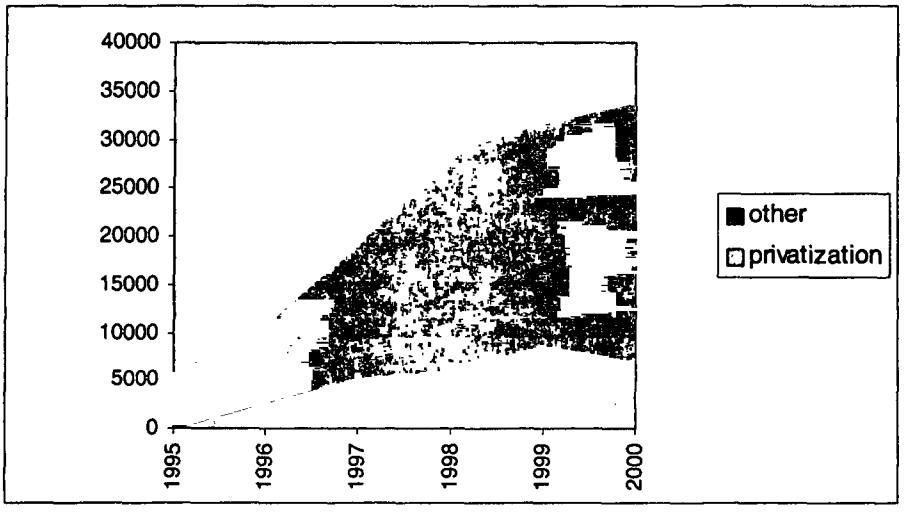


Figure A22. Domestic Investment and FDI

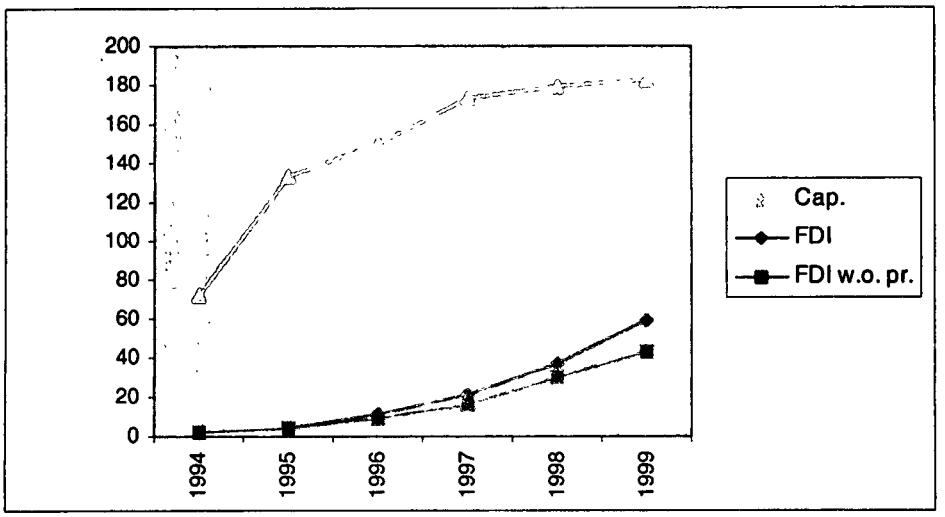


Figure A23. Brazil FDI and cross-border M&A

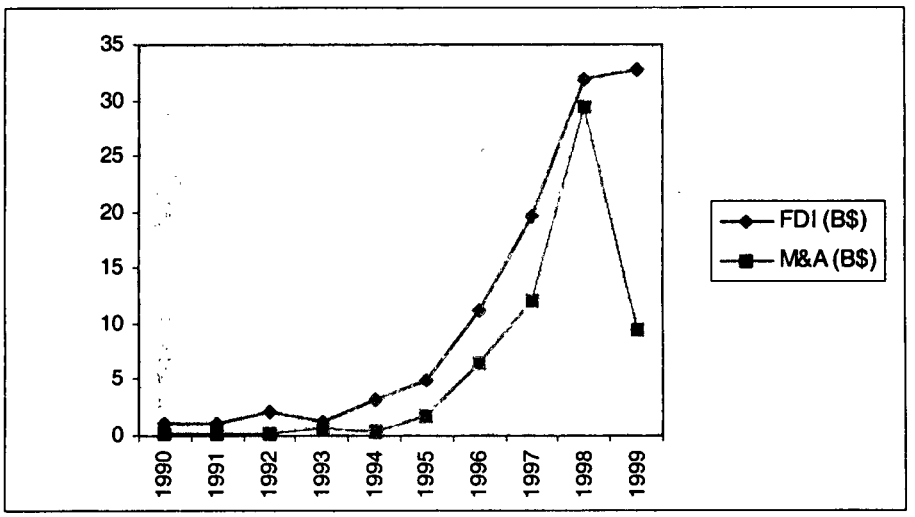


Figure A24. Brazil FDI by Sectors

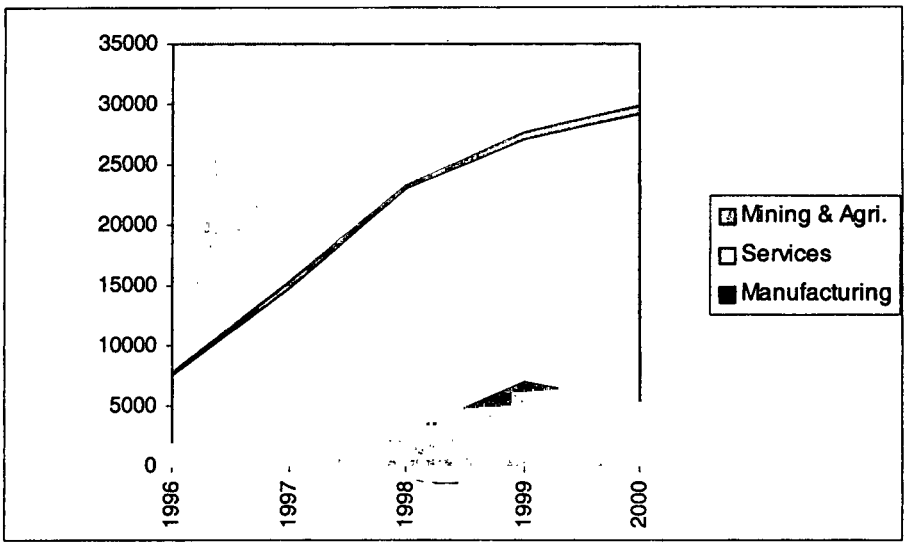


Figure A25. AT Kearney – Drivers of FDI into Mexico and Brazil

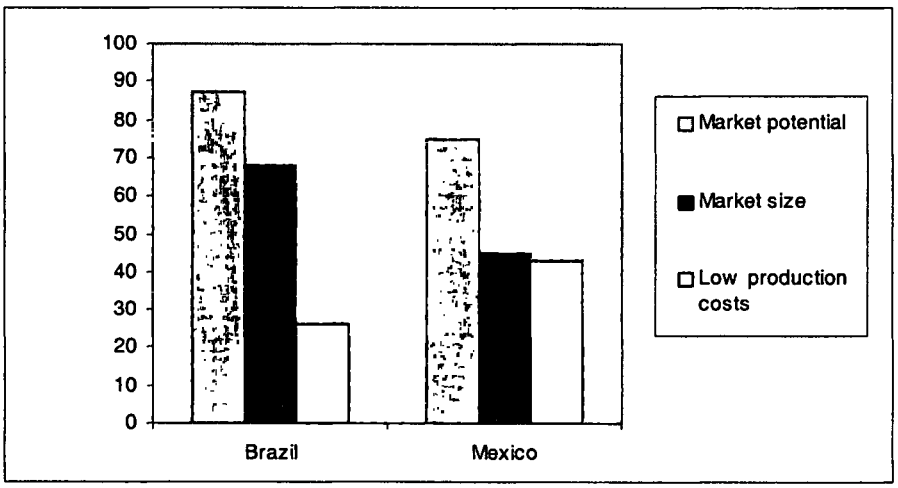
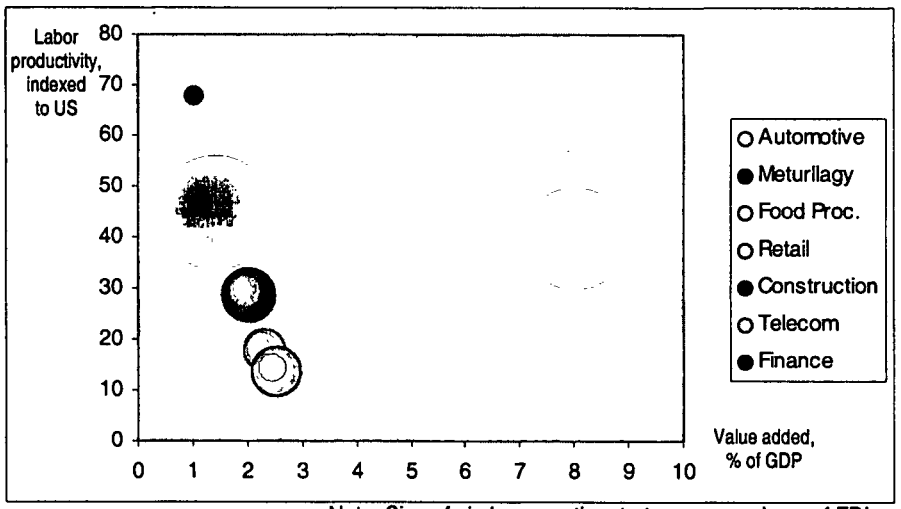
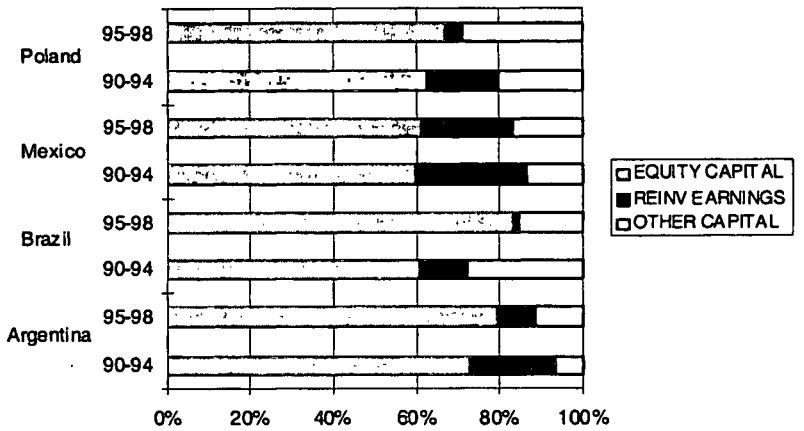


Figure A26. Sector breakdown of FDI inflow



Note: Size of circle proportionate to average share of FDI
Source: McKinsev(1998). World Bank SIMA

Figure A27. FDI component as share of total in select countries (period average)



Source: IMF Balance of Payments Statistics

Figure A28. AT Kearney – Top Decision-Making Factors for Long Term Investment into LAC

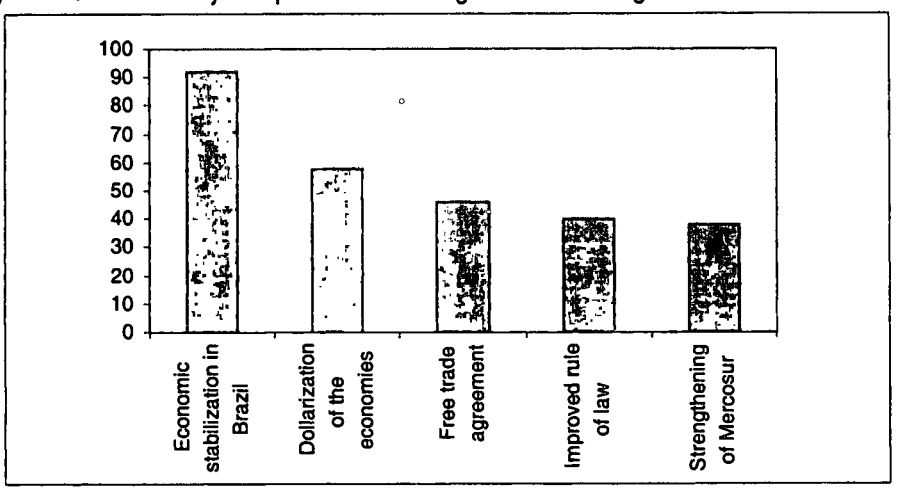
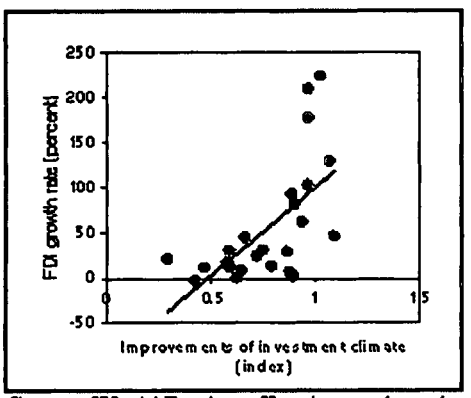
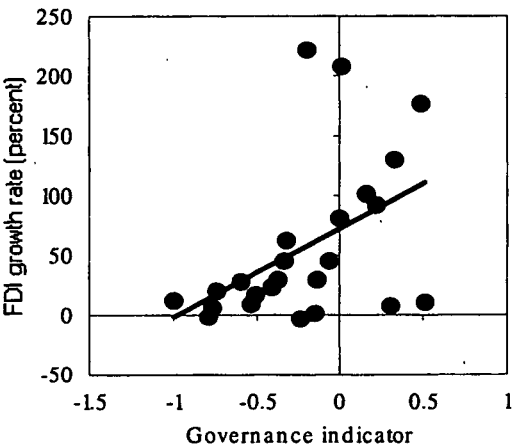


Figure A29. World Bank Global Development Finance (GDF)



Source: World Bank staff estimates based on European



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