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# Capital Mobility in Developing Countries: Some Measurement Issues and Empirical Estimates

Peter J. Montiel

*A fundamental determinant of the macroeconomic properties of an economy is its degree of financial integration with the outside world. Yet very little is known about this characteristic of many developing economies. An important stumbling block in the empirical assessment of financial integration is the multiplicity of approaches to measurement. This article describes and evaluates alternative tests of capital mobility and applies four such tests to assess the degree of integration with external financial markets exhibited by a large group of developing countries in recent years. The evidence suggests that a substantial number of developing countries can be considered financially open.*

An economy is financially open when its residents are able to trade financial assets with residents of another country. The degree of financial openness, however, is a somewhat amorphous concept, not clearly defined in many applications and difficult to measure. This is unfortunate because analytical models suggest that the nature of the relationship between domestic and world financial markets (also referred to as the degree of capital mobility) is one of the key characteristics of any economy, serving as a fundamental determinant of many of its most basic macroeconomic properties.

Residents of different political jurisdictions may issue financial assets of many types. As in the case of goods, such assets may be traded or nontraded and, if traded, may or may not be close substitutes for foreign assets of the corresponding type. Assets may become nontraded for a variety of reasons, including the existence of transaction costs in trading assets across political jurisdictions, as well as the presence of information costs, coupled with asymmetric information between domestic and foreign agents. In addition, and particularly in the case of developing countries, legal barriers to trading assets (capital controls), both those already in place and (separately) prospective future barriers, play roles similar to quotas in goods markets. Asymmetric political risks or taxes borne by domestic and foreign investors may also inhibit arbitrage.

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Intuitively, a high degree of financial integration exists when traded assets are close substitutes in private portfolios for their foreign counterparts and when either a large proportion of domestic financial assets are traded, or traded assets are close substitutes for assets that are not traded. In such cases, prices of domestic assets are closely linked with prices of world assets and, at least for small countries, domestic asset prices would not be affected by domestic excess demands or supplies of specific types of financial assets.

Most of the existing literature on financial integration—both for industrial and for developing countries—fails to address explicitly the scope of traded assets in particular economies or the strength of domestic arbitrage links between traded and nontraded assets. Instead, the focus has been on assessing the nature of arbitrage between domestic and foreign assets of the same type. Even in this partial context, however, it may be useful to distinguish between weak and strong financial integration.

The former refers to a situation in which the law of one price holds for individual financial assets—that is, domestic and foreign residents trade identical assets at the same price. This situation implies the absence or relative unimportance of the barriers listed above. However, it leaves room for assets issued in one political jurisdiction to be imperfect substitutes in all private portfolios with otherwise identical assets issued in a different one, as well as for differences in preferences between domestic and foreign agents as to the composition of their portfolios. Strong financial integration, by contrast, would prevail when identically defined assets (for example, a six-month Treasury bill) issued in different political jurisdictions and denominated in different currencies are perfect substitutes in all private portfolios. This would imply that the relative rates of return on such assets would be unaffected by their relative supplies. Under these circumstances, of course, any scope for differences in preferences between domestic and foreign portfolio managers is eliminated.

Economies that exhibit strong financial integration have very different macroeconomic properties from those that exist in financial autarky. The macroeconomic consequences of strong financial integration are typically derived on the usual assumption that all domestic interest-bearing assets are perfect substitutes (so the distinction between traded and nontraded assets can be ignored). Five macroeconomic implications of strong financial integration are especially important.

First, changes in excess supplies and demands of assets in a small economy have no influence on the world prices of the assets. Thus, shocks to domestic saving and investment schedules, which affect the domestic flow of excess supply and demand for financial assets, leave unchanged the rates of return on assets confronting domestic agents. In particular, changes in domestic investment do not affect the rates of return on assets available to domestic savers, and changes in domestic saving do not affect the cost of capital for domestic firms.[1]

1. This statement needs to be interpreted with care. I mean it to imply only that domestic nominal interest rates are unaffected by such changes. As further discussion will show, real rates may well be affected.

Instead, increases in domestic investment are financed voluntarily by foreign private agents. Similarly, reductions in domestic saving simply decrease the country's rate of accumulation of foreign assets. The implication is that economic growth is not limited by a scarcity of domestic saving. It follows that policy measures to promote saving do not increase domestic investment but merely reduce the current account deficit.

Second, as is well known, the effects of domestic fiscal and monetary policies on aggregate demand also depend on the extent to which the economy is financially integrated with the rest of the world. Under the fixed (or predetermined) exchange rate regime that characterizes most developing countries, strong financial integration implies that in a small economy neither fiscal nor monetary policy can influence the terms for domestic borrowing and lending.

Third, the economy's steady-state inflation rate may be affected by the extent of its integration with world capital markets. The revenue that a government can collect from the inflation tax depends on the stock of base money and on the elasticity of base money demand with respect to the rate of inflation. Given the revenue to be raised through the inflation tax, the smaller the stock of base money and the higher its elasticity with respect to the rate of inflation, the higher the steady-state inflation rate. Even under weak financial integration, domestic agents have more means at their disposal to escape an inflation tax (for example, by taking capital abroad) than when the economy is financially closed. This is likely to increase the elasticity of base money demand, implying that the inflationary consequences of a given fiscal deficit are magnified.

Fourth, taxes on capital more generally become problematic under a situation of high capital mobility because the taxes can be evaded by taking funds out of the country. With high capital mobility, the taxation of capital would leave the domestic economy with a suboptimal capital stock because owners of capital would require an after-tax rate of return in the domestic economy equal to the pre-tax return available externally.

Fifth, interest rate policy in repressed economies, in which domestic interest rates are subject to binding legal restrictions, is affected by the implications of financial openness. The pursuit of positive real interest rates in a closed economy in which the domestic marginal product of capital is the relevant opportunity cost of funds may easily be frustrated by capital inflows if the economy is sufficiently open.

These macroeconomic implications of strong financial integration are well known, but not much has been done to assess where developing countries may lie along the spectrum from effective financial autarky to strong financial integration. Although the vast majority of developing countries maintain controls on capital movements (see IMF 1991), the effectiveness of the controls is often questioned, and the view is widespread that the mere existence of these controls does not justify treating these economies as financially closed.

The issue addressed here is whether existing empirical approaches to the measurement of capital mobility can be applied to developing countries. Section I

briefly discusses some conceptual issues associated with alternative approaches to the measurement of financial integration and summarizes the evidence from existing empirical studies of financial integration in developing countries. Section II presents the results of applying the empirical techniques to a large developing-country sample. Section III offers conclusions.

## I. The Measurement of Capital Mobility

Perhaps one reason for the ambiguity that surrounds the empirical degree of financial integration that characterizes developing economies is that no single approach to its measurement has become widely accepted. Several empirical methods have been applied, either formally or informally, to measure capital mobility. These include measures of the magnitude of gross capital flows, the degree to which a variety of arbitrage conditions are satisfied, the scope for sterilization of the effects of reserve movements on the domestic money supply, saving-investment correlations, and, more recently, tests based on the Euler equation for the path of optimal consumption. This section describes these measures, treats some conceptual issues that arise in their application, and summarizes the evidence on financial integration in developing countries.

### *The Magnitude of Capital Flows*

Many economists have a strongly held belief that industrial countries are, or at least have recently become, highly integrated financially. This belief is at least partly based on the observation that gross financial flows among industrial countries are very substantial. Golub (1990) cites the examples of Feldstein (1983: 150), Caprio and Howard (1984: 4), Obstfeld (1986a: 70), and Penati and Dooley (1984: 7). But the size of gross flows is often taken to be an imperfect indicator of the degree of financial integration. The reason is that although capital flows would indeed be zero under financial autarky, they need not necessarily occur between strongly integrated financial markets. Continuous equalization of the prices of financial assets would remove the incentives for capital movements.

Nevertheless, there are at least two reasons to expect that a country enjoying a high degree of financial integration with the rest of the world should, on average, experience large gross capital flows. First, in markets that are strongly integrated, the geographic locations of the parties on the two sides of a financial transaction are indeterminate. Thus, borrowing and lending by domestic residents should frequently cross international boundaries.[2] Second, although changes in international rates of return should quickly be reflected in domestic rates under such conditions, preservation of portfolio equilibrium for domestic

2. This insight formed the basis for an empirical test (Golub 1990) for capital mobility among industrial countries.

residents in response to such changes will typically require net capital flows. For example, in response to a change in world interest rates, the preservation of domestic monetary equilibrium under fixed exchange rates would be achieved through capital flows unless effects on the demand for money were accommodated by the domestic monetary authority.

The gross-flow evidence, which unfortunately is available only for the indebted major developing countries, indicates that these countries have exhibited a substantial amount of at least de facto financial openness. (See Calvo, Leiderman, and Reinhart 1992; Rojas-Suarez 1990; Montiel 1993; Cuddington 1986; and Dooley 1988.)

### *Interest Parity Conditions*

The degree of financial integration has typically been assessed not in terms of the size of either gross or net capital flows between jurisdictions but by the extent to which expected returns are equalized between domestic and foreign assets of the same type. The equalization of returns can be measured by simple interest arbitrage (for assets of the same type, denominated in different currencies but issued in the same political jurisdiction), covered interest parity (for assets of the same type, issued in different political jurisdictions but with forward cover for exchange risk), uncovered interest parity (for assets of the same type, issued in different jurisdictions without forward cover), and real interest parity (for testing the equalization of expected real returns across similar assets issued in different jurisdictions). For present purposes, comparisons of simple and real interest parity are not of direct relevance. Because the former is restricted to the same political jurisdiction, it has nothing to say about capital mobility per se, whereas the latter confounds financial with goods market integration. Covered interest parity, by contrast, is of limited empirical relevance for most developing countries because forward markets exist for very few developing-country currencies.

Uncovered interest parity (UIP) is thus the most relevant interest parity measure for the majority of developing countries.[3] It consists of the assertion that arbitrage equalizes expected returns on domestic and foreign assets of the same type:

$$(1) \qquad (1 + i_t) = E_t[(1 + i_t^*)\, s_{t+1}/s_t]$$

where $i_t$ and $i_t^*$ are the domestic and foreign interest rates respectively, $s_t$ is the domestic-currency price of foreign exchange (equal to $s_{t+1}$ next period), and $E_t$ is the expectations operator. The asset in question in this example is taken to be

3. For applications, see Lizondo (1983) and Khor and Rojas-Suarez (1991) for Mexico; Phylaktis (1988) and Dooley and Isard (1980) for Argentina; Edwards and Khan (1985) for Colombia and Singapore; Reisen and Yeches (1991) for the Republic of Korea and Taiwan (China); Robinson, Byeon, and Teja (1991) for Thailand; Faruqee (1991) for several Pacific Basin countries; and Haque and Montiel (1991) for several developing countries.

a nominally safe asset. Yet, because of political and currency risk, $i_t^*$ and $s_{t+1}$ are both random.

In equation 1, the expected value of $(1 + i_t^*)s_{t+1}/s_t$ is not observable. Testing UIP thus requires making an ancillary assumption about how the unobservable subjective expectations of future returns on foreign-currency assets are formed. With rational expectations, $E_t[(1 + i_t^*)s_{t+1}/s_t]$ becomes the expectation of the true distribution of $(1 + i_t^*)s_{t+1}/s_t$, conditioned on the available information. Under these circumstances, $(1 + i_t^*)s_{t+1}/s_t = E_t[(1 + i_t^*)s_{t+1}/s_t] + e$, where the prediction error, $e$, must be a mean-zero random variable. The contents of the information set used to form the expectation $E_t[(1 + i_t^*)s_{t+1}/s_t]$ depend on the efficiency of the foreign exchange market. If the market is weakly efficient, the information set must contain at least the past prediction errors (that is, lagged values of $e$). Under these circumstances, $e$ must be serially uncorrelated. Now consider the ex post return differential, $d_t$, given by

$$d_t = (1 + i_t) - (1 + i_t^*)s_{t+1}/s_t. \tag{2}$$

Under the null hypotheses of UIP and rational expectations, $d_t$ is the negative prediction error. Thus the joint hypothesis can be tested by examining whether $d_t$ has a zero mean and is serially uncorrelated.

Several conceptual and empirical complications arise in applying tests of uncovered interest parity. First, differences in rates of return between otherwise identical assets issued in different political jurisdictions are consistent with weak financial integration, so interest parity tests are tests of strong financial integration. Weak financial integration between two countries means that a given financial asset is traded at the same price by residents of both countries so that no profitable arbitrage opportunities remain. Thus, the degree of financial integration can, in principle, be measured as the difference between the prices of identical assets in the two countries. However, the identification of identical assets in different political jurisdictions is not a trivial matter. If an asset is defined by the probability distribution of its prospective returns, then the requirement that two assets are identical, that is, that they offer the same payoff in all states of the world, is very stringent. If the distributions of prospective payoffs for the two assets differ in their second moments, they would probably not be priced so as to yield the same expected rate of return, even in perfectly integrated financial markets, unless agents were risk-neutral.

Second, there is a wide range of assets in each jurisdiction. Arbitrage tests may hold for some assets but not for others. If transaction costs differ across assets, then those assets with the largest transaction costs may effectively be nontraded. Alternatively, some assets (for example, equities) may be more idiosyncratic than others and thus may be less similar to their foreign counterparts. Prices of such assets would fail parity tests, although other domestic assets may pass.

Third, and more fundamental, an operationally meaningful measure of financial integration must focus on the scope for domestic variables to affect the

prices of domestic financial assets, rather than on the validity of restrictions derived from arbitrage considerations. These notions are conceptually distinct. The interpretation of the failure of UIP for industrial countries, for example, remains controversial. The failure may arise from a nonconstant (time-varying) risk premium. The premium could be consistent with strong financial integration, as long as the assets are perfect substitutes after the premium is taken into account. Alternatively, systematic differences in rates of return on otherwise similar assets denominated in different currencies and issued in different political jurisdictions could respond to changes in the relative supplies of such assets. This "imperfect substitutes" case is inconsistent with strong financial integration. In general, the policy implications of the failure of parity conditions depend on the source of the failure.

In addition to these conceptual problems, tests of UIP encounter some empirical complications. One complication is that because the expected future exchange rate is unobservable, tests of UIP are of necessity tests of joint hypotheses, combining equalization of expected returns with a hypothesis about expectations formation. Rejection of the joint hypothesis can arise if either component fails. A second empirical difficulty is associated with the "peso problem" (Krasker 1980). When the exchange rate is fixed, but market participants perceive a finite probability of a discrete devaluation that does not in fact take place during the sample period, the observed forward rate will systematically exceed the future spot rate even if it truly reflects the expected future spot rate. In this case, the null hypothesis (of unbiasedness) will tend to be rejected, even when true, more often than the investigator intends.[4]

### *Tests of Monetary Autonomy*

One of the important policy implications of strong financial integration under fixed exchange rates is that monetary policy becomes powerless to affect aggregate demand. Essentially this is because the domestic monetary authorities lose control over the money supply. Changes in the domestic assets of the central bank (for example, through open market operations) intended to influence the money stock would create incipient changes in the rates of return on domestic assets. But these changes would not in fact materialize, because they would quickly be arbitraged away through foreign borrowing and lending. In the process, the central bank's net foreign assets would change by an amount equal in magnitude but opposite in sign to the triggering change in the central bank's domestic assets, leaving the stock of high-powered money and the total money supply unchanged. This result would not hold if domestic and foreign interest-bearing assets were imperfect substitutes, because then changes in the relative supplies of such assets in private portfolios would affect their relative rates of return. In this case, changes in the domestic assets of central banks could, by

4. Strictly speaking, the difficulty here is not bias, but a small-sample problem. The problem is that the sampling distribution for the hypothesis that $d = 0$ converges very slowly to its limiting distribution under the conditions postulated, so statistical tests based on the asymptotic distribution result in Type I error.

changing the composition of outside assets in private portfolios, alter domestic interest rates and achieve changes in the domestic money stock.

Tests of monetary autonomy are not feasible to perform for large groups of countries, because the tests require the construction of structural models of each country's financial sector. However, analysts have applied tests of monetary autonomy to several developing countries (see Cumby and Obstfeld 1984 for Mexico; Rennhack and Mondino 1988 for Colombia; Bini Smaghi 1982 for Malaysia; Boschen and Newman 1989 for Argentina; and Montiel 1989 and Dowla and Chowdhury 1991 for other developing countries).

*Saving-Investment Correlations*

Consider a small country that produces a single good and that is perfectly integrated with world goods markets as well as integrated in the strong sense with world financial markets. As previously suggested, changes in domestic saving should have no effect on the rates of return faced by domestic agents, because these rates are determined in the world capital market and accordingly should not affect domestic investment. Based on this insight, Feldstein and Horioka (1980) proposed assessing the degree of financial integration in the world economy by measuring the extent to which national saving and investment rates are correlated. They estimated cross-section regressions of the form

$$(I/Y)_i = a + b(S/Y)_i + e \tag{3}$$

where $(I/Y)$ is the ratio of gross domestic investment to gross national product (GNP), and $(S/Y)$ is the ratio of national saving to GNP. Feldstein and Horioka argued that, under the null hypothesis of perfect financial integration, $b$ should be zero for small countries. For large countries, $b$ should approximate the country's share of the world capital stock, because any increment in domestic saving should be invested without regard to national boundaries.

An attractive feature of this test is that by focusing directly on a macroeconomic implication of strong financial integration, it does not face the problem of asset heterogeneity associated with tests of parity conditions for individual asset types. However, tests of saving-investment correlations have proven to be a very controversial approach to the measurement of financial integration, because Feldstein and Horioka's original estimates of $b$ were close to the high value of 0.9. Feldstein and Horioka interpreted that value as consistent with a low degree of financial integration among industrial countries during the 1970s, a view in direct opposition to what had become the conventional wisdom. Feldstein and Horioka's findings for industrial countries have been confirmed in broad terms by many other researchers who used different samples and different empirical techniques. At best, other investigators have been able, in certain samples, to detect values of $b$ statistically different from the autarky value of unity, but the point estimates of $b$ continue to be relatively high, even among industrial countries with few formal barriers to capital movements.

Although Feldstein and Horioka's empirical findings have proven difficult to refute, their interpretation of the evidence as suggesting that industrial countries

are much less integrated financially than is commonly believed has not been generally accepted. A conceptual problem with their approach is that although zero capital mobility implies that $I/Y$ and $S/Y$ would be highly correlated, the converse is not true—national saving and investment rates could be highly correlated even if world financial markets are perfectly integrated in the sense defined previously. There are at least two ways that saving and investment could be correlated even if financial markets were well integrated, in the sense that uncovered interest parity (UIP) held exactly.

First, $I/Y$ and $S/Y$ could be correlated even if real interest parity also held, because they are both endogenous variables that respond to movements in common factors, both in time series and in cross-section. The source of this correlation differs, however, between time-series and cross-section applications. In time series, the correlation could be caused by any of the following:

- Both $I/Y$ and $S/Y$ could be functions of the state of the business cycle, that is, of a third variable, $Y/\overline{Y}$. In particular, both $I/Y$ and $S/Y$ are known to be procyclical. On analytical grounds, there is reason to believe that temporary real shocks to the productivity of domestic capital and labor, to the prices of imported inputs, or to world real interest rates would move domestic saving and investment in the same direction (Obstfeld 1986a).
- Governments could respond to incipient current account deficits (increases in $I/Y$ in relation to $S/Y$) by contracting fiscal policy to achieve a current account target. Taking national saving as the sum of private and public saving, this makes national saving endogenous through its public component (Summers 1988).
- The country in question could loom large in world financial markets. Shocks to national saving could thus affect world interest rates and through them domestic investment.
- The pattern of shocks to saving and investment in the country in question could closely replicate that of shocks to world saving and investment. Because the saving-investment correlation for the world as a whole must be unity, such countries would exhibit a high correlation of saving and investment.

In a cross-section context neither the first nor third explanation is relevant. However, national saving and investment rates may be functions of the country's long-run growth rate (Obstfeld 1986a). The dependence of national saving on the rate of growth is a direct and familiar implication of life-cycle consumption theory, whereas steady-state growth implies that $I/Y = (n + \delta)(K/Y)$, where $n$ is the population growth rate and $\delta$ is the rate of capital depreciation. If the capital-output ratio $(K/Y)$ depends on a real interest rate that is common to all countries, then $(I/Y)$ is an increasing function of $n$.

Second, shocks that are specific to saving or investment would also give rise to a positive correlation between the two variables, even under UIP, because goods markets are not as well integrated as financial markets. Frankel (1986, 1992)

develops an argument that reconciles perfect financial integration as measured by tests of nominal interest parity with high saving-investment correlations. Suppose that UIP holds, but that a temporary exogenous increase in saving results in a temporary real exchange rate depreciation (that is, ex ante relative purchasing power parity fails, because the real exchange rate will be expected to appreciate in the future). Since, under UIP, this would cause the expected domestic real interest rate to fall, investment would rise, resulting in a positive correlation between saving and investment. Even a permanent saving shock could have this effect, if the initial real exchange rate depreciation overshot its long-run level.

To the extent that saving-investment correlations arise from this second source, however, they may nevertheless provide evidence of the extent to which exogenous shifts in domestic saving or investment can induce changes in the other variable. As indicated in the introduction, this is one of the key policy issues motivating a concern with the degree of financial integration (see Dooley, Frankel, and Mathieson 1987; Summers 1988; Wong 1988; and Frankel 1986).

### *Euler Equation Test*

Obstfeld (1986a) proposed a test that is an alternative both to arbitrage conditions and to saving-investment correlations as measures of the degree of financial integration among countries. This test is based on the Euler equation that characterizes the optimal intertemporal behavior of consumption. The test attempts to detect whether residents of different political jurisdictions have access to the same risk-free asset.

For domestic residents, the Euler equation for optimal intertemporal consumption plans is

$$U'(c_t) = E_t[\beta U'(c_{t+1})(1 + i_t) P_t / P_{t+1}], \tag{4}$$

which can be written as

$$E_t[(P_t / P_{t+1}) \beta U'(c_{t+1}) / U'(c_t)] = 1/(1 + i_t) \tag{5}$$

for each period $t$. Here $c$ denotes real per capita consumption, $\beta$ is a subjective discount factor, $P$ is the domestic price level, and $i$ is the riskless interest rate. The corresponding condition for foreigners is

$$E_t[(s_t P_t^* / s_{t+1} P_{t+1}^*) \beta^* U^{*\prime}(c_{t+1}^*) / U^{*\prime}(c_t^*)] = 1/(1 + i_t) \tag{6}$$

where $s$ is the nominal exchange rate and asterisks denote foreign variables, but where the same risk-free rate $i$ applies. Equations 5 and 6 imply that the expected marginal rates of substitution between current and future units of the domestic currency must be equal for foreign and domestic residents. To test this, Obstfeld assumes that domestic and foreign residents have the same utility function and that utility takes the constant relative risk-aversion form

$$U(c_t) = (1/1 - a) c_t^{1-a}. \tag{7}$$

Under these circumstances, the difference between the marginal rates of substitution between current and future units of the domestic currency, denoted $n$, is given by:

$$n_t = \left(\frac{c_t}{c_{t+1}}\right)^a \left(\frac{P_t}{P_{t+1}}\right) - \left(\frac{c_t^*}{c_{t+1}^*}\right)^a \left(\frac{S_t P_t^*}{S_{t+1} P_{t+1}^*}\right) \tag{8}$$

and the equality of the expected marginal rates of substitution becomes

$$E_t n_t = 0. \tag{9}$$

In other words, $n_t$ should be expected to be zero based on information available before it is observed; that is, no variable contained in the information set available prior to the present period should help to predict the current value of $n$.

This test possesses several features that make it more attractive than the tests considered above. Unlike tests of nominal interest parity, the Euler equation test does not require comparisons between rates of return on what might be dissimilar assets. Unlike tests of real interest parity, the null of strong financial integration would not be rejected because of a failure of ex ante relative purchasing power parity. Furthermore, unlike the Feldstein-Horioka tests, it is not vulnerable to indirect sources of saving-investment correlations. Moreover, it focuses specifically on what is meant by weak financial integration—that is, that residents in different political jurisdictions be able to trade the same asset on the same terms.

The disadvantage of the Euler equation test, of course, is that restrictive assumptions are required to implement it. The underlying consumption model must be correct for both countries, and cross-country differences in utility functions must be negligible. Because the test therefore embodies multiple hypotheses, rejections may be difficult to interpret. Finally, as in the case of arbitrage tests, statistically significant rejections may not be economically important if $n_t$ is small on average.

## II. Empirical Estimates of Financial Integration in Developing Countries

According to IMF (1991), of 136 IMF-member developing countries, 113 were classified as maintaining formal restrictions on capital-account transactions. Yet, in spite of the controls, the existing evidence for developing countries suggests that few, if any, of them can be considered financially closed. For the majority of developing countries, however, either formal tests of financial integration have not been conducted or only very limited evidence is available. A survey of existing evidence is presented in Montiel (1993). Saving-investment correlations and consumption-based tests have simply not made their way to the developing-country literature. The bits and pieces of evidence on financial integration that exist for developing countries do not lend themselves to drawing systematic conclusions for any but a very few countries. Existing tests have been applied in limited fashion, over disparate periods of time, and use very different

methodologies. To gain a more comprehensive perspective, it is desirable to unify this piecemeal evidence by applying the existing approaches to the measurement of financial integration in a uniform fashion to large samples of developing countries over similar periods of time.

In this section, I apply four of the tests described previously to measure capital mobility during the 1980s in a large number of individual developing countries. The samples in each case are comprised of the largest groups of developing countries for which the relevant data could be acquired conveniently. The four tests consist of measures of gross capital flows, saving-investment correlations, tests of arbitrage conditions, and Euler equation tests. In view of the discussion in section I, these are listed, at least conceptually, in order of increasing reliability as indicators of the degree of financial integration in the sense defined here. All of these tests have shortcomings of varying degrees of severity. By using a battery of tests, the hope is that a coherent picture may emerge for some countries, although each test individually may provide a noisy indicator. Some problems, however, apply to more than one test. Particularly important for the last three regression-based tests, the degree of capital mobility is treated as constant over the period of estimation. Thus, recent changes in financial openness cannot be captured by measures of this sort.

### *Gross Capital Flows*

The first measure to be constructed consists of the value of capital transactions in the balance of payments (average of inflows and outflows) expressed as a fraction of gross domestic product (GDP). This is analogous to measures of commercial openness derived by expressing the sum (or the average) of exports and imports as a ratio to GDP. This measure has the conceptual problem associated with measures of gross flows described in section I and has some very substantial empirical problems.

In particular, the gross capital flow measure could be very sensitive to the level of aggregation at which it is constructed, that is, to the degree of "netting out" in published balance of payments data. To the extent that published data are reported on a net basis, of course, the size of gross flows will be understated, and differences among countries in the size of such flows underlying the net data will distort cross-country comparisons. This would be a problem, for example, where annual balance of payments data record changes in gross stocks during the course of the year, rather than all the transactions that took place during the year. Nevertheless, gross capital flows may be worth examining as the only available indicator of the volume of capital-account transactions for developing countries. To the extent that reported capital-account transactions in the balance of payments reflect the true underlying volume of transactions, this indicator has the dual virtues of serving as a (crude) check on prior beliefs, both across countries and over time, and of being able to be constructed year by year.

Table 1 reports the ratios of trade and capital flows to GDP for eighty-eight developing countries. The second column gives the average ratio of the mean

value of capital inflows and outflows to GDP from 1980 to 1989 (the last year for which data were available for a large group of countries). An interesting contrast emerges between capital and commercial flows. The standard measure of commercial openness (the ratio of the average value of exports and imports of goods and services to GDP) is reported in the first column. Commercial flows are much larger for almost all countries in this group than are reported capital flows.[5] Commercial flows amounted to almost 45 percent of GDP for the group as a whole, whereas capital flows represented only 12 percent of GDP. By this measure, then, developing countries would seem to be much less open financially than they are commercially. However, this conclusion is not warranted, because the "netting out" problem described above does not apply to commercial transactions, implying that the two measures are not directly comparable.

Little movement in the direction of increased financial openness is evident in these data. For most countries, the capital flow ratio exhibits little change in the years from 1984 to 1986 (third column) and from 1987 to 1989 (fourth column). The slight increase in the average between these periods for the group as a whole is largely accounted for by the extreme values reached in Panama during the latter period.

The distribution of capital flow ratios for the countries listed in table 1 is skewed to the right. Eight countries exhibit ratios in excess of 20 percent; thirteen countries in the range below 20 but above 15 percent; fifteen countries below 15 but above 10 percent; thirty-nine countries between 5 and 10 percent; and the remaining thirteen countries below 5 percent. Panama and India are at the extremes of the distribution, with capital flows substantially exceeding GDP in Panama and amounting to only about 1.5 percent of GDP in India.

The group of countries that registered capital flows in excess of a fifth of their GDP included—in addition to Panama—Antigua, Congo, Costa Rica, Jamaica, Nicaragua, São Tomé and Principe, and Singapore. The inclusion of Singapore in this group is consistent with evidence from existing studies of a high degree of financial integration for this country. But neither Malaysia nor Guatemala, which also appear highly integrated with external financial markets on the basis of independent evidence, scored very high on this particular index of openness. Both of these countries were in the modal range of 5 to 10 percent. For several countries in the modal range, independent evidence reviewed in Montiel (1993) is suggestive of an intermediate degree of capital mobility. If this range is used as a benchmark for an intermediate degree of integration, and the gross capital flow ratio is used as an indicator, the overwhelming majority of countries in the sample exhibit at least an intermediate degree of integration with external financial markets. The exceptions are the Bahamas, Bangladesh, Burkina Faso, Haiti, India, Indonesia, Pakistan, Rwanda, South Africa, Sudan, Suriname, and Tonga, where gross flows represented less than 5 percent of GDP.

5. The sole exception is Nicaragua, a country undergoing a civil war for much of this period.

Table 1. *Ratios of Trade and Gross Capital Flows to GDP, 1980–89*
(annual average in percent)

| Country | Trade ratio 1980–89 | Capital flow ratio 1980–89 | 1984–86 | 1987–89 |
|---|---|---|---|---|
| Algeria | 24.94 | 7.34 | 6.22 | 9.01 |
| Antigua | 99.72 | 20.21 | 19.09 | 19.89 |
| Bahamas, The | 70.84 | 3.84 | 3.54 | 3.00 |
| Bahrain | 115.94 | 11.18 | 9.53 | 12.09 |
| Bangladesh | 13.41 | 3.79 | 3.77 | 3.57 |
| Barbados | 62.48 | 8.08 | 7.38 | 6.58 |
| Bolivia | 29.46 | 16.67 | 18.10 | 11.26 |
| Botswana | 88.73 | 10.02 | 11.02 | 9.07 |
| Brazil | 11.75 | 7.77 | 9.60 | 6.94 |
| Burkina Faso | 21.74 | 4.45 | 4.92 | 5.01 |
| Cape Verde | 44.15 | 6.38 | 7.83 | 4.20 |
| Central African Republic | 29.73 | 6.31 | 8.37 | 3.41 |
| Chad | 25.02 | 5.46 | 6.31 | 8.80 |
| Chile | 32.03 | 16.70 | 24.18 | 13.63 |
| Colombia | 17.88 | 5.89 | 7.55 | 6.25 |
| Congo | 59.48 | 31.64 | 32.43 | 32.80 |
| Costa Rica | 41.29 | 20.28 | 17.03 | 14.86 |
| Côte d'Ivoire | 40.56 | 15.07 | 14.15 | 17.58 |
| Cyprus | 58.85 | 9.59 | 9.74 | 10.10 |
| Dominica | 54.25 | 8.85 | 8.04 | 13.12 |
| Dominican Republic | 31.21 | 6.63 | 5.72 | 5.55 |
| Ecuador | 28.07 | 19.73 | 20.49 | 20.32 |
| Egypt | 33.16 | 8.55 | 7.52 | 7.62 |
| El Salvador | 28.92 | 7.67 | 7.31 | 5.46 |
| Ethiopia | 17.34 | 4.10 | 4.44 | 5.02 |
| Fiji | 51.18 | 8.10 | 6.69 | 8.56 |
| Gabon | 54.63 | 15.93 | 16.25 | 21.05 |
| Gambia, The | 61.39 | 17.02 | 19.78 | 17.45 |
| Ghana | 20.55 | 6.74 | 7.98 | 7.11 |
| Grenada | 68.46 | 10.14 | 7.90 | 14.47 |
| Guatemala | 18.80 | 6.66 | 6.93 | 8.28 |
| Guinea-Bissau | 28.82 | 18.07 | 21.59 | 31.36 |
| Haiti | 22.25 | 3.63 | 3.80 | 3.12 |
| Honduras | 34.01 | 10.06 | 9.59 | 10.87 |
| India | 8.49 | 1.50 | 1.51 | 2.31 |
| Indonesia | 25.99 | 4.96 | 4.45 | 7.15 |
| Israel | 45.94 | 12.90 | 11.86 | 10.39 |
| Jamaica | 60.91 | 24.39 | 33.61 | 22.81 |
| Kenya | 29.16 | 5.99 | 5.50 | 6.51 |
| Korea | 38.57 | 5.42 | 5.27 | 4.25 |
| Kuwait | 68.68 | 19.47 | 20.07 | 19.98 |
| Lesotho | 131.66 | 15.87 | 13.09 | 17.32 |
| Libya | 41.53 | 5.38 | 2.32 | 10.01 |
| Madagascar | 19.22 | 10.76 | 9.63 | 14.45 |
| Malaysia | 62.43 | 9.10 | 10.10 | 8.88 |
| Mali | 28.59 | 6.73 | 7.57 | 8.25 |
| Mauritania | 61.36 | 17.91 | 19.33 | 16.83 |
| Mauritius | 59.00 | 7.04 | 6.78 | 7.38 |
| Mexico | 17.40 | 9.01 | 9.05 | 6.98 |
| Morocco | 28.09 | 7.23 | 6.86 | 5.56 |
| Nicaragua | 29.76 | 29.48 | 23.61 | 38.03 |
| Niger | 26.29 | 8.77 | 9.44 | 7.18 |
| Nigeria | 21.37 | 9.22 | 6.65 | 20.18 |
| Pakistan | 18.45 | 3.58 | 3.46 | 4.58 |

| Country | Trade ratio 1980–89 | Capital flow ratio 1980–89 | 1984–86 | 1987–89 |
|---|---|---|---|---|
| Panama | 154.22 | 140.16 | 78.85 | 186.53 |
| Papua New Guinea | 51.33 | 12.99 | 11.06 | 9.70 |
| Paraguay | 25.35 | 8.48 | 8.29 | 11.00 |
| Philippines | 28.51 | 7.94 | 9.77 | 6.09 |
| Rwanda | 16.49 | 3.34 | 3.38 | 3.42 |
| São Tomé and Principe | 51.79 | 23.60 | 33.49 | 14.25 |
| St. Kitts and Nevis | 75.00 | 15.03 | 12.99 | 18.79 |
| St. Lucia | 75.10 | 11.81 | 8.43 | 11.64 |
| St. Vincent | 79.43 | 6.77 | 5.88 | 9.25 |
| Saudi Arabia | 58.02 | 12.08 | 11.09 | 10.54 |
| Senegal | 39.88 | 11.36 | 10.83 | 9.36 |
| Seychelles | 74.92 | 11.75 | 13.55 | 11.00 |
| Sierra Leone | 21.08 | 12.05 | 13.95 | 12.35 |
| Singapore | 191.48 | 21.15 | 22.99 | 23.07 |
| Somalia | 41.09 | 12.38 | 11.77 | 16.33 |
| South Africa | 30.22 | 2.88 | 3.25 | 1.71 |
| Sri Lanka | 35.56 | 9.15 | 9.14 | 10.37 |
| Sudan | 15.06 | 4.28 | 3.32 | 3.98 |
| Suriname | 48.20 | 4.21 | 3.11 | 6.97 |
| Swaziland | 99.46 | 13.74 | 13.48 | 19.17 |
| Syrian Arab Rep. | 23.94 | 6.19 | 5.45 | 8.26 |
| Tanzania | 20.06 | 9.57 | 13.47 | 12.70 |
| Thailand | 31.48 | 6.20 | 6.45 | 6.04 |
| Togo | 53.65 | 17.40 | 16.20 | 14.12 |
| Tonga | 53.54 | 4.62 | 3.97 | 3.13 |
| Trinidad and Tobago | 40.97 | 7.67 | 6.33 | 10.79 |
| Tunisia | 42.59 | 9.05 | 8.65 | 9.25 |
| Turkey | 20.71 | 6.36 | 7.24 | 7.01 |
| Uganda | 22.18 | 10.03 | 8.02 | 12.03 |
| Uruguay | 25.04 | 8.04 | 4.57 | 9.65 |
| Venezuela | 26.29 | 6.48 | 3.36 | 9.04 |
| Western Samoa | 47.24 | 5.67 | 5.42 | 4.06 |
| Zaire | 25.30 | 9.29 | 8.11 | 12.28 |
| Zambia | 41.64 | 18.38 | 20.94 | 23.88 |
| Average | 44.89 | 11.90 | 11.27 | 13.12 |

*Note*: To calculate the capital flow value, the sum of all inflows and outflows, using the finest classification available to avoid netting, was divided by two and converted into domestic currency using the World Bank's Atlas exchange rate to smooth the effects of changes in exchange rates. This was then divided by GDP.

*Source*: Author's calculations based on data from IMF (various issues a) and World Bank (various issues).

### *Saving-Investment Correlations*

In spite of the interpretation problems posed by saving-investment correlations as indexes of capital mobility, it is useful to examine what information such correlations can provide about capital mobility in developing countries. Where the data are available, such correlations can be calculated at low cost. The coefficient $b$ derived from time-series estimates of Feldstein-Horioka regres-

Table 2. *Feldstein-Horioka Regressions for Developing Countries: Coefficient of the Saving Ratio, 1970–90*

| | *Ordinary least squares* | | | *Instrumental variables* | | |
|---|---|---|---|---|---|---|
| *Country* | *Levels* | *First differences* | *Error correction* | *Levels* | *First differences* | *Error correction* |
| Algeria | 0.68[a] | −0.14[b] | −0.01[b] | 0.89[a] | −0.22[b] | −0.13[b] |
| Argentina | 1.08[a] | 0.21[c] | 0.22[b] | 0.88[a] | 0.34[b] | 0.49 |
| Benin | 0.04 | 0.58[c] | 0.53[c] | 0.07 | 0.51[c] | 0.06 |
| Brazil | 0.58[c] | 0.13[c] | 0.12[c] | 0.27[b] | 0.39 | 0.21[b] |
| Burkina Faso | 0.69[a] | 0.58[c] | 0.37 | — | — | — |
| Burundi | 0.87[a] | 0.54[c] | 0.59[c] | 1.52[c] | 0.25 | 0.64 |
| Cameroon | 0.42[c] | 0.37[c] | 0.32[c] | 0.42[c] | 0.30[b] | 0.43[c] |
| Central African Republic | 0.71 | 0.19[b] | 0.32[c] | 1.24[a] | 0.39 | −0.30 |
| Chile | 0.51[c] | 0.63[c] | 0.52[c] | 0.40[b] | 0.30 | 0.65[a] |
| Colombia | 0.07 | 0.07 | −0.05 | 0.03[b] | 0.14[b] | −0.01[b] |
| Congo | 0.87[a] | 0.24 | 0.33 | 0.49[c] | 0.10[b] | 0.29 |
| Costa Rica | −0.28 | 0.09 | 0.09 | 0.57[a] | 0.45 | 0.93 |
| Côte d'Ivoire | 0.36 | 0.13 | 0.15 | 0.06[b] | −1.26 | −1.22 |
| Dominican Republic | 0.81[c] | 0.22[c] | 0.31[c] | 0.51[c] | 0.07 | 0.41 |
| Ecuador | 0.42[c] | −0.23 | −0.17 | 0.73[a] | −0.13[b] | 0.22[b] |
| Egypt | 0.43[c] | 0.44[c] | 0.54[c] | 1.07[a] | 0.73 | 0.60 |
| El Salvador | 0.29[c] | 0.06[b] | 0.22[b] | 0.50[c] | 0.26[b] | 0.29[b] |
| Fiji | 2.15[a] | 0.34[b] | 0.36[c] | −0.34 | 0.63 | 1.01 |
| Gabon | 0.05[b] | 0.38[c] | 0.35[c] | 0.50[c] | 0.14 | 0.19[b] |
| Gambia, The | 0.00[b] | −0.18[b] | −0.20[b] | −1.44 | −0.53[b] | −0.69[c] |
| Ghana | 1.07[a] | 0.18[b] | 0.51[c] | 1.25[a] | 1.05 | 4.43 |
| Guatemala | 0.23 | 0.40 | 0.34 | 0.54[c] | 0.22 | −0.08 |
| Haiti | 0.15[b] | 0.04[b] | 0.08[b] | −0.39 | 0.16[b] | 0.00[b] |
| Honduras | 0.53[c] | 0.69[a] | 0.59[a] | 0.80[a] | 1.18[a] | 0.50 |
| India | 1.02[a] | 0.99[a] | 0.97[a] | 1.45[a] | 0.43 | 0.24 |
| Indonesia | 0.82[a] | 0.23[b] | 0.20[b] | 1.37[a] | −0.04[b] | 0.23 |
| Israel | −0.18 | −0.01[b] | −0.12[b] | — | — | — |
| Jamaica | 0.28[b] | 0.09[b] | 0.16[b] | — | — | — |
| Kenya | 0.24 | 0.37[c] | 0.12[b] | −0.49[b] | −0.05[b] | −0.49[b] |
| Korea | 0.35[c] | 0.15[b] | −0.37[b] | 0.31[c] | 0.50 | 0.07[b] |
| Lesotho | −0.29[b] | 0.17[b] | 0.20[b] | −0.89[b] | −0.12[b] | −0.16 |
| Madagascar | 0.20[b] | −0.02[b] | −0.01[b] | −11.10[c] | 0.04 | 0.54 |
| Malawi | 0.79[a] | 0.65[a] | 0.39[b] | 0.59 | −0.35 | −0.65 |
| Malaysia | 0.24 | 0.11[c] | −0.06[b] | 0.41 | 0.08[b] | 0.08[b] |
| Mali | 0.22[c] | 0.82[a] | 0.11[c] | −0.35[b] | 0.11[b] | 0.09[b] |
| Malta | 0.62[c] | 0.65[c] | 0.80[c] | −0.10[b] | −0.68[b] | −0.61[c] |
| Mauritania | −0.06[b] | 0.40[c] | 0.50[c] | −0.43[b] | −0.45 | 0.86 |
| Mauritius | 0.56 | 0.37[c] | 0.50[c] | 0.43[b] | 0.35 | 0.11 |
| Mexico | 0.28[c] | 0.05[b] | 0.39[c] | 0.20[b] | 0.01[b] | 0.03[b] |
| Morocco | −0.13[b] | 0.37[c] | −0.05[b] | 0.48 | 0.36[b] | 0.35[b] |
| Nepal | 1.09[a] | 0.80[a] | 0.64[c] | 0.94[a] | 0.38[c] | 0.51[c] |
| Niger | 0.98[a] | −0.09[b] | 0.84[a] | 0.69[a] | 0.91[a] | 0.74[a] |
| Nigeria | 0.64[a] | 0.07[b] | −0.01[b] | 1.20[a] | 0.65[a] | 0.74[a] |
| Pakistan | 0.44[c] | 0.73[c] | 0.11[b] | 1.07[a] | 0.04[b] | 0.10[b] |
| Paraguay | 0.52[c] | −0.05[b] | −0.03[b] | 0.60 | −0.66[b] | 0.55[b] |
| Peru | 0.43[c] | 0.24[b] | 0.19[b] | 0.53 | 0.18[b] | 0.30[b] |
| Philippines | 1.16[c] | 0.56[c] | 0.45[c] | 1.04[a] | 0.49[c] | 0.67[c] |
| Rwanda | 0.47[c] | 0.02[b] | 0.13[b] | 1.05[a] | −0.41 | 0.37 |
| Senegal | 0.36[c] | 0.19[c] | 0.18[c] | 0.56[c] | −0.11[b] | −0.04[b] |
| Sierra Leone | 0.00[b] | 0.21[b] | 0.20[c] | −0.10[b] | −0.02[b] | −0.01[b] |
| Singapore | 0.06[b] | 0.08[b] | 0.17[b] | — | — | — |
| Sri Lanka | 0.73 | −0.08[b] | 0.01[b] | — | — | — |

| Country | Ordinary least squares | | | Instrumental variables | | |
|---|---|---|---|---|---|---|
| | *Levels* | *First differences* | *Error correction* | *Levels* | *First differences* | *Error correction* |
| Thailand | 0.72[c] | 0.62[c] | 0.55[c] | −0.53 | −0.11 | −0.30 |
| Togo | 0.17[b] | −0.08[b] | −0.05[b] | 0.33 | 0.06[b] | 0.22[b] |
| Trinidad and Tobago | 0.22[c] | −0.03[b] | −0.04[b] | — | — | — |
| Tunisia | 0.77[c] | 0.15[b] | 0.19[b] | 1.29[a] | 0.44 | 0.48[c] |
| Turkey | 0.47[c] | 0.41[c] | 0.41[c] | 1.01[a] | 0.55 | 0.45 |
| Uganda | 0.07[b] | −0.05[b] | 0.02[b] | 0.33[c] | 0.48 | 0.32[b] |
| Uruguay | 1.10[a] | 0.20[b] | 0.28[b] | 0.58 | 0.14[b] | 0.20[b] |
| Venezuela | 0.70[c] | −0.28 | −0.22[b] | 1.88[c] | 1.53[a] | 1.59[a] |
| Zambia | 0.54[c] | −0.23[b] | 0.01[b] | 0.81[a] | 0.42 | 0.71 |
| Zimbabwe | 0.56[c] | 0.64[c] | 0.66[c] | 1.72 | 0.36[b] | 0.40[b] |

— Not available.
a. Different from zero at the 5 percent level.
b. Different from one at the 5 percent level.
c. Different from both zero and one at the 5 percent level.
*Source*: Author's calculations based on data from World Bank (various issues).

sions at least represents a straightforward index of the degree of capital mobility, an index that can, in principle, be compared across countries.[6]

Table 2 presents the estimates of the coefficient of the saving ratio, $b$, derived from standard Feldstein-Horioka regressions. The first column presents the estimates in levels (that is, as in equation 8). Ordinary least squares (OLS) is used for a sample of sixty-two developing countries for which data on national saving and gross domestic investment were available in World Bank (various issues) from 1970 to 1990.[7] Of the sixty-two countries in the sample, eleven produced such imprecise estimates of $b$ that they could not be statistically distinguished from either zero or unity at the 95 percent confidence level. Of the remaining group, fourteen yielded estimates of $b$ that could not be statistically distinguished from the closed-economy value of unity, yet were different from zero at the 95 percent confidence level. By contrast, twelve countries were at the other extreme—that is, with $b$ not different from zero but distinguishable from one at the 95 percent confidence level. The remaining twenty-five countries were in an intermediate position. Using the small industrial-country value of 0.6 derived by Murphy (1984) as well as by Caprio and Howard (1984) as a benchmark, nineteen of the countries in the intermediate group produced point estimates of $b$ below what might be considered a "representative" industrial-country value. Thus, consistent with what has been found by others, the Feldstein-Horioka

6. Feldstein and Horioka regressions based on time-series data have not previously been reported for large samples of developing countries.

7. Although the focus here is on the decade of the 1980s, restricting the sample period to this decade would have left too few degrees of freedom.

methodology applied to this group of countries appears to suggest a surprisingly high degree of capital mobility in the majority of developing countries in this sample.

Moreover, one explanation for the high degree of correlation between national saving and investment rates in industrial countries has been the endogeneity of saving in OLS regressions. Thus the estimates above may be biased upward. To address this potential problem, the Feldstein-Horioka regressions were reestimated with instrumental variables, using the share of government consumption in GNP and (one minus) the population dependency ratio as instruments for the saving rate. The results are reported in the fourth column of table 2. Because data on the instruments were not available for some countries, the sample size in this case dropped to fifty-six. Surprisingly, the instrumental-variable correction did not seem to have the effect of reducing the estimated coefficient on the saving rate appreciably. Thirteen countries yielded estimates of $b$ that were too imprecise to be useful, and the remainder were approximately evenly split between those with $b$ not statistically different from unity (nineteen countries) and those with estimated values either not different from zero (twelve countries) or below the benchmark of 0.6 (nine countries).[8]

Several of the studies that have addressed the Feldstein-Horioka results for industrial countries have estimated regressions of investment on saving in first differences. These papers have not always provided a rationale for doing so, but a case can be made that this is indeed the appropriate procedure. To the extent that the reasoning underlying the test is valid, the results should hold as well in first differences, and rerunning the regressions in this form provides at the very least a test of robustness. Estimates of $b$ using first-difference regressions are reported in the second column for the OLS regressions and in the fifth column for the instrumental variable (IV) regressions in table 2. Casual inspection of these columns in comparison with the results of the regressions in levels suggests that the Feldstein-Horioka regressions do not pass the robustness test. Estimates of $b$ change sharply for individual countries in the majority of cases. If $b$ is taken as an indicator of a country's degree of financial integration with the outside world during this period of time, it would appear that several countries could be classified as effectively closed or almost perfectly integrated financially, depending on whether the estimate of $b$ was derived from a regression estimated in levels or first differences.

A possible reason for this result is that the regressions based on levels of the variables may be producing spurious results. A valid reason to estimate in first differences rather than levels is that the saving and investment ratios entering the Feldstein-Horioka regressions may be nonstationary variables. If they are, and they are not cointegrated, then a regression in levels may lead to spurious

8. I exclude Burundi, Madagascar, and Venezuela from any of these categories because the point estimates of $b$ for each of them was estimated with high confidence to be outside the theoretically prescribed range of zero to unity.

correlation (see Granger and Newbold 1974). If each of these variables possesses a single unit root, then first-differencing would render them stationary, and regressions based on changes would not exhibit the spurious correlation problem. As it happens, the null hypothesis of a single unit root cannot be rejected for any of the saving and investment ratios in this data set.[9] Thus the regressions based on levels of the variables may indeed be inappropriate in this case.

However, the first-difference regressions may themselves be misspecified. If the saving and investment ratios for individual countries are cointegrated, the relationship between them can be given an error-correction representation (Engle and Granger 1987). Estimating in first differences has the effect of omitting the error-correction term from the regression, leaving it misspecified. In the case at hand, the null hypothesis of no cointegration could be rejected only for a minority of countries.[10]

Although on the face of it this would suggest that proceeding with the first-difference regressions is acceptable, this conclusion may be unwarranted for two reasons. First, the cointegration tests have very low power, particularly in samples this small (twenty-one observations) and against alternatives involving a high degree of serial correlation. Second and more important, theoretical considerations suggest that saving and investment should be cointegrated, even under perfect capital mobility. The reason is that the current account provides the resources with which a country repays its external creditors. Solvency thus imposes a constraint that prevents deviations between national saving and investment from becoming permanent. Because gaps between saving and investment must eventually be reversed for the country to remain solvent, sufficient observations should show these two series to be cointegrated. This suggests that the failure to reject cointegration in the majority of cases may represent a small-sample problem.

To guard against this possibility, the Feldstein-Horioka regression was also estimated in an error-correction version. To conserve degrees of freedom, given the small number of observations, the simplest such specification was chosen, consisting of a regression of the change in the investment ratio on a constant, the lagged residual from the cointegrating regression, and the change in the saving ratio. The coefficient of the latter is the estimate of $b$. It is reported in the third column of table 2 for the OLS version and in the sixth column for the IV version. Focusing on the latter, the respecification makes a substantial difference to both the qualitative and the quantitative nature of the results. Of the fifty-six countries in the sample, only four (Chile, Niger, Nigeria, and Venezuela) produced estimates of $b$ insignificantly different from the closed-economy value of unity. Only one country (the Philippines) yielded an estimate that was both precisely estimated and greater than the benchmark value of 0.6. Of the remaining coun-

9. This is based on augmented Dickey-Fuller tests. The results are available on request.

10. Again, the results are available on request.

tries, twenty-five had estimates of $b$ that were either indistinguishable from zero (22 cases) or below the benchmark.[11]

Taken at face value, these results would appear to suggest that the developing countries in this sample have exhibited a substantial amount of capital mobility—more so, in fact, than this methodology is able to detect for industrial countries with more highly developed capital markets and fewer explicit barriers to capital movements. However, alternative interpretations can be provided for this finding. Notice that, unlike the situation for industrial countries, the problem here is to explain why saving-investment correlations are so low, not so high. An easy, but rather destructive explanation is that the data for these countries are simply very poor. Developing-country macro data are commonly held to be much worse than their industrial-country counterparts, and because saving estimates tend to be calculated as residuals, saving ratios may be particularly poor approximations to their true values (Aghevli and others 1990). Errors in variables problems here would indeed tend to bias estimates of $b$ downward. What little can be done about this—that is, using instrumental variables to minimize the negative correlation between the contaminated variable and the error term—has already been done in the sixth column.

An alternative interpretation relies on the role of nonmarket flows. The rationale for the Feldstein-Horioka test is that with zero capital mobility, domestic investment must be financed with national saving, whereas when capital mobility is high, domestic investment can be independent of national saving because external creditors will supply the requisite financing on market terms. In many developing countries, however, domestic investment can differ from national saving even if capital is perfectly immobile in the sense defined here, that is, even if markets do not arbitrage at all between domestic and foreign financial instruments. The reason is that many developing countries have access to a nonnegligible quantity of external financing on nonmarket terms. Bilateral and multilateral external assistance is indeed often intended precisely to supplement national saving as a source of financing for investment. Yet, such nonmarket aid flows do not represent financial integration in the sense described previously, because they do not represent an endogenous response of the market to arbitrage opportunities among financial assets. Most important, such nonmarket flows do not have the policy implications associated above with the presence of a high degree of capital mobility.

Intuitively, because nonmarket flows break the link between national saving and domestic investment, the measured saving-investment correlations should be weakened if nonmarket flows are important. More formally, consider a country that is financially closed, but that receives foreign nonmarket assistance. To the extent that the assistance is devoted to investment, it belongs in the Feldstein-Horioka regression, because domestic investment now depends not

11. Nonsense results (that is, $b$ estimated precisely, but outside the unit interval) were produced by two countries in this case.

just on national saving but also on the magnitude of aid inflows. Omitting the aid flows would leave the Feldstein-Horioka regression misspecified.

Standard specification error analysis suggests that the coefficient of the saving rate would still correctly capture the independent effect of national saving on domestic investment—and thus serve its intended role as an indicator of the degree of capital mobility—as long as all of the aid inflow was absorbed by investment. National saving and aid would be independent variables, and their effects on investment could be independently measured. However, if the receipt of aid affects the saving rate, then the omission of the aid variable from the regression would bias the coefficient of the saving rate, because the latter would pick up some of the effects of the former on domestic investment. Suppose, in particular, that aid receipts are only partially invested, the rest being consumed. Then the receipt of aid would lower the measured saving rate. If aid flows are omitted from the Feldstein-Horioka regression in this case, the coefficient of the saving ratio would be biased downward as a measure of the independent effect of national saving on domestic investment. The bias would be downward because the omitted variable, which has a positive coefficient in the "true" regression, would be negatively correlated with the included variable; that is, an increase in the saving rate would often reflect a reduction in aid receipts, and the latter would lower investment.

To correct for this problem, the regressions underlying the results reported in table 2 were reestimated taking aid flows into account. This was done by measuring aid flows as net financing (disbursements minus repayments) received from multilateral and bilateral creditors expressed as a share of GNP. In addition, the change in net foreign assets of the central bank in each of these countries was treated in the same manner as the receipt of nonmarket financing, essentially because reserve flows represent an additional source for financing saving-investment imbalances in developing countries without relying on private capital markets. Because most of the countries in the sample maintained a fixed exchange rate during the sample period, the contribution of reserve flows is potentially large. Indeed such flows accounted for several percentage points of GNP in a number of instances in this sample. To conserve degrees of freedom, the reestimation was performed under the restriction that each of the financing sources had the same effect on domestic investment. In other words, the saving ratio was replaced by the ratio of the sum of national saving, net nonmarket inflows, and reserve depletion to GNP.

The results of the reestimation are reported in table 3. The estimates of error-correction instrumental variables contained in the sixth column are the preferred results because they simultaneously address all of the econometric issues raised in this subsection. Using these estimates, for nine of the fifty-seven countries in the sample, the null hypothesis of $b = 1$ could not be rejected at the 95 percent level of confidence. This group includes India, Nigeria, the Philippines, and Venezuela, as well as smaller countries such as Ghana, Honduras, Kenya, and Niger. Malawi is also in this group, although the point estimate of 0.53 is below

Table 3. *Modified Feldstein-Horioka Regressions for Developing Countries: Coefficient of the Saving Ratio, 1970–90*

| | *Ordinary least squares* | | | *Instrumental variables* | | |
|---|---|---|---|---|---|---|
| *Country* | *Levels* | *First differences* | *Error correction* | *Levels* | *First differences* | *Error correction* |
| Algeria | 0.96[a] | 0.08[b] | 0.27[b] | 1.12[a] | 0.01[b] | 0.21 |
| Argentina | 0.63[c] | 0.22[c] | 0.24[c] | 1.07[a] | 0.36[c] | 0.57 |
| Benin | 0.31[c] | 0.31[c] | 0.33[c] | 0.37[c] | 0.32[c] | 0.33[c] |
| Brazil | 0.19[c] | 0.17[c] | 0.17[c] | 0.31[b] | 0.32[b] | 0.16[b] |
| Burundi | 0.81[c] | 0.61[c] | 0.71[c] | 0.86[a] | 0.68[a] | 0.64[c] |
| Cameroon | 0.33[c] | 0.39[c] | 0.33[c] | 0.38[c] | 0.39[c] | 0.38[c] |
| Central African Republic | 0.69[c] | 0.23[c] | 0.35[c] | 1.00[a] | 0.00[b] | 0.64 |
| Chile | 0.41[c] | 0.58[c] | 0.52[c] | 0.03[b] | 0.34 | 0.35[b] |
| Colombia | 0.36[c] | 0.41[c] | 0.43[c] | 0.35[c] | 0.46[c] | 0.54[c] |
| Congo | 0.51[c] | 0.37[c] | 0.49[c] | 0.54[c] | 0.35[b] | 0.66 |
| Costa Rica | 0.47[c] | 0.28[c] | 0.32[c] | 0.60[c] | 0.36[b] | 0.41[c] |
| Côte d'Ivoire | 0.77[a] | 0.02[b] | 0.11[b] | 0.16 | −2.32 | −2.88 |
| Dominican Republic | 0.41[c] | 0.24[c] | 0.34[c] | 0.24[b] | 0.02[b] | 0.18[b] |
| Ecuador | 0.43[c] | 0.19[b] | 0.19[b] | 0.60[a] | 0.25[b] | 0.34[b] |
| Egypt | 0.50[c] | 0.40[c] | 0.41[c] | 0.61[c] | 0.40[c] | 0.42[c] |
| El Salvador | 0.45[c] | 0.04[b] | 0.15[b] | 0.47[c] | 0.12[b] | 0.21[b] |
| Fiji | 0.51[c] | 0.17[b] | 0.23[b] | 0.25[b] | 0.08[b] | 0.10[b] |
| Gabon | 0.67[a] | 0.50[c] | 0.51[c] | 0.68[c] | 0.42 | 0.50 |
| Gambia, The | 0.52[c] | 0.01[b] | 0.13[b] | 0.76[a] | 0.01[b] | 0.37[b] |
| Ghana | 0.80[a] | 0.37[b] | 0.61[c] | 1.02[a] | 0.90 | 1.23[a] |
| Guatemala | 0.72[c] | 0.41[c] | 0.68[a] | 0.45[c] | 0.30[b] | 0.42[b] |
| Haiti | 0.24[c] | 0.08[b] | 0.12[b] | 0.61[a] | 0.44[b] | 0.48 |
| Honduras | 0.72[c] | 0.73[a] | 0.76[a] | 0.78[a] | 0.68[a] | 0.75[a] |
| India | 1.07[a] | 0.92[a] | 0.93[a] | 1.35[a] | 0.72[a] | 0.75[a] |
| Indonesia | 1.01[a] | 0.37[c] | 0.42[c] | 1.21[a] | 0.61 | 0.71 |
| Kenya | 0.55[c] | 0.83[a] | 0.77[c] | 0.20[b] | 0.82[a] | 0.78[a] |
| Korea | 0.48[c] | 0.53[c] | 0.27[b] | 0.26[b] | 0.83[a] | 0.72 |
| Lesotho | −0.16[b] | 0.19[c] | 0.10[c] | −0.78 | 0.10[b] | 0.00[b] |
| Madagascar | 0.45[c] | 0.09[b] | 0.10[b] | 0.52 | 0.22[b] | 0.28[b] |
| Malawi | 0.75[a] | 0.50[b] | 0.65[a] | 0.64[a] | 0.31[b] | 0.53[a] |
| Malaysia | 0.54 | 0.15[b] | 0.14[b] | 0.82[a] | 0.27[b] | 0.25[b] |
| Mali | 0.30[c] | 0.11[c] | 0.11[c] | 0.24[b] | 0.12[b] | 0.11[b] |
| Malta | 0.30[c] | 0.54[c] | 0.54[c] | 0.11[c] | 0.13[b] | 0.10[b] |
| Mauritania | 0.44[c] | 0.58[c] | 0.57[c] | 0.25[b] | 0.38[b] | 0.47[c] |
| Mauritius | 0.58[c] | 0.47[c] | 0.46[c] | 0.50[c] | 0.45[c] | 0.45[c] |
| Mexico | 0.28[c] | 0.30[c] | 0.37[c] | 0.20[b] | 0.01[b] | 0.03[b] |
| Morocco | 0.59[a] | 0.48[c] | 0.47[c] | 0.48 | 0.36[b] | 0.35[b] |
| Nepal | 0.88[a] | 0.48[c] | 0.55[c] | 0.94[a] | 0.38[c] | 0.51[c] |
| Niger | 0.91[a] | 0.84[a] | 0.89[a] | 0.69[a] | 0.91[a] | 0.74[a] |
| Nigeria | 0.99[a] | 0.67[c] | 0.73[c] | 1.20[a] | 0.65[a] | 0.74[a] |
| Pakistan | 0.80[a] | 0.11[b] | 0.26[c] | 1.07[a] | 0.04[b] | 0.10[b] |
| Papua New Guinea | −0.64[c] | −0.27[b] | −0.34[c] | −0.39[b] | −0.26[b] | −0.21[b] |
| Paraguay | 0.24[b] | −0.09[b] | −0.04[b] | 0.60 | −0.66[b] | −0.55[b] |
| Peru | 0.70[a] | 0.40[c] | 0.47[c] | 0.53 | 0.18[b] | 0.30[b] |

| | *Ordinary least squares* | | | *Instrumental variables* | | |
|---|---|---|---|---|---|---|
| *Country* | *Levels* | *First differences* | *Error correction* | *Levels* | *First differences* | *Error correction* |
| Philippines | 1.16[a] | 0.53[c] | 0.72[c] | 1.04[a] | 0.49[c] | 0.67[a] |
| Rwanda | 0.60[c] | 0.42[c] | 0.57[c] | 1.06[a] | −0.41 | 0.37 |
| Senegal | 0.50[c] | 0.16[b] | 0.20[c] | 0.56[a] | −0.11[b] | −0.04[b] |
| Sierra Leone | −0.10[c] | 0.02[b] | −0.01[b] | −0.10[b] | −0.02[b] | −0.01[b] |
| Thailand | 1.13[a] | 0.56[c] | 0.72[a] | −0.52 | −0.11 | −0.30 |
| Togo | 0.36[b] | −0.02[b] | 0.03[b] | 0.33 | 0.07[b] | 0.22[b] |
| Tunisia | 1.12[a] | 0.42[c] | 0.53[c] | 1.29[a] | 0.44 | 0.48[c] |
| Turkey | 0.79[a] | 0.51[c] | 0.52[c] | 1.01[a] | 0.55 | 0.45 |
| Uganda | 0.14[b] | −0.03[b] | 0.05[b] | 0.33[c] | 0.48 | 0.32[b] |
| Uruguay | 0.79[a] | 0.16[b] | 0.18[b] | 0.58 | 0.14[b] | 0.20[b] |
| Venezuela | 1.70[c] | 1.18[a] | 1.29[a] | 1.87[c] | 1.53[a] | 1.59[a] |
| Zambia | 0.59[c] | 0.05[b] | 0.22[b] | 0.81[a] | 0.42 | 0.71 |
| Zimbabwe | 0.69[c] | 0.54[c] | 0.59[c] | 1.72 | — | — |

— Not available.
a. Different from zero at the 5 percent level.
b. Different from one at the 5 percent level.
c. Different from both zero and one at the 5 percent level.
*Source*: Author's calculations based on data from World Bank (various issues).

the industrial-country benchmark value of 0.6. With the exception of Honduras, all of these countries were found in the modal or below-modal group for the gross-flow index calculated in the previous subsection.[12] At the other extreme are twenty-four countries with $b$ indistinguishable from zero statistically, as well as nine countries in which $b$ can be distinguished from both zero and unity, but with point estimates of $b$ below 0.6. Among countries discussed in the previous section, Brazil, Mexico, and Morocco, all of which were taken as exhibiting financial openness but not necessarily strong financial integration, are in this group. Not surprisingly, so is Malaysia. In this case, thirteen countries produced estimates of $b$ that were too imprecise to be useful.

Overall, taken at face value, the Feldstein-Horioka methodology indicates that developing countries tend to differ substantially among themselves with respect to their degree of financial integration with world capital markets. For a substantial majority of developing countries (thirty-two out of the forty-three relevant cases here), however, the data are consistent with a substantial degree of financial openness. Only about a fifth of the countries in the sample produced estimates of $b$ consistent with financial autarky. What cannot be determined, of course, is the extent to which these results truly reflect a high degree of financial integration, rather than just poor data. The broad consistency of the results with previous estimates as well as with the gross-flow index suggests that the results may have some information content.

12. Honduras, with a gross-flow ratio of 10.06 percent, barely escaped the modal group (see table 1).

### *Arbitrage Conditions*

Direct tests of arbitrage conditions have the advantage not only of avoiding the use of suspect macro data, but also of not being subject to some of the methodological problems with saving-investment correlations discussed in section I. In this section, accordingly, tests of UIP are constructed for a large group of developing countries. Uncovered, rather than covered, interest parity is tested because very few forward markets exist for the currencies of developing countries. Even uncovered interest parity tests are difficult to conduct for very many developing countries, because time-series observations on interest rates of adequate length are often not available. The country sample was determined by the availability of monthly data on interest rates payable to private savers during the period January 1985 to December 1990.[13] The interest rate tended to be either short-term (zero to six-month) deposit rates or six-month treasury bill rates. The countries in the sample and the interest rate chosen for each are listed in table 4.

The tests were based on the behavior of the return differential, that is, the difference between the domestic interest rate and the relevant exchange rate–corrected ex post foreign interest rate.[14] The use of ex post exchange rates is required, as usual, because the appropriate ex ante expectations of future exchange rates are unobservable. If expectations are formed rationally, however, UIP nevertheless imposes some restrictions on the data that can be tested. Among the restrictions are that the mean value of the return differential should be zero and that deviations from the mean should be serially uncorrelated. These propositions are tested in the second and fourth columns and of table 4. The second column lists the mean value of the return differential for each country, with an asterisk indicating cases in which the mean is statistically different from zero at the 95 percent confidence level. Of the forty-eight countries in the sample, thirty-two exhibited mean deviations that were different from zero during this period. Moreover, in all but one case (the rather extreme one of Argentina), Q tests indicated with a very high degree of confidence that deviations from UIP were serially correlated. Thus, leaving Argentina aside, at least one of the predictions of the joint hypothesis of UIP, rational expectations, and weak market efficiency can be rejected in every case.

To facilitate comparisons across countries, I computed for each country the ratio of its mean absolute deviation from UIP (that is, the mean over the sample period of the absolute value of the return differential observed each month) to the mean of the exchange rate–corrected foreign interest rate. Because the for-

13. The data are taken from IMF (various issues b). The restriction that interest rates apply to assets available to private savers ruled out the inclusion of several countries for which only discount rate data were available.

14. The "foreign" interest rate was taken to be the relevant U.S. interest rate in each case. The rate on U.S. three-month certificates of deposit was used when the domestic rate was a short-term deposit rate, and the U.S. six-month Treasury bill rate was used when the domestic rate was a Treasury bill rate. In all cases, the exchange rate was the period-average market-based exchange rate against the U.S. dollar.

eign interest rate indicates what the domestic interest rate would have been if ex post UIP had held exactly during each month of the sample period, the computed ratio measures how far the domestic interest rate deviated on average from what would have been observed under strong financial integration. The ratio for the total sample period is reported in the fifth column of table 4.

Evidently the countries in the sample are divided into two groups: the CFA franc countries of West Africa and everyone else. The ratio is large and negative for CFA franc countries (consisting in this sample of Cameroon, the Central African Republic, Chad, Congo, Equatorial Guinea, Gabon, Mali, and Senegal). The appreciation of the French franc against the U.S. dollar during the period made the ex post external interest rate take on negative values averaging close to zero for these countries. The vast majority of the non-CFA countries exhibit average absolute deviations up to twice the magnitude of the UIP interest rate. By this measure, countries such as Chile, Colombia, Costa Rica, Mexico, Sri Lanka, and Uruguay are characterized by a high degree of capital mobility in the sense that their domestic interest rates show relatively small deviations from their UIP values, whereas Cyprus, Mauritius, and Seychelles are at the opposite extreme of very low capital mobility.

To assess whether comparisons of this type provide any evidence of an increase in the degree of integration with world financial markets among the sample countries in recent years, the sample period was divided in half for each country, and mean absolute deviations were calculated separately for each half of the period. The results are reported in the last two columns of table 4. In eleven of the forty-eight countries, there was a statistically significant decline in the mean absolute deviation during the second half of the sample. Among the larger countries in this group were Israel and Mexico. There were seven cases in which the mean absolute deviation increased in the second half of the sample, including in Argentina, Brazil, Egypt, the Republic of Korea, and Turkey. Overall, there is little evidence of widespread increases in financial integration here, although several countries may indeed have evolved in this direction.

These results must be viewed with caution, however. First, the peso problem may be endemic in this data set. The majority of the countries in the sample maintained predetermined exchange rates during the sample period. It is possible that ex post deviations from UIP reflected expected devaluations that did not come to pass, or surprise devaluations, particularly because several countries in the sample did experience large discrete devaluations during this time. Second, in many cases the interest rates used for these calculations do not reflect market-determined rates, but rather the administered rates characteristic of a repressed financial system. Frankel (1991) has argued that this problem does not matter, because the ability to sustain domestic interest rates at levels that differ from their international counterparts is precisely what we mean by imperfect capital mobility. This argument is not convincing, however, for three reasons:

- The interest rates in the formal financial system may indeed deviate substantially from their foreign counterparts, as do many of the interest rates in the

Table 4. *Deviations from Uncovered Interest Parity in Developing Countries, 1985–90*
(percent)

| Country | Interest rate | Mean deviation | Standard error | Q(6) | Ratio of mean absolute deviation to mean of uncovered interest parity: Total | First half | Second half |
|---|---|---|---|---|---|---|---|
| Argentina | Deposit rate | −66,234 | 61,513 | 6.17 | 1.15 | 0.00 | 2.30[a] |
| Bhutan | Deposit rate | −8.17* | 1.42 | 72.32 | 0.76 | 0.52 | 10.01[a] |
| Botswana | Deposit rate | −7.40 | 4.98 | 54.34 | 2.00 | 2.62 | 1.37[a] |
| Brazil | Treasury bill rate | −1,168 | 374.56 | 89.75 | 0.87 | 0.12 | 1.63[a] |
| Cameroon | Deposit rate | 9.11* | 2.67 | 46.46 | −11.82 | −12.42 | −11.23 |
| Central African Republic | Deposit rate | 9.07* | 2.66 | 46.04 | −11.77 | −12.42 | −11.13 |
| Chad | Deposit rate | 6.49* | 2.70 | 48.15 | −11.27 | −11.51 | −11.02 |
| Chile | Deposit rate | −1.14 | 2.43 | 45.10 | 0.50 | 0.50 | 0.49 |
| Colombia | Deposit rate | −13.79* | 1.48 | 105.80 | 0.34 | 0.39 | 0.28 |
| Congo | Deposit rate | 9.60* | 2.67 | 46.40 | −11.95 | −11.78 | −11.11 |
| Costa Rica | Deposit rate | −5.77* | 1.05 | 88.76 | 0.29 | 0.24 | 0.33 |
| Cyprus | Deposit rate | 4.25* | 2.04 | 36.44 | 9.49 | 9.93 | 9.05 |
| Ecuador | Deposit rate | −70.25* | 19.36 | 29.82 | 0.80 | 0.83 | 0.76 |
| Egypt | Deposit rate | −67.23* | 29.83 | 32.32 | 0.94 | 0.05 | 1.83[a] |
| El Salvador | Deposit rate | −72.82* | 36.40 | 27.86 | 0.97 | 1.42 | 0.52 |
| Equatorial Guinea | Deposit rate | 8.81* | 2.70 | 48.15 | −11.87 | −12.67 | −11.07 |
| Ethiopia | Deposit rate | −4.65* | 0.14 | 83.25 | 0.60 | 0.51 | 0.70 |
| Gabon | Deposit rate | 5.96* | 2.80 | 44.28 | −10.84 | −11.49 | −10.31 |
| Gambia, The | Maximum deposit rate | −41.94 | 23.57 | 21.60 | 1.28 | 2.04 | 0.51 |
| Ghana | Treasury bill rate | −46.13* | 7.16 | 65.76 | 0.80 | 1.20 | 0.40[a] |
| Guatemala | Maximum deposit rate | −199.84 | 104.73 | 31.05 | 0.97 | 1.76 | 0.18 |
| Honduras | Deposit rate | −63.65 | 36.28 | 29.99 | 0.92 | 0.04 | 1.80 |
| Indonesia | Deposit rate | −6.10 | 4.16 | 80.50 | 1.00 | 0.95 | 1.04 |
| Israel | Treasury bill rate | 16.73 | 10.39 | 37.54 | 1.04 | 1.78 | 0.31[a] |
| Jamaica | Treasury bill rate | 6.03* | 2.04 | 132.62 | 1.12 | 1.15 | 1.11 |
| Kenya | Maximum deposit rate | 4.26* | 1.73 | 53.01 | 0.79 | 0.81 | 0.77 |
| Korea | Deposit rate | 0.76 | 2.22 | 203.72 | 1.00 | 0.91 | 1.09[a] |
| Lesotho | Treasury bill rate | −10.12* | 3.81 | 52.21 | 1.44 | 1.81 | 1.08[a] |
| Malawi | Treasury bill rate | 8.85* | 1.83 | 132.38 | −18.26 | −24.32 | −18.21[a] |
| Malaysia | Deposit rate | −4.29* | 1.09 | 50.94 | 0.79 | 0.81 | 0.77 |
| Mali | Deposit rate | 7.25* | 2.69 | 46.44 | −11.27 | −12.42 | −10.12 |
| Mauritius | Deposit rate | 2.78 | 2.26 | 43.22 | 2.01 | 1.84 | 2.17 |
| Mexico | Treasury bill rate | −17.30* | 8.10 | 138.61 | 0.61 | 0.77 | 0.44[a] |

| Country | Interest rate | Mean deviation | Standard error | Q(6) | Ratio of mean absolute deviation to mean of uncovered interest parity: Total | First half | Second half |
|---|---|---|---|---|---|---|---|
| Nepal | Treasury bill rate | −12.42* | 1.79 | 76.48 | 0.78 | 0.74 | 0.83 |
| Nigeria | Deposit rate | −333.75 | 194.60 | 11.84 | 1.00 | 1.83 | 0.16 |
| Philippines | Treasury bill rate | 3.55* | 1.37 | 27.31 | 0.59 | 0.71 | 0.48 |
| Rwanda | Deposit rate | 4.41* | 1.66 | 41.45 | 1.65 | 2.23 | 1.07[a] |
| Senegal | Deposit rate | 7.79* | 2.70 | 47.14 | −11.57 | −11.80 | −11.34 |
| Seychelles | Treasury bill rate | 12.29* | 1.24 | 91.89 | 11.54 | 15.24 | 7.84 |
| Sierra Leone | Treasury bill rate | −383.25* | 128.12 | 65.87 | 1.00 | 1.72 | 0.31[a] |
| Singapore | Deposit rate | −0.20 | 1.06 | 50.94 | 1.83 | 1.69 | 1.97 |
| South Africa | Treasury bill rate | −3.24 | 3.76 | 52.49 | 1.42 | 1.85 | 0.97a |
| Sri Lanka | Treasury bill rate | −3.67* | 1.27 | 84.60 | 0.40 | 0.19 | 0.60[a] |
| Thailand | Deposit rate | 4.14* | 0.70 | 37.90 | 0.94 | 1.11 | 0.77[a] |
| Trinidad and Tobago | Treasury bill rate | −18.64* | 4.82 | 80.45 | 0.81 | 1.18 | 0.44[a] |
| Turkey | Deposit rate | −4.62 | 3.72 | 83.25 | 0.45 | 0.34 | 0.57[a] |
| Uruguay | Deposit rate | −3.54 | 2.59 | 61.13 | 0.19 | 0.19 | 0.18 |
| Venezuela | Deposit rate | −265.84* | 119.94 | 31.09 | 0.97 | 0.45 | 1.49 |

*Different from zero at the 5 percent level.

a. Statistically significant change in the mean absolute deviation between the first and second half of the period.

*Source*: Author's calculations based on data from IMF (various issues b).

present sample. But unobserved market-determined domestic interest rates, such as those in informal financial markets, may be tied much more closely to external rates. To the extent that external rates represent the marginal cost of funds in the domestic economy, the policy environment may be more closely characterized as one with high capital mobility than one with capital immobility.

- The prevalence of domestic deposit interest rates that are substantially different from foreign ones may not reflect the absence of arbitrage, but rather imperfect substitutability arising from liquidity services rendered by claims on domestic banks.
- Reported Treasury bill interest rates may not in fact reflect rates of return on assets that are willingly held, but rather the administered interest rates paid on instruments that financial institutions are required to hold in order to satisfy legal "liquidity" requirements.

Thus, the use of interest rates that are not market determined raises an impor-

tant caveat in the interpretation of the results of tests of arbitrage conditions. The finding that reported domestic interest rates move closely with foreign rates may indeed suggest a high degree of capital mobility. The opposite finding may simply indicate that financial repression is high and that a closer examination of the behavior of domestic market–determined interest rates is required.

### *Euler Equation Tests*

Euler equation tests may provide the most direct tests of financial integration. They also avoid some of the conceptual difficulties associated with tests of arbitrage conditions and saving-investment correlations. The data required are time series on real per capita private consumption, national price levels, and exchange rates. Although consumption data are often a binding constraint in developing countries, the Summers-Heston (1991) data set provides the relevant series (in annual form) for many developing countries for the period 1960–85. Thus the variable $n_t$ used by Obstfeld (1986b), as defined in equation 8, was constructed for the sixty developing countries for which at least fifteen years of data were available. The data for the nominal exchange rate against the U.S. dollar are from Summers and Heston (1991), while the data for the consumer price index are from IMF (various issues b). The variable $n_t$ was constructed with the United States as the domestic country and each of the developing countries in the sample in turn as the foreign country. Two alternatives were chosen for the parameter $a$ (the inverse of the intertemporal elasticity of substitution): 2 and 1. These correspond to the values estimated by Obstfeld for the United States and Japan, respectively. The procedure involves determining whether variables contained in the information set available before time $t$ can help to predict $n_t$.

The results are presented in table 5. The probability values are for the likelihood-ratio test of exclusion restrictions on the constant and a single lagged value of $n_t$, as well as on the constant and two lagged values of $n_t$, for $a = 2$ and for $a = 1$. Failure to reject the null hypothesis embodying the exclusion restrictions is consistent with perfect capital mobility, that is, with complete financial integration. Rejection is indicated if it occurs with either one or two lags. No additional lags were tried because of the scarcity of degrees of freedom.

The outcomes of these tests are quite similar to those of the saving-investment correlations reported in tables 3 and 4. For the large majority of countries the results would seem to be consistent with a high degree of capital mobility. Specifically, the null is rejected in only twenty-five of the sixty countries tested with $a = 2$, and in only 17 countries with $a = 1$. With the single exception of Singapore, every case of rejection with $a = 1$ was also a rejection with $a = 2$. As in the case of saving-investment correlations, however, the interpretation of these results is complicated by poor data and few degrees of freedom. Because the null is consistent with a high degree of capital mobility, it is unclear whether a failure to reject reflects poor data or substantial financial integration.

Summers and Heston provide an indicator of the relative quality of their data

across countries. This data "grade" is reported in table 5, with quality deteriorating from A to D. For $a = 2$, the incidence of rejection for grades A to C was twenty of forty-four countries, whereas for countries graded D it was only five of sixteen. For $a = 1$, only 2 of 16 countries with grade D rejected the null, whereas for those graded C and higher about a third (fifteen of forty-four) involved rejections. This disparity suggests a clear association between poor data quality and failure to reject, and it implies that Euler equation tests using annual data for large groups of developing countries can in many cases provide only weak evidence on the issue of financial integration.

## III. Summary and Conclusions

An economy's degree of financial integration with the rest of the world is a key determinant of many of its most important macroeconomic properties. For the vast majority of developing countries, however, little is known about the nature of the links between domestic and external financial markets. As a result, conflicting assumptions are often made about this important feature of developing economies in both analytical and policy work. The question addressed here is whether the data impose any restrictions on assumptions about financial integration. This article presents the first systematic application of existing approaches to the measurement of capital mobility to large groups of developing countries.

Unfortunately, a number of complicating conceptual and empirical factors are encountered in attempting to answer this question. Conceptually, there are two types of complicating factors. First, there is no widely accepted empirical measure of the degree of an economy's financial integration with the rest of the world. This problem arises precisely because of the large number of implications that follow from financial integration in the strong sense. Because tests of financial integration essentially examine whether the data are consistent with these implications, each such implication provides a separate test. Second, each of the existing empirical tests presents problems of interpretation. The tests are based on the magnitude of gross capital flows, the strength of saving-investment correlations, the applicability of arbitrage conditions, the scope for sterilization, and the cross-country uniformity of Euler equation relationships.

Perhaps the most widely used tests of financial integration have been tests of arbitrage conditions and saving-investment correlations. Yet tests of arbitrage conditions suffer from the need to identify comparable assets across countries and to make ancillary assumptions about unobservable expectations and agents' information sets (resulting in tests of joint hypotheses). They also suffer from the peso problem. Moreover, the policy implications of rejections of arbitrage conditions depend on the reasons for rejection, and this has proven to be a difficult question to resolve in the industrial-country context. Tests of saving-investment correlations, by contrast, are contaminated by a host of factors that could cause

Table 5. *Euler-Equation Estimates of Capital Mobility*

| Country | Sample period | Quality of data[a] | $a = 2$ 1 lag | $a = 2$ 2 lags | $a = 2$ Reject? | $a = 1$ 1 lag | $a = 1$ 2 lags | $a = 1$ Reject? |
|---|---|---|---|---|---|---|---|---|
| Bangladesh | 1961–84 | C | 0.37 | 0.03 | Yes | 0.39 | 0.02 | Yes |
| Bolivia | 1961–85 | B | 0.24 | 0.44 | No | 0.44 | 0.67 | No |
| Burundi | 1967–84 | D | 0.64 | 0.23 | No | 0.89 | 0.97 | No |
| Cameroon | 1970–84 | C | 0.84 | 0.12 | No | 0.59 | 0.8 | No |
| Chile | 1961–84 | C | 0.38 | 0.56 | No | 0.5 | 0.7 | No |
| Colombia | 1961–84 | B | 0.47 | 0.6 | No | 0.39 | 0.55 | No |
| Congo | 1961–84 | D | 0.06 | 0.13 | No | 0.32 | 0.56 | No |
| Costa Rica | 1961–84 | B | 0.14 | 0.01 | Yes | 0.28 | 0.01 | Yes |
| Côte d'Ivoire | 1962–84 | C | 0.16 | 0.16 | No | 0.18 | 0.25 | No |
| Cyprus | 1961–84 | B | 0.7 | 0.49 | No | 0.65 | 0.46 | No |
| Dominican Republic | 1961–84 | C | 0.9 | 0.92 | No | 0.75 | 0.8 | No |
| Egypt | 1961–84 | D | 0.88 | 0.54 | No | 0.99 | 0.75 | No |
| El Salvador | 1961–84 | B | 0 | 0 | Yes | 0.01 | 0 | Yes |
| Ethiopia | 1967–84 | C | 0.03 | 0.12 | Yes | 0.26 | 0.57 | No |
| Gabon | 1964–84 | C | 0.64 | 0.78 | No | 0.97 | 0.67 | No |
| Gambia, The | 1963–84 | D | 0.49 | 0.79 | No | 0.48 | 0.71 | No |
| Ghana | 1966–84 | D | 0.01 | 0.03 | Yes | 0.01 | 0.02 | Yes |
| Guatemala | 1961–84 | B | 0 | 0 | Yes | 0 | 0 | Yes |
| Guyana | 1961–84 | C | 0.42 | 0.44 | No | 0.35 | 0.2 | No |
| Haiti | 1961–84 | C | 0.16 | 0.29 | No | 0.56 | 0.61 | No |
| Honduras | 1961–84 | C | 0.02 | 0.02 | Yes | 0.02 | 0.04 | Yes |
| India | 1961–84 | B | 0.01 | 0.16 | Yes | 0.04 | 0.02 | Yes |
| Iran, Islamic Rep. of | 1961–84 | C | 0.02 | 0.04 | Yes | 0.01 | 0.02 | Yes |
| Israel | 1961–84 | A | 0.25 | 0.77 | No | 0.14 | 0.58 | No |
| Jamaica | 1961–84 | C | 0.23 | 0.18 | No | 0.3 | 0.18 | No |
| Kenya | 1961–84 | B | 0.18 | 0.01 | Yes | 0.08 | 0 | Yes |
| Korea | 1968–84 | B | 0.15 | 0.31 | No | 0.46 | 0.76 | No |
| Liberia | 1967–84 | D | 0.1 | 0.29 | No | 0.21 | 0.45 | No |
| Madagascar | 1966–84 | C | 0.03 | 0.04 | Yes | 0.16 | 0.28 | No |
| Malaysia | 1961–84 | B | 0.16 | 0 | Yes | 0.19 | 0.16 | No |
| Mauritius | 1965–84 | D | 0.5 | 0.62 | Yes | 0.46 | 0.54 | No |
| Mexico | 1961–84 | B | 0.38 | 0.01 | Yes | 0.62 | 0.03 | Yes |
| Morocco | 1961–84 | C | 0.01 | 0.08 | Yes | 0.04 | 0.14 | Yes |
| Myanmar | 1961–84 | C | 0.72 | 0.81 | No | 0.58 | 0.38 | No |
| Nepal | 1966–84 | D | 0.03 | 0.39 | Yes | 0.05 | 0.01 | Yes |
| Niger | 1965–84 | D | 0.08 | 0.02 | Yes | 0.69 | 0.63 | No |
| Nigeria | 1961–84 | C | 0.11 | 0.24 | No | 0.27 | 0.4 | No |
| Pakistan | 1961–84 | B | 0.18 | 0.32 | No | 0.2 | 0.32 | No |
| Panama | 1961–84 | B | 0.48 | 0.42 | No | 0.46 | 0.41 | No |
| Paraguay | 1961–84 | C | 0.02 | 0.04 | Yes | 0.03 | 0.04 | Yes |
| Philippines | 1961–84 | A | 0.61 | 0.01 | Yes | 0.53 | 0.9 | No |
| Rwanda | 1968–84 | D | 0.99 | 0.96 | No | 0.49 | 0.64 | No |
| Saudi Arabia | 1965–84 | C | 0 | 0 | Yes | 0 | 0 | Yes |
| Senegal | 1969–84 | C | 0.34 | 0.33 | No | 0.3 | 0.5 | No |
| Sierra Leone | 1961–84 | D | 0.02 | 0.05 | Yes | 0.23 | 0.23 | No |
| Singapore | 1962–84 | C | 0.11 | 0.27 | No | 0.04 | 0.02 | Yes |

| Country | Sample period | Quality of data[a] | a = 2 | | | a = 1 | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1 lag | 2 lags | Reject? | 1 lag | 2 lags | Reject? |
| Somalia | 1962–84 | D | 0.07 | 0.15 | No | 0.36 | 0.63 | No |
| South Africa | 1961–84 | B | 0.13 | 0.18 | No | 0.09 | 0.07 | No |
| Sri Lanka | 1961–84 | B | 0.31 | 0.03 | Yes | 0.12 | 0.17 | No |
| Sudan | 1961–84 | D | 0.09 | 0.09 | No | 0.2 | 0.25 | No |
| Swaziland | 1967–84 | D | 0.99 | 0.36 | No | 0.9 | 0.39 | No |
| Tanzania | 1967–84 | C | 0.97 | 0.2 | No | 0.52 | 0.14 | No |
| Thailand | 1961–84 | C | 0.8 | 0.96 | No | 0.63 | 0.83 | No |
| Togo | 1968–84 | D | 0.09 | 0.14 | No | 0.23 | 0.49 | No |
| Tunisia | 1961–84 | C | 0.04 | 0.04 | Yes | 0 | 0.02 | Yes |
| Turkey | 1962–84 | B | 0.55 | 0.24 | No | 0.51 | 0.73 | No |
| Venezuela | 1961–84 | B | 0.17 | 0.4 | Yes | 0.24 | 0.5 | No |
| Zaire | 1966–84 | D | 0.29 | 0.33 | No | 0.64 | 0.57 | No |
| Zambia | 1962–84 | B | 0.01 | 0.04 | Yes | 0.01 | 0.01 | Yes |
| Zimbabwe | 1966–84 | C | 0.1 | 0.21 | No | 0.15 | 0.26 | No |

*Note*: The parameter a is the inverse of the intertemporal elasticity of substitution.

a. The quality of data deteriorates from A to D.

*Source*: Author's calculations based on data from Summers and Heston (1988) and IMF (various issues b).

saving and investment to move together even under perfect capital mobility. Tests of restrictions implied by Euler equations, a more promising recent approach that avoids the problems associated with arbitrage conditions and saving-investment correlation, require very strong restrictions on consumer behavior across countries for their implementation.

Empirically, developing-country data provide a serious challenge that compounds these conceptual problems. The main difficulties are that the national income accounting data that underlie both saving-investment correlations and tests based on Euler equations tend to be of poor quality. The resulting errors-in-variables problem makes it difficult to reject null hypotheses consistent with high capital mobility. Reported data on interest rates often do not refer to market-determined rates. Arbitrage conditions may therefore not tend to hold for observed interest rates but may well hold for "informal" rates that represent the true cost of funds in the economy. This could lead to a rejection of high capital mobility when it indeed holds. The central difficulty is that these data problems operate in opposite directions. Poor macro data will yield results consistent with a high degree of financial integration when saving-investment correlations and Euler equation tests are applied, whereas poor interest-rate data will cause tests of arbitrage conditions to support a finding of low financial integration.

In view of the direction of these biases, the juxtaposition of several tests may be the most judicious manner to formulate at least a first-pass impression of the extent to which large groups of individual developing countries have been inte-

grated with world financial markets in recent times. This was attempted in section II. For the 103 countries contained in the various samples examined, the weight of the evidence in each case is summarized in the appendix. Of this group, a majority of countries provided enough evidence to permit at least a crude subjective characterization of their degree of integration with world financial markets during the period considered here. In some cases, however, the tests proved contradictory, and such cases will require further study.

The degree of financial integration with the rest of the world is characterized for 58 of the 103 developing countries listed in the appendix. The financial integration of the countries is characterized as high, intermediate, or low. An important finding of this article, consistent with a growing body of empirical work, is that a large number of developing countries can be described as financially open. Thirty-nine of the 58 countries classified in the appendix are characterized as exhibiting a high or intermediate degree of financial integration. And in some of the countries characterized as having a low degree of financial openness, other forms of evidence (for example, capital flight from Venezuela) indicate that financial autarky is not an apt description of the nature of their relationship with world financial markets. Specific policy implications for individual countries will have to await more careful country-specific work to yield more refined measures of the degree of financial integration in specific cases. Nonetheless, both the evidence in the existing literature and that presented here imply that, although cases of strong financial integration may be rare in the developing world, the majority of developing countries must be regarded, for both policy and analytical work, as de facto financially open.

## Appendix

Table A-1 is a country-by-country summary of the results of the tests that appear in the text and includes all the countries contained in any of the samples. On the basis of the results, each country has also been classified subjectively as being in one of three categories of financial integration (high, intermediate, or low) during the 1980s. Countries for which information was available for only one measure of integration (typically the gross-flow ratio measure, or GFR) were left unclassified, as were those for which the various measures were judged too contradictory to permit even a rough classification. No systematic rules were imposed on the classification procedure except that the presumption was against classification in the high range if the preferred Euler equation test rejected integration. By contrast, little weight was given to this test when it failed to reject integration with poor data (rated D by Summers and Heston 1991).

The group classifications reported in table A-1 for the GFR measure refer to the ranges reported in the text: the GFR for group 1 was greater than 20 percent; the GFR for group 2 was between 15 and 20 percent; the GFR for group 3 was between 10 and 15 percent; the GFR for the modal group 4 was between 5 and 10 percent; and the GFR for group 5 was below 5 percent.

Table A-1. *Results of Tests of Financial Integration for 103 Countries*

| Country | Classification of the degree of financial integration | Gross-flow ratio measure group | Test results: Feldstein-Horioka b coefficient | Test results: Euler | Test results: Uncovered interest parity differential |
|---|---|---|---|---|---|
| Algeria | — | 4 | Not different from 0 or 1 | — | — |
| Antigua | — | 1 | — | — | — |
| Argentina | — | — | — | — | Not different from 0 |
| Bahamas | — | 5 | — | — | — |
| Bahrain | — | 3 | — | — | — |
| Bangladesh | Low | 5 | — | Rejects integration | — |
| Barbados | — | 4 | — | — | — |
| Benin | — | — | Different from 0 and 1 | — | — |
| Bhutan | — | — | — | — | Different from 0, but not large |
| Bolivia | High | 2 | — | Fails to reject integration; data quality B | — |
| Botswana | Intermediate | 3 | — | — | Not different from 0, and high |
| Brazil | — | 4 | Test rejects $b = 1$, but not $b = 0$ | — | — |
| Burkina Faso | — | 5 | — | — | — |
| Burundi | Intermediate | — | Different from 0 and 1 | Fails to reject integration; data quality D | — |
| Cameroon | Intermediate | — | Different from 0 and 1 | Fails to reject integration; data quality C | — |
| Cape Verde | — | 4 | — | — | — |
| Central African Republic | — | 4 | Not different from 0 or 1 | — | — |
| Chad | — | 4 | — | — | — |
| Chile | High | 2 | Test rejects $b = 1$ | Fails to reject integration; data quality C | Not different from 0 |
| Colombia | Intermediate | 4 | Intermediate range | Fails to reject integration; data quality B | Different from 0, but low |
| Congo | High | 1 | Intermediate range | Fails to reject integration; data quality D | — |
| Costa Rica | Intermediate | 1 | Intermediate range | Rejects integration | Different from 0, but low |
| Côte d'Ivoire | High | 2 | Intermediate range | Fails to reject integration; data quality C | — |

*(Table continues on the following page.)*

Table A-1. *(continued)*

| Country | Classification of the degree of financial integration | Gross-flow ratio measure group | Test results: Feldstein-Horioka b coefficient | Test results: Euler | Test results: Uncovered interest parity differential |
|---|---|---|---|---|---|
| Cyprus | Intermediate | 4 | — | Fails to reject integration; data quality B | Different from 0, and large |
| Dominica | — | 4 | — | — | — |
| Dominican Republic | High | 4 | Low | Fails to reject integration; data quality C | — |
| Ecuador | Intermediate | 2 | Test rejects $b = 1$, but not $b = 0$ | — | Not different from 0 |
| Egypt | Intermediate | 4 | Intermediate range | Fails to reject integration; data quality D | Different from 0 |
| El Salvador | Low | 4 | Test rejects $b = 1$, with low $b$ | Rejects integration | Different from 0 |
| Equatorial Guinea | — | — | — | — | Different from 0 |
| Ethiopia | Low | 5 | — | Rejects integration | Different from 0, but not large |
| Fiji | — | 4 | Test rejects $b = 1$, but not $b = 0$ | — | — |
| Gabon | High | 2 | Intermediate range | Fails to reject integration; data quality C | — |
| Gambia, The | High | 2 | Test rejects $b = 1$, but not $b = 0$ | Fails to reject integration; data quality D | Not different from 0 |
| Ghana | Low | 4 | Test rejects $b = 0$, but not $b = 1$ | Rejects integration | Different from 0 |
| Grenada | — | 3 | — | — | — |
| Guatemala | Intermediate | 4 | Test rejects $b = 1$, but not $b = 0$ | Rejects integration | Not different from 0 |
| Guinea-Bissau | — | 2 | — | — | — |
| Guyana | — | — | — | Fails to reject integration; data quality C | — |
| Haiti | Intermediate | 5 | — | Fails to reject integration; data quality C | — |
| Honduras | Low | 3 | Test rejects $b = 0$ | Rejects integration | Not different from 0 (would be rejected at slightly higher significance level) |
| India | Low | 5 | Test rejects $b = 0$, and $b$ is high | Rejects integration | — |

| Country | Classification of the degree of financial integration | Gross-flow ratio measure group | Test results: Feldstein-Horioka b coefficient | Test results: Euler | Test results: Uncovered interest parity differential |
|---|---|---|---|---|---|
| Indonesia | — | 5 | — | — | Not different from 0 |
| Iran | — | — | — | Rejects integration | — |
| Israel | High | 3 | — | Fails to reject integration; data quality A | Not different from 0 |
| Jamaica | High | 1 | — | Fails to reject integration; data quality C | Different from 0, and high |
| Kenya | Low | 4 | Different from 0, not different from 1 | Rejects integration | Different from 0 |
| Korea | Intermediate | 4 | — | Fails to reject integration; data quality B | Not different from 0 |
| Kuwait | — | 2 | — | — | — |
| Lesotho | Intermediate | 2 | Test rejects $b = 1$, but not $b = 0$ | — | Different from 0, and high |
| Liberia | — | — | — | Fails to reject integration; data quality D | — |
| Libya | — | 4 | — | — | — |
| Madagascar | Intermediate | 3 | Test rejects $b = 1$, but not $b = 0$ | Rejects integration | — |
| Malawi | Intermediate | — | Test rejects $b = 0$, but estimate is low ($b = 0.53$) | — | Different from 0 |
| Malaysia | Intermediate | 4 | Test rejects $b = 0$, and $b$ is very low (0.25) | Rejects integration | Different from 0 |
| Mali | — | 4 | Test rejects $b = 1$, but not $b = 0$ | — | — |
| Malta | — | — | Test rejects $b = 1$, but not $b = 0$ | — | — |
| Mauritania | Intermediate | 2 | Intermediate range | — | — |
| Mauritius | Low | 4 | Intermediate range | Rejects integration | Not different from 0, and high |
| Mexico | Intermediate | 4 | Test rejects $b = 1$, with very low $b$ | Rejects integration | Different from 0, but low |
| Morocco | Low | 4 | Test rejects $b = 1$, but not $b = 0$ | Rejects integration | — |

*(Table continues on the following page.)*

Table A-1. *(continued)*

| Country | Classification of the degree of financial integration | Gross-flow ratio measure group | Test results: Feldstein-Horioka b coefficient | Test results: Euler | Test results: Uncovered interest parity differential |
|---|---|---|---|---|---|
| Myanmar | — | — | — | Fails to reject integration; data quality C | — |
| Nepal | Low | — | Intermediate range | Rejects integration | Different from 0 |
| Nicaragua | — | 1 | — | — | — |
| Niger | Low | 4 | Test rejects $b = 0$, but not $b = 1$ | Rejects integration | — |
| Nigeria | Low | 4 | Test rejects $b = 0$, but not $b = 1$ | Fails to reject integration; data quality C | Not different from 0, but high |
| Pakistan | Intermediate | 5 | Test rejects $b = 1$, but not $b = 0$ | Fails to reject integration; data quality B | — |
| Panama | High | 1 | — | Fails to reject integration; data quality B | — |
| Papua New Guinea | Intermediate | 3 | Test rejects $b = 1$, but not $b = 0$ | — | — |
| Paraguay | Low | 4 | Test rejects $b = 1$ | Rejects integration | — |
| Peru | — | — | Test rejects $b = 1$ | — | — |
| Philippines | Low | 4 | Test rejects $b = 0$, but not $b = 1$ | Rejects integration | — |
| Rwanda | Low | 5 | Imprecise | Fails to reject integration; data quality D | Different from 0, and high |
| São Tomé and Principe | — | 1 | — | — | — |
| St. Kitts | — | 2 | — | — | — |
| St. Lucia | — | 3 | — | — | — |
| St. Vincent | — | 4 | — | — | — |
| Saudi Arabia | — | 3 | — | Rejects integration | — |
| Senegal | High | 3 | Test rejects $b = 1$, but not $b = 0$ | Fails to reject integration; data quality C | — |
| Seychelles | Intermediate | 3 | — | — | Different from 0, and very high |
| Sierra Leone | Intermediate | 3 | Test rejects $b = 1$, but not $b = 0$ | Rejects integration | Different from 0 |
| Singapore | High | 1 | — | Rejects integration | Not different from 0 |
| Somalia | — | 3 | — | Fails to reject integration; data quality D | — |

| *Country* | *Classification of the degree of financial integration* | *Gross-flow ratio measure group* | *Test results* | | |
|---|---|---|---|---|---|
| | | | *Feldstein-Horioka b coefficient* | *Euler* | *Uncovered interest parity differential* |
| South Africa | Low | 5 | — | Fails to reject integration; data quality D | Not different from 0, though high |
| Sri Lanka | Low | 4 | — | Rejects integration | Different from 0 |
| Sudan | — | 5 | — | Fails to reject integration; data quality D | — |
| Suriname | — | 5 | — | — | — |
| Swaziland | — | 3 | — | Fails to reject integration; data quality D | — |
| Syrian Arab Rep. | — | 4 | — | — | — |
| Tanzania | — | 4 | — | Fails to reject integration; data quality D | — |
| Thailand | Intermediate | 4 | — | Fails to reject integration; data quality C | Different from 0 |
| Togo | High | 2 | Test rejects $b = 1$, but not $b = 0$ | Fails to reject integration; data quality D | — |
| Tonga | — | 5 | — | — | — |
| Trinidad and Tobago | Intermediate | 4 | — | — | Different from 0, but not large |
| Tunisia | Low | 4 | Intermediate range | Rejects integration | — |
| Turkey | Intermediate | 4 | — | Fails to reject integration; data quality C | Not different from 0 |
| Uganda | Intermediate | 3 | Test rejects $b = 0$, but not $b = 1$ | — | — |
| Uruguay | High | 4 | Test rejects $b = 1$ | — | Not different from 0, and small |
| Venezuela | Low | 4 | Test rejects $b = 0$ | Rejects integration | Different from 0 |
| Western Samoa | — | 4 | — | — | — |
| Zaire | — | 4 | — | Fails to reject integration; data quality D | — |
| Zambia | — | 2 | — | Rejects integration | — |
| Zimbabwe | — | — | — | Fails to reject integration; data quality D | — |

— Not available.
*Source*: Author's calculations.

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# The Political Economy of Growth: A Critical Survey of the Recent Literature

Alberto Alesina and Roberto Perotti

*This article reviews the recent literature on the political economy of growth, focusing on the research that has developed at the intersection of the endogenous growth literature and the new political economy. It explores the relationships among four key variables: economic growth and capital accumulation, political instability, political freedom and democratic institutions, and income inequality.*

Two of the most active fields in economics in the past few years have been growth theory and political economy. Empirical and policy questions motivate both lines of research. The growth literature, with its new endogenous growth theories, analyzes economic factors such as education, openness, infrastructure, and government spending to determine which are more important or less important for growth. The political-economy literature argues that economics alone cannot fully explain the enormous variance across countries in growth and, more generally, in economic outcomes and policy choices. Political-economy models begin with the assertion that economic policy choices are not made by social planners, who live only in academic papers. Rather, economic policy is the result of political struggle within an institutional structure. The empirically oriented researcher and the policy adviser have to be well aware of how politics influences policymaking.

This article reviews the recent literature that has grown at the intersection of these two very active areas of research. Specifically, we analyze what we have learned and what puzzles are left unsolved in the area of the sociopolitical determinants of growth. We focus on the relationships among four key variables: economic growth and capital accumulation, political instability, political freedom and democratic institutions, and income inequality.[1]

1. For a more extensive, more technical, and less policy-oriented discussion of some of the same issues, see Alesina and Perotti (1994b).

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Both political scientists and economists have devoted decades to the study of these interactions (see Huntington 1968 and Hibbs 1973). We do not attempt to offer a comprehensive review of this literature. For more comprehensive surveys see Adelman and Robinson (1988) on income distribution and growth, and Roubini (1990) on democracy and growth. We focus on the more recent research efforts in this area. Several recent papers have investigated various links among subsets of the variables listed above: income distribution and growth; political instability and growth; political rights, democracy, and growth; and savings, investment, and political instability. By taking a more systematic view of the interactions among the variables, this article attempts to clarify how all these contributions to the literature fit together.

Section I discusses whether democratic institutions and, more generally, political rights foster or hinder economic growth. Section II discusses the relation between political instability and growth. The two key issues are how to define and measure political instability and how to account for the fact that neither of the two variables is exogenous to the other. Section III reviews the basic insights of several recent papers that have argued that income inequality is harmful for growth and reviews several theories linking income inequality and growth. Section IV discusses the empirical evidence on the effects of inequality on growth, in particular, whether or not the evidence can distinguish between alternative theories.

## I. Democracy and Growth

Do democracies grow faster than dictatorships? Do the noneconomic benefits of democratic institutions and civil liberties come at the price of low growth, or do civil liberties and democratic institutions foster economic development?

To answer these questions, we need to make a distinction between two, related definitions of democracy. The first identifies a democracy as a nation with regular, free, competitive (multiparty) elections. The second focuses on the amount of civil and economic liberties available to the population. The two definitions are not identical. In fact, some dictatorships that are certainly undemocratic according to the first criterion grant a fair amount of individual, and especially economic, rights to their citizens. The "four dragons" in Southeast Asia (Hong Kong, the Republic of Korea, Singapore, and Taiwan, China) are a good example.

Consider the first definition of democracy. Why should free, multiparty competition negatively influence growth? Perhaps with political freedom various pressure groups have a voice in the political arena. Their demands for redistributive policies may imply legislative deadlocks. Or their demands may be resolved by increasing the size of the government, in particular, the size of distributive programs rather than of productive expenditure. Furthermore, democratic institutions may be slow in responding to external shocks. Finally, in their efforts to

be reelected, incumbent politicians may engage in suboptimal and shortsighted policies.[2]

Each of these arguments, however, has a rebuttal. Even dictators need to please various constituencies to avoid being overthrown (Ames 1987). Redistributive struggles between various socioeconomic groups can occur in various forms even without democratic institutions. In fact, where there is no constitutional way to change leaders, political change often requires violence and disruption of market activities. Thus, other things being equal, there seems to be no obvious correlation between democracy and growth.

The recent empirical literature on this point is fairly unanimous in finding inconclusive results. Controlling for the economic determinants of growth, democracy has no effect on growth, either positive or negative. This result appears in several papers that have looked at cross-country regressions. Helliwell (1992), the most recent detailed study using this definition of democracy, reports inconclusive results. Alesina and others (1992) and Alesina and Rodrik (1994) report similar findings.

The explanation for these inconclusive results is that the (large) group of dictatorships is not homogeneous at all: several dictatorships (particularly in Southeast Asia) have done rather well in terms of growth; many others (particularly in Africa and Latin America) have done much less well. By contrast, the group of democracies is more homogeneous: the democracies have done much better than the worst dictatorships but not as well as some of the most successful dictatorships.

The group of dictatorships may be disaggregated by differentiating the truly kleptocratic ones from the more benevolent. The truly kleptocratic dictatorships include those rulers who have aimed at maximizing their personal wealth and the welfare of their clan and close supporters and have to a large extent disregarded social welfare. The more benevolent dictatorships include the dictators who have followed policies favorable to the socioeconomic development of their countries. The problem of this exercise, of course, is that it becomes close to a tautology: growth is high in dictatorships that enhance growth and low in dictatorships that follow suboptimal policies.

The pattern of correlations among democracy, income, and education raises the additional problem of difficulties in disentangling cause and effect (see Helliwell 1992). Table 1 reports sample means for variables measuring democracy, the rate of growth of gross domestic product (GDP), and education for selected groups of countries. It is quite clear from the table that democracy, GDP per capita, and education are highly correlated: rich countries are democratic and have high levels of education.

2. On pressure groups and lobbying, see Krueger (1974), Bhagwati (1982), and Mueller (1979). On fiscal deadlocks, see Alesina and Drazen (1991), and Spolaore (1993). For a survey of political business cycle models, see Alesina (1994). For a survey of models of budget deficits which, among other things, emphasize fiscal deadlocks, see Alesina and Perotti (1994a).

Table 1. *Democracy, Growth in GDP, and Primary Education in Selected Groups of Countries, 1960–82*

| *Variable* | *All countries* | *Latin America* | *Africa* | *Asia* | *Industrial countries* | *Developing countries in Europe*[a] |
|---|---|---|---|---|---|---|
| Democracy[b] | 2.24 | 2.18 | 2.83 | 2.33 | 1.07 | 2.33 |
| Rate of growth of per capita GDP (average annual percent) | 0.024 | 0.022 | 0.015 | 0.033 | 0.029 | 0.041 |
| Primary school enrollment rate, 1960 (percentage of school-age children) | 0.827 | .963 | .625 | .826 | 1.020 | 0.995 |
| Per capita GDP in 1960 | 2,626 | 2,170 | 881 | 3,379 | 6,021 | 1,879 |
| Number of countries | 113 | 24 | 41 | 21 | 21 | 6 |

*Note*: The regional breakdowns use the IMF coding system.

a. Cyprus, Greece, Malta, Portugal, Turkey, and Yugoslavia.

b. A dummy variable that takes the value 1 for democratic regimes, 2 for regimes mixing democratic and authoritarian features, and 3 for authoritarian regimes.

*Source*: Alesina and others (1992); Banks (various issues).

The second definition of democracy does not focus only on elections; rather, it focuses more generally on civil and economic rights. The most widely used index of civil liberties is the Gastill index, which ranks countries in seven groups. As with the first definition of democracy, arguments can be made that are consistent with either a positive or a negative correlation between civil liberties and growth. On the one hand, economic liberty fosters entrepreneurship, market activities, and growth. On the other hand, more civil liberties may translate into more conflicts over distribution. Results by Barro (1991) and Ozler and Rodrik (1992) suggest that, in fact, civil liberties are conducive to growth and capital accumulation.

Measures of restrictions on capital mobility, trade restrictions, or other measures of economic regulations can be used as indicators of economic rights. It is straightforward to argue that less regulation and fewer obstacles to individual market activities should spur growth. For instance, the black-market premium could be a proxy for economic freedom. The problem with these concepts of economic liberty, however, is that the results obtained by using them are virtually undistinguishable from statements such as "economic inefficiencies are bad for growth." It is not completely clear whether these results on economic freedom imply something other than the fact that economic inefficiencies are not conducive to growth.

In summary, there is no evidence that, on average, a democracy with civil liberties is costly in terms of economic development. If anything, it may be the other way around, that a democracy with civil liberties promotes economic development. This result is encouraging in view of the democratization process that has swept the world in the past decade, not only in Eastern Europe but also

in large parts of the developing world. But establishing democratic institutions is not the "deus ex machina" that resolves all the problems of development. A sound and stable political-economic climate is essential.

## II. Political Instability and Growth

Quantitative studies of the relation between political instability and growth have to tackle two major issues. The first is how to define political instability. The second is how to deal with joint endogeneity. Does political stability foster growth? Or does growth foster political stability? Or do political stability and growth reinforce each other?

Researchers have defined and measured political instability in two ways. The first way uses an index of sociopolitical unrest that summarizes several indicators of more or less violent forms of political protest and social violence. The second way focuses on executive turnover, namely, on the frequency of government collapses.

The first measure, which we label the sociopolitical instability (SPI) approach, begins with a list of variables that identify events such as riots, political demonstrations against the government, and assassinations (see Taylor and Jodice 1983 and Banks various issues). The researcher must then construct an aggregate index that projects in one dimension this multitude of variables. A statistical technique that leads to this type of reduction from a multidimensional set of variables to a single one is the method of principal components. The classic reference for this approach is Hibbs (1973). In his large multiequation study, Hibbs finds that political instability has no effects on growth. Venieris and Gupta (1986) use the method of principal components to construct an SPI index and show that SPI has a negative effect on the saving rate. However, the index of sociopolitical instability they use has some serious problems. One of the components of their index is a dummy variable for democratic regimes. The weight of this democracy variable is so large that the SPI index is almost totally dominated by a classification of countries in the democracy or nondemocracy categories.

Using measures similar to those of Venieris and Gupta, Ben-Habib and Spiegel (1992) argue that sociopolitical instability reduces investment. However, their empirical results are not very strong.

The concept of SPI has proven quite powerful in explaining other phenomena, especially in developing countries. For example, Ozler and Tabellini (1992) show that more instability leads to an increase in external debt in developing countries. Rather than constructing a specific index, Barro (1991) adds two political variables—the frequency of coups d'etat and the number of political assassinations—in his cross-sectional growth regressions and finds that they negatively influence growth. Easterly and Rebelo (1993) find similar results.

The second approach to modeling political instability focuses on executive turnover. This executive instability approach begins by using probit regressions to estimate the propensity of a government to collapse. The independent vari-

ables in these regressions are political variables (protests, riots, executive reshuffling), economic variables (past growth, inflation), and institutional variables (whether the country is a democracy or not, the type of electoral system). A high estimate of the probability of a change of government is viewed as an indicator of executive instability.

Before executive turnover was applied in the growth literature, Cukierman, Edwards, and Tabellini (1992) had used this measure of instability in regressions where the dependent variable is inflation. They conclude that political instability increases inflation. Edwards and Tabellini (1991) pursue this line of research further and show that executive instability leads to myopia in fiscal policy decisions in that unstable executives borrow more heavily than stable ones. Goodrich (1991) finds that in developing countries foreign direct investments are negatively affected by this measure of executive instability.

An important problem that many of these contributions do not formally address is the joint endogeneity of political instability and growth or inflation (exceptions are Hibbs 1973 and Gupta 1990). Economic variables such as growth and inflation can explain the propensity of government changes, which, in turn, are used as an explanatory variable for economic outcomes. Clearly, problems of simultaneity and reverse causality abound.

Londregan and Poole (1990), using results by Heckman (1978), suggest a clever way of dealing with these problems. They estimate a two-equation model. One equation is a probit regression where the dependent variable captures the occurrence of coups d'etat. The dependent variable in the second equation is growth in per capita income. Londregan and Poole find that poverty and, to some extent, low growth increase the likelihood of coups. Furthermore, coups d'etat are persistent in that past coups increase the likelihood of future coups. Thus, if a country has a history of coups, it is likely to experience more coups in the future. And, somewhat surprisingly, they find that the propensity to have a coup does not reduce growth. Londregan and Poole (1992) confirm these results using a different sample and estimation techniques.

Alesina and others (1992) adopt Londregan and Poole's (1990) technique but use different specifications for both the growth equation and the executive change equation. First, they control for many more economic determinants of growth. Second, they focus not only on coups but on a broader definition of "government changes," which also includes constitutional changes of the executive. They consider the following as three separate variables: (a) every government change; (b) major changes in government, a subset of changes involving a substantial turnover in the political composition of the executive, that is, major government changes including all the coups plus a fraction of constitutional major cases of government changes (see Alesina and others 1992); and (c) coups d'etat. Although Alesina and others (1992) confirm Londregan and Poole's results on the effects of poverty on coups, they find, contrary to Londregan and Poole, that a high propensity to executive instability reduces growth. This result is quite robust and holds in several different specifications of the system. Recent

results by Block-Blomberg (1992) confirm the findings of Alesina and others (1992) on this point.

Tables 2 and 3, taken from Alesina and others (1992), present statistics that highlight the basic results. From table 2, the average frequency of government changes for the sample of all countries is 0.28; that is, governments change on average about every three years. The frequency of major government changes is 0.11, and the frequency of irregular government changes (military coups) is about 0.048. Military coups are most frequent in Latin America (0.078) and Africa (0.057) and practically nonexistent in industrial countries. Latin America has an average frequency of total government changes (0.29) similar to the world average, but it has the highest frequency of major government changes (0.16) and of military coups (0.078) in the world.

In Africa, total government changes (and in particular nonmajor ones) are quite unlikely. African countries are typically authoritarian regimes with very few regular elections and changes in power. Executive changes mostly take the form of major changes (0.11), of which military coups are more than half (0.06). Finally, in Asia, government changes are close to the world average (0.30), but major government changes are much lower than in any other region. Moreover, with the exclusion of the industrial countries, the frequency of coups is lowest in Asia. These data confirm the view of Asia as a region with authoritarian but stable political regimes.

Table 3 presents the average annual per capita rate of growth of GDP, separately for the years with and without government changes. The rate for all countries in years without government changes is 2.8 percent, but in years with

Table 2. *Democracy, Growth in GDP, and Average Frequency of Changes in Government in Selected Groups of Countries, 1960–82*

| *Variable* | *All countries* | *Latin America* | *Africa* | *Asia* | *Industrial countries* | *Developing countries in Europe*[a] |
|---|---|---|---|---|---|---|
| Change in government | 0.28 | 0.29 | 0.21 | 0.30 | 0.39 | 0.37 |
| Major changes in government | 0.11 | 0.16 | 0.11 | 0.07 | 0.12 | 0.16 |
| Military coup | 0.048 | 0.078 | 0.057 | 0.040 | 0.00 | 0.058 |
| Democracy[b] | 2.24 | 2.18 | 2.83 | 2.33 | 1.07 | 2.33 |
| Rate of growth of per capita GDP (average annual percent) | 0.024 | 0.022 | 0.015 | 0.033 | 0.029 | 0.041 |
| World growth rate | 0.029 | n.a. | n.a. | n.a. | n.a. | n.a. |
| Number of countries | 113 | 24 | 41 | 21 | 21 | 6 |
| Number of observations | 2,592 | 552 | 943 | 476 | 483 | 138 |

n.a. Not applicable.

*Note*: The regional breakdowns use the IMF coding system.

a. Cyprus, Greece, Malta, Portugal, Turkey, and Yugoslavia.

b. A dummy variable that takes the value 1 for democratic regimes, 2 for regimes mixing democratic and authoritarian features, and 3 for authoritarian regimes.

*Source*: Alesina and others (1992); Banks (various issues).

Table 3. *Average Annual Per Capita Growth in GDP in Years with and without Changes in Government in Selected Groups of Countries, 1960–82*
(percent)

| *Item* | *All countries* | *Latin America* | *Africa* | *Asia* | *Industrial countries* | *Developing countries in Europe*[a] |
|---|---|---|---|---|---|---|
| *Years without government change* | | | | | | |
| Growth rate | 2.8 | 2.4 | 2.0 | 2.9 | 3.9 | 5.2 |
| Number of observations | 1,860 | 393 | 745 | 295 | 340 | 87 |
| *Years with government change* | | | | | | |
| Growth rate | 1.3 | 1.5 | −0.4 | 2.7 | 1.7 | 2.0 |
| Number of observations | 739 | 159 | 198 | 188 | 143 | 51 |
| *Years with major government change* | | | | | | |
| Growth rate | 0.1 | 0.2 | −1.9 | 2.3 | 1.4 | 1.3 |
| Number of observations | 299 | 86 | 100 | 57 | 34 | 22 |
| *Years with coups* | | | | | | |
| Growth rate | −1.3 | −0.6 | −2.7 | 1.3 | — | −2.2 |
| Number of observations | 125 | 43 | 54 | 20 | 0 | 8 |

— Not available.
*Note*: The values are average per capita growth rates in country-years in percent.
a. Cyprus, Greece, Malta, Portugal, Turkey, and Yugoslavia.
*Source*: Alesina and others (1992).

government change, the rate is only 1.3 percent. The difference is even stronger for major government changes, when average annual growth is 0.1 percent. The growth gap is largest and most striking for years with coups, when the average annual country GDP growth rate is −1.3 percent.

The other columns of table 3 show that the same empirical observations are common to every region of the world. Growth is, on average, highest in years with no change, lower in years with government change, still lower in years with major change, and lowest in years with coups. Note, however, that in years with coups, growth is substantially higher in Asia than in every other region of the world.

Mauro (1993) and Knack and Keefer (1993) use another measure of political instability: subjective indexes collected by private organizations that are monitoring countries. These indexes are typically used by international investors to evaluate country risk. Both Mauro and Knack and Keefer report that instability has negative effects on investment and growth. They also find that subjective indexes of corruption and the quality of bureaucracy are negatively associated with growth. One problem is that measures of corruption are highly correlated with measures of instability. Whether or not these subjective measures provide

any additional information beyond actual observations of sociopolitical variables remains to be seen.

In summary, the following picture emerges. Poor countries are sociopolitically unstable. Since political instability reduces the incentives to save and invest and therefore reduces growth, poor countries may fall into a vicious circle. They are unstable because they do not manage to become rich, and they do not manage to become rich because they are politically unstable.

A somewhat different view has been put forward by Huntington (1968), who concentrates on the causal link from growth to sociopolitical instability. He argues that it is not always true that all good things go together. When poor countries experience a period of takeoff and rapid growth, social unrest may actually increase. New demands are generated, the process of urbanization accelerates, and the entire society is in turmoil. This is not in general true for those rich countries that, for some reason, experience a period of high growth. Rich countries, unlike poor ones, already have the institutions in place to cope with social and economic transformations. Therefore, according to Huntington, the relation between instability and growth is nonlinear, and its sign depends on the level of development. It is positive for poor economies and negative for richer economies.

The results of this section and the previous section lead to two interesting observations. First, growth is influenced not so much by the nature of the political regime (democracy or dictatorship) as by the stability of the political regime. Second, transitions from dictatorship to democracy, being associated with sociopolitical instability, should typically be periods of low growth. The social demands that were repressed under unconstitutional rule are likely to explode at the beginning of a new democratic regime. Until the new democratic regime is consolidated, it may face tremendous pressure to accommodate the conflicting demands of different groups.

In addition, collapsing dictatorships are likely to bequeath to their successors serious economic problems for two reasons. First, poor economic performance is likely to be one of the causes of the collapse of the old regime. Second, collapsing dictators may follow very shortsighted policies because they have no future in office. Haggard, Shariff, and Webb (1990) and Haggard and Kaufman (1989) document that countries in transition perform worse in terms of many economic indicators than either established democracies or strong (established and not-collapsing) dictatorships.

## III. Income Distribution and Growth: Theory

Starting from the theories of Kuznets and Kaldor, the development economics literature has hotly debated the relation between income distribution and growth (for a survey, see Adelman and Robinson 1988). Recent contributions to the literature are characterized by their close connection with the new theories of endogenous growth and a focus on previously neglected links from income distribution to growth, rather than from growth to income distribution.

In what follows, we concentrate on political links from income distribution to growth. There are, however, important nonpolitical links. One purely economic link pointed out by Murphy, Shleifer, and Vishny (1989) is that income distribution can influence growth by affecting the size of domestic demand and, as a consequence, the potential for industrialization. Another nonpolitical channel stresses the role of imperfect capital markets. In perfect capital markets, anyone could borrow for education against expected future earnings. However, with imperfect capital markets, imperfect information about individual abilities and imperfect enforcement of loans severely restrict the option of borrowing for education. Thus, most people heavily rely on their own resources to invest in education, and the initial distribution of personal resources determines how many agents can invest and, as a consequence, the resulting rate of growth of the economy. Important contributions to this line of research are Galor and Zeira (1993), Banerjee and Newman (1991), and Aghion and Bolton (1991).

Three political channels link income inequality and growth. In the first political channel, the distribution of resources is linked to large incentives for the poor to engage in rent-seeking activities, which hinder investments and growth (Ben-Habib and Rustichini 1991). Fay (1993) shows that the more unequal the distribution of income, the larger the number of people who engage in illegal activities that pose a threat to property rights. In what follows, however, we focus more on the second and third political channels: the fiscal channel and the political instability channel.

In the fiscal channel, the level of government expenditure and taxation is the result of a voting process in which income is the main determinant of a voter's preferences; in particular, poor voters will favor a high level of taxation. This line of research generalizes the static models of voting on the tax rate by Romer (1975), Roberts (1977), and Meltzer and Richard (1981) to a dynamic context. The poor will either pay a lower share of taxes or will disproportionately benefit from government spending. In a society with income inequality, thus with many poor agents, the majority of voters will vote for high taxation, which will discourage investment and therefore growth.

Alesina and Rodrik (1994), Bertola (1993), and Persson and Tabellini (1991) are three contributions in the literature on the fiscal channel. Despite some differences in the specifics of the models, these three papers share a common structure. Each consists of an economic mechanism and a political mechanism (for a more complete survey of these models, see Perotti 1992). The former describes the effects of fiscal policy on growth. The latter describes how income distribution determines fiscal policy (taxes and government expenditure) through the voting process.

The papers differ in the type of government expenditure they consider: public investment (Alesina and Rodrik), redistribution from capital to labor (Bertola), and purely redistributive transfers (Persson and Tabellini). The common element is that whenever the share of government expenditure in GDP rises, the accompanying increase in taxation reduces the after-tax marginal product of capital

that can be appropriated by private investors. This reduces the rate of accumulation of capital and therefore growth. The distribution of initial resources comes into play because it helps explain how these types of government expenditures are determined.

In Alesina and Rodrik (1994), the key distributional variable is the relative share of labor endowment and capital endowment, which is monotonically related to the distribution of income. The economic mechanism is that public investment is financed by proportional taxation of capital income. Therefore, when taxes increase in order to finance more public investment, the after-tax return from private capital investment decreases. This effect tends to decrease the rate of investment and therefore the rate of growth of an economy. The political mechanism is that the higher the proportion of capital income in an individual's total income (or, equivalently, the higher the individual's total income), the higher the price the individual has to pay for the benefits of public investment and therefore the lower the individual's preferred tax rate. According to the median voter theorem, when agents vote on the tax rate, the level of taxation preferred by the median agent in the distribution of resources will prevail over all the other proposed tax rates.

Combining the economic and the political mechanisms, the higher the proportion of capital income to total income of the median voter, the lower the tax rate chosen by the voting process and the higher the rate of investment and growth. In terms of income distribution, the poorer the median voter in relation to the voter with average income, the higher the equilibrium tax rate and the lower the growth rate. Therefore, the model of Alesina and Rodrik (1994) implies an inverse relationship between growth and inequality in income or wealth.

Bertola (1993) also focuses on the functional distribution of income, but the economic mechanism is different. Revenues from taxation are used for redistribution, not for infrastructure investment. Capital income is taxed, and the proceeds are directly redistributed to agents who derive their income from labor. The effect of a higher level of taxation is then similar to the Alesina and Rodrik model. The higher level of taxation decreases the after-tax marginal product of capital that an investor can appropriate and therefore decreases investment and growth. The political mechanism is also similar to that of Alesina and Rodrik. The higher the proportion of capital income to labor income, the more an individual has to lose from a proportional tax rate on capital that is redistributed to the individual in proportion to the individual's labor income. Thus, the tax rate that prevails through the voting process is again a negative function of the wealth-labor ratio of the median voter. Combining the two mechanisms yields the same reduced-form prediction as in Alesina and Rodrik. The higher the wealth-labor ratio of the median voter, the higher the rate of growth of the economy. This can be translated into the testable prediction that there should be a positive association between the income of the median voter and the rate of growth of the economy.

Persson and Tabellini (1991) also analyze the effects of redistributive policies, but they focus on redistribution from rich agents to poor agents rather than from capital to labor. The relevant concept is the distribution of personal income. In the economic mechanism, agents work and invest in human capital. Taxes are proportional to income, and the revenues are redistributed lump-sum to all agents. Again, higher taxes discourage investment in human capital and therefore reduce growth. As to the political mechanism, because taxes are redistributed lump-sum, poor voters pay a relatively small amount in taxes but receive the same benefits as rich voters. This means that the tax rate favored by an individual is inversely related to the individual's income. When preferences are aggregated through the voting process, the implication is that the poorer the median voter relative to the average, the higher the tax rate and again the lower the rate of investment and growth.

Perotti (1993b) and Saint-Paul and Verdier (1991) study the effects of income distribution on growth in a similar manner. In both papers the agents vote on the level of government expenditure, and growth is driven by the accumulation of human capital, but the mechanisms in the two papers are different. In Perotti, individuals vote on the level of purely redistributive transfers that determine the post-tax income of the agents of the economy and therefore who can privately invest in education. In turn, this determines the rate of accumulation of human capital. In Saint-Paul and Verdier, agents vote on public expenditure on education, which is the channel through which income distribution affects the accumulation of human capital.

The third political mechanism linking income distribution and growth, the instability channel, emphasizes the effect of income inequality on social unrest. This hypothesis stresses two links. The first link is from income distribution to political instability, and the second link is from political instability to growth. A large group of impoverished citizens, facing a small and very rich group of well-off individuals, is likely to become dissatisfied with the existing socioeconomic status quo and demand radical changes. As a result, mass violence and illegal seizures of power are more likely the more unequal the distribution of income is.

The idea is that income inequality is an important determinant of sociopolitical instability. Countries with more unequal income distribution are more politically unstable. In turn, as argued in the preceding section, sociopolitical instability has adverse effects on growth. The instability channel is certainly not a novelty (see, for instance, Huntington 1968); however, Alesina and Perotti (1993) have formulated this hypothesis in a quantitatively testable way (see also Gupta 1990).

In summary, the fiscal and political instability channels imply that income inequality is an obstacle to growth. Both channels have the same reduced-form implications. They both imply that after controlling for other determinants of growth, in a cross-section growth regression, the measure of income inequality should have a negative coefficient. The interpretation of this coefficient, however, depends on which channel is used.

## IV. Income Distribution and Growth: Some Evidence

The reduced-form regressions in Alesina and Rodrik (1994) and Persson and Tabellini (1991) show an inverse relationship between income inequality and growth. Table 4 presents an example of the results from this kind of regression. The two measures of the distribution of income and wealth are the Gini coefficient of income and the Gini coefficient of land distribution. (Other and more comprehensive measures of wealth are not available for a sufficiently large number of countries.) Both variables are measured on or around 1960. The theory implies that initial income distribution affects subsequent growth; in turn, growth may also influence the evolution of income distribution. The three samples of countries refer to two different data sets for the Gini coefficient of income and another for the Gini coefficient of land distribution (see Alesina and Rodrik 1994 for more details).

Table 4. *Income Distribution and Growth in Sample Groups of Countries, 1960–82*

| | *High-quality sample (46 countries)* | *Largest-possible sample (70 countries)* | *Largest-possible sample* | | | |
|---|---|---|---|---|---|---|
| | | | *(49 countries)* | *(41 countries)* | | |
| *Variable* | *(1)* | *(2)* | *(3)* | *(4)* | *(5)* | *(6)* |
| Constant | 3.60 | 1.76 | 3.71 | 6.22 | 6.24 | 6.21 |
| | (2.66) | (1.50) | (3.86) | (4.69) | (4.63) | (4.61) |
| GDP in 1960 | −0.44 | −0.48 | −0.38 | −0.38 | −0.39 | −0.38 |
| | (−3.28) | (−3.37) | (−3.61) | (−3.25) | (−3.06) | (2.95) |
| Primary school enrollment rate, 1960 | 3.26 | 3.98 | 3.85 | 2.66 | 2.62 | 2.65 |
| | (3.38) | (4.66) | (4.88) | (2.66) | (2.53) | (2.56) |
| Gini coefficient of income, 1960 | −5.70 | −3.58 | | −3.47 | −3.45 | −3.47 |
| | (−2.46) | (−1.81) | | (−1.82) | (−1.79) | (−1.80) |
| Gini coefficient of land distribution, 1960 | | | −5.50 | −5.23 | −5.24 | −5.21 |
| | | | (−5.24) | (−4.38) | (−4.32) | (−4.19) |
| Interactive term between democracy and land distribution[a] | | | | | 0.12 | |
| | | | | | (0.12) | |
| Democracy[b] | | | | | | 0.02 |
| | | | | | | (0.05) |
| $\bar{R}^2$ | 0.28 | 0.25 | 0.53 | 0.53 | 0.51 | 0.51 |

*Note*: Ordinary least squares was used. The dependent variable is average per capita growth rate during 1960–85. t-statistics are in parentheses.

a. Combines democracy with the Gini coefficient on land distribution.

b. A dummy variable that takes the value 1 for democratic regimes, 2 for regimes mixing democratic and authoritarian features, and 3 for authoritarian regimes.

*Source*: Alesina and Rodrik (1994).

The negative coefficients on the two Gini variables are consistent with the theory that more inequality reduces growth. The other control variables, GDP in 1960 and the primary school enrollment rate in 1960, are standard in the growth literature, and their coefficients have the expected sign and order of magnitude. They indicate that there is a certain amount of conditional convergence and that human capital increases growth.

The fifth column in table 4 adds an interactive term for democracy and the Gini coefficient on land distribution.[3] This term is meant to capture an additional implication of the fiscal channel, which emphasizes voting as the mechanism that links inequality to fiscal policy to growth. Because the theory relies on voting, it should be particularly applicable to democracies, and less so to dictatorships. The insignificant coefficient on this interactive term suggests that in this respect there is no difference between the two types of regimes. One interpretation of this result is that the fiscal channel with its voting mechanism is rejected by the evidence. The second, and more reasonable, interpretation is that the concept of voting in these models should not be interpreted too literally. To put it differently, the pressure for fiscal redistributions arising from a large impoverished majority of citizens affects not only democratically elected representatives, but, also, to some extent, dictators.

Clarke (1993) finds that the effect of inequality on growth is robust across different measures of inequality and different specifications of the growth regression. He also generally finds no differences in the effects of inequality in democracies and dictatorships. Easterly and Rebelo (1993) present similar results, also reporting no significant differences between democracies and nondemocracies.

Persson and Tabellini (1991) use a different data set and somewhat different specifications and also find that inequality is harmful to growth. They also find, however, that, in their sample and with their data, the effect of inequality on growth is stronger in democracies than in nondemocracies. The latter result is directly supportive of the fiscal and voting channel; however, the robustness of the result is rather unclear.

In summary, there is relatively robust evidence that initial income inequality and subsequent growth are inversely related. The next step is a more precise investigation of which channel links these two variables.

An investigation of the fiscal channel requires introducing a fiscal policy variable, which is influenced by income distribution and which, in turn, affects growth. The difficulty in pursuing this analysis is that the redistributive policy instruments may vary across countries and time periods. In some cases, progressive taxation of labor income is the instrument; in other cases, the composition of government spending; and still in others, trade policy. It may be hopelessly restrictive to focus on one specific policy tool to test these models of

3. Note that Alesina and Rodrik (1994) define their democracy variable as a zero-one dummy variable; the variable in the table is thus slightly different from the one discussed previously in this article.

income distribution and growth. Nevertheless, it may be instructive to study the transmission mechanism from income distribution to growth, while keeping in mind that all the results have to be evaluated considering the important caveats above.

Perotti (1993a) and Alesina and Perotti (1994b) consider the fiscal variable "transfers" as the link between income distribution and growth. Perotti (1993a) estimates a system of two equations where the dependent variables are transfers and growth (or private investment). A measure of income inequality (in addition to other controls) is introduced in the transfer equation. Thus the key coefficients are those of income inequality on transfers and those of transfers on growth.

The results are rather disappointing for the theory. The two coefficients are generally insignificant and have the wrong sign. These inconclusive results hold both for democracies only and for the entire sample of countries. Sala i Martin (1992) also finds that transfers are positively rather than negatively associated with growth.

Perhaps these disappointing results arise from the fact that direct transfers are not the only or even the most important channel through which redistribution occurs. The composition of public expenditure in different programs, the degree of progressivity of the tax system, and the relative shares of income taxes and property taxes are only a few of the many channels that fiscal redistributions can take. Easterly and Rebelo (1993) address some of these issues, and some of their results are more consistent with the models by Alesina and Rodrik (1994), Persson and Tabellini (1991), and Bertola (1993) than with Perotti's evidence on transfers.

For instance, Easterly and Rebelo find that in a large sample of countries for the period 1970–88, income inequality before 1970 was associated with higher income taxes and more publicly provided education. Thus, public education might be the channel through which income inequalities are mitigated. In the Alesina and Rodrik model, in fact, redistribution can occur through an increase in the (productive) role of government, which raises labor productivity and therefore the real wage. Easterly and Rebelo's results could be interpreted as an indication that public education is, in fact, an operative channel. Engen and Skinner (1992) present another piece of evidence that is consistent with the direction of the effects of fiscal policy in the Alesina and Rodrik model. They find that after correcting for problems of endogeneity of fiscal policy in a sample of 107 countries for the period 1970–85, a balanced budget increase in government spending and taxation reduces growth.

In summary, the evidence is inconclusive on the fiscal channel. There are some positive and some negative results. A more systematic and comprehensive research effort on the fiscal channel is needed.

Alesina and Perotti (1993) have explicitly investigated the instability channel. They construct an index of sociopolitical instability by applying the method of principal components to the following variables: the number of politically moti-

vated assassinations, the number of people killed in conjunction with phenomena of domestic mass violence, the number of successful coups, the number of attempted but unsuccessful coups, and a dummy variable that identifies democracies.

The variables for assassinations and the number of people killed capture phenomena of mass violence as well as violent and illegal forms of political expression. The variables for successful and unsuccessful coups capture illegal and violent transfers of executive power, successful or attempted. The dummy variable for democracy is included mainly because of reporting problems. In most dictatorships the government controls the press and restricts the diffusion of information, particularly abroad; thus, for propaganda reasons, measures of sociopolitical unrest are likely to be underreported. The inclusion of the dummy variable for democracy is also advisable because dictatorships are much more prone to be overthrown by extremists than are stable democracies. That is, for the same level of observed political violence, the likelihood of a violent, unconstitutional overthrow of the government with a breakdown of legality is higher in a dictatorship.

Alesina and Perotti (1993) obtain an index of sociopolitical instability, SPI, which is a linear combination of the above-mentioned variables, with weights given by the principal components method. The computed index appears reasonable, and none of the individual components has an overwhelming weight. The SPI index is related, but far from identical, to other indexes recently proposed by Venieris and Gupta (1986) and Gupta (1990).

Alesina and Perotti (1993) then estimate a system of equations in which the two left-hand variables are the SPI index and investment. Table 5 reports a typical example of these estimates. The authors discuss in more detail the specification of the two-equation system and the identifying assumptions. The specification of the investment equation heavily draws on Barro (1991).

The two critical coefficients are those of the middle class variable (the share of income of the third and fourth quintiles of the population in GDP in 1960) in the SPI equation and of the SPI variable in the investment equation. For both coefficients the sign is consistent with the theory, and both coefficients are statistically significant at conventional levels. The magnitude of these coefficients is also significant. An increase by one standard deviation of the share of the middle class causes a decrease in the index of sociopolitical instability of about 3.3, which is about one-quarter of the standard deviation of the index. This decrease in the index of political instability in turn causes an increase in the share of investment in GDP of about 1 percentage point.[4] These effects are not negligible; the difference between the highest and lowest value of the middle class variable in the sample is about four standard deviations. An exogenous increase in the SPI

4. The specific system shown in table 5 does not include a dummy for Latin America. When this dummy is included, for some but not all specifications, the coefficient of the middle class variable on SPI becomes insignificant (the t-statistics $t \cong -1.3$). This is because the variable is highly correlated with the regional variable for Latin America. See Alesina and Perotti (1993) for further discussion of this point.

Table 5. *Estimation Results for the Investment and Sociopolitical Instability Equations, 1960–82*

| *Variable* | *Investment equation* | *Sociopolitical instability equation* |
|---|---|---|
| Constant | 20.75 | 31.98 |
| | (5.34) | (2.93) |
| Primary school enrollment rate, 1960 | 0.09 | −0.19 |
| | (2.64) | (−1.78) |
| Sociopolitical instability index | −0.45 | |
| | (−2.62) | |
| Deviation of the investment deflator[a] | 3.90 | |
| | (0.68) | |
| Investment deflator in 1960 (U.S. = 1.0)[b] | −12.81 | |
| | (−3.61) | |
| GDP in 1960 | | −2.26 |
| | | (−1.93) |
| Middle class share of GDP, 1960[c] | | −0.62 |
| | | (−2.20) |
| Ratio of real domestic investment to real GDP, 1960–85 average | | 0.55 |
| | | (1.03) |
| Asia dummy | | −7.78 |
| | | (−1.37) |
| Africa dummy | | −8.62 |
| | | (−1.94) |
| s.e.e. | 6.30 | 11.54 |

*Note*: The table presents the results of two-stage least squares estimation; t-statistics are in parentheses. Estimates using three-stage least squares are very similar. The sample includes seventy observations.

a. Deviation of the purchasing power parity value for the investment deflator from the sample mean in 1960.

b. Purchasing power parity value of the investment deflator (U.S. = 1.0) in 1960.

c. The share of income of the third and fourth quintiles of the population in GDP in 1960.

*Source*: Alesina and Perotti (1993).

index by one standard deviation causes a decrease in the share of investment in GDP of about 4 percentage points. All the other coefficients in the two equations are sensible and consistent with previous results (for instance, Barro 1991).

Alesina and Perotti (1993) also show that results favorable to the instability channel are quite robust to changes in the specification of the system of equations and in the specification of the SPI index. For instance, they find very similar results when they use the SPI index proposed by Gupta (1990).[5]

These results have both positive and normative implications. From a positive point of view, they suggest an argument that might help explain different investment and growth performances in different parts of the world. Several countries in Southeast Asia have had very high growth rates in the post–World War II period. In the aftermath of the war these countries had land reforms that re-

5. Gupta's (1990) index is similar to the one constructed by Alesina and Perotti (1993) but includes a larger number of variables. Note that with Gupta's SPI index, the issues concerning the Latin American dummy variable discussed in footnote 4 disappear. The coefficient of the middle class variable remains highly significant even when the Latin American dummy is added in the regression.

duced income and wealth inequality. Furthermore, and perhaps as a result of this reform, these countries have been relatively stable politically, compared with, for example, Latin American countries. The latter, in turn, have had a much more unequal income distribution, more sociopolitical instability, and lower growth rates.

From a normative point of view, these results have implications for the effects of redistributive policies. Fiscal redistribution, by increasing the tax burden on investors, reduces the propensity to invest. However, the same policies may reduce social tensions and, as a result, create a sociopolitical climate more conducive to productive activities and capital accumulation. Thus, by this channel fiscal redistribution might actually spur economic growth. The net effect of redistributive policies on growth has to weigh the costs of distortionary taxation against the benefits of reduced social tensions.

In summary, the instability channel appears to be more successful, at least at this stage, than the fiscal channel. However, before drawing firm policy prescriptions based on these results, more empirical research is needed.

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# A Presumptive Pigovian Tax: Complementing Regulation to Mimic an Emissions Fee

Gunnar S. Eskeland

*If regulations are used to make cars and fuels cleaner, should gasoline taxes be used to manage demand for trips that pollute? Analysis of a well-composed program for Mexico City indicates that the emission reductions would cost 24 percent more if a tax on gasoline was not introduced.*

*A simple analytical framework is developed to analyze the use of abatement requirements to make cars cleaner, and a gasoline tax to economize on the use of cars. The two instruments should be combined to mimic the incentives that would have been provided by an emissions fee. Thus, cleaner cars and fewer trips are analogous to competing suppliers of emission reductions; the planner should buy from both so that marginal costs are equal. Applying that rule, the marginal cost of emission reductions is, simply, the gasoline tax rate divided by emissions per liter.*

This article is prompted by the practical challenge of reducing air pollution from transport in a metropolitan area such as Mexico City while keeping an eye on the welfare costs of doing so. A least-cost solution to such a problem could involve behavioral change, such as modified travel patterns, as well as a number of technical modifications, whether in the form of tune-ups and retrofitting of existing capital equipment or in the form of new configurations of machinery (for example catalytic converters) or improved fuels.

These details have not been of great interest to economists in the public finance tradition (with some notable exceptions) because a fee levied on individual emissions would provide perfect incentives. Firms and households exposed to such a fee would self-select, taking (only) those measures that are most effective from society's point of view, irrespective of whether they are technical modifications, changes in input mix, or changes in the consumption basket. Using such a fee, or tradable pollution permits, the detailed actions that can be

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taken to reduce pollution need be known only to the economy's microagents, because the market can help the planner find cost-effective abatement (Baumol and Oates 1988 provides good coverage of this topic).

If a social planner were to possess data on how much pollution each individual caused through the year, then a year-end tax bill based on emissions or related damages would provide appropriate incentives for pollution reduction. When continuous monitoring of individual emissions is not applied, however (and it is not yet feasible for motor vehicles), the planner needs to investigate which sectors are polluting, what options exist within those sectors, and how to best stimulate each option. This is the context in which the analysis of a program to control air pollution from motor vehicles in Mexico City takes place.

Real-world programs to control pollution rely almost entirely on abatement, or technical controls, aimed at reducing emissions per unit of production or consumption. Abatement measures, such as the use of (costlier but) cleaner fuels and catalytic converters, will then generally be induced by regulatory and price-based policies, the design of which may have a great impact on the efficiency of the program. One example is emission standards with periodic emissions testing. The effect of the policy will obviously depend on whether the test result is a reasonable proxy for emissions in use, which again will depend on technical, institutional, and behavioral conditions.[1] Technical standards, such as mandating the use of catalytic converters and unleaded gasoline, may be easier to monitor but are less flexible and less directly related to emissions and may thus be costlier. Both emission standards and technical standards may be enforced by policies imposing penalties or revoking privileges. Other inducement mechanisms may be lower taxes on cleaner fuels and on cars equipped for natural gas. The costs and benefits of these measures will depend on how well the planner knows the field and, in particular, on how much the planner knows about the individuals whose behavior is to change.

Even when well designed, a program that emphasizes technical controls may be improved in a variety of ways. The most obvious way would be to use the car's emissions factor (grams emitted per liter or per mile, as determined from biannual emission tests), multiply it by the odometer reading (as a proxy for the utilization of the "pollution plant" since the last test), and apply an emissions fee to the result. The fee could be paid upon testing, or it could be uniformly paid as a presumptive tax, at the gas station, to be refunded in part to the owners of vehicles that tested to be cleaner than presumed. The efficiency gains from such a reform would come through several channels. First, all owners would have a continuous incentive to drive less, and owners of the more polluting cars would have a greater incentive. Second, all owners would have continuous incentives to make their cars cleaner, but owners that rarely use their cars would be subject to

1. Lawson and others (1990) used a test technology different from those used in mandatory test programs, and surprise roadside tests, and found that the length of time since the last periodic emissions test had little influence on whether a car's emissions were within the compliance range.

less of this pressure. As a consequence, society would waste few resources cleaning cars that are rarely used. As an added benefit, the car market would facilitate the exchange of vehicles to make sure that households that use their vehicles intensively end up with the cleaner ones.

This article investigates the gains to be made from a less ambitious reform of a traditional program. A traditional program does little or nothing to discourage the use of goods that pollute. The article assesses the advantages of including such discouragement, without trying to differentiate this discouragement according to how clean the car is (or how easy it is to clean it). The proposed reform is a gasoline tax, presumptive of emissions. It is shown that a gasoline tax, even when uniformly applied, makes sense.

The practical motivation for suggesting such a modest reform is the general suspicion that administrative and technical systems for monitoring and enforcement are still weak and vulnerable, so that it is doubtful whether emission tests can be used as major tax-collecting devices. Of course, when monitoring technology and technical capacity so allow, the program can (and should) be improved. The most immediate direction would be to use emissions test results and utilization rates to collect an emissions fee, so as to increase pressure on high polluters and to reduce wasteful pressure on low polluters. The proposed uniform increase in the variable costs of polluters could also be a reform that would allow such refinements to gain momentum over time.

Section I briefly reviews the theoretical literature. Section II develops the theoretical background for analyzing cost-effectiveness from the perspective of very simple, general equilibrium, welfare economics. Section III applies the analytical framework to data from a program to contain pollution in Mexico City and shows how inclusion of a gasoline tax in the program would reduce the costs of attaining the targeted emission reductions. Section IV offers conclusions.

## I. Theoretical Background

The theory of optimal taxation has mainly been concerned with minimizing the distortionary costs of revenue-raising taxes (see, for instance, Mirrlees 1976). The broader normative public-finance literature has provided a case for an authoritative government and intervention through public expenditures, taxation, and regulation, with the two main rationales being market failure and concerns about income distribution (see Atkinson and Stiglitz 1980; Starrett 1988, for broad coverage). The result of greatest relevance for this study was provided by Pigou (1932), whose recommendation that pollution problems could best be taken care of by taxes gave rise to the term "Pigovian taxes" (the term "corrective taxes" is also used). The theory prescribes that taxes be applied so that individuals are confronted with the full marginal social costs of their activities. If taxes are applied this way, and if the definition of social costs

includes such effects as the problems caused by pollution, then pollution control would be efficient in the sense that there would be no net benefits to society from different or further prevention of pollution or from more pollution. The position that authoritative intervention, for instance through Pigovian taxation, is necessary for efficiency when there are external effects was later challenged by Coase (1960). Coase argued that voluntary negotiations between those causing and those affected by an external effect could provide for efficiency. Later literature has emphasized that negotiations, as well as an intervening, poorly informed bureaucrat, may be costly and inefficient (see Farrell 1987 for a simple exposition and discussion).

Sandmo (1975) combines the motive of revenue generation with the need to discourage pollution when he analyzes how a revenue-motivated optimal tax structure would be modified when a negative external effect, such as pollution, is associated with one of the taxed commodities. He shows that traditional, distortion-minimizing revenue formulas will prevail but that a Pigovian element will be contained in the formula for the polluting good. As a special case, if the revenue requirement is sufficiently low, taxation of the polluting good may be sufficient so that revenues can be raised without causing distortions.

Other theoretical contributions concerned with Pigovian taxes have generally abstracted from the need to generate revenues through distortionary taxes. These theoretical contributions could be interpreted as effectively assuming that it is not costly to fund the public sector or, simply, that the topics can be analyzed separately. Sandmo (1975) may provide some support for such a separation, although the pollution-control agency would need to coordinate with the revenue-generating agency.

Many analysts have, however, been concerned with the distortionary effects of Pigovian taxes when the taxes do not perfectly correct the external effects. Notable among these are Sandmo (1976), Balcer (1980), and Wijkander (1985), all of whom ask whether taxes and subsidies levied on complements and substitutes can be helpful when taxation of the polluting good is either not feasible or not perfect. They find that such supportive instruments can be helpful when (a) the polluting good is used both in a polluting and in a nonpolluting activity (Sandmo 1976), (b) some users of the polluting good cause more harm per unit consumed than others (Balcer 1980), and (c) taxing the polluting good directly is not feasible (Wijkander 1985). These results can all be read as special cases of the point made by Greenwald and Stiglitz (1986) that market equilibria in economies with market failures are not constrained Pareto optimal and that a demand system, with all its own- and cross-price elasticities, can provide opportunities to seek Pareto improvements.

Designing pollution-control policies may involve more complex mechanisms than those discussed here, in particular when the costs of pollution reductions are better known to the individual than to the planner. The literature on incentives under asymmetric information and revelation mechanisms discusses whether optimal pollution control can still be induced (or whether the losses

arising from the information asymmetry will be great).[2] Generally, the planner wants less pollution control from firms with high pollution-control costs. However, sending out such a signal would give firms incentives to exaggerate their control costs. The planner thus wants a mechanism that induces the firm to truthfully reveal its costs, or that induces self-selection based on true characteristics. Much of this literature centers on problems caused by small numbers of polluters, in which case the position of their individual control cost curves can be of great relevance for the desired total level of pollution.

For several reasons, however, it may be less important to construct mechanisms more complex than a straight fee when emissions are caused by many polluters—as with millions of vehicles causing urban smog. When there are many polluters, communication costs for sophisticated mechanisms may be higher. Also, the uncertainty with respect to each polluter's control cost will be of less relevance to the planner, unless the hidden parts of individual control costs are highly correlated (in which case more information through sampling of the population might be valuable). Dasgupta, Hammond, and Maskin (1980) show that the planner can do almost as well with knowledge about the population of polluters as with (additional) information about individual polluters when the number of polluters is large and the disturbance terms are uncorrelated. Hammond (1979: 263) points to an important feature of economies with many agents: "In a large economy, no agent has sufficient influence to be able to distort the terms of trade in his favor by distorting his true characteristics." When efficiency is not achieved in models of asymmetric information, constraints such as the participation constraint (that agents prefer to sign the contract with the principal) and the balanced budget constraint (that the contract neither generates nor requires funds) often play a role. In the model to be presented, in contrast, it is assumed not only that the planner has authoritative powers—and thus can impose new costs on polluters (the polluter-pays principle)—but also that a mechanism that generates or uses revenue is acceptable. Furthermore, risk aversion plays no role in the model.

In a traditional control program (which emphasizes making fuels and vehicles cleaner) the planner undertakes costly efforts to estimate the costs of pollution control for various groups of vehicles and users. These efforts are mostly based on surveys, sample tests, and engineering estimates and serve to narrow the planner's prior distribution of cost estimates for each of the groups. This information is used to estimate what the total of emission reductions should be and to design mechanisms for inducing change. Sometimes, although not always, a mechanism can be chosen that is sensitive to the particular circumstances of a vehicle or a vehicle owner in a subgroup (as when the price of conversion kits and the price of natural gas are used to make high-use vehicles self-select for conversion to natural gas).

2. See, for instance, Baron and Myerson (1982) or Besanko and Sappington (1987). For a review of results with emphasis on pollution control, see Laffont (1993).

A program consisting mostly of mandated abatement requirements has many potentially important weaknesses. The improvement proposed here—the uniform taxation of a major input or output of the polluting activity—merely removes one of these weaknesses, namely, that abatement requirements do not efficiently discourage demand for polluting goods. The gasoline tax is an indirect instrument that, through one-way communication, reveals privately held information about which trips can be sacrificed at a low social cost and encourages firms and individuals to sacrifice those. (The term "sacrifice of trips" is used figuratively for options that reduce pollution through reduced demand for the polluting good. Among other such options are more efficient cars.)

The analysis here makes the assumption that the pollution-control agency has all the existing knowledge about the status of vehicles and the efficiency of various abatement options. Removing this assumption would, obviously, open the door to further improvements through instruments that more closely mimic a true emissions fee. Consequently, the proposed program is poorer than a theoretically conceivable program in which, for instance, a pollution tax would reveal and exploit all relevant privately held information. How much poorer the program is depends on how important these remaining information gaps are, assuming that the agency exploits rationally the information that it holds. It is good to know, however, that the additional information upon which the proposed improvement relies—gasoline consumption—is readily available at the pump.

Lastly, in the theoretical literature the distinction between the optimal scale of polluting activities and optimal abatement has been treated only tangentially. The point has been made that pollution taxes are superior to abatement subsidies because the latter may lead to too much of the polluting activity (see, for instance, Baumol and Oates 1988). However, making polluters pay for abatement (as advocated by the Organization of Economic Cooperation and Development; see OECD 1975 and Opschoor and Vos 1989) does not imply optimal discouragement if they do not also pay for damages. Making polluters pay for damages would imply optimal discouragement; polluters would then choose to pay for optimal abatement. In the present study, two instruments are assumed available to the planner: an abatement requirement and a tax on a variable input (the one most strongly associated with pollution generation) in the polluting activity. Unless the emissions or the polluting good is taxed, the polluting activity is too large, even when polluters pay for abatement.[3] The use of more than one instrument to deal with only one negative external effect is driven by a monitoring problem. When monitoring of individual contributions to pollution is costly, indirect instruments should be used to influence the different choices that can affect pollution (see Eskeland and Jimenez 1992).

3. Some insight into the role that can be played by changes in the level of activity in polluting sectors is provided by Jorgenson and Wilcoxen (1990) and Hazilla and Kopp (1990). However, they explore changes in sectoral activity levels as result of abatement costs, rather than as a result of pollution taxes, input taxes, or output taxes.

## II. A Simple Model with Demand Management and Abatement

The model must not only allow for behavioral responses to policies that can influence demand, but must also provide a measure of the social costs of such demand manipulation. The models proposed in the literature on welfare economics are tailored to these purposes. Ideally, the model would have many consumers or groups of consumers. This would allow for analysis of the distribution of costs and benefits across economic agents, apart from efficiency aspects.

To focus on efficiency, the model used here is one with a representative consumer. Such a framework has two principal shortcomings. First, it cannot be used to analyze the effects on income distribution. The use of a representative consumer can be justified only by assuming that the effects of the air pollution control strategy on income distribution is not of major interest because, for instance, the planner can use other instruments that can cheaply transfer income between groups. Second, in practice consumers differ along other dimensions, for instance, by owning unevenly polluting vehicles. The model can best be interpreted as one in which a representative consumer owns a composite of the vehicle fleet in Mexico City.

The model employed here is separable along two lines in the direct utility function, as in Balcer (1980) and Wijkander (1985), and has a representative consumer, as in Sandmo (1976) and Wijkander (1985). Finally, it is assumed that generating public revenue is not costly in itself. This assumption is reasonable only if the requirement for public sector revenue does not exhaust the potential of instruments available for costless transfers to the public sector.

### *The Consumer's Problem*

Let consumers be numbered 1 through $n$ and let individual $j$'s emissions depend on the individual's consumption of the polluting good and the abatement applied. The individual's preferences are represented by a utility function, with utility depending on the quantities of polluting goods and nonpolluting goods consumed, as well as on the total amount of emissions from all $n$ individuals. It is assumed that the utility function satisfies the traditional regularity conditions: it is quasi-concave, continuous, and twice differentiable. Furthermore, it is assumed that the quantities consumed of polluting goods and nonpolluting goods, $x$ and $y$, respectively, are constrained to non-negative values, as is abatement, $a$, and that the individually optimal solution does not involve either of the corners $y = 0$ or $x = 0$. Furthermore, in this section, it is assumed that initial expenditures on abatement are very productive (abatement is produced at constant returns to scale, but its effect on emissions is declining), so that the corner $a = 0$ does not occur in the planner's optimum unless in combination with $t_x = 0$, where $t_x$ is the rate of tax on the polluting good. The latter assumption is relaxed in section III.

It is assumed that individual $j$ takes consumer prices as given and chooses a consumption vector that maximizes utility, $u$, under a budget constraint that requires that the total value of the individual's consumption not exceed the individual's income. Letting $\beta^j$ be the shadow price of $j$'s budget constraint, the Lagrangian of $j$'s maximization problem can be written

$$(1) \qquad \mathscr{L}^j = u^j\left[y^j, x^j, \sum_{i=1}^{n} e^i(x^i, a^i)\right] - \beta^j\left[y^j + (p_x + t_x)x^j + p_a a^j - \left(I^j + \frac{1}{n} t_x \sum_{i=1}^{n} x^i\right)\right],$$

where superscripts denote individuals and $\Sigma e^i(x^i, a^i)$ is the sum of emissions, $e$, generated by all individuals. In the budget constraint, $(p_x + t_x)$ and $p_a$ are the consumer prices of the polluting good and of abatement, respectively, whereas $p_x$ and $p_a$ are the producer prices. The nonpolluting good is untaxed, and its price is normalized to one. Furthermore, the budget constraint reflects the assumption that tax revenues are redistributed to consumers as transfers, to be added to the consumer's lump-sum income, $I^j$. The consumer, if expanding the consumption of the taxed good, will share the generated tax revenues with all the other individuals. Thus, public and private income at the margin have the same social value, so that there is no need for costly revenue generation. For simplicity of exposition, it is furthermore assumed that an individual's abatement has little or no value to that individual compared with the price of the abatement. Thus, the consumer applies as little abatement as possible: zero or the level mandated by the planner. Then, as abatement is chosen by the planner, the first-order condition for consumer optimum is found by setting the partial derivatives of equation 1 with respect to $x^j$ and $y^j$ equal to zero:

$$(2) \qquad u^j_{x^j}/u^j_{y^j} + u^j_{e^j}\, e^j_{x^j}/u^j_{y^j} = p_x + t_x - t_x/n,$$

where subscripts to the function symbols denote partial derivatives, and the equation has been solved for the shadow price of income for consumer $j$. Notice that there are superscripts for only one individual in the first-order conditions. We assume that individuals are equal, in order to be able to work with a representative consumer, and may thus eliminate individual superscripts.

Additional assumptions are that individuals do not take into account the effect of their own pollution on themselves and that they do not take into account that a share of their own tax payments will be returned to them. Both are either theoretically correct descriptions or minor approximations if $n$, the number of individuals who pollute each other and share public revenues (here assumed to be the same), is large (Sandmo 1975). Then, from the perspective of individual optimization, the second term and the term $t_x/n$ in equation 2 are both zero, so the first-order condition for individual optimum is

$$(3) \qquad u_x/u_y = p_x + t_x.$$

Generally, the Marshallian demand functions $x(\cdot)$ and $y(\cdot)$ consistent with equation 3 will depend on the consumer's income, consumer prices, the mandated abatement, and the level of pollution. However, to simplify exposition and focus on the policy instruments, prices and income are suppressed. Also, the simplifying assumption that demand does not depend on the level of pollution gives the demand functions $x = x(a, t_x)$ and $y = y(a, t_x)$.[4]

### *The Planner's Problem*

The planner affects abatement through regulation, whereas consumption decisions are influenced by the regulation and by the tax rate levied on the polluting good. It is assumed that the technology is such that production costs (and thus producer prices) are constant, that is, not influenced by the manipulation of consumer prices. As is demonstrated in the literature, the analysis extends to the case with responsive producer prices as long as there are constant returns to scale (see, for instance, Diamond and Mirrlees 1971 or Atkinson and Stiglitz 1980: 373).

In advising a benevolent planner whose objective is to maximize consumer utility, the relevant resource constraint is that of the economy as a whole because it is assumed there is no need for distortionary taxation. The problem is formulated as one of maximizing the utility of the representative consumer, and the budget constraint can be written net of taxes and transfers. The Lagrangian of this problem, with mandated abatement and a tax on the polluting good as instruments, can be written

$$\begin{aligned}(4)\qquad \mathscr{L} = {} & u\{y(a, t_x), x(a, t_x), ne[x(a, t_x), a]\} \\ & - \gamma\,[y(a, t_x) + p_x x(a, t_x) + p_a a - I],\end{aligned}$$

where $u(y, x, ne)$ is substituted for $u(y, x, \Sigma_i e^i)$. Comparing equations 1 and 4, the difference between the individual's objective function and the planner's is that the individual does not take into account his effect on emissions, whereas the planner takes into account the effect of emissions on all individuals. A similar difference is present in the constraints of the two problems: whereas the individual looks at tax payments as costs, the planner takes into account that they are all redistributed. Thus, to the planner, taxes paid are not lost and involve costs only to the extent that they distort resource use.

An optimal program is characterized by the partial derivatives of equation 4 with respect to the abatement requirement and the tax rate both being equal to zero. Using also the partial derivatives of the resource constraint (which ties the demand responsiveness for the two consumption goods to each other), and

4. To see how the results extend, notice first that prices will be determined by the use of these policy instruments and that if producer prices are constant, $x_t = dx/d(p_x + t_x)$, and so on. Let $x = x(a, t_x, e)$, $y = y(a, t_x, e)$, and $e = e(x, a)$. Totally differentiating and solving, $dx/da$, $dy/da$, $dx/dt_x$, and $dy/dt_x$ can substitute for $x_a$, $y_a$, $x_t$, and $y_t$, and the subsequent analysis and results apply.

assuming that demand for the polluting good is not completely insensitive to its price ($x_t \neq 0$), we find that the optimal allocation is characterized by[5]

$$u_x/u_y + nu_e e_x/u_y = p_x \tag{5}$$

$$nu_e/u_y = \frac{p_a}{e_a}. \tag{6}$$

Equation 6 requires that the sum across individuals of the marginal rates of substitution be equal to the marginal rates of transformation, consistent with Samuelson's (1954) result for optimal provision of public goods. Air quality, or absence of pollution, is an ideal example of a public good according to Samuelson's definition that consumption of a public good is nonexclusive.

Using the fact that marginal rates of substitution in consumption will equal consumer prices (equation 3), the optimal allocation is induced by an appropriate abatement requirement and a tax to be levied on the polluting good equal to

$$t_x/(p_x + t_x) = -nu_e e_x/u_x. \tag{7}$$

Thus, the consumer price of the polluting good shall be such as to incorporate the social costs that its consumption imposes on others (notice that no such tax on the polluting good is desirable if emissions themselves are taxed).

Solving for $nu_e$, optimality requires that

$$t_x/e_x = -p_a/e_a. \tag{8}$$

Equation 8 states that the optimal tax rate on the polluting good, per unit of emissions from the polluting good, is equal to the direct marginal cost of abatement per unit of achieved emission reductions. This will prove a useful comparison in the next subsection, in the characterization of a cost-effective program.

The optimal program, as completely characterized by equations 5 and 6, could be implemented by one instrument: an emissions fee, if it were available. This fact is easily checked by replacing the instruments in equation 4 with a tax levied on emissions and modifying the individual budget constraint accordingly.

### *Cost-effective Pollution Control*

In the optimal program, abatement and demand management are pursued to the point where marginal benefits equal marginal costs. If benefit estimates are unavailable, or in dispute, it is helpful to ask how a specified target for emissions

5. In general, if consumption of the polluting good is completely insensitive to its price (meaning that the adjustments to price changes will be in the consumption of nonpolluting goods only), then $c_a/e_a = nu_e$ characterizes the optimal program, whereas $t_x$ is not determined by pollution-control objectives, because it has no effect on pollution.

(or emission reductions) can be achieved at lowest possible costs.[6] The following shows how the concept of cost-effectiveness, emphasizing the costs of manipulating demand, fits into a traditional framework of welfare analysis.

Starting from an arbitrary set of policies—an abatement requirement, $a$, and tax rate, $t_x$—welfare and emissions will be given as functions of $a$ and $t_x$: $w(a, t_x) = u\{y(\cdot), x(\cdot), e[a, x(\cdot)]\}$ and $e(a, t_x) = e[a, x(\cdot)]$. The estimated marginal effect on welfare from a small change in the tax rate, per unit of associated reductions in emissions, is found by partial differentiation and division:

$$\frac{\partial w}{\partial t_x} \Big/ \frac{\partial e}{\partial t_x} = \frac{u_y t_x}{e_x} + n u_e. \tag{9}$$

In conventional terminology, the first element in equation 9 is the marginal cost of a change in the tax rate, and the second is the marginal benefit. Following the same procedure, but this time differentiating with respect to the abatement requirement, the marginal impact on welfare of an adjustment in the abatement requirement, per unit of associated reductions in emissions, is

$$\frac{\partial w}{\partial a} \Big/ \frac{\partial e}{\partial a} = \frac{(t_x x_a - p_a) u_y}{e_x x_a + e_a} + n u_e \tag{10}$$

where similar comments apply for the two elements.

Equations 9 and 10 are valid expressions for the net marginal impact on welfare of a change in the tax rate and the abatement requirement, respectively, even when the instruments are not applied cost-effectively or optimally. Furthermore, should the use of one of the instruments be constrained to some value, then the optimal policy (as opposed to cost-effective pollution control), conditional on the actual application of one instrument, is characterized by the available (unconstrained) instrument's net marginal impact on welfare being equal to zero.

Composing a cost-effective program requires the comparison of marginal costs of emission reductions across instruments. It is now easily seen that a comparison of the two instruments—abatement and taxation—is robust to imprecision in the benefit estimate, because the benefit estimate is added in the same way to the expressions for the marginal impact on welfare.

The cost expression in equation 9 is very simple: marginal costs depend only on the tax rate on the polluting good (assuming that other goods are priced at marginal costs) and on the marginal impact on emissions of consuming the polluting good (grams of pollutants emitted per liter of gasoline con-

6. Quantifiable estimates of environmental benefits can be hard to come by, both in physical terms (for example, improved visibility or reduced mortality) and in value terms (for example, willingness to pay for improved visibility or reduced mortality). For a recent, general discussion, see Cropper and Oates (1992). Briefly, on what is applicable to Mexico, see Margulis (1991). For a methodology based on health effects, see Ostro (1994).

sumed).[7] Thus, the marginal cost of using tax rate changes to reduce emissions does not depend on the elasticity of demand for polluting goods. This result is illustrated in figure 1, which is drawn for a given level of abatement and consequently a given $e_x$. The welfare cost (emission benefits excluded) of a tax change, $dt$, is the trapezoid $abcd$, approximated by the rectangle $tdx = tx_t dt$ for small tax changes. Emission reductions, $de$, will equal $e_x dx = e_x x_t dt$, and $x_t$ cancels out in the ratio between the two, that is, $(dw/dt)/(de/dt) = t/e_x$, which is the expression for marginal costs. Thus, the part of the gasoline demand curve that lies above the supply curve can be seen as a supply curve for emission reductions (emissions per liter of gasoline, $e_x$, is shown as an alternative unit of measurement along the $x$ axis). This result does not say that the amount of emission benefits offered by a given tax change is independent of the demand elasticity. It says that the marginal welfare costs, per unit of obtained emission reductions, are independent of the demand elasticity. As an example, if the elasticity were small, the emission reductions would be small, but so would be the costs from sacrificed consumption, because changes in consumption would be small. The result should be of no surprise. A basic result of welfare economics says that efficiency is ensured when agents face the marginal social costs and benefits of their actions. In the absence of other distortions, that result does not depend on demand elasticities.

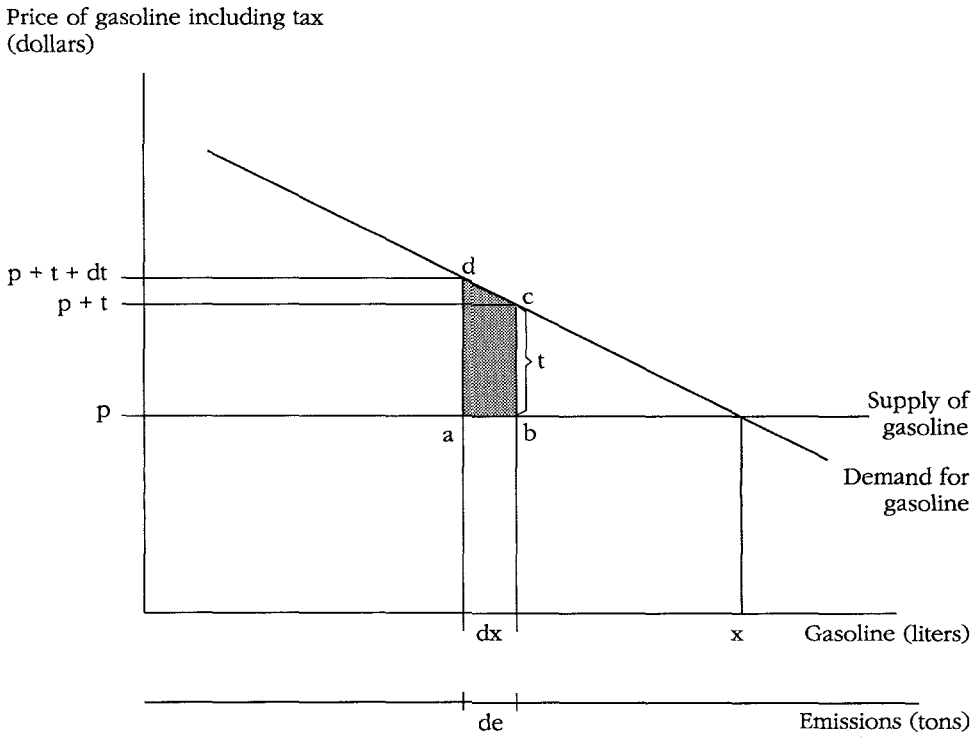
In comparison with equation 9, the expression for marginal welfare costs of abatement requirements, equation 10, is considerably more complicated. In particular, the responsiveness of demand to stricter abatement requirements, $x_a$, remains a determinant both of the welfare costs (in the numerator) and of the emission reductions (in the denominator). Somewhat paradoxically, the cost of emission reductions through abatement depends on the demand responsiveness, whereas the cost through changing the tax rate, the demand management instrument, does not.[8]

Figure 1 also shows, however, that the cost of achieving a given emissions reduction is higher, the lower the demand elasticity. This result carries over to the case in which abatement is available. With abatement available, the implication is that the cost of not applying a gasoline tax is higher, the higher the

7. The assumption that the responsiveness of emissions to small changes in gasoline prices will be proportional to the responsiveness of gasoline consumption, that is, that $e_x(a, x)x_t = kx_t$, is probably fair, although conservative (Krupnick 1992 provides some analysis). Proportionality is assumed in the main emissions projection models, such as the U.S. Environmental Protection Agency's Mobile 4 and AP-42 models. In this analysis, the use of different fuels and the relative prices of fuels are suppressed so that the results apply to a general price level for automotive fuels. In practice, relative prices between fuels may not be available for manipulating demand between fuels. Technical considerations may give the planner preferences for a specific match between car type and fuel type. (The concern in Mexico City was to reserve limited supplies of unleaded gasoline for cars with catalytic converters.)

8. Several authors have addressed the issue that abatement requirements also affect emissions through demand responsiveness, but I have not seen noted that this responsiveness affects welfare costs as well. An effect explored in the literature is that the higher costs of new cars decelerate replacement of older, dirtier cars (Crandall and others 1986; Berkovec 1985). Equation 10 does not include such effects on fleet demographics, which will, to some extent, wash out in the long run.

Figure 1. *The Welfare Cost of an Increase in the Tax on Gasoline*




demand elasticity. As an example, if abatement is cheap and demand inelastic, a cost-effective program would take only small emission reductions from demand reductions, so losses in a program that failed to stimulate demand reductions would not be large. One may notice, here, an important distinction between Pigovian and revenue-motivated taxes. For Pigovian purposes, it is particularly important to tax goods if they are elastic in demand, because one seeks reductions in demand. For revenue generation, one seeks to tax goods inelastic in demand, to minimize demand distortions.

Minimizing the welfare costs of targeted emission reductions, one would utilize the two instruments (the gasoline tax and mandated abatement) so that their marginal costs are equalized (just as one would procure goods from two suppliers). Setting the marginal-cost expressions, equations 9 and 10, equal to each other, some elements cancel out, and a cost-effective program is characterized by

$$t_x/e_x = -\,p_a/e_a\,. \tag{11}$$

Equation 11 is the solution to the maximization of welfare subject to an emissions constraint. Constrained maximization would, in addition, yield a shadow price equal to the two expressions in equation 11 on the emissions

constraint. The indirect method used here also derives the marginal cost for the two instruments when they are not exploited cost-effectively (equations 9 and 10). Equations 9 through 11 illustrate that the attractiveness of a tax on the polluting good does not depend on the availability of benefit estimates. The mere application of mandated abatement reveals that welfare costs can be saved by taxing polluting goods.

To interpret this result in light of a first-best program, notice that a program with direct taxation of individual emissions (or with tradable emission permits) optimally combines discouragement of the polluting activity with incentives to make the activity cleaner. Mandated abatement, instead, needs to be accompanied by instruments discouraging activity levels to minimize welfare costs of emission reductions. Also, the left side of equation 11 is the marginal cost measure for the tax on polluting goods, and the right side is the simple, or direct, marginal cost for abatement expenditures. Thus, this simplistic measure of cost-effectiveness, often used in applied studies, is valid, but only if the polluting good is taxed accordingly (otherwise, equation 10 gives a different measure, which is the correct one). Equation 11, which is a complete characterization of a continuum of cost-effective programs, is equal to equation 8, which, together with equation 6, gives a complete characterization of the optimal program. Thus, the optimal program is a special case among cost-effective programs.

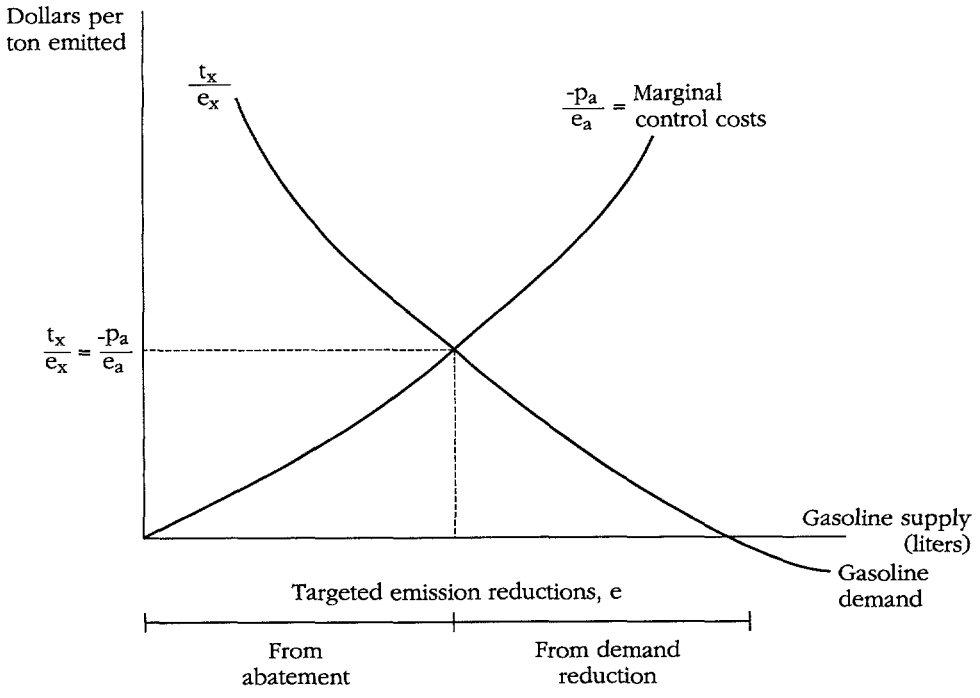
Figure 2 illustrates a cost-effective program. The horizontal line is the amount of emission reductions targeted. The marginal cost curve for emission reductions through abatement expenditures, equation 10, is drawn from left to right (for simplicity, it is assumed that $x_a = 0$). The part of the gasoline demand curve that lies above the marginal cost of supply, recalculated to be quoted per gram of implied emissions, is a supply curve for emission reductions provided by the other instrument, the gasoline tax (equation 9). A cost-effective program is found where the two curves intersect. For any other combination of abatement and tax rate that satisfies the target, the difference between the two marginal cost curves can be saved by substituting, at the margin, the cheaper for the more expensive instrument, holding emissions constant.

There is another way of exploiting the results of this section, however. Equation 11 states that knowledge of the marginal costs per unit of emissions reduced through technical controls implies knowledge of the gasoline tax rate with which it should be combined for the program to be cost-effective. This perspective is applied in the following application to data on pollution-control options in Mexico City.

## III. Application to an Air Pollution Control Program

In an analysis of emissions control options for motor vehicles in Mexico City, technical control options were ranked according to incremental costs per unit of

Figure 2. *Abatement and Demand Reduction in a Cost-Effective Program*




weighted emission reductions (table 1).[9] The list is thus sorted in the sequence in which measures would be implemented if the ambition level of the control program (or, equivalently, the willingness to pay for emission reductions) were gradually increased. However, demand responsiveness is not incorporated in the figures, which simply show the direct incremental costs of abatement divided by the increment in emission reductions, $-p_a/e_a$. The figures in table 1 are, however, valid estimates of marginal costs if the abatement initiatives are accompanied by a gasoline tax that is optimal, conditional on the extent of abatement (equation 11). Such a matching gasoline tax is shown in the fourth column.[10]

9. The term "weighted emission reductions" refers to the prioritization of air pollution control programs that address several kinds of emitted pollutants simultaneously. In the World Bank's analysis of the Mexico City program, weights attempted to reflect both the desirability of achieving ambient standards and the contribution of each emitted gram of a particular pollutant to total ambient concentrations of pollutants. The following weights were applied: lead, 85/g; nitrogen oxides, 4.7/g; respirable dust, 2.3/g; dust, 0.9/g; sulphur oxides, 1.4/g; carbon monoxide, 0.04/g; and nonmethane hydrocarbons, 1.8/g (see Weaver 1991).

10. For simplicity, these calculations assume that the abatement requirement does not affect demand, that is, that $x_a = 0$, and that the cost of abatement, $-p_a/e_a$, is unaffected by the gasoline tax. The latter assumption may be valid even when sizable changes in instrument use are considered, but the assumption

An example may illustrate the calculations in table 1. If the measure called "Mandate '1993 standards' for passenger cars" was the costliest applied in a program, then the cost of abatement to be matched by the gasoline tax would be $669 per weighted ton of emissions. With this and all the cheaper measures in effect, emissions per liter for the fleet as a whole would average 60 weighted grams, and the gasoline tax should be 4 cents a liter, as calculated by equation 11.[11] These tax rates represent optimal discouragement of gasoline use, given the burden placed on gasoline users to make their use cleaner. Any combination of technical controls with a lower gasoline tax than suggested implies that, keeping total emissions unchanged, consumers could be better off by spending less on abatement and sacrificing more trips in return.

The tax rate per liter of gasoline in table 1 increases less than proportionally with the costs of applied technical measures. The explanation for this is that the technical measures reduce emissions per liter, so the tax base for a presumptive Pigovian gasoline tax declines with increasing control costs. Therefore, there are several reasons why the gasoline tax becomes an increasingly expensive instrument the more aggressive the program is. One is that each liter carries fewer grams of emissions as successive control measures are undertaken, so the sacrifice of a liter in consumption offers less in terms of emission reductions the cleaner the average vehicle is. Another is that, the higher the rate of the gasoline tax, the more valuable are the trips that households and firms have already sacrificed.

An estimate of the elasticity of gasoline demand is needed to estimate the emission reductions resulting from the gasoline tax. Berndt and Botero (1985) estimated demand equations based on pooled regional (1973–78), as well as national (1968–79), time-series data for gasoline sales in Mexico. On the basis of several models, they concluded with price elasticity estimates in the range of −0.2 to −0.7.[12] Eskeland and Feyzioglu (1994), using an improved

that abatement requirements affect demand in the same way that output taxes do would be more appropriate, particularly in the long run (abatement requirements affect fixed costs of vehicle ownership more than they affect short-term variable costs). This alternative assumption would increase the emission reductions offered at any of the suggested policy combinations and thus not change the way the curve is shifted to the right when a matching gasoline tax is included in the program.

11. For the 1993 standard, annualized toxicity-weighted emissions are calculated to be 0.036 tons a year, whereas the baseline alternative would give 0.191 tons a year, so the emissions reduction is calculated to be 0.155 tons a year. Annualized costs, including fuel savings but also a higher maintenance bill, are calculated to be $104. The 1993 standard thus offers emission reductions at $104/0.155 = $669/ton. To calculate the matching gasoline tax, observe that when emission controls cheaper than and including $669 a ton are applied, the emissions coefficient is calculated to be 60 grams a liter, that is, ($t_x$ dollars a liter/60 grams a liter) × $10^6$ grams a ton = $669/ton, which implies that $t_x = (669 \times 60)/10^6 = 0.04$.

12. Some other empirical studies indicate the same range. Pindyck (1979) uses pooled data and finds that for OECD countries, the price elasticity exceeds −0.4 when the time for adjustment is four years or more; for Brazil and Mexico, estimates are −0.12 for the short run and −0.55 for the long run. Sterner, Dahl, and Franzen (1992) report estimation of various models for 21 OECD countries (time series and pooled), with an average of −0.25 for short-run elasticities and −0.8 for long-run elasticities.

Table 1. *Mexico City: Abatement Measures and Matching Gasoline Tax Rates*

| *Abatement measure* | *Cost of weighted emission reductions (U.S. dollars per ton)* | *Cumulative weighted emission reductions (thousands of tons)* | *Cumulative costs of abatement (millions of U.S. dollars)* | *Matching gasoline tax (cents per liter)* |
|---|---|---|---|---|
| Retrofit trucks for liquid petroleum gas | −379 | 90 | 0 | −4.4 |
| Retrofit minibuses for compressed natural gas | −248 | 148 | 0 | −2.8 |
| Retrofit trucks for compressed natural gas | −225 | 231 | 0 | −2.4 |
| Recover gasoline vapor | −80 | 275 | 0 | −0.8 |
| Provide light buses with new engines | 140 | 299 | 3 | 1.4 |
| Bring minibuses to "1992 standards" | 181 | 391 | 20 | 1.7 |
| Mandate inspection and maintenance of high-use vehicles | 209 | 545 | 52 | 1.8 |
| Mandate "1993 standards" for gasoline trucks | 264 | 632 | 75 | 2.1 |
| Mandate "tier-1 standards" for taxis | 322 | 641 | 78 | 2.5 |
| Provide R-100 buses with new engines | 482 | 651 | 83 | 3.7 |
| Replace taxis to conform to "1993 standards" | 510 | 714 | 115 | 3.7 |
| Test emissions for passenger cars | 651 | 771 | 152 | 4.4 |
| Mandate "1993 standards" for passenger cars | 669 | 883 | 227 | 4.0 |
| Provide special diesel | 699 | 893 | 234 | 4.2 |
| Lower vapor pressure to 7.5 | 836 | 904 | 243 | 4.9 |
| Provide regular unleaded gasoline | 923 | 954 | 289 | 5.1 |
| Decentralize inspection and maintenance of passenger cars | 1,034 | 1,018 | 356 | 5.3 |
| Replace gasoline trucks | 1,114 | 1,096 | 442 | 5.0 |
| Require 5 percent MTBE[a] in regular gasoline | 1,201 | 1,116 | 467 | 5.3 |
| Lower vapor pressure in premium unleaded to 7.5 | 1,313 | 1,128 | 482 | 5.6 |
| Pave roads (1000 km) | 1,335 | 1,136 | 498 | 5.7 |
| Require "1991 standards" for passenger cars | 1,367 | 1,180 | 508 | 5.4 |
| Reduce sulphur to 0.1 percent in diesel | 1,371 | 1,187 | 569 | 5.3 |
| Require "tier-1 standards" for passenger cars | 1,629 | 1,201 | 578 | 6.2 |
| Conform to U.S. specifications for diesel fuel | 2,097 | 1,207 | 601 | 7.9 |
| Require 11 percent MTBE[a] in regular gasoline | 2,447 | 1,219 | 613 | 9.0 |
| Require 5 percent MTBE[a] in premium gasoline | 13,487 | 1,222 | 643 | 49.0 |
| Require 11 percent MTBE[a] in premium gasoline | 14,728 | 1,226 | 686 | 53.2 |

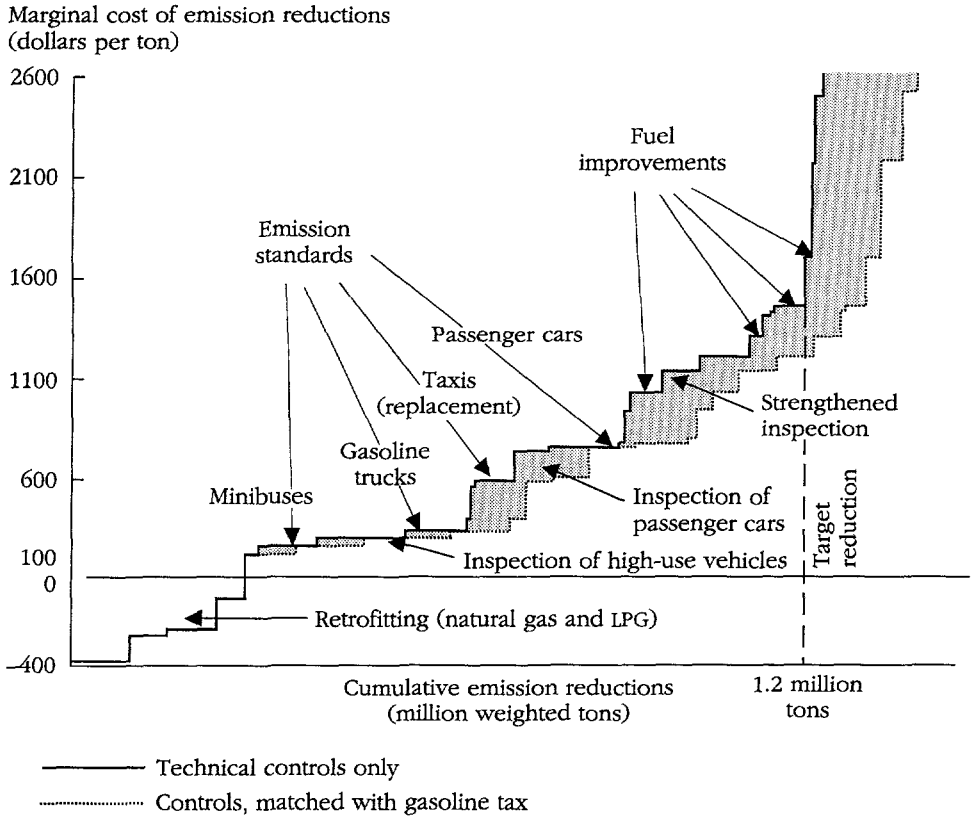
a. MTBE is a fuel oxygenator, as an alternative to lead for raising octane levels.
*Source:* World Bank 1992.

methodology and more recent data, estimate short- and long-term elasticities for total gasoline consumption of −0.79 and −0.8, respectively. Thus, the most important difference in terms of estimated parameters is a higher short-term elasticity; the longer-term effects are quite similar. To estimate the effects on the 1995 emissions inventory, a price elasticity of −0.8 is employed.

Because the gasoline tax will induce demand to contract, more emission reductions will be provided at every cost level, and the result will be a more moderately sloped control cost curve. The two control cost curves are shown in figure 3, with the area between the curves representing the difference in total costs between a strategy based solely on technical controls and a strategy including demand management with the help of a gasoline tax.

Under these assumptions, a gasoline tax of 6.2 cents a liter (26 percent, ad valorem) reduces demand by about 20.8 percent for a program targeted to reduce weighted emissions by 1.2 million annual tons by 1995. Applying such a

Figure 3. *Program to Reduce Air Pollution Emissions from Transport in Mexico City, with and without a Gasoline Tax*




*Note:* Calculations are based on –0.8 elasticity of demand for gasoline.

tax thus allows for 20.8 percent additional emission reductions at a willingness to pay of $1,629 a ton. Not one of the abatement measures offers emission reductions of that magnitude. Alternatively, settling for a target of 1.2 million tons in emission reductions would make unnecessary the use of measures escalating in costs from $1,114 to $1,629 a ton. The cost savings would be an estimated $111 million annually, or 19.2 percent of the estimated total control costs.

The following can highlight the interdependency between the two sets of instruments. When control costs reach $1,629 a ton, average emission coefficients are reduced by 70 percent, reducing the base for the presumptive emissions tax on gasoline to 30 percent of its precontrol level. Thus, at a willingness to pay of $1,629 a ton, the optimal gasoline tax rate would be 20, rather than 6.2, cents a liter if the gasoline tax was the only available instrument.

A higher gasoline tax could be justified by a number of alternative assumptions, but not (as shown in section II) by a higher (or lower) demand elasticity. First, because the cost curve for technical controls is assumed to be steep for reductions exceeding 1.2 million tons, a further rise in the gasoline tax is one of the very few instruments that are effective if further reductions are needed. Second, reduction in usage also has benefits in terms of reduced congestion, noise, and accidents, none of which are accounted for in this analysis. It might be tempting to add that attaching a separate value to the transfer of funds from the private sector to the public sector would also justify a higher rate and that such transfers are to be valued in an economy that has suffered severely under strained public finances. However, such a change in modeling assumptions would motivate broadly based taxes on all goods without necessarily raising the part of the rate levied on gasoline that is motivated by the emissions control objective. (But the use of Pigovian taxes would reduce the distortionary costs of revenue generation; see Sandmo 1975). Although the present model has been developed under the assumption that generating public revenues is not costly and thus cannot be used to gauge the importance of revenue generation, it might be of interest that the tax rate indicated by the narrowly focused model would generate an estimated $350 million in annual revenue in Mexico City alone.

## IV. Concluding Remarks

Can demand management instruments such as a gasoline tax play a role in a cost-effective pollution control program? An analytical framework was presented that allows the comparison of demand management instruments with mandated abatement requirements. The framework provided the following results:

- Adding mandated abatement requirements to a program consisting of indirect taxes—or vice versa—will improve the program.

- The set of programs in which abatement and demand management are combined in a cost-effective fashion is characterized without knowledge of the demand elasticity for gasoline (equation 11).
- The cost associated with not including gasoline taxes in the tool kit for the control program is larger, the higher the demand elasticity.

To investigate the practical significance of these findings, the framework was applied to a recently analyzed program of technical interventions to reduce air pollution from urban transport in Mexico City. It was found that a tax of 6.2 cents a liter (26 percent, ad valorem) would be suitable to complement abatement in a program aimed at reducing emissions from the 1995 vehicle fleet by about 70 percent. Using a demand elasticity of $-0.8$, the inclusion of a gasoline tax in the program would make the targeted emission reductions attainable at 19.2 percent lower social costs, including the welfare costs of demand manipulation. The low level of the tax is partly explained by the fact that abatement will, by then, have reduced average emission coefficients by 60 to 70 percent, so marginal emissions per liter, the base of a presumptive Pigovian tax on gasoline, are also diminished.

The recommended tax could have been higher if higher emission reductions were targeted or if reduced congestion, accidents, and road damage were valued as well. For a city with a persistent problem of air pollution, the tax rate could decrease over time if reductions in emission coefficients so warrant. Alternatively, the tax rate could increase over time if the increase in demand for the polluting good is such that increasingly expensive measures must be undertaken.

After recent policy-induced increases in gasoline prices of 40 to 50 percent, implicit tax rates in Mexico are higher than those suggested above. The higher tax rate may well be justified by the reasons mentioned, as well as by the fact that average emission coefficients are still much higher than those assumed above for 1995. More important, the actual setting of tax and price policy in Mexico is one of a multitude of objectives and interests, including the important one of funding public budgets. The model presented here is far too modest in scope to judge a complex tax structure in a more general context.

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# Changing Labor Market Conditions and Economic Development in Hong Kong, the Republic of Korea, Singapore, and Taiwan, China

Gary S. Fields

*In the newly industrializing economies (NIEs) of Hong Kong, the Republic of Korea, Singapore, and Taiwan (China), the entire working population has benefited from labor market institutions. The East Asian NIEs attained and maintained generally full employment, improved their job mixes, raised real earnings, and lowered their rates of poverty.*

*This article reaches two principal conclusions. First, labor market conditions continued to improve in all four economies in the 1980s at rates remarkably similar to their rates of aggregate economic growth. Second, labor market repression was not a major factor in the growth experiences of these economies in the 1980s. It thus appears that labor market repression is neither necessary nor desirable for outward-oriented economic development.*

The newly industrializing economies (NIEs) of East Asia grew at very rapid rates in the 1980s. During the decade, real per capita income grew by 64 percent in Hong Kong, by 122 percent in the Republic of Korea, by 78 percent in Singapore, and by 88 percent in Taiwan (China) (see table 1). This economic growth was fueled in large part by the growth of exports.

The purpose of this article is to determine how labor market conditions changed during this period of rapid, export-led growth. Two a priori hypotheses have been formulated. One is that wages and other forms of labor remuneration must be held down for East Asian exports to remain competitive in world markets. According to this view, it would be expected that any improvements in labor market conditions would be at a slower rate than overall economic growth. Wage repression would be necessary to prevent higher returns to labor from pricing the exports of the NIEs out of competition in world markets,

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Table 1. *Growth in National Income and in Earnings in Four Newly Industrializing Economies in East Asia, 1980–90*
(percent)

| *Economy* | *Growth in real GNP or GDP per capita* | *Growth in real earnings* |
|---|---|---|
| Hong Kong | 64.2[a] | 60.0[c] |
| Korea | 121.8[b] | 115.8[d] |
| Singapore | 77.5[a] | 79.8[e] |
| Taiwan (China) | 88.0[b] | 102.7[c] |

a. GDP growth.
b. GNP growth.
c. Manufacturing.
d. Mining and manufacturing.
e. All industries.
*Source*: For Hong Kong: Government of Hong Kong (various years); for Korea: unpublished country data; for Singapore: Government of Singapore (1990); for Taiwan (China): Government of China (1991b).

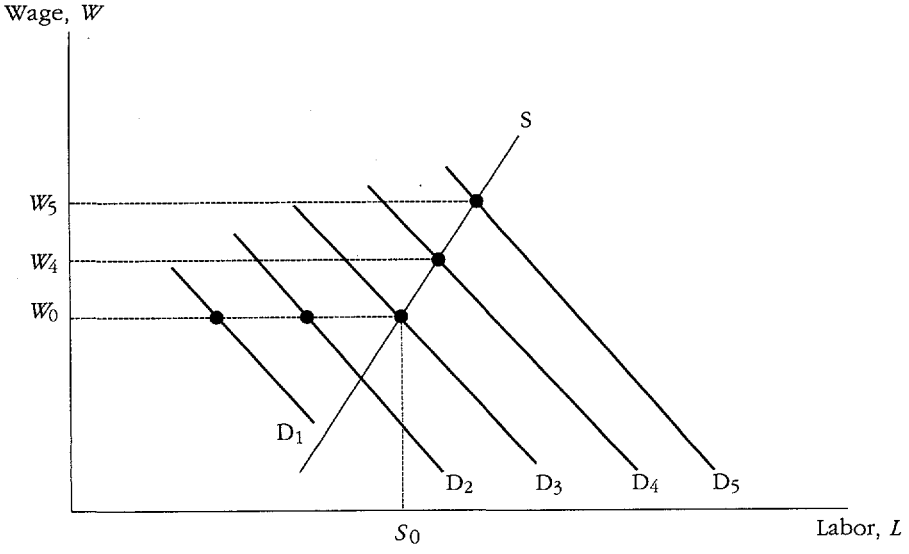
thereby slowing economic growth. The other prior hypothesis, contradictory to the first, is that growth would lead to ever-tightening labor markets and hence to higher returns to labor—perhaps explosively higher—as employers compete with one another for scarce workers to staff their growing enterprises.

This article assembles new data on what happened in Hong Kong, Korea, Singapore, and Taiwan (China) in the 1980s. Earlier evidence for the 1960s and 1970s (Fields 1984, 1985) is very clear. In the first stages of rapid economic growth, these economies moved closer to full employment; the job mix improved but real wages changed little. But once full employment was attained, as economic growth proceeded further, real wages rose rapidly in Hong Kong, Korea, and Taiwan (China), and the job mix improved.

These patterns can be understood by building upon the famous accounts of dualistic development offered by Lewis (1954) and by Fei and Ranis (1964). At first, the wage was high enough that there was an essentially unlimited supply of labor, $S_0$, at the prevailing wage, $W_0$ (figure 1). Rapid, export-led growth shifted the demand for labor curve rightward faster than the supply of labor curve shifted rightward; as a stylization of this, the supply of labor curve is held constant in the figure. As long as the excess supply persisted, the growing demand for labor (from $D_1$ to $D_3$) resulted in increased employment but not increased wages. However, once more labor was demanded at wage $W_0$ than was supplied, wages started to increase. As the demand for labor curves shifted to positions such as $D_4$ and $D_5$, wages rose to $W_4$ and $W_5$, respectively.

The process described above continued virtually without interruption in Hong Kong, Korea, and Taiwan (China), but in Singapore the picture is different. Real wages barely grew in the 1970s because of the strong repressive hand of the Singaporean government in the labor market. Wages there were held well below market-clearing levels for several years.

Figure 1. *Supply and Demand for Labor with Demand Increasing Faster Than Supply*




This article extends the earlier analysis of labor market conditions and income distribution in these four economies to cover the 1980s. I address two major issues. One is how conditions changed during the decade. I look at changes in five indicators: the rate of unemployment, the composition of employment, average real wages, income inequality, and absolute poverty. The second issue is labor market repression. Is there evidence of repression of wages or of labor unions? If so, how was this repression effectuated? Is there evidence that economic growth was affected, for better or for worse?

## I. Changes in the 1980s

The data for all four economies tell a very consistent story: rapid economic growth led to improvements in labor market conditions (as measured by unemployment rates, job mix, and real earnings) and reductions in poverty. The workers in these economies benefited handsomely indeed from the economic growth that took place. Furthermore, the gains received by workers were remarkably similar to the gains in national income, as table 1 shows. East Asian economic growth did not leave workers behind. Annual data on changes in labor market conditions and income distribution in the 1980s for the four East Asian NIEs are presented in table 2.[1]

### *Hong Kong*

In Hong Kong, real gross domestic product (GDP) per capita grew by 64.2 percent in the 1980s. This growth was quite uneven, however; in several years,

1. Unless otherwise noted, the sources for the data mentioned throughout the article are in tables 1 and 2.

Table 2. *Changes in Labor Market Conditions and Income Distribution in Four Newly Industrializing Economies in East Asia, 1980–90*

| *Indicator* | *Year* | *Hong Kong* | *Korea* | *Singapore* | *Taiwan (China)* |
|---|---|---|---|---|---|
| I. Unemployment rate (percent) | 1980 | 3.8 | 5.2 | 3.1 | 1.2 |
| | 1981 | 3.5 | 4.5 | 2.9 | 1.4 |
| | 1982 | 3.8 | 4.4 | 2.6 | 2.1 |
| | 1983 | 4.1 | 4.1 | 3.2 | 2.7 |
| | 1984 | 3.8 | 3.9 | 2.7 | 2.4 |
| | 1985 | 3.3 | 4.0 | 4.1 | 2.9 |
| | 1986 | 2.6 | 3.8 | 6.5 | 2.7 |
| | 1987 | 1.9 | 3.1 | 4.7 | 2.0 |
| | 1988 | 1.5 | 2.5 | 3.3 | 1.7 |
| | 1989 | 1.4 | 2.6 | 2.2 | 1.6 |
| | 1990 | 1.7 | 2.4 | 2.0 | 1.7 |
| II. Employment composition (percentage of total employment) | | | | | |
| A. Agriculture | 1980 | — | 34.0 | 1.75 | 19.5 |
| | 1981 | 2.0 | 34.2 | 1.49 | 18.8 |
| | 1982 | — | 32.1 | 1.35 | 18.9 |
| | 1983 | — | 29.7 | 1.34 | 18.6 |
| | 1984 | — | 27.1 | 1.08 | 17.6 |
| | 1985 | — | 24.9 | 1.11 | 17.5 |
| | 1986 | 1.8 | 23.6 | 1.20 | 17.0 |
| | 1987 | — | 21.9 | 0.87 | 15.3 |
| | 1988 | — | 20.7 | 0.72 | 13.7 |
| | 1989 | — | 19.5 | 0.71 | 12.9 |
| | 1990 | — | 18.3 | 0.32 | 12.8 |
| B. Employees | 1980 | — | 47.3 | 85.0 | 64.4 |
| | 1981 | 88.5 | 47.2 | 85.1 | 64.3 |
| | 1982 | — | 47.6 | 84.7 | 64.1 |
| | 1983 | — | 49.5 | 84.3 | 63.8 |
| | 1984 | — | 52.9 | 84.4 | 64.4 |
| | 1985 | — | 54.1 | 84.4 | 64.1 |
| | 1986 | 87.4 | 54.4 | 84.4 | 64.7 |
| | 1987 | — | 56.2 | 84.2 | 66.7 |
| | 1988 | — | 57.0 | 85.4 | 67.1 |
| | 1989 | — | 59.1 | 85.6 | 67.4 |
| | 1990 | — | 60.2 | 87.5 | 65.6 |
| C. Professional and technical, administrative and managerial, clerical, and sales occupations | 1980 | — | 29.0 | 42.9 | 31.8 |
| | 1981 | 30.8[a] | 29.2 | 42.8 | 32.7 |
| | 1982 | — | 30.6 | 44.2 | 33.1 |
| | 1983 | — | 32.1 | 45.5 | 33.4 |
| | 1984 | — | 32.9 | 46.5 | 33.7 |
| | 1985 | — | 34.3 | 46.5 | 34.2 |
| | 1986 | 37.9[a] | 34.3 | 46.2 | 34.3 |
| | 1987 | — | 34.1 | 47.0 | 35.1 |
| | 1988 | — | 34.6 | 46.1 | 37.2 |
| | 1989 | — | 35.4 | 46.8 | 38.5 |
| | 1990 | — | 36.2 | 60.0[b] | 39.8 |
| D. Employed workers with no schooling | 1980 | — | — | 25.2 | 9.8 |
| | 1981 | — | — | 24.5 | 9.4 |
| | 1982 | — | — | 24.9 | 8.9 |
| | 1983 | — | — | 23.3 | 8.9 |
| | 1984 | — | — | 20.7 | 8.6 |

| *Indicator* | *Year* | *Hong Kong* | *Korea* | *Singapore* | *Taiwan (China)* |
|---|---|---|---|---|---|
| | 1985 | — | — | 22.8 | 8.2 |
| | 1986 | — | — | 22.1 | 8.0 |
| | 1987 | — | — | 23.1 | 7.1 |
| | 1988 | — | — | 19.5 | 6.2 |
| | 1989 | — | — | 19.4 | 5.7 |
| | 1990 | — | — | — | 5.1 |
| III. Average real monthly earnings[c] (index, 1980 = 100) | 1980 | 100 | 100.0 | 100.0 | 100.0 |
| | 1981 | 102 | 98.9 | 105.5 | 102.0 |
| | 1982 | 107 | 105.9 | 116.9 | 108.7 |
| | 1983 | 106 | 114.6 | 125.9 | 114.1 |
| | 1984 | 114 | 120.7 | 134.1 | 124.0 |
| | 1985 | 119 | 129.7 | 146.6 | 129.5 |
| | 1986 | 132 | 137.8 | 151.1 | 141.6 |
| | 1987 | 140 | 149.0 | 152.9 | 154.8 |
| | 1988 | 147 | 165.6 | 158.4 | 169.5 |
| | 1989 | 155 | 195.3 | 170.4 | 186.0 |
| | 1990 | 160 | 215.8 | 179.8 | 202.7 |
| IV. Poverty[d] (percent) | 1980 | — | 4.8 | — | 30.7 |
| | 1981 | 28.5 | 5.3 | — | 32.9 |
| | 1982 | — | 8.6 | 31.2[f] | 32.6 |
| | 1983 | — | 7.3 | — | 29.0 |
| | 1984 | — | 6.2 | — | 24.9 |
| | 1985 | — | 5.6 | — | 23.9 |
| | 1986 | 18.3 | 5.3 | — | 20.8 |
| | 1987 | — | 5.7 | 26.1[f] | 18.5 |
| | 1988 | — | 5.5 | — | 15.2 |
| | 1989 | — | 5.6 | — | 13.4 |
| | 1990 | — | 5.3 | — | — |
| V. Inequality, as measured by the Gini coefficient of income among households | 1980 | — | 0.3891[e] | — | 0.277 |
| | 1981 | 0.414 | — | — | 0.281 |
| | 1982 | — | — | 0.418[f] | 0.283 |
| | 1983 | — | — | — | 0.287 |
| | 1984 | — | — | — | 0.287 |
| | 1985 | — | 0.3449[e] | — | 0.290 |
| | 1986 | 0.388 | — | — | 0.296 |
| | 1987 | — | — | 0.402[f] | 0.299 |
| | 1988 | — | — | — | 0.303 |
| | 1989 | — | — | — | 0.303 |
| | 1990 | — | 0.2886[e] | — | 0.312 |

— Not available.

a. Total employed includes unemployed workers who have previously held jobs.

b. Includes service workers.

c. For Hong Kong the data are wages in manufacturing; for Korea, earnings in mining and manufacturing; for Singapore, earnings in all industries; and for Taiwan, earnings in manufacturing.

d. Percentage of households with monthly income less than HK$2,000 (1981 prices) for Hong Kong, S$1,000 (1982/83 prices) for Singapore, and NT$200,000 (1986 prices) for Taiwan. For Korea the data are the percentage of the total population receiving livelihood protection.

e. The Gini coefficient of urban income.

f. Data refer to fiscal year.

*Source*: For Hong Kong: Government of Hong Kong (1981: table 2.9; 1986a; 1986b; various years) and unpublished country data. For Korea: Government of Korea (various issues; various years; 1988); Y.-B. Park (1992a; 1992b); and unpublished country data. For Singapore: Fields (1985) and Government of Singapore (various years). For Taiwan: Government of China (various years; 1991b).

the growth rates were below 2 percent, whereas in several others years, they ranged from 9 to 13 percent.

It would be expected that when growth is uneven, unemployment would be variable. Indeed, in Hong Kong's economic slowdown of 1982, the unemployment rate increased to 4 percent. But subsequent economic growth brought unemployment down, and it has been below 2 percent of the labor force since 1987.

The tight labor market is also manifested in an improved job mix.[2] Agriculture's share of total employment, already very low, fell even further. A larger share of workers came to be employed in professional, administrative and managerial, clerical, and sales occupations. The share of paid employees in total employment fell, however, because of a substantial increase in the fraction of self-employed. Information is not available on the changes in workers' earnings in these different occupational categories. One other indicator of improved job mix is the educational attainments of workers. Because of a change in the way this information is reported, however, comparable data across years are not available for Hong Kong.

The continued tightness in the labor market also shows up in real wages. Real wages grew by 60 percent in Hong Kong during the 1980s, slightly below the rate of growth of real per capita GDP (64.2 percent). The growth in real wages caused the poverty head-count ratio to fall from 28.5 percent in 1981 to 18.3 percent in 1986. Income inequality, already at moderate levels in Hong Kong, fell further—from a Gini coefficient of 0.414 in 1981 to a Gini of 0.388 in 1986.

### *The Republic of Korea*

In the 1980s the Korean economy continued its remarkable progress in improving labor market conditions. The labor market, already tight, became even tighter. The unemployment rate, which had hovered around 4 percent in the 1970s and had reached 5.2 percent by 1980, began falling. It fell to 3.1 percent by 1987 and to 2.4 percent by 1990. The job mix also continued to improve as the increase in job opportunities for workers in the better-paying sectors and occupations continued to outpace the growth of labor supply. In the 1980s agriculture as a share of total employment continued to decline, falling almost by half. The fraction of workers engaged as paid employees (as opposed to self-employed or unpaid family workers) grew from 47.3 to 60.2 percent. The fraction of workers employed in the top occupations (professional, technical, administrative and managerial, clerical, and sales) increased by 24.8 percent. The educational composition of the labor force also improved. The percentage of employed workers with only primary schooling fell by nearly half.

Real earnings doubled within the decade in Korea. By 1990 real average earnings in mining and manufacturing had reached 215.8 percent of their 1980

2. Job mix information is not available in annual surveys. The sources for the figures presented here are the 1981 census and 1986 by-census. The 1991 census results had not been released at the time this article was written.

levels. The growth of real earnings over the decade (115.8 percent) was virtually the same as the growth of real per capita gross national product (GNP, 121.8 percent). The 7.7 percent average real growth rate of earnings was extremely high. Overall, in the twenty-five years between 1966 and 1990, real earnings in Korea increased sixfold among a fully employed labor force—the best record of any economy in the world during that period.

Information on poverty is something of a problem in Korea. What is available is information on the number of "livelihood protection persons," that is, individuals who receive assistance from the Ministry of Health and Social Affairs in the form of home care, institutional care, or consumption assistance. The percentage of Koreans receiving such assistance was 4.8 in 1980, rose to 8.6 during the recession of the early 1980s, and then fell to 5.6 by 1985, where it has more or less remained since. It would be better to have information on the fraction of households or individuals with income or consumption below a constant real poverty line, but to the best of my knowledge such information is not yet available.

In terms of relative inequality, there is a strong divergence between what people perceive and what the numbers show (Choo 1992; Leipziger 1992). Although it is thought that the very rich in Korea have gotten richer even faster than have other Koreans (which would produce an increase in inequality of total incomes), the available evidence shows that income inequality in Korea fell in the 1980s (see the studies by Choo 1992; Leipziger 1992; and Y.-B. Park 1992a, 1992b). Topel and Kim (1992) attribute the equalization of incomes to the equalization of human capital levels and to a sharp narrowing of the differential in wages between college graduates and grade school graduates. Kwark and Rhee (1992) show that this equalization was caused both by the narrowing of the occupational wage structure and by the fact that many of the newly educated workers moved down in the job ladder to take lower-level jobs than previously educated workers had taken.

Overall, the record for Korea is one of extraordinarily rapid and sustained improvements in labor market conditions.

### *Singapore*

Except for a recession in 1985 and 1986, the Singaporean economy grew rapidly in the 1980s. As a result, per capita GDP was 77.5 percent higher at the end of the decade than it was at the beginning.

The unemployment rate mirrors the country's growth performance. Unemployment was around 3 percent until the mid-decade recession raised it to 6.5 percent. With the economic recovery, unemployment again fell, reaching just 2.0 percent by 1990.

The job mix continued to improve in Singapore, albeit slowly. The share of workers in professional and technical, administrative and managerial, clerical, and sales occupations rose from 42.9 percent at the beginning of the decade to 46.8 percent by the end. The fraction of total employment accounted for by paid

employees (as opposed to self-employed or unpaid family workers), already high, grew even higher: from 85.0 percent at the beginning of the decade to 87.5 percent by the end. The labor force continued to become better educated, and the fraction of employed workers with no schooling fell by nearly one-fourth. One other commonly used indicator of job mix is the percentage of the labor force in agriculture. In Singapore, however, agriculture has become such an insignificant percentage of the labor force (just 0.3 percent of the labor force at present) that this information is of little value.

Real earnings in Singapore grew by 79.8 percent during the 1980s. This growth rate was virtually the same as the growth rate of real per capita GDP during the decade (77.5 percent). Parity between growth in real earnings and growth in real per capita GDP was in marked contrast to Singapore's experience in the 1970s, during which time earnings grew by just 2 percent annually while the economy was growing at 9 percent. The reason for the difference between the 1970s and 1980s was that Singapore abandoned its earlier practice of wage repression.

Information on inequality is available only for scattered years. According to data from Government of Singapore (various years, 1990), the Gini coefficient was 0.418 in 1982–83 and 0.402 in 1988–89. Whether this decline in inequality is economically meaningful is debatable; what can be said clearly from the data is that inequality in Singapore did not increase in the 1980s.

Poverty continued to fall. The proportion of households with incomes below S$1,000 a month (in 1982–83 prices) declined from 31.2 percent in 1982–83 to 26.1 percent in 1987–88.

### *Taiwan (China)*

The economy of Taiwan (China) maintained its high growth rate throughout the 1980s. Real per capita GNP was twice as high in 1991 as it had been in 1980. But the slower growth rate in the early 1980s caused the unemployment rate to move up gradually from 1.2 to 2.9 percent before coming back down to 1.7 percent. The job mix continued to improve over the decade: there was a one-third decrease in agriculture's share of total employment, a small increase in the number of paid employees as a percentage of total employment, a larger increase (from 31.8 to 39.8 percent) in the share of high-level workers (professional and technical, administrative and managerial, clerical, and sales workers) as a percentage of total employment, and a halving of the percentage of employed workers who had no schooling. Real earnings again doubled, growing even faster between 1980 and 1990 (102.7 percent) than did real per capita GNP (88.0 percent). The workers of Taiwan benefited handsomely from economic growth in the 1980s.

Not surprisingly, given the rapid growth of GNP and of earnings, poverty dropped sharply from 30.7 percent of households in 1980 to 13.4 percent by 1989. As for inequality, although Taiwan has had the world's most equal distribution of income, the 1980s were a time of inexorable increase in inequality.

The Gini coefficient rose from 0.277 to 0.312, a fairly substantial increase in so short a time. The real incomes of the upper-income groups more than doubled while those of the lower-income groups fell just short of doubling, hence the percentage increase for the rich was larger than for others.

## II. Labor Market Repression

It is sometimes said that export-led industrialization can succeed only if labor's real earnings do not rise. The data presented in the previous section show conclusively that this was not the case in the four East Asian NIES. Instead, economic growth led by increasing export penetration in world markets is quite consistent with rising real earnings of labor.

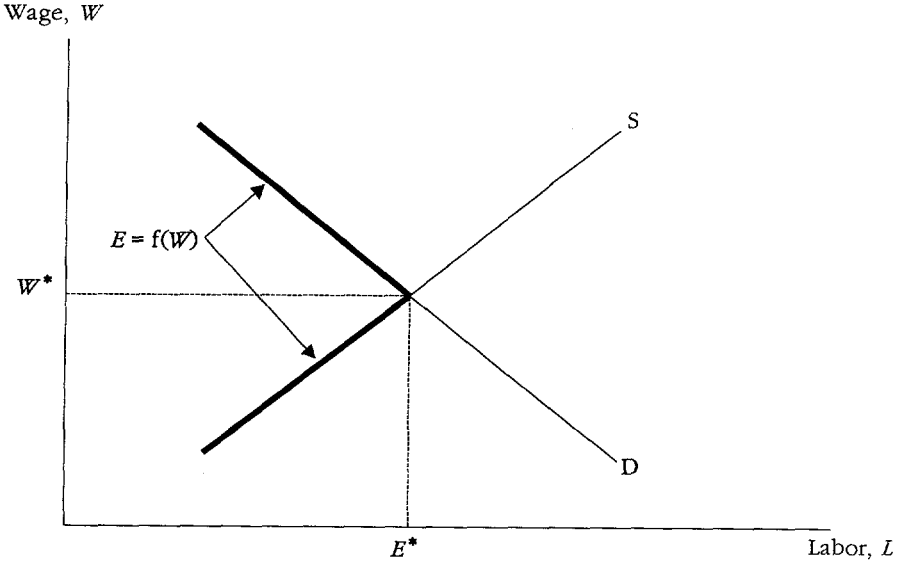
Nonetheless, it may still have been the case that one or more of the East Asian NIES developed by limiting the growth of wages or the power of organized labor or both, with the aim of maintaining international competitiveness and facilitating economic growth. In what follows, I use the term "labor market repression" to denote either the restraint on wage growth ("wage repression") or the restraint on organized labor ("labor repression").

Could wages have risen while at the same time being repressed? Did public policy weaken the bargaining strength of organized labor, causing wage increases to be less than they would otherwise have been? What were the indications of the presence of labor market repression? It is beyond the scope of this article to provide complete answers to these questions. As a referee correctly notes, a full answer would require building a model simulating the path of hypothetical wages in the formal sector of the economy under free labor market conditions and then comparing this against the actual path. Nonetheless, two kinds of evidence are informative.

The first is direct evidence on the operation of the repressive forces, that is, "the smoking gun approach." The direct government role in wage setting in Singapore and the passage of industrial relations legislation weakening trade union bargaining power in Korea fall into this category. It might be argued that these institutions, although potentially repressive, may in fact have made little difference. This is where a second kind of evidence comes in, that is, the pattern of wages and employment in labor markets.

Wage repression, if serious enough, would be expected to have the following effect: when the wage is suppressed, less labor is supplied than at the market-clearing wage, causing employment to fall because of the resultant labor shortages. Figure 2 shows this, along with the well-known result that a wage above the market-clearing level also reduces employment. Thus, employment is maximized when the wage is at the market-clearing level rather than above or below it. Singapore's wage-repression policy curtailed employment and therefore hampered economic growth. This is illustrated in figure 2 for a country that has moved beyond the surplus labor stage to the stage where its labor market is of the neoclassical type. Wage repression lowers economic growth by reducing the

Figure 2. *The Effects of Wage Repression on the Labor Market*




amount of labor supplied, which reduces the amount of labor input ($L$) in a standard production function of the type $Q = f(K, L)$, causing less output to be produced than otherwise.

Labor market repression can operate in another way, which is to weaken labor's bargaining power. In this case, labor's share of national output would be expected to be low, or wages would be expected to rise at a slower rate than output.[3] This was not the case in the East Asian NIEs, even in Korea, where labor repression is said to have been practiced.

*Hong Kong*

Hong Kong does not appear to have had any important labor market repression or wage distortions. Hong Kong's labor market institutions are very close to laissez-faire (Cheng 1977; Hsia and Chau 1978; Rabushka 1979; Turner 1980; Chow and Papanek 1981; Young 1989). Hong Kong does not have an active economic policy, either in general or with respect to the labor market. The government is not involved in wage determination. In particular, Hong Kong has no minimum wage or special provisions about what foreign-owned firms must pay, and there is no mechanism by which the government can repress wages, for instance, by exercising power through a national wages council as in Singapore. The public sector does not pay a wage premium over the private

3. In personal correspondence, Bruce Reynolds has suggested a different interpretation, which is that repressive institutions were present and did make a difference because they counterbalanced or preempted organized labor activity.

sector. Unions are permitted, but they are neither favored nor discouraged by public policy. Workers have exhibited little enthusiasm for joining unions or for bargaining collectively in pursuit of improved working conditions. Although strikes are allowed in the private sector, few unions have strike funds apparently because they have little inclination to strike. Hong Kong's labor code has little effect on the labor market. For example, employers are required to give only seven days' advance notice of layoffs or dismissal and must give only seven days worth of severance pay.

In sum, Hong Kong's situation is one of labor peace with market-determined wages and employment conditions.

### *The Republic of Korea*

Several authors have characterized labor market conditions in Korea as being market-determined (Moran 1976; Lindauer 1984; Fields 1985; Richardson and Kim 1985; Castaneda and F.-K. Park 1986; Fields and Wan 1989). This conclusion is based on the apparent lack of forces that push wages appreciably above market-clearing levels and on the attainment of generally full employment, except temporarily during brief economic recessions.

Whether Korean wages were below market levels is widely debated. The evidence is that real wages in Korea rose rapidly, faster even than GNP growth: between the mid-1960s and the mid-1980s, real wages in manufacturing (which has been the engine of Korean economic growth) rose at an annual rate of 8.1 percent while real per capita GDP grew by 6.9 percent (Lindauer 1991: 19, 29). Some authors (Deyo 1989; Vogel and Lindauer 1991) claim that labor repression was in force in Korea. Now however, according to Vogel and Lindauer (1991: 5–6), "Korea is currently in the midst of a transition away from a historically repressive system of labor control that is no longer viable. . . . It [is] impossible to maintain the old system of tight labor control backed by state force." Possibly, wages would have risen even more rapidly if labor had been less controlled, but we cannot know.

S.-I. Park (1992) has prepared a comprehensive review of the stages in Korea's industrial relations practices. There were three mechanisms by which labor repression may have been practiced in Korea: restrictions on unions, government jawboning for private firms to limit wage increases, and restrictions on credit to noncompliers. Until 1987 labor unions in Korea were very weak. Only about 15 percent of the workers were unionized (S.-I. Park 1992). The powers of unions were limited in a number of ways: only enterprise unions were permitted; national unions and the nationwide Federation of Korean Trade Unions were under the control of the government and did not intervene in collective bargaining; strikes could be ended by police action, arrest of union leaders, or both; and in the event of a labor dispute, arbitration was compulsory. Consequently, unions had little economic power, and wage growth was kept down as a result of this deliberate attempt by previous Korean governments to weaken

unions. For accounts of the pre-1987 period, see You (1990) and Lindauer (1991).

Another way in which government may have exercised labor repression was through jawboning, both open and covert. The government issued open "guidelines" for wage increases. These were "enforced" behind the scenes through the credit system:

> Acting through the Bankers' Association of Korea, the government also tried to keep wage increases low by having banks restrict credit for firms which increased wages beyond government guidelines. . . . Whenever there was a more explicit confrontation over this issue, the government would say 'There is no official guideline. It is just a suggestion on the part of the government.' (Nam 1984: 73–74)

Given the heavy involvement of government in the Korean economy, many labor economists in Korea (for example, Bai 1985) have viewed efforts at jawboning to lower wages as repressive.

Several pieces of evidence suggest that unions were indeed weak in Korea, at least until 1987, and that wage growth may have been slowed as a result of the various government-imposed restrictions.

- S.-I. Park (1980) found that membership in a union was not a significant determinant of earnings in Korea in the 1970s—a result that could only be found if unions were too weak to have had much of an economic impact.
- For the 1978–85 period, Topel and Kim (1992: figure 9c) found no relation between wage growth and employment growth for different manufacturing industries. This means that aggregate wage growth was neutral among sectors, leading Topel and Kim to conclude that there is "one labor market in Korea" and that unions did not play an important role in raising the wages of their members in relation to other workers in the economy.
- You (1990: 110–11) shows that three periods of intense political repression (1961–64, 1971–72, and 1980–82) were also times of negative or sluggish real wage growth. These were, however, times of overall economic improvement. You interprets this as showing that "the labor rights situation has had a substantial impact on wage formation."

Various authors have also commented on the growth of wages and of productivity, with inconclusive results. Some authors find evidence of wage repression. Topel and Kim (1992, figure 1) find that in the early 1980s real wage growth lagged far behind productivity growth. They conclude (p. 8) that "government efforts to suppress wage growth—at least for less skilled workers—seem to have been successful" in those years. Mazumdar (1990) shows that for the period 1967–86 Korea experienced a "sustained and substantial rate of increase in labor productivity" (p.16). He finds, however, that real wages grew more slowly than productivity. He interprets this as evidence of "the importance of state paternalism in wage negotiations in the formal sector in keeping real wage

increases in line with productivity growth but somewhat below it in most periods. . . . It was also eminently successful in drastically slowing down or even halting real wage growth during the short-run periods of crisis." He terms this wage-productivity relationship "healthy"—a characterization not shared by everyone.

Other wage-productivity comparisons give a very different picture. Lindauer (1991) indicates that between 1965 and 1984 real wage growth in Korea kept pace with productivity increases. You (1992: 21, 31) observes that over the long run, the growth rate of real wages in Korean manufacturing (8 percent a year) was higher than the growth rate of productivity (6 percent a year). You concludes that "Korea's success in rapid industrialization and, in particular, manufacturing exports was therefore *not* based on low wages. Rather, it was achieved with an extraordinarily fast real wage growth. . . . *The rapid rise in real wages in Korea is a result of the rapid productivity growth and the rapid growth in demand for labour.*" (Emphasis added.)

Data on labor's share in national income help resolve the conflict over whether there was labor market repression. Y.-B. Park (1992a: 25) shows that employee compensation as a percentage of national income increased from 31.8 percent in 1965 to 39.7 percent in 1970, to 51.6 percent in 1980, and to 56.3 percent in 1989. Korean labor cannot have been repressed too badly.

It is important to note that all of the preceding evidence predates 1987, a significant year in Korea's labor history because on June 29 of that year, Korea's industrial relations system was substantially reformed. As part of a larger political liberalization, the government granted new rights. Most important, the government agreed to keep out of labor-management negotiations, allowing the two sides to bargain autonomously.

The 1987 reforms had two immediate impacts: increased strike activity and greater union organizing. A rash of strikes immediately followed the 1987 liberalizations; there were as many strikes in Korea in July and August of 1987 as there had been in the preceding twenty-five years combined. But the industrial relations climate soon stabilized: the number of labor disputes fell from 3,749 in 1987 to 1,873 in 1988 and to just 234 in 1991. Meanwhile, the trade union movement expanded rapidly. Between July 1987 and December 1989 the number of organized establishments tripled, and union membership doubled. But even so, only 17.4 percent of all employees are covered by collective bargaining agreements.

Union activities remain limited. Korea's Trade Union Act maintains the principle of "exclusive jurisdiction," that is, that each group of workers is eligible for representation only by an established union, thus preventing competitive organizing drives. The Federation of Korean Trade Unions remains the only legally sanctioned trade union federation. This renders illegal the operations of more radical and independent unions and the council into which they are organized (the National Council of Trade Unions) and weakens the labor movement. Although employees in public enterprises have now received the same labor

rights as private sector workers, teachers and civil servants still do not have the right to join trade unions or to strike. Major revisions to Korea's labor laws were passed by the National Assembly in 1989 but vetoed by the president. Since 1990, the government has once again tried to influence collective bargaining outcomes by pushing for prompt settlement of wage negotiations and by urging that wage increases be kept within single digits. (S.-I. Park 1993 characterizes the post-1989 period as one of "selective intervention," in contrast to 1987–89, which he characterizes as "laissez-faire.") These limitations on union organizing and collective bargaining notwithstanding, two leading Korean labor economists conclude that Korean workers "have gained fuller freedom in exercising their basic labor rights to organize, to bargain collectively, and to strike" (F.-K. Park and Y.-B. Park 1991: 3).

The greater liberalization of Korea's industrial relations system is reflected in changed labor market conditions. Between 1986 and 1991 the real wage in the manufacturing sector increased by 67.7 percent while productivity increased by only 40.6 percent (Y.-B. Park 1992b: 13). More recently, the one-digit policy failed, and wages rose by 18.8 percent in 1990 (20.3 percent in manufacturing). Interestingly, the wage increases reported to the government averaged just 9.1 percent. This was the increase of basic wages, excluding increases in bonuses, special wages, and other fringe benefits. Now the government is trying to implement a "total wage system," which it seeks to enforce through financial sanctions in credit allocation and through safety and health inspections. The effect of this system is not yet clear.

That growth in real wages was faster than growth in productivity was opposite to the earlier mixed evidence reported for the period before the liberalization of Korea's industrial relations system. The faster growth in real wages suggests that the additional support provided to unions, and to workers more generally, enabled wages to increase at higher real rates than they had during the earlier, more repressive period. It is impossible to say which was more important—the strengthening of organized labor or the tightening of labor market conditions—in producing these wage increases. Undoubtedly both played a role.

### *Singapore*

Detailed accounts of the Singapore labor relations experience may be found in Pang (1988), Lim (1990), and Pang and Lim (1989), from which the following information is taken. The early labor history of Singapore was marked by an emphasis on labor peace. Communist unions were disbanded and strikes outlawed. Unions were free to bargain over wages. Until 1972, wages in Singapore were determined largely by market forces.

But in 1972 the National Wages Council (NWC) was set up to make annual recommendations for wage increases. Equal representation was given to management, the National Trade Union Congress (NTUC), and government. The relationship between the NTUC and the government was, and still is, extremely close. That fact, along with the very strong role of government in Singapore,

meant that the NWC's "guidelines" were nearly always followed. And the NWC recommended very modest wage increases. Between 1972 and 1979, real wages rose by 2 percent while real GDP rose by 9 percent (Fields 1985).

The purpose of the 1972–79 wage repression was to maintain the international competitiveness of Singapore's labor-intensive export industries. The Labor Minister in the mid-1970s, Mr. Ong Pang Boon, said at that time:

> Our working population may well have to undergo a period of belt-tightening all round. . . . It is clear that an essential element in our new strategy must be a tighter grip on wage increases. . . . If we do not quickly and willingly change to low gear on the wages front, we shall further discourage investment and aggravate the unemployment problem. (*The Straits Times*, February 29, 1976)

But the wage repression policy went too far, and the labor market tightened to the point where labor shortages became severe. Employers wanted to offer higher wages to attract the workers they needed but were prevented by the NWC guidelines from doing so. Immigration quotas were loosened somewhat to meet a fraction of the excess demand, but labor shortages worsened. The overall result, unfortunately, was not only that economic growth was curtailed but also that the rate of improvement of living standards slowed down.

By 1979 the failures of the wage repression regime were evident. In that year the government announced a policy of "wage correction" aimed at alleviating labor shortages and restructuring the economy away from labor-intensive industries and toward capital-intensive and skill-intensive ones. Under the wage-correction policy, real wages were supposed to rise at double-digit rates. In the event, this did not happen; wages rose at a real rate of 7 percent, in line with real GDP growth but no faster.

In 1982 and 1983 the role of the NWC in wage determination was substantially weakened. The government removed itself from the NWC (which became bipartite), and the guidelines became less central to the wage-determination process (Lim 1990: 83). In 1985 real GDP declined by 1.7 percent, and 90,000 jobs were lost. The government imposed a temporary wage freeze, which lapsed a year later. Except for the recession year of 1985, the Singaporean government has kept out of the wage-setting process.

In summary, for purposes of assessing the issue of wage repression, the history of Singapore may be divided into four periods: reliance on market wage determination before 1972, wage repression from 1972 to 1979, wage correction from 1979 to 1982, and a return to market wage determination since then.

### *Taiwan (China)*

In Taiwan (China) real GDP and real manufacturing earnings grew at very similar rates in the 1980s (88.0 and 102.7 percent, respectively) while the unemployment rate remained around 2 percent. This suggests that Taiwan had neither wage repression nor artificial wage increases. Wages seem to have been set by supply and demand.

The supply-demand explanation is consistent with the observation by several writers that such forces as unions, minimum wages, public sector pay policy, multinational corporations, and labor codes are of little importance in Taiwan (Kuo 1983: chap. 4; Hou and Wu 1985: 6; Wu 1986: 51; Kuznets 1988: S27–29; Deyo 1989; Li 1989: 143; and Fields and Wan 1989: 1477). Unions have limited power for a number of reasons: market factors (the Hicks-Marshall laws of derived demand), the principle of exclusive jurisdiction in labor relations, the prohibition on the Chinese Federation of Labor from engaging in collective bargaining, and worker disinterest in general. As a result of the weak union movement, unionized employees are estimated to earn only 0.3 to 1.9 percent more than comparable nonunion employees (Lin 1989). Minimum wages are a nonissue, both because they are quite low (less than half the average wage) and because no employer has ever been reported for violating the scale (Chang 1989). Taiwan introduced the Basic Labor Standards Law in 1984; but although it came under attack for the possible difficulties it might cause, it is judged to have had little effect up to now.

The evidence in Taiwan is of a remarkably integrated labor market. Manufacturing wages are only 20 percent higher than agricultural wages (compared with wages that are 150 percent higher in Colombia and Jamaica).[4] The data also show no significant correlation between the growth rate of earnings in various industries and the growth of output, of employment, or of exports in those industries (Fields 1992: 413). This is because the labor markets in the various sectors are so closely tied together that changes in earnings are determined by the growth of the economy as a whole and not by economic growth in any particular sector. By contrast, output growth is related to a sector's rate of employment growth. This highly significant correlation may be interpreted as shifting the demand for labor curves that determine firms' willingness to grant wage increases to attract or retain workers.

In sum, Taiwan's labor market closely approximated the competitive labor market scenario. Wage repression was not practiced there.

## III. Conclusions

This article reaches two principal conclusions. The first is that labor market conditions continued to improve in all four economies in the 1980s at rates remarkably similar to their rates of aggregate economic growth. The second is that although wage repression was not a major factor in the growth experiences of these economies in the 1980s, the weakening of the labor movement was a significant factor in one country, the Republic of Korea, at least until 1987.

Is labor market repression necessary for successful economic growth? The answer suggested by the available evidence is no. Labor market repression is not

4. The Colombia figure is for manufacturing compared with agriculture; the Jamaica figure is for unskilled construction compared with agriculture.

necessary, because Taiwan (China) and Hong Kong developed very nicely without labor market repression. Is labor market repression desirable? Again, no. Wage repression had such negative economic consequences in Singapore in the 1970s that it was abandoned and has not been reinstituted since. Korea's labor repression became untenable, so that in 1987 that country instituted a general political liberalization that included fundamental changes in industrial relations practices.

Nonetheless, there are those who argue that wages should be held down in the future lest economic growth be stifled because of the loss of export competitiveness. I would ask two questions of those who hold such views. First, if wages are held down, how would companies deal with the labor shortages that would be expected to result? Would economic growth be curtailed? Second, what is the point of export-led growth if working people do not benefit from it? Why achieve growth?

The general labor market lesson coming from the East Asian NIEs is that the entire working population can and has benefited from labor market institutions. Labor market institutions enabled employment and earnings to be pulled up rapidly, increasing demands for labor emanating from export-led growth. The records of these economies in attaining and maintaining generally full employment, improving their job mixes, raising real earnings, and lowering their rates of poverty are the envy of the rest of the developing world.

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# The Welfare Costs of Price Controls for Cars and Color Televisions in Poland: Contrasting Estimates of Rent-Seeking from Recent Experience

David G. Tarr

*The welfare costs of price controls can vary enormously, depending on the method of allocating the good in shortage and the possible rent-seeking costs that may result. With full rent dissipation, the welfare loss from price controls on Polish color televisions in 1989 was about ten times the standard estimates of distortion costs, which ignore rent-seeking, and was more than 100 percent of the value of domestic producers' sales. The methods of allocating cars, however, did not result in rent-seeking costs. The domestic price controls were an unintended implicit subsidy to imports. Subsidies for cars were estimated at 43 percent and for color televisions at 22 percent.*

Although the macroeconomic features and accomplishments of the Polish "Big Bang" reforms of January 1990 have been extensively analyzed and debated (see, for example, Rocha and Coricelli 1991; Rosati 1991; Pinto, Coricelli, and de la Calle 1990; and Lipton and Sachs 1990), the impact of the reform at the microeconomic level has been largely unanalyzed.[1] This article provides empirical assessments of two phenomena that have been frequently discussed but rarely estimated. The first is the microeconomic policy changes in socialist economies, in this case the benefits of price decontrol in the Polish automobile and color television industries, and of trade liberalization in the presence of domestic price controls. The second is the extent of rent-seeking activities in these markets and the relative magnitude of the traditional distortion costs compared with rent-seeking costs.[2]

1. Some examples of microeconomic empirical work in Poland include Konovalov (1989), Tarr (1990b), Milanovic (1991), and Jorgensen, Gelb, and Singh (1991).

2. When goods are allocated by nonmarket-clearing methods, such as price control, the value of the goods to the recipient typically exceeds the costs. Expenditures of resources by agents who compete to obtain such goods is referred to as rent-seeking. Deacon and Sonstelie (1985), Alderman (1987), Lindsay and Feigenbaum (1984), and Sah (1987) have estimated rent-seeking.

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Section I outlines the theory of rent-seeking and how it applies to the automobile and color television industries in Poland. Section II discusses the institutional details of the automobile and color television markets in Poland, lays out the stylized facts that are incorporated in the model of these markets, and discusses the methods of allocating cars and color televisions in the context of the rent-seeking and rent dissipation literature. In section III a graphic version of the model is developed and interpreted and the results are explained. Section IV offers conclusions. The appendix develops a mathematical version of the model, which fits the stylized facts that prevailed in Poland in 1989. It is a differentiated product model in which consumers optimize their consumption expenditures across commodities subject to rationing constraints on their purchase of domestic cars and color televisions, and an implicit tariff on imports caused by the foreign exchange policy. Firms optimize their quantity choice subject to price controls. A model developed in the appendix analyzes the consumption-labor-leisure choice in the presence of price-controlled commodities that require queuing. The appendix also treats calibration of the model and derivation of cross elasticities in a model subject to rationing.

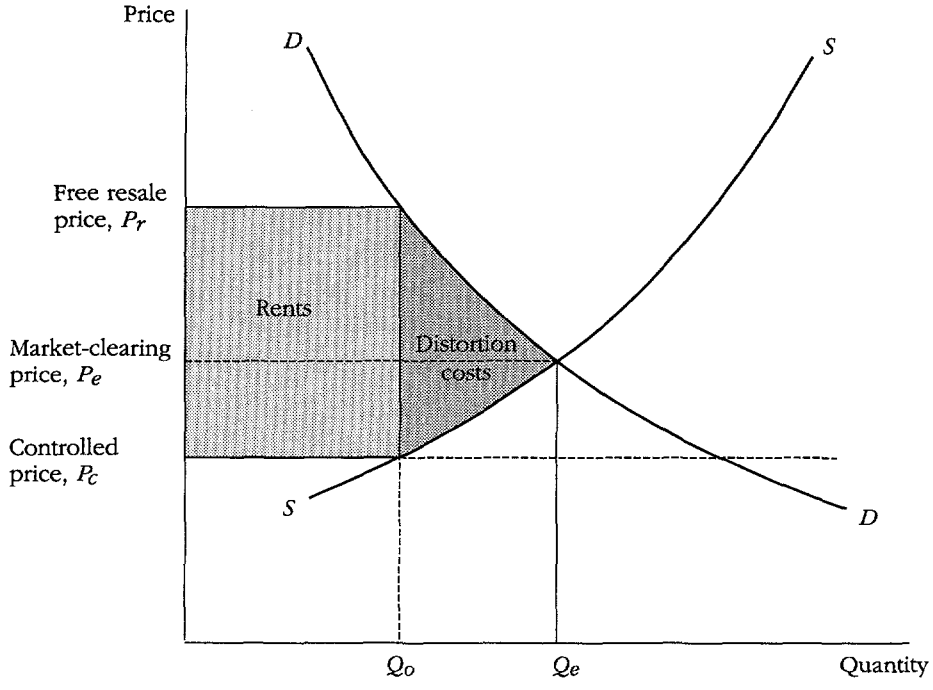
## I. Rent-Seeking

Figure 1 depicts a competitive market under price control. Firms may not sell the good above the controlled ceiling price $P_c$. Thus, they choose to offer for sale the quantity $Q_o$, for which their marginal costs equal the controlled price. Because consumers at the margin value the quantity supplied at $P_r$, the value to consumers exceeds the marginal costs to society of producing the good. Thus, there are gains from expanding output up to the market-clearing quantity-price combination ($Q_e$, $P_e$). These gains, which would be realized by eliminating the price control, are the triangle ("Harberger" triangle) labeled "distortion costs" in figure 1.

Figure 1 also labels a rectangle "rents." Because the controlled price does not clear the market, a nonmarket method of allocating the good must be employed. Those who receive the good under nonmarket allocation receive a good valued at $P_r$ at the margin (if free resale of the good is permitted, the price $P_r$ will clear the resale market) but only have to pay the controlled price $P_c$. The difference between the value of the good on the free resale market and the cost to the recipient is defined as rents. A problem arises because if agents can compete to obtain the rationed good, they will expend resources in competing to obtain these rents (the activity known as rent-seeking). The expenditure of resources may be sufficiently great for all the rents to be dissipated; that is, the full cost to the recipient of the good under price control is $P_r$. In that case the rent rectangle is an additional cost to society of the price control. Because the rent rectangle is typically large in relation to the distortion triangle, the extent of rent dissipation is important.

The early theory of rent-seeking tended to focus on cases in which rent-seeking activities exactly dissipated available rents. One of the most important

Figure 1. *Rents and Distortion Costs in a Competitive Market under Price Control*




early models is that of Barzel (1974), in which the method of allocating goods in shortage is through queuing. An individual who is deciding whether to join the queue must assess the value of the rent received compared with the opportunity cost of time spent in the queue. The full price to the buyer is the money price of the good plus the opportunity cost of the buyer's time. Subject to an uncertainty premium (see Hillman and Katz 1984), the individual will join the end of the queue if the value of the rent exceeds the value of the individual's time. The queue lengthens until the full price to the buyer (including the opportunity cost of time) exactly dissipates the rents. This implies that the full price to the consumer rises to $P_r$ (in figure 1), which is higher than the market-clearing price without a price control. Because the full price exactly dissipates the rents, queuing is a very inefficient method of allocating rationed goods.

One rationale for queuing is that if a distinction is made between consumers who have a high, as opposed to low, opportunity cost of time, it is those with the low opportunity cost of time who will choose to queue and obtain the goods. Insofar as these are likely to be poorer consumers, some will argue that there is an equity advantage to queuing as an allocation method. But if only those with a low opportunity cost of time queue, then the full cost to these consumers is the price $P_r$, which exceeds the market-clearing price even for these consumers. See

Table 1. *The Impact of Eliminating Domestic Price Controls on the Automobile and Color Television Markets in Poland*

| | *1988 data* | | *Low elasticities* | | *Medium elasticities* | | *High elasticities* | |
|---|---|---|---|---|---|---|---|---|
| *Item* | *Cars* | *Televisions* | *Cars* | *Televisions* | *Cars* | *Televisions* | *Cars* | *Televisions* |
| Domestic controlled price, $P_c$ | 1.27 | 0.394 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| Domestic free price, $P$ | 3.54 | 0.788 | 2.52 | 0.610 | 2.52 | 0.610 | 2.52 | 610 |
| Import price (tariff-inclusive), $p(1 + t)$ | 4.26 | 0.873 | 4.26 | 0.873 | 4.26 | 0.873 | 4.56 | 873 |
| Domestic quantity, $Q$ | 177 | 294 | 210 | 327 | 250 | 365 | 351 | 455 |
| Import quantity, $q$ | 61.6 | 156 | 43.5 | 135 | 30.7 | 117 | 15.2 | 87 |
| *Welfare gains* | | | | | | | | |
| Triangle of distortion | n.a. | n.a. | 37 | 7 | 82 | 14 | 200 | 32 |
| Rectangle of rent dissipation | n.a. | n.a. | 0 | 116 | 0 | 116 | 0 | 116 |
| Total | n.a. | n.a. | 37 | 123 | 82 | 130 | 200 | 148 |
| *Welfare gains (percentage of)* | | | | | | | | |
| GDP | n.a. | n.a. | 0.13 | 0.43 | 0.29 | 0.46 | 0.70 | 0.52 |
| Domestic producers' sales | n.a. | n.a. | 16.6 | 105.8 | 36.3 | 112.2 | 87.3 | 127.4 |
| Domestic producers' sales plus imports | n.a. | n.a. | 7.7 | 48.8 | 16.8 | 51.8 | 40.5 | 58.8 |
| Subsidy equivalent to imports caused by the price controls[a] | n.a. | n.a. | 44 | 23 | 43 | 22 | 42 | 21 |

n.a. Not applicable.

*Note*: Prices are in millions of 1988 zlotys, quantities in thousands of cars or color televisions, welfare gains in billions of 1988 zlotys or as a percentage of 1988 estimated GDP.

a. The percentage subsidy to imports necessary to reduce imports to their 1988 level, once price controls are removed.

*Source*: Author's calculations.

Sah (1987) for a formal derivation that even for the poor, queues are welfare-inferior to other rationing schemes. If there are transactions costs in reselling the product, the length of the queue and the amount of rent-seeking should be shorter in equilibrium because transactions costs reduce the rents. These transactions costs are also lost to society, so the full rent rectangle would remain as a cost to society.

In addition, buyers will incur transactions costs in the resale market. Because available data on the resale market exclude buyers' transactions costs, the extent of these costs is underestimated in the rent rectangle. The underestimate is likely to be small, however, especially for cars. As elaborated below, the value of the rents in the automobile market was about forty-six months of wages, but the transactions costs involved search costs of one to two weeks.

Another important model of full rent dissipation focuses on the expenditures of agents who lobby or compete to obtain a favorable allocation decision from the government. A number of models have been developed in which, depending on the nature of the market and the method of allocation of rents, wasteful rent-seeking activities may be greater or less than the available rents. Rent dissipation may be greater than available rents in the model of Deacon and Sonstelie (1989) and less than available rents in the models of Hillman and Katz (1984), Bhagwati and Srinivasan (1980), Bhagwati (1980, 1982), and Flowers (1987). See Tarr (1991) for a survey. A distinguishing empirical feature of the present study is that it examines in detail the methods through which cars and color televisions were rationed in Poland to assess the extent to which these rents were dissipated.

For color televisions in Poland in 1989, the early, more conventional view of exact and full rent dissipation appears appropriate because queues formed that dissipated the rents according to the model developed by Barzel (1974). This article estimates that rent dissipation under price controls equals about ten times the triangle of distortion costs, for a total cost of 0.46 percent of Polish gross domestic product (GDP), or 112 percent of the value of Polish producers' sales of color televisions (see table 1).

For cars, however, rationing was carried out through a variety of methods that, overall, did not increase the social costs of the price controls above the Harberger costs. For example, for a significant share of rationed cars, the allocation method was equivalent to the government's taxing the automobile sector and using the taxes it received to pay bonus payments to workers in other state-owned enterprises. Because these bonus payments were required to induce a greater supply of socially productive effort, they were not rents. Therefore, in cars with no rent dissipation, the triangle of distortion costs was the entire cost of the price control program; it equaled 0.29 percent of GDP, or 36 percent of the value of Polish producers' sales (see table 1).

## II. The Markets for Cars and Color Televisions in Poland before the Big Bang

The foreign trade regime in Poland as of early 1989 was largely open. One significant exception was that exporting enterprises had to surrender, on aver-

age, 70 percent of their foreign exchange earnings to the central government at the official exchange rate. (See Tarr 1990c, Rosati 1991, Olechowski and Oles 1991, or UNDP/World Bank 1989 for further details of the trade regime in Poland in 1989. See Brown 1987 and Rodrik 1992 for studies of the impact of trade policy on Poland.) This requirement represented a significant disincentive to export, because the official exchange rate was about 20 percent of the parallel market exchange rate. As elaborated in Tarr (1990c), the punitive foreign exchange surrender requirements represented an implicit tax on imports. The requirements made less foreign exchange available for imports and depreciated the market exchange rate.

Although the import market in 1989 was distorted by the aggregate surrender requirements on foreign exchange, this was an implicit tax caused by the premium on foreign exchange rather than a quota on cars or color televisions. There was no license or right to import for which it was necessary to compete. Anyone with the foreign exchange could import a car or television. I assume, therefore, that there were no rent-seeking activities in imported cars or color televisions.

This section describes the basic structures of the automobile and color television markets in Poland in 1989. An important difference between the two markets was the method of allocating rationed domestic goods under price control.

### *Color Televisions*

Imported and domestic televisions are not homogeneous; imported televisions are regarded as being of higher quality. Except for small tariffs and the implicit tax on foreign exchange, importing color televisions was free in 1989. It was not necessary to go through the official foreign trade organization to import a television, and foreign exchange was available (subject to the implicit import tax discussed above). Thus, the market for imported color televisions cleared.

Domestic color televisions were in severe shortage. The average domestic official price in 1988 was controlled at 394,000 zlotys (136 U.S. dollars at the parallel market exchange rate). At this controlled price, there was great excess demand. Because of the excess demand, the supplies were allocated in a negotiation process between producers and internal trade organizations (with a representative of the Ministry of Internal Markets present). The internal trade organizations are regional trade organizations that have retail outlets (one for each of the fifty voivodships or regions), rural cooperatives (CS Samopomoc Chlopska), and some small trading companies. Sometimes, in an effort to avoid the price controls, producers sold television sets to their suppliers, demanding goods or services that were also under price control in return, in the fashion described by Kornai (1980). Barter is inefficient compared with a well-functioning money-based payments system. With price controls, however, barter has a second-best benefit because it encourages greater production. A full treatment of this subject, however, is beyond the scope of this article.

The final consumers of the color televisions, who wanted to pay the official price, had to wait in front of the stores for days or weeks until a shipment arrived. Those who waited at the stores formed waiting lists, called "social waiting lists." The lists, through rules set by the customers, determined who had the right to buy a television at a particular store when a shipment arrived. Although there were cases in which the lists were operated by the staff of the stores, such cases were unusual. At least one person from the list had to be at the store at all times, or a newcomer could start a new list. Normal procedure obliged everyone on the list to appear at the store at least once a day at a designated time to keep his or her name on the list. There were cases of people taking leave from work to ensure that they would be able to buy a color television and of people who waited in line so they could resell a television. It appears that the best way to characterize the allocation of domestic color televisions is described by Barzel's (1974) model.

Domestic color televisions could be, and were, resold in open-air markets where goods (not limited to color televisions) were sold and through advertisements. The free-market price was periodically reported in newspapers, and in 1988 it was two times the official price. Thus, the resale market in Poland for color televisions (both new and used) cleared. The per-unit value of the rent (defined as the difference in the price on the resale market and the official price) could be directly observed, but that rent had likely been dissipated through lost time in the queue, so that the rents were an additional cost to society.

### *Cars*

Polish cars and imported cars are not homogeneous products. Poland imported cars from a number of foreign countries, including Japan, Germany, Sweden, and the former Eastern bloc countries, most notably Czechoslovakia and the Soviet Union. Imported vehicles generally sold for considerably more than domestic vehicles (on the domestic free market), reflecting assessed quality premia for imports from Western countries.

After the decontrol of prices in January 1990, the market for domestic cars cleared. Before that, the market for domestically produced cars was characterized for many years by severe shortages. The official price of domestically produced cars was controlled at a level that induced great excess demand. The weighted average official price of a Polish-made car in 1988 was 1.27 million zlotys. At the parallel market exchange rate prevailing in mid-March 1989 (2,900 zlotys to one U.S. dollar), that was 434 U.S. dollars.

Given the existence of huge excess demand at the official prices, cars were rationed through two methods: a lottery system and "asygnata" (an assignment by government system). The Ministry of Industry and the Ministry of Internal Trade decided how to divide the cars available for domestic consumption. This included a decision on how many cars should go to the lottery or to the asygnata system. Cars in the asygnata system were available for allocation as intermediate input use in enterprises and, more significantly, for individuals. Asygnatas given

to individuals were awarded either by ministers (or committees acting on their behalf) or by directors of enterprises. Asygnatas were generally awarded to the staff of large organizations such as coal mines, central or local bureaucracies, physicians in rural areas, journalists, taxi drivers, handicapped persons, and groups associated with the Council of Ministers. Between 120,000 and 140,000 cars, out of 177,000 produced for the domestic market, were estimated to be in the asygnata system in 1988.[3]

A final key piece of the market for domestic cars in Poland was the free market for cars offered for resale. Resales occur at large open-air markets in Warsaw and a few other large cities. In addition, trades occur through advertisements in newspapers. In addition, a state-owned company, POLMOZBYT, resells domestic cars, and private individuals advertise in newspapers to sell cars for other individuals for a commission. Both new and used cars, domestic and foreign, can be bought and sold in the free market. In particular, the price of newly produced domestic cars clears on the resale free market. One important implication is that any individual willing to pay the market-clearing price can buy a domestic vehicle. A second important implication is that individuals receiving a vehicle at the official price receive a rent equal to the difference between the market-clearing price and the official price. Those individuals may choose to sell the car and capture the rent in cash or use the car because they value its use more than they value the price they would receive on the free market. In the latter case, they are consuming the rent. In either case, the producers of the cars do not receive the incentive to produce more cars at the higher price. A small number of cars are allocated to the domestic market for sale for hard currency; the price charged for these vehicles is close to the free-market price for domestic vehicles.

In December 1988, even the least expensive Polish car, the 126p, cost an estimated 17.5 months of wages for the average Polish worker at the official, controlled price. At the price on the free market, the 126p cost an average of 63.5 months of wages (*Gazeta Bankowa* 1989). Thus, the value of the rent from receiving an allocated car was worth approximately 46 months of wages.

During the late 1980s it was possible to import vehicles freely, provided that the buyer could obtain hard currency. Organizations, such as POLMOT, would import the vehicles for a quoted price in hard currency. The 1989 liberalization of organizations with the right to import opened this process to competition and reduced the profit margins of these importing organizations. Individuals could travel abroad and bring back a car or color televisions. (These are referred to as "private imports.") Although tariffs on imports through foreign trade organizations are very low (see the data appendix in Tarr 1991), private imports are subject to a special customs duty. The duty was high enough in 1985 to severely retard private imports, but because it was a specific duty in zlotys, the high rate of Polish inflation made it relatively unimportant by 1988. In addition, the mid-

3. Of the 293,000 cars that were produced, only 116,000 were exported; 103,000 of these were exported to non-CMEA (Council for Mutual Economic Assistance) countries.

March 1989 liberalization of the currency exchange, whereby Poles could freely exchange zlotys for dollars internally (at parallel market rates), implied that the market for imported cars cleared. Previously, it would have been necessary for some individuals to purchase dollars through the black market.

Regarding rent dissipation in cars, first consider the asygnata system. On the one hand, many automobile awards (such as groups favored by the Council of Ministers) likely did fit into the socially wasteful category of classical rent dissipation. That is, awards going to the politically favored and awards going to some professions involved lobbying-type activity that is socially wasteful; moreover, some of the activities involved may be socially counterproductive. For example, if society at large values a diverse press, but the allocation of awards to journalists facilitates the control of the press by nonrepresentative authorities, the awards are likely to be counterproductive. The "lobbying" by the journalists is not only a waste of resources but also conveys negative externalities on the rest of the economy.

On the other hand, when the cars were awarded to coal miners or factory workers who were assessed to be the most productive workers, the asygnata system played a socially useful function. A low level of effort and efficiency was reported in many state-owned factories and mines. Competition for these cars among factory workers raised productivity and was socially productive. It seems inappropriate, therefore, to define the allocation of cars to the most productive workers as rent-seeking. Rather, it is equivalent to the government's taxing the automobile sector (by requiring delivery of the goods to the government at the controlled price and reselling them at the market-clearing price) and using the taxes it receives to pay bonus payments to workers. Then the workers are merely receiving higher wages in accordance with their productivity, and because the bonus payments induce a greater supply of effort, the payments are not rents. In fact, in an economy under generalized shortages, the excess demand for goods implies from Walras's law an excess supply of money. Then payment in kind is usually a more effective method of inducing effort than cash payments are. Regardless of whether the payments to workers are called bonus wages or rents, the key point is that in Poland in the late 1980s these payments were not socially dissipated but rather added to output in the economy. That is, these payments did not contribute to dissipation of the rectangle of rents or add to the welfare costs to society of the price controls.

Now consider the lottery system, which forms a waiting list by random allocation. It is evident that little could be done in the way of lobbying to alter the timing of receipt of a car through the lottery system. In 1981, more than 1.5 million people entered the lottery for the right to buy a Polish-made car at the official price. The outcome of the lottery was that all participating individuals received the right to buy a car in a certain year. Lucky individuals received the right to buy the car in 1981 or 1982. Unlucky individuals received the right for later years throughout the 1980s. Individuals paid 50 percent of the official price of the vehicle to enter the lottery and agreed to make additional annual pay-

ments so that the price would be paid by the time their delivery date arrived. Insufficient numbers of cars were allocated to meet the requirements of the lottery system, however, so that in early 1989 there were about 400,000 people waiting for prepaid 126ps and 70,000 for prepaid FSOs.

Lindsay and Feigenbaum (1984) have shown that rent dissipation can occur with waiting lists even when no lobbying-type activities take place. Their model requires that the value of the product decline with the delay of receipt, because of considerations such as style changes or time of year of receipt. Polish cars, whose style used to change little from year to year, do not appear to fit into the category of products they analyzed.

Thus, the lottery system caused very little rent dissipation, and the asygnata system had socially wasteful or counterproductive effects as well as productive effects. It is impossible to determine which effects were dominant. For the purpose of the estimation I assume that, on balance, there was no socially wasteful rent dissipation from the price controls on cars. Because the judgment involves some arbitrariness, in the next section I also calculate the rent rectangle.

## III. The Graphic Model and Results

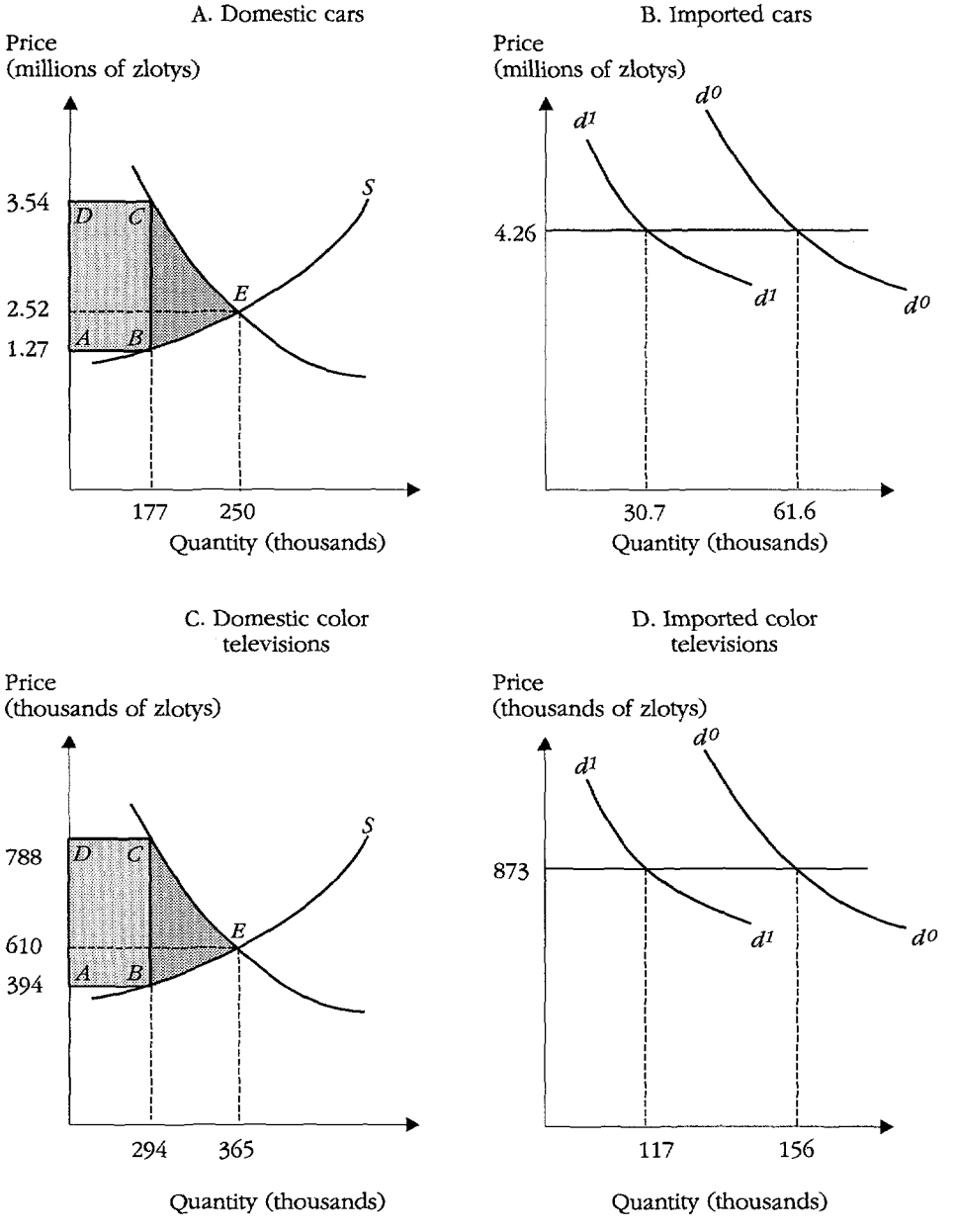
This section describes and interprets the model graphically. An algebraic characterization of the model is developed in the appendix, along with the derivation of the cross elasticities and an explanation of the elasticities chosen and the calibration procedures.

### *Price Decontrol*

The first policy simulated is the elimination of price controls. The results, under different elasticity assumptions, are presented in table 1 and depicted in figure 2. The curve representing the initial equilibrium is depicted with superscript zero, and those of the new equilibrium after the policy shift are shown with superscript 1. If domestic price controls are removed, domestic output will expand because of the greater incentive provided by the higher prices. In the short run, the expansion of output is likely to be small because of capacity constraints, but I view this as a long-run model. The greater production of Polish vehicles and color televisions increases welfare because the value to consumers of additional domestic vehicles exceeds the opportunity costs of the resources to produce these vehicles. That is, there is a Harberger triangle of benefits equal to the area *BCE* in figure 2.

In the initial price control situation there is a rectangle of rents equal to *ABCD*. I have argued that for color televisions these rents were dissipated, so the value of this rectangle represents an additional gain to society when price controls are removed. In the central elasticity case, the rectangle of rents equals 116 billion zlotys (about 0.4 percent of Polish GDP, or 112 percent of the value of sales of domestic producers), which is about ten times the triangle of distortion costs. Moreover, unlike the distortion cost triangle (where the full gains to

Figure 2. *Impact of Eliminating Price Controls on Cars and Color Televisions in Poland*




*Note:* Estimates are for the medium-elasticity case.
*Source:* Author's calculations.

society will occur with a significant lag), the gains from the rectangle of rents were achieved very rapidly because the queues vanished almost overnight. Thus, the color television case is consistent with the view that, other things being equal, freeing prices results in an immediate and substantial improvement in the standard of living (Lipton and Sachs 1990).

In the case of cars in figure 2, the rectangle of rents equals 402 million zlotys, which is about five times the Harberger triangle costs of 82 million zlotys in the medium-elasticity case. As discussed above, however, the rectangle of rents did not represent an additional loss to society. Thus, despite the fact that the Harberger triangle for cars is about six times larger than for color televisions, the total benefits from price decontrol in color televisions are larger than those in cars. Increased production of domestic cars and color televisions reduces the demand for the import substitutes but has no effect on welfare because no price change occurs in the import market; that is, there is no change in the distortion. Given the estimate of 402 million zlotys for nondissipated rents in cars, and given the uncertainty regarding their nondissipation, the estimate of the rent rectangle can be added to the estimate of the distortion costs in cars if it seems that automobile rents are dissipated.

Estimates of the rents are invariant with respect to the elasticity assumptions. The reason is that points *B* and *C* in figure 2 are predetermined by the data. Therefore a change in the curvature of the demand and supply curves is permitted only to the extent that these curves pass through the points *C* and *B*.[4] Regarding the triangle of distortion costs, from figure 2, an increase in either elasticity will increase the triangle and hence increase the estimated benefits of removal of the price control.

An important implication of the model is that the controlled price on domestic cars (or televisions) led to an increase in the demand for the import substitute. Because of price control, any increase in the production of domestically produced cars is purchased, so the substitution effect of increased domestic cars on the demand for imported cars is strong. Moreover, the domestic controlled price is a parameter in the demand function for imported cars, and an increase in the domestic controlled price has the effect of decreasing demand for imported cars through an income effect. Because all cars produced under price control are consumed, there is no substitution effect for an increase in the domestic controlled price subject to continued excess demand. But the increase in the controlled price leaves less income for the purchase of all other goods, including imported cars. Moreover, the domestic free-market price does not affect import demand at all; it simply determines rents among consumers of the fixed quantity of domestic cars but does not affect the aggregate income available for the purchase of other goods by consumers in aggregate.

4. Starting instead from an equilibrium without price controls and considering the costs of *imposing* price controls, then the rents would be affected by the elasticities.

Thus, when price controls are relaxed, the demand for imported cars decreases, not only because the controlled price increases but also, and numerically much more important, because domestic production increases. As discussed below, the market for imports is distorted. Any second-best effects in the market for imports that could arise from the change in import demand will be extremely small. This is because the price distortion does not change (the height of the triangle), so the change in import demand simply shifts the measured triangle of distortion costs toward the left without affecting its size.

In the case of cars, eliminating price controls in the model reduced imports from 61.6 thousand units to 30.7 thousand units. What subsidy rate to imports would be required to increase imports back to their original level if the price controls were not in effect? The answer is an estimate of 43 percent for cars and 22 percent for color televisions.[5] That is, without domestic price controls the government would have to pay 43 percent of the cost of imported cars to induce consumers to import as many cars as they would with price controls. With a smaller subsidy, consumers would import fewer cars than in the original 1988 situation after price controls are eliminated. Thus, although the government of Poland had no intention of subsidizing imported cars, the system of price controls was a very substantial implicit subsidy to imports. In the initial equilibrium, the data indicate that free-market cars sold for 2.8 times the controlled price, in comparison with a ratio of 2.0 for color televisions. Holding other things constant, freeing the price of domestic cars would lead to a greater expansion of domestic production and a greater substitution for imported cars. This in turn would require a greater import subsidy to induce an increase in imports to their original level.

### *Improved Foreign Exchange Policy*

The second simulated policy change is an improvement in the exchange rate policy, with price controls remaining in place. The results are presented in table 2 and depicted in figure 3. The parallel market exchange rate (in March 1989 it was 2,900 zlotys to one U.S. dollar) was itself distorted (too high) because of the surrender requirements (at the official, grossly overvalued exchange rate) imposed on exporters for about 70 percent of their foreign exchange earnings. Tarr (1990c) has estimated the shadow foreign exchange rate at about 63 percent of the parallel market exchange rate (more than three times greater than the official exchange rate), where the parallel market exchange rate represented the cost of foreign exchange for individuals. The parallel exchange rate, which was quite volatile, depreciated by about 1,000 zlotys per U.S. dollar in April 1989. Exact estimation of a shadow exchange rate is, of course, problematical. The shadow exchange rate is clearly less than the parallel rate, however, and these estimates are illustrative of the impact of appreciating the parallel exchange rate toward

5. The policy is simulated by changing equation A-8 in the appendix to $u^*p^*(1 + t)$, removing price controls, and finding the value of $u$ that yields imports in the original equilibrium. The implicit subsidy is then $1 - u$.

Table 2. *The Impact of Eliminating Macroeconomic Foreign Exchange Restrictions on the Automobile and Color Television Markets in Poland*

| | *1988 data* | | *Low elasticities* | | *Medium elasticities* | | *High elasticities* | |
|---|---|---|---|---|---|---|---|---|
| *Item* | *Cars* | *Televisions* | *Cars* | *Televisions* | *Cars* | *Televisions* | *Cars* | *Televisions* |
| Domestic controlled price, $P_c$ | 1.27 | 0.394 | 1.27 | 0.394 | 1.27 | 0.394 | 1.27 | 0.394 |
| Domestic free price, $P$ | 3.54 | 0.788 | 3.09 | 0.705 | 3.00 | 0.634 | 2.96 | 0.602 |
| Import price (tariff-inclusive), $p(1 + t)$ | 4.26 | 0.873 | 2.67 | 0.548 | 2.67 | 0.548 | 2.67 | 0.548 |
| Domestic quantity, Q | 177 | 294 | 177 | 294 | 177 | 294 | 177 | 294 |
| Import quantity, $q$ | 61.6 | 156 | 77.8 | 197 | 98.2 | 249 | 156.6 | 397 |
| *Welfare gains* | | | | | | | | |
| Triangle of distortion | n.a. | n.a. | 13 | 7 | 29 | 15 | 75 | 39 |
| Rectangle of rent dissipation | n.a. | n.a. | 0 | 24 | 0 | 45 | 0 | 55 |
| Total | n.a. | n.a. | 13 | 31 | 29 | 60 | 75 | 94 |
| *Welfare gains (percentage of)* | | | | | | | | |
| GDP | n.a. | n.a. | 0.05 | 0.11 | 0.10 | 0.21 | 0.27 | 0.33 |
| Domestic producers' sales | n.a. | n.a. | 5.7 | 27.0 | 12.9 | 52.0 | 33.4 | 81.1 |
| Domestic producers' sales plus imports | n.a. | n.a. | 2.6 | 12.4 | 6.0 | 24.0 | 15.5 | 37.4 |

n.a. Not applicable.

*Note*: Prices are in millions of 1988 zlotys, quantities in thousands of cars or color televisions, welfare gains in billions of 1988 zlotys or as a percentage of 1988 estimated GDP.

*Source*: Author's calculations.

the shadow exchange rate. See Pinto (1991) for a model in which devaluation imposes a tradeoff in costs.

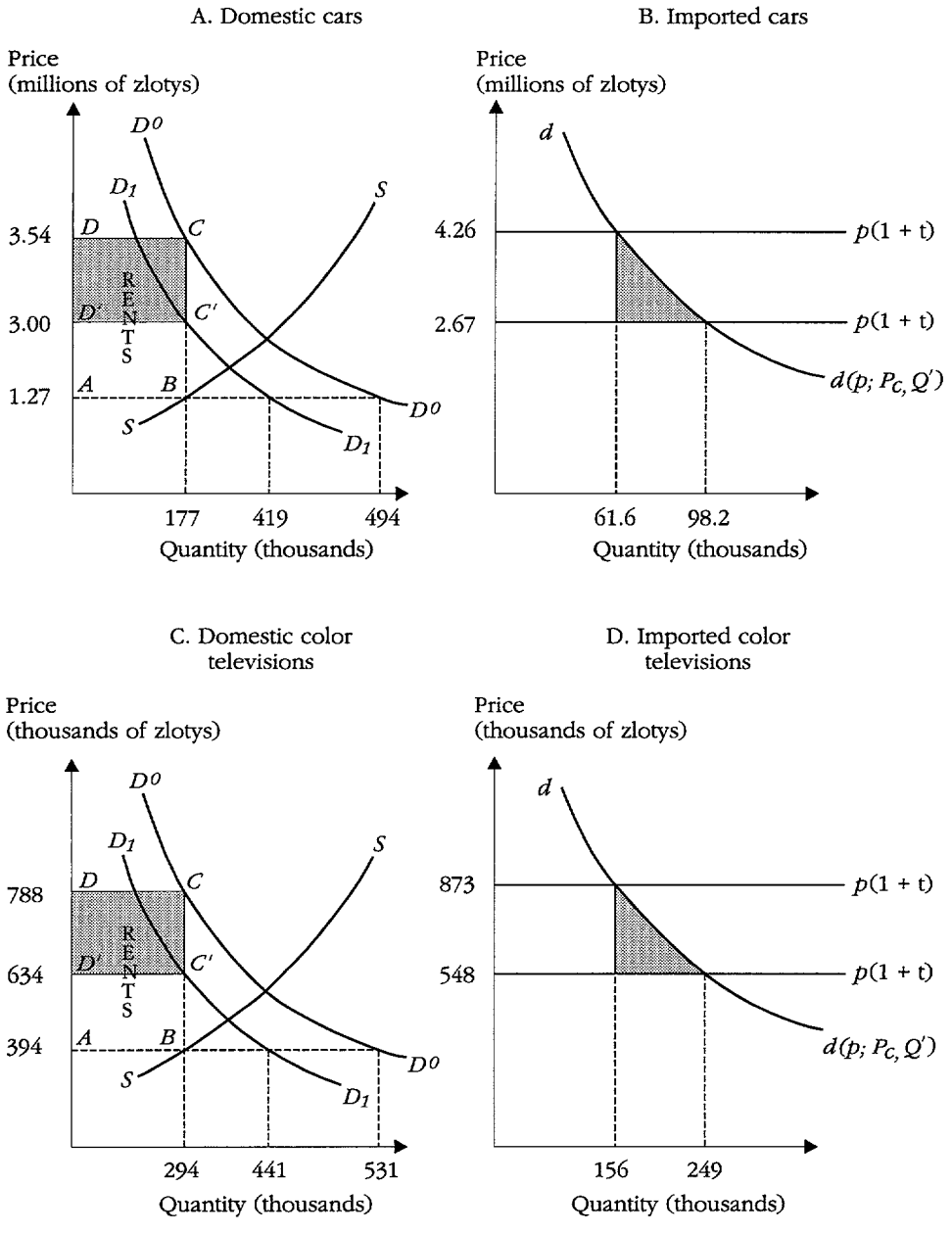
The opportunity costs of imports to Poland were more properly valued at the shadow exchange rate. At the parallel exchange rate, individuals were discouraged from consuming imported cars. If aggregate policies were changed (with a devaluation as occurred in 1990, or with a reduction in the surrender requirements of exporters), thus providing greater incentive to export and thereby inducing a lower exchange rate equal to the shadow exchange rate, individuals would import more, generating gains in consumption efficiency. The devaluation of 1990 encouraged a massive export boom during the first three quarters of 1990 until inflation (in significant part caused by the export boom with a fixed exchange rate) eliminated the highly favorable exchange rate for exporters (see the above-cited macroeconomic papers on Poland, especially, Pinto, Coricelli, and de la Calle 1990).

The gains from the improved foreign exchange policy estimated here are only the gains measured in the automobile and color television industries. Gains would also accrue throughout all importing industries in the economy. The estimates presented here, however, are illustrative of the magnitude of the likely gains from this policy in two important markets.

The decrease in the price of imports reduces the demand for domestic cars, because the goods are gross substitutes. The decrease in the demand for domestic cars results in a decrease in the price of cars on the free resale market for cars. Consequently, rents for domestic cars are reduced. There is no feedback effect on the price of imported cars, however, because under rationing of domestic cars the demand for imported cars depends on the market for domestic cars only through the controlled price in the domestic market and through the quantity of domestic cars produced (see equation A-3), neither of which changes. (Thus, the cross elasticity of demand for imports with respect to a change in the domestic price is not important for the welfare results.)

For both cars and televisions, the improved foreign exchange policy results in a triangle of benefits in the import market, which is shaded in panel B of figure 3. This is a traditional Harberger-type triangle, in which the marginal valuation of imports by consumers exceeds the marginal costs to society. In addition, the presence or lack of rent dissipation has a strong effect on the welfare results through second-best effects. Because import liberalization reduces the demand for the domestic substitute, it reduces the rent on domestic cars and color televisions to the smaller rectangle $ABC'D'$. Thus, the reduction in rents is equal to the rectangle $DD'C'C$. In color televisions the reduction in rents should reduce queuing time and therefore constitutes an additional benefit of import liberalization. This is a second-best type of benefit from the foreign exchange liberalization because it would not be a gain without the existence of the price control distortion in the domestic market. For cars, where I have argued that the rents are not dissipated, there is no second-best welfare effect in the domestic market.

Figure 3. *Impact of Eliminating Foreign Exchange Restraints on Cars and Color Televisions in Poland*




*Note:* Estimates are for the medium-elasticity case.
*Source:* Author's calculations.

In the central elasticity case, the second-best benefits of reduced rent dissipation in domestic color televisions (45 billion zlotys) are three times the direct distortion costs in the import market. Because there are no benefits from reduced rent dissipation in cars, the total benefits of foreign exchange liberalization in color televisions (0.21 percent of GDP) are about twice those of cars.

As the demand curve for imports becomes more elastic, it is evident from figure 3 that the triangle of estimated distortion costs in the import market increases. In addition, in the high-elasticity case, the cross elasticity of domestic demand with respect to a change in the price of imports increases. Then, in response to the decline in the price of imported cars, the demand for domestic cars on the free market shifts leftward in the high-elasticity case. This shift implies a greater reduction in rent and greater benefits from reduced rent dissipation. The triangle of distortion, however, becomes a larger share of the total benefits as elasticities increase, in part because the rectangle of reduced rent dissipation is limited by the finite amount of rent dissipation in the initial equilibrium. Based on the calibrated demand curve, excess demand for cars is 317,000 units initially and is reduced to 232,000 units after the import price is lowered (see figure 2).

## IV. Conclusions

One important set of results in the article is that because the allocation method affects rent dissipation, the method of allocating the good under price control has a crucial impact on the welfare costs of the price control. For color televisions, where the allocation method leads to rent dissipation, the estimated welfare loss to the economy is about ten times the estimated standard distortion costs (based on Harberger triangles) when rent-seeking is ignored. The estimated welfare loss is more than 100 percent of the value of domestic producers' sales. By contrast, the evidence suggests that the allocation methods for cars did not result in rent-seeking costs.

A second set of results is that the price controls on domestic cars and color televisions increased demand for imported cars and color televisions and induced firms to produce fewer domestic cars and color televisions. Reduced domestic production of these products means that consumers who do not receive a domestic product must buy an import. This implies that the price controls on Polish domestic cars were an implicit subsidy to imported cars. The estimated rate of implicit subsidization (defined as the ad valorem rate of subsidy to imports necessary to increase imports to their original level if price controls were counterfactually removed) is 43 percent in cars and 22 percent in color televisions. Clearly, this was an unintended effect of the price controls and contrary to any desire of the government of Poland.

Given that the price control policies were generalized across most Polish industries in 1989, the macroeconomic implication is that Polish demand for foreign exchange was distorted upward, inducing a depreciation of the real

exchange rate on the free market. Tarr (1990c) examines the macroeconomic implications of this implicit subsidy to imports in a model that estimates optimal foreign exchange policy. Polish foreign exchange policy in 1989 discouraged exports through surrender requirements of foreign exchange at punitive rates. Reducing surrender requirements would improve welfare, but positive surrender requirements would be the optimal second-best policy in the presence of implicit import subsidies from price controls.

A third set of results is that with rent dissipation the costs of import restraints are considerably magnified in the presence of price controls on the domestic good. Constraining imports increases demand for the domestic price-controlled variety of the product; this will increase the rents of the domestic product and may increase wasteful rent-seeking activity. For color televisions, with dissipation of rents, the costs of import restraints are four times greater when the effect of the rent dissipation in the market for domestic cars is incorporated.

Taking into account the costs of rent-seeking, the welfare costs of price controls can be dramatically high; therefore, policymakers should be extremely cautious when using these devices. The estimates here have focused only on the static effects of price controls. Rent-seeking is also likely to produce reduced-growth effects as agents in the economy devote resources to petitioning their government rather than to innovation that develops new products or reduces costs.

Because rents may not be fully dissipated, to assess the quantitative importance of rent-seeking in particular markets requires the empirical investigation of allocation methods as well as estimation. In some situations in which policymakers must ration a good subject to a quantity constraint, such as the allocation of an export quota under the Multifibre Arrangement, devices that would avoid or reduce rent dissipation, such as auction quotas, have a significant argument in their favor.

## Appendix: The Model of the Automobile and Color Television Markets in Poland

Differences in quality between Polish cars and imported cars, especially those from the West, are considered quite significant; a model that must take these products as differentiated is necessary. The model discussed here uses cars as the example. The alterations needed in the model for the case of color televisions are discussed later.

The essential feature of the Polish domestic automobile market in 1989 was that it was in shortage. Regardless of the price on the free resale market for domestic cars, aggregate production, and consequently consumption, of domestic cars was fixed (unless the official price changed). Within the range of the relevant policy experiments to be considered, whatever was produced and offered at the official controlled price (denoted by $P_c$) would be purchased by domestic consumers.

Let there be three goods: domestic cars ($Q$), imported cars ($q$) and a composite of other goods ($X$). Assume that the preferences of different consumers can be aggregated such that they may be represented by a single utility function.[6] Then maximize utility $u(Q, q, X)$, subject to income and prices.

Let $Q'$ denote the fixed amount of domestic cars produced and purchased by consumers. There is a resale market for domestic cars, which clears, but sales on this market do not affect the quantity of domestic cars consumed, which is fixed at $Q'$. Because sales on the resale market only represent income transfers among consumers, they do not affect total income available to all consumers for purchase of the other goods, $q$ or $X$. Thus, for the purpose of deriving the aggregate demand function for car imports, the resale market may be ignored. Consumers consume the fixed number of units $Q'$, for which they pay $P_c$ per unit, and the maximization problem is reduced to

$$\text{(A-1)} \qquad \max u(Q', q, X) \qquad \text{subject to } Y = P_c Q' + p'q + P_x X$$

where $Y$ denotes income, $P_x$ denotes the price of $X$, and $p'$ denotes the tariff-inclusive price of $q$.

Define utility, $U$, as a function of $q$ and $X$, with $Q'$ as a parameter: $U(q, X; Q') = u(Q', q, X)$ and $Y' = Y - P_c Q'$, where $Y'$ is residual income available for purchase of $q$ and $X$ after $Q'$ is purchased at the controlled price.

Then the utility maximization problem may be further reduced to

$$\text{(A-2)} \qquad \max U(q, X; Q') \qquad \text{subject to } Y' = p'q + P_x X.$$

From equation A-2, maximization of $U$ subject to $Y'$ yields the following market demand function for $q$:

$$\text{(A-3)} \qquad q = d[p', P_x; Y'(P_c Q'), Q'].$$

Equation A-3 explicitly incorporates the parameters on which residual income depends. Note that the demand function depends on both $P_c$ and the additional parameter $Q'$. Both $P_c$ and $Q'$ have an effect on the demand for $q$ through their impact on $Y'$. In addition, because the utility function depends on the additional parameter $Q'$, it is included separately as a parameter.[7]

Define the free-market price of domestic cars on the resale market as $P$. Note that $P$ is not included in the demand function for imported cars because $P$ has no effect on the amount of domestic cars consumed as a result of the shortage. In other words, there is no substitution effect. A change in $P$ has a redistributive

6. The necessary and sufficient condition for this aggregation is that the indirect utility of all consumers satisfy the "Gorman form." That is, the indirect utility of all individual consumers ($v_i$) satisfies

$$v_i(\mathbf{p}, y_i) = a_i(\mathbf{p}) + b(\mathbf{p})\, y_i$$

where $i$ is an index over consumers, $y$ is income, and $\mathbf{p}$ is the price vector (see Varian 1984: 150–53). This implies, in particular, that the marginal propensity to consume any good with respect to income is independent of both the level of income and of the consumer.

7. Equation A-3 is analogous to equation 11 in Neary and Roberts (1980), except that the demand function for the unconstrained good in Neary and Roberts is compensated (Hicksian).

effect among consumers but does not affect the aggregate residual income of all consumers available for the purchase of $q$ or $X$, that is, the change in the free-market price has no aggregate income effect.

The aggregate quantity demanded of domestic cars ($Q'$), imported cars (from equation A-3), and the composite good (an equation of the same form as equation A-3) can be completely characterized without reference to the free-market price, $P$. This result derives from the aggregation of the demand functions of different consumers and the fact that the economy consumes the allocated number of cars.

The case of color televisions is more complicated because of the assumption that the rents are dissipated through queuing. That is, the difference between the free-market price and the controlled price is the value of foregone leisure. The full price to the consumer-worker (which is equal to the controlled price plus the wage rate times the waiting time) is the relevant price for determining the demand curve. As shown below, however, the full price in equilibrium depends on the fixed quantity $Q'$ and the controlled price; so the demand function for imported color televisions is written with $P_c$ and $Q'$ as parameters.

*The Demand Function for Domestic Cars*

To simulate the impact of removing price controls, it is necessary to know the Marshallian market demand curve for domestic cars. Suppose there is no price control and the quantity of domestic cars available to consumers is a variable over which they may optimize. Assuming that the preferences of individual consumers may be aggregated, and denoting aggregate income by $Y$, the form of the aggregate Marshallian demand function for domestic cars is standard:

$$Q = D(P, p', P_x; Y). \tag{A-4}$$

Fortunately, from the resale open-air market for domestic cars, observations are available for the price of domestic cars that clears the resale market. That is, an observation of a point on equation A-4 is available because the free-market price is the price at which the Marshallian demand curve clears for the number of cars produced, given other parameters in the economy affecting demand (including the supply of used cars and the extent of their substitution with new cars). These observations allow us to avoid the indirect methods sometimes used to infer such a point, such as virtual prices in Neary and Roberts (1980) or inventory models.

With the demand curve given by equation A-4, the new equilibrium prices and welfare effects in the event of price decontrol can be determined. In addition, it will be possible to determine the value to consumers of additional units of $Q$ deriving from an easing or termination of domestic price controls; to assess the rent transfers among consumers; and to compute excess demand directly.

*Equations of the Simulation Model*

To simulate the model, it is necessary to specify a specific functional form. One method would be to choose a specific form of the utility function and derive the

demand functions. Instead, I specify the "linear in the logs" form because of the convenient interpretation of the coefficients as elasticities and because it is robust (for large changes in the variables) regarding the existence of a solution. The right-hand variables in the import demand function are those derived from the above theory. Thus, the specification is analogous to an econometrician's use of reduced-form equations where the theory is employed to determine the relevant variables and, in this case, to assist with the specification of the elasticities.

Two concerns may arise in determining how the lack of a direct correspondence between the theory and the simulation model affects the measurement of welfare. One concern might be that because the simulation model does not follow directly from the choice of a specific utility function, a "consumers' surplus" measure of change in welfare must be employed, as opposed to an "exact" welfare measure such as Hicksian equivalent or compensating variation. Willig (1976) has shown, however, that consumers' surplus is bounded from above and below by equivalent and compensating variation; and his numerical results and those of de Melo and Tarr (1992) have shown that estimates of compensating and equivalent variation are generally close. Thus, estimates of consumers' surplus will be close to estimates of both compensating and equivalent variation. To the extent that estimates of consumers' surplus depart from one Hicksian measure, they will be close to the other Hicksian measure, and there is no a priori reason to believe one Hicksian measure is superior to the other.

A second concern could be that the wrong rectangles and triangles are being measured. Specification of a specific utility function could give rise to a demand function different from the one pictured in figure 1. But any demand function chosen would have to be calibrated to be consistent with both the initial data point and the exogenously specified elasticities. The rent rectangle is completely independent of the functional form because the demand function must pass through the initial data point. Regarding the triangle, the first-order effect on determination of its size is the slope of the demand curve at the initial data point. The initial slope of the demand curve is also unaffected by choice of functional form, because any functional form for the demand function must be calibrated to the exogenously specified elasticity. Alternate specifications to the log log would yield different measurements of the triangle if the alternate specifications were not constant elasticity; but these would be smaller second-order effects. In addition, these differences would not be based on any known data, but rather on the arbitrary assumption of a particular functional form.

I invoke a standard assumption in applied microeconomic modeling and assume that utility is weakly separable between aggregate automobile consumption and the composite good, $X$. This implies that the demand functions for domestic and imported cars may be formulated without explicit reference to the price of the composite good, $X$. The price of the composite good will affect demand for cars only through its impact on the income allocated to aggregate automobile consumption.

The simulation model is partial equilibrium. Consequently, I ignore the effects of changes in income and other variables outside the automobile sector on the variables of the model. These other variables are incorporated into the constant of the demand function. The model is characterized by equations A-5 through A-8.

$$\ln(q) = a + b\ln(P_c) + c\ln[p(1+t)] + s\ln(Q) \tag{A-5}$$

$$\ln(Q) = A + B\ln(P) + C\ln[p(1+t)] \tag{A-6}$$

$$P_c = P_c' \tag{A-6'}$$

$$\ln(Q) = D + E\ln(P_c) \tag{A-7}$$

$$p(1+t) = \mathrm{k} \tag{A-8}$$

where k is a constant and $t$ is the tariff rate, so that $p(1+t) = p'$(where p′was defined above) is the tariff-exclusive price of imported cars.

Equations A-5 and A-6 are the demand functions for imported and domestic cars, respectively. Equation A-6′ states that the controlled price is fixed at $P_c'$, which applies in the experiment in which price controls are maintained and the import regime is liberalized. When price controls are removed, equation A-6 replaces equation A-6′. Equation A-6 is also used when price controls are in place to estimate the value of the rent from receiving an allocated car and the amount of excess demand.

Equation A-7 is the supply function for domestic cars. Despite the fact that there were only two Polish automobile producers, I have chosen to ignore monopoly power issues on the supply side of the market and to model the industry as competitive. The reason is that import competition from many countries was present in Poland. In the case of cars, Romanian, Czechoslovakian, and Russian cars were of comparable quality and would be expected to restrain price increases if the price controls were removed. In addition, used cars from Western Europe (which became very popular in Poland after the Big Bang) represented another constraint on price increases of domestic cars beyond competitive levels. In the case of color televisions, imports from Russia, the Republic of Korea, and Taiwan (China) (among other economies) offered significant competition.

Automobile producers are assumed to face increasing marginal costs of production. To increase production would require more labor, for example. To attract additional workers to an automobile company requires paying higher wages because there is little unemployment in Poland. Increasing marginal costs implies that the supply curve is upward sloping, and the supply curve depends on the price received by the firms, which is the controlled or official price.[8] In addition, Poland is an economy facing generalized shortages. As a result, some

8. Either profit maximization or cost-plus-markup pricing rules lead to an upward-sloping supply curve, given increasing marginal costs.

inputs into automobile production will be fixed or close to fixed. It follows from the Le Chatelier principle (see Varian 1984: 56, 57) that the more inputs are in fixed supply, the more inelastic is the supply curve of the firm. Thus, I assume a very low elasticity of supply by Western standards and simulate the results over a range of elasticities.

In equation A-8, I adopt the small country assumption and assume that imports of cars are supplied to Poland at a delivered price, in dollars, that Poland cannot influence. Poland does, however, have the ability to impose tariffs and influence its exchange rate so the price to consumers of imported cars in zlotys can be altered.

*Elasticities*

I have made an effort to search for econometrically estimated elasticities relevant to the color television and automobile industries in Poland. The elasticities chosen are more in the nature of best guesses rather than precise estimates. As is commonly done in applied welfare analysis, sensitivity analysis is performed by doubling and halving all elasticities.

*Own Elasticities.* In the case of cars, estimates of the own price and income elasticities are obtained from the econometric study of the Polish automobile market by Charemza, Gronicki, and Quandt (1988). Their broad conclusion is that the price elasticities of demand are high (usually greater than unity) but the income elasticity is low. Thus, in the central elasticity case, the own elasticities ($B$ and $c$) are set at $-1$ and the income elasticity at 0.5.

In the case of color televisions, in the central elasticity case, the own price elasticities are $-0.855$, based on the estimates of Shiells, Stern, and Deardorff (1986). From the same source, the income elasticity is 1.65. Because of generalized input shortages prevalent in Poland in 1989 (as discussed in the text), the supply elasticity ($E$) is taken to be a rather low 0.5 in the central elasticity case for both cars and color televisions.

*Cross Elasticities in the Demand for Imported Cars.* The appropriate values for the cross elasticities of equation A-5 can be obtained from equation A-3. First consider the elasticity of demand for imported cars with respect to a change in the controlled price of domestic cars. Taking partial derivatives from equation A-3,

$$\frac{\partial q}{\partial P_c} = \frac{\partial q}{\partial Y'} \frac{\partial Y'}{\partial P_c}.$$

From the definition of $Y'$

$$\frac{\partial Y'}{\partial P_c} = -Q'.$$

Thus $b$, from equation A-5, can be expressed as

$$b = \frac{P_c}{q} \frac{\partial q}{\partial P_c} = \frac{P_c}{q} \frac{\partial q}{\partial Y'} (-Q').$$

Define the income elasticity of imported cars as

$$e = \frac{\partial q}{\partial Y'} \frac{Y'}{q}.$$

Rearranging yields

$$b = \frac{-P_c Q'}{Y'} e = (-S_Q) e$$

where $S_Q = P_c Q'/Y'$ is the share of residual income spent on domestic cars. That is, the cross elasticity of import demand with respect to the price of domestic cars reduces to the share of residual income spent on domestic cars times the income elasticity of demand for imported cars. Given $e = 0.5$ (1.65 in color televisions) from above, and given data on $S_Q$, $b = -0.008$ in cars and $-0.004$ in color televisions.

Note that, although small, the value of $b$ is negative. This contrasts sharply with equilibrium models. Here the increase in the controlled price of domestic cars does not induce a decrease in domestic quantity demanded, so there is no substitution effect. There is only an income effect of the domestic price increase, which reduces demand for all normal goods, including imported cars.

Now consider $s$, the elasticity of demand for imported cars with respect to the quantity of domestic cars. Differentiate equation A-3 with respect to a change in the amount of domestic cars allocated. The change in demand for imported cars is

$$\text{(A-9)} \qquad \frac{\partial q}{\partial Q'} = \frac{\partial q}{\partial Y'} \frac{\partial Y'}{\partial Q'} + \frac{\partial q}{\partial Q'}$$

(with residual income, $Y'$, constant). The change in the demand for imported cars when the quantity of domestic cars changes is decomposed in equation A-9 into two components. The first component is the income effect on purchases of imported cars when an additional unit of domestic cars becomes available. The second component is the substitution effect. This equation is analogous to the Slutsky equation and to equation 21 in Neary and Roberts (1980). Because $\partial Y'/\partial Q' = -P_c$, the first term on the right side of equation A-9 is

$$\frac{\partial q}{\partial Y'} \frac{\partial Y'}{\partial Q'} = \frac{\partial q}{\partial Y'} (-P_c).$$

Now consider the second term, $\partial q/\partial Q'$ in equation A-9. If the goods are perfect substitutes, then a one-unit increase in the quantity of domestic cars available would, absent income effects, decrease the purchase of imported cars by exactly one unit. That is, $\partial q/\partial Q' = -1$. If the goods are not perfect substitutes, a one-unit increase in domestic cars will induce a decrease of less than one unit in imported cars. The decrease, for example $-v$, where $0 < v < 1$, is a product-differentiation parameter, where smaller values imply that the goods are less perfect substitutes. Here $v$ is assumed to take the value 0.7.

Combining these results yields

$$\frac{\partial q}{\partial Q'} = \frac{\partial q}{\partial Y'} (-P_c) - v.$$

Multiplying both sides by $Q'/q$ and the first term by one in the form of $qY'/qY'$, yields the elasticity $s$:

$$s = \frac{Q'}{q} \frac{\partial q}{\partial Q'} = -S_Q e - \frac{vQ'}{q}.$$

The first term on the right-hand side, $-S_Q e$, has been calibrated above. (It is the income effect of the change in quantity, and it affects residual income in a symmetric manner to the price of domestic cars.) Given $v = 0.7$ and data on $Q'/q$, the second term $v\,Q'/q$ numerically dominates the first, and so $s = -2.0$ in the case of cars and $-1.32$ in the case of color televisions. Thus, in the simulation of decontrol of domestic prices, the demand for imports decreases; this is because the increase in the demand for imports, caused by the increase in $P_c$, is considerably less than the decrease in the demand for imports caused by the increase in $Q'$.

*The Cross Elasticity in the Demand for Domestic Cars.* Finally, the value C is the cross elasticity of demand for domestic cars with respect to the price of imported cars. As mentioned above, I assume the consumer's utility function for cars (imported and domestic) is "weakly separable" from all other goods. Given weakly separable utility, it is possible to derive the following:

$$S_{Q'}C + (S_q)c + S_q = \frac{\partial Y_A}{\partial p'} \frac{p'}{Y_A} \tag{A-10}$$

where $S_q = p'q/Y_A$ and $S_{Q'} = PQ'/Y_A$ and $Y_A$ denotes income allocated to cars, and C and $c$ are from equations A-5 and A-6. This relationship follows from a result in Tarr (1990a) for the share-weighted sum of own and cross elasticities within a branch of a utility tree.

The shares are known data, and I have an estimate of the own elasticity of demand. The term on the right of equation A-10 is the elasticity of demand of income allocated to aggregate automobile consumption with respect to a change in the price of imported cars. It is reasonable to assume that a change in the price of imported cars has only a small impact on the income allocated to cars; I take this value to be 0.25. Solving equation A-10, C = 0.35 in the case of cars and C = 0.40 for color televisions.

### *Calibration and Sensitivity*

The model was calibrated to 1988 data. All the parameters in equations A-5 through A-8 are known except $a$, $A$, and $D$. Thus, data are available for the values of $Q$, $q$, $P$, $P_c$, and $p(1 + t)$ for 1988 (these data are presented in table 1). I assume that these values are a solution to the system of equations A-5 through

A-8.[9] The above values of the elasticities are used to solve for the constants $A$, $D$, and $a$. Note that the observed values of $Q$ and $P$ in 1988 are on the demand curve given by equation A-6, but there is a shortage in the market for domestic cars at the controlled price.

To assess the sensitivity of the estimates to the elasticities, I choose high- and low-elasticity estimates by doubling and halving all elasticity values. The constants $a$, $A$, and $D$ are recalibrated and the policies are resimulated.

### *The Choice between Labor and Leisure and the Demand for Price-Controlled Commodities with Queuing*

I extend the model of Abbott and Ashenfelter (1976) to justify writing the demand for imports as a function of $Q'$ and $P_c$.

Assume that the consumer-worker must allocate income and time. Let $q_i$, $i = 1, \ldots, n$ represent commodities; $q_0$ represent leisure; and q be the vector of $n + 1$ commodities plus leisure. Let one of the commodities, say $q_1$, be subject to a price control. To obtain each unit of $q_1$, the consumer must pay the controlled price $P_c$ plus $e$ units of time in the queue. Let $w$ denote the wage rate. Income available to the consumer-worker is $wL + \mu$, where $L$ denotes hours worked, $\mu$ denotes nonlabor income, and the total time available to the consumer-worker is $T$, where $T = q_0 + L + eq_1$. Because the opportunity cost of time is $w$, the full cost to the consumer of one unit of $q_1$ is $p_1 = P_c + we$.

Money expenditure must satisfy

$$P_c q_1 + \sum_{i=2}^{n} p_i q_i = wL + \mu.$$

Add $wq_0 + weq_1$ to both sides to obtain

$$\text{(A-11)} \qquad \sum_{i=0}^{n} p_i q_i = wT + \mu = X$$

where $p_1 = P_c + we$, $p_0 = w$, and $T = q_0 + L + e\,q_1$; the latter substitution guarantees that the consumer-worker satisfies the time constraint that includes queuing time. Define the right-hand side as "full income," $X$.

Note that because $X$ is fixed, the consumer-worker-queuing problem can be converted into the standard form of consumer utility maximization. That is, the consumer-worker will seek to

$$\text{(A-12)} \qquad \max u(q) \text{ subject to } \sum_{i=0}^{n} p_i q_i = X.$$

Maximization yields the standard condition that the marginal rate of substitution is equal to the ratio of prices:

$$\text{(A-13)} \qquad \frac{u_i}{u_j} = \frac{P_i}{P_j} \qquad \forall\, i, j$$

9. The details regarding the data sources are described in appendix B of Tarr (1991). The reader may request this paper through Internet by sending an electronic message to MPATENA@WORLDBANK.ORG.

and demand functions will depend on the vector of $n + 1$ prices and full income. Because $p_1 = P_c + we$, it is evident that the market demand for $q_1$ and close substitutes are a function of $P_c$.

Although the individual consumer-worker takes the wait in the queue as a given parameter, $e$, for the market as a whole $e$ is a decreasing function of $Q'$, the quantity available on the market. Thus, if $Q'$ increases, the quantity demanded of $q_1$ will increase and the quantity demanded of close substitutes will decrease; that is, the quantity available of the price-controlled commodity is a parameter of the market demand curve for $q_1$ and for its close substitutes. This justifies writing the demand curve for imports as a function of both $P_c$ and $Q'$.

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