NBER WORKING PAPER SERIES

BUSINESS CYCLE VOLATILITY AND OPENNESS: AN EXPLORATORY CROSS-SECTION ANALYSIS

Assaf Razin

Andrew Rose

Working Paper No. 4208

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
November 1992

NBER Working Paper #4208
November 1992

BUSINESS CYCLE VOLATILITY AND OPENNESS: AN EXPLORATORY CROSS-SECTION ANALYSIS

ABSTRACT

This paper links business cycle volatility to barriers on international mobility of goods and capital. Theory predicts that capital market integration should lower consumption volatility while raising investment volatility, if most shocks are country-specific and transitory. The removal of barriers to trade in goods should enhance specialization and hence output volatility. We test these ideas using a unique panel data set which includes indicators of barriers to trade in both goods and capital flows. However, our empirical results indicate that neither the degree of capital mobility, nor the degree of goods mobility is strongly correlated with the volatility of consumption, investment or output. This may reflect the fact that many business cycle shocks are both persistent and common to many countries.

Assaf Razin
Tel Aviv University
Tel Aviv, 67798, ISRAEL
Phone: 972-3-640-9712
Fax: 972-3-642-08074
and NBER

Andrew Rose
School of Business
University of California, Berkeley
Berkeley, CA 94720-0001
Phone: 1-510-642-6609
Fax: 1-510-642-5018

Motivation and Introduction

Countries which reduce international barriers to movements in either goods or capital flows, sacrifice domestic autonomy in the hope of a higher standard of living. The elimination of trade barriers should result in increased opportunities to exploit country-specific comparative advantages and hence higher income on average. However, in reducing barriers to trade, countries also become more susceptible to shocks from the rest of the world (e.g., terms of trade shocks). In this paper, we explore the link between openness and domestic economic conditions, focussing on the impact of international openness on business cycle volatility.

Our work is empirical in nature, and exploits a panel of data which covers some 130 countries over the post-war period. We distinguish between barriers to capital mobility and barriers to goods mobility, since openness in goods flows and capital flows often have different theoretical implications. We first develop theoretical arguments which informally link the effects of increased accessibility to international goods and capital markets to business cycle volatility. We then examine the empirical validity of these theoretical effects. We find that at this level of aggregation the theory does not perform well; for instance, countries with greater capital mobility do not appear to have systematically smoother consumption streams. This may reflect the fact that many business cycle shocks are both persistent and common across countries.

There are a number of different motivations for our interest in the links between mobility and business cycle volatility. Recently, closer ties in both goods and capital markets have been established through a variety of regional arrangements such as the European Community's Single Market and the North America Free Trade Agreement. However, at the same time, after decades of successful negotiations the progress in multilateral trade liberalization in the GATT framework, has slowed considerably. Regionally-based trade liberalization may have an important effect on business cycle volatility of member countries if volatility and openness are interrelated, and shocks are

common across countries within a region. Further, regionally-based trade liberalization may potentially be explainable by a political-economic aversion to the effects of openness-induced macroeconomic shocks. Virtually all of the EC, NAFTA and ASEAN countries are included in our sample.

The collapse of the Eastern Bloc has resulted in substantial openness in foreign trade of the former CMEA countries. Exchange controls have virtually disappeared on current account transactions, barter trade has given way to market determined trade, and so far only relatively light import tariffs have been put in place. The potentially important effects of these trade policies on volatility has yet to be determined, but could have important effects on the economic and political success of the transition process. Along similar lines, several Latin American countries have recently unilaterally slashed trade barriers as an integral part of their inflation stabilization program. The possibility that this regime switch may have changed the business cycle process in these countries is worthy of investigation. Our cross-sectional analysis includes a wide range of countries which are comparable in wealth and size to the former socialist and Latin American countries.

Surveying trade reforms in developing countries the 1991 *World Development Report* (page 103) concluded that "Despite the difficulties in implementing reform and sustaining it once introduced, liberalizing countries outperformed the others. Growth rates of the reforming countries exceeded the rest when other factors have been taken into account, including external financing, changes in the terms of trade, real exchange rate movements and faster growth in OECD countries." However, the issue of business cycle volatility has not yet been addressed and may bring related economic costs to liberalizing countries even to the point of threatening the political sustainability of the programs.

Our theoretical analysis is presented in the next section of the paper. This is followed by a description of the data in section II, and presentation of our empirical methodology and some preliminary diagnostics in section III. Our results on cross-country

volatility are then presented in the following section. The conclusion of the paper is in section V.

I: Theoretical Considerations

Ia: Introduction

This paper is a preliminary exploration into some of the linkages which might exist between business cycle volatility and barriers to international flows of goods and capital. It would be premature for us to develop and estimate a completely specified general equilibrium model. Our goal is much more modest, and should be viewed as an attempt to determine whether a more involved inquiry is warranted. Rather than specify and estimate a stochastic general equilibrium model, we investigate the sort of linkages between volatility and openness that economic theory suggests; we then perform non-structural empirical analysis in an attempt to discover stylized facts and see whether the links are even close to what is suggested. Promising positive results would certainly not result in strong conclusions without further investigation; the weak links between openness and business-cycle volatility which we find may warrant additional, more refined analysis.

We use theory informally to pin down the links between three different aspects of business cycle volatility (output, consumption, and investment volatility) and two distinct concepts of openness, since reduced barriers to international trade in goods across countries often has different implications from international trade in goods across time. For simplicity, we refer to the former as barriers to current account or goods mobility, while the latter are referred to as barriers to the capital account, or simply capital mobility.

We take care below to treat four different sorts of shocks distinctly. Our shocks can be transitory or persistent in duration; in addition, they may also be either common across countries, or idiosyncratic (country-specific).

Our heuristic reasoning about the effects of trade and capital flow barriers on volatility is as follows. Restrictions to the free flow of goods across time (i.e., capital flows) have strong theoretical implications for investment and consumption volatility. Reduction in barriers to capital mobility provide for enhanced investment opportunities and allow countries to diversity country-specific productivity shocks. Thus, increased capital mobility can be expected to enhance the volatility of investment. At the same time, the ability to use the current account for international borrowing and lending facilitates consumption smoothing. Hence, *enhanced capital mobility should be associated, ceteris paribus, with smoother consumption and more volatile investment*. This intuition is well-known in the literature (e.g., Backus et. al. (1992)); we seek to quantify the relationship between the degree of capital mobility and the volatility in both consumption and investment.1/

Turning to goods markets, international economic integration of goods markets intuitively allows national economies to specialize in goods in which they have some competitive advantage. A reduction in trade barriers (e.g., import tariffs or non-tariff barriers [NTBs]) through either the use of comparative advantage or the exploitation of external economies, will lead to geographical concentration of industries and to export specialization. Thus, random non-diversifiable industry specific shocks that lead to erratic shifts in exports will make output volatility more pronounced as international trade transactions are liberalized; Krugman (1992) discusses the same phenomenon at the

---

1/ Recent empirical literature on the intertemporal approach to the current account (Glick and Rogoff (1992), Leiderman and Razin (1991)) have also emphasized the distinctions between temporary or persistent and common or idiosyncratic shocks, usually in the context of explaining time-series behavior of consumption, investment and the current account. Glick and Rogoff analyzed data for a variety of industrialized countries; Leiderman and Razin considered Israel. Both papers were somewhat successful in finding different effects from different kinds of shocks.

Some of our objects of interest are similar to those of Backus et. al. (1992), but are methodology is different; our paper can be thought of as measuring the importance of some of the "trade frictions" considered by Backus et. al.

regional level. Succinctly, *increased goods mobility should be associated, ceteris paribus, with increased output volatility*. Of course, if most of these shocks are persistent in nature, then consumption volatility should also be expected to rise with reductions in barriers to trade.

In the sub-sections which follow, we sketch out these ideas in more detail. Our objective is to outline the effects that differing shocks will have on each of our three measures of business cycle volatility, under varying levels of both goods and capital mobility.

Ib: Investment

Restrictions on international capital flows directly affect intertemporal trade opportunities of a country and consequently the volatility of its investment and consumption. Investment theory predicts that reduction in barriers to the free flow of capital would enhance investment volatility as the substitution between investment at home and investment abroad becomes larger.

The point can be made simply with a picture like figure 1. We imagine a small open economy which experiences productivity shocks and analyze the implications of restrictions on international capital flows for the volatility of the country's investment and consumption. In the upper panel of the diagram we show the familiar Solow model. The concave schedule represents the constant saving rate, s, times output, hF(k), where h is a Hicks-neutral technological coefficient, F(.) denotes the production function, and k denotes the stock of capital. The ray from the origin represents

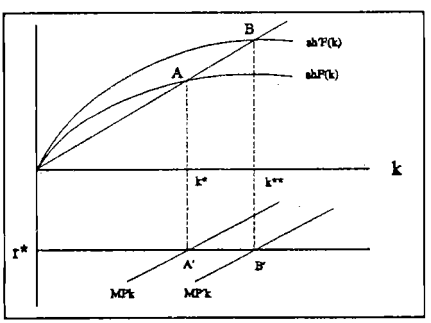


Figure 1: Capital Mobility and Investment

the depreciation rate, g, times the capital stock, k. In the steady state, the level of capital is k*. Thus, without international capital mobility the steady state condition is:

$$shf(k^*) = gk.$$

The downward sloping schedule in the bottom panel portrays the marginal productivity of capital. To facilitate comparison with the perfect capital mobility case, we assume that at the steady-state stock of capital k*, the schedule intersects a line representing the exogenous world rate of interest, r*. Thus, the home country's marginal productivity of capital is equal to the world rate of interest in every period. Therefore, in the perfect capital mobility case, the equality:

$$hf_k(k^*) = r^*.$$

holds at all times, while in the zero-capital mobility case, it holds only at the steady state.

Now, suppose that a productivity-enhancing shock takes place.1/ The shock shifts both the saving schedule in the upper panel and the marginal productivity schedule in the bottom panel outward. If the production function is Cobb-Douglas, the change in the steady state capital stock, is given by (both in the case of free capital mobility and in the case of no capital mobility):

$$dk^*/dh = k^*/h(1-\alpha)$$

1/ The response of investment to a one-time unanticipated shock in a deterministic world is also relevant for behavior in a stochastic world. A linear-quadratic approximation of a dynamic stochastic model in which disturbances take place repeatedly can be viewed as a linear combination of responses to one-time shocks, with the nature of the behavior similar in stochastic and deterministic models.

where α is the income share of capital. That is, a permanent country-specific shock generates the same *long-run* investment response, whether or not there is capital mobility.

However, the short-run response may be quite different, depending on the degree of capital mobility. Under free capital mobility the capital stock is quickly adjusted from point A to point B in the bottom panel. In contrast, if no international capital flows are allowed, the capital stock is slow to adjust since the country's investment is rigidly tied to its savings, and the latter typically adjusts slowly along the transition path so as to smooth out consumption over time.

A comparable *global* shock need not change world saving patterns. However, since the demand for investment rises after an unanticipated productivity increase, an upward pressure on the rate of interest is exerted. Thus, if the productivity shock is common to the home country and the rest of the world, both the world interest rate and the marginal productivity schedule must rise. As the cost and payoff of the investment project both go up, the effect on domestic investment is ambiguous. If the proportional increases in productivity and the rate of interest are the same, investment spending will remain unchanged. Hence, reductions in barriers to capital flows will enhance investment volatility to the extent that shocks are both persistent and country-specific.

Transitory shocks will have little effect on investment behavior, whether or not they are common across countries, since investment responds to a change in the expected discounted sum of future profits, which cannot be altered significantly by a nonpersistent shock. To the extent that investment is irreversible, a non-persistent shock may have no effect at all.

Ic: Consumption

To highlight the effect of capital mobility on consumption behavior we graph in figure 2 the standard Fisherian two-period diagram. We assume that the subjective rate of time preference is equal to the rate of interest and let point A in figure 2 describe the initial autarky equilibrium, in which the consumption point coincides with the GDP point. Restrictions on capital flows are therefore, initially, irrelevant.

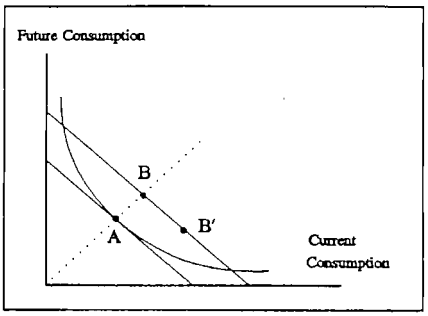


Figure 2: Capital Mobility and Consumption

Suppose that a *country-specific permanent* shock to productivity takes place, shifting the GDP point from A to B. At the same time assume that the world rate of interest remains unchanged. With homothetic preferences, the new consumption point moves to point B, so that capital-mobility restrictions are of no consequence. If, however, the shock is transitory, without capital mobility the intertemporal consumption pattern must be tilted in favor of the period in which the supply shock is experienced. That is, consumption smoothing is facilitated by capital outflows. Thus, in the presence of non-persistent country-specific shocks, reductions in barriers to capital flows should lower the volatility of consumption.

Consider now what happens if the productivity shock is common across countries. A persistent, common, positive shock raises the world rate of interest, as the saving patterns in the world economy remain unchanged but global investment demand rises. This is also true in a closed economy facing a persistent shock. Consequently, the degree of capital mobility does not affect consumption volatility, in the case of persistent global shocks.

A common *transitory* increase in productivity tends to create excess world saving that consequently lowers the world rate of interest. If capital is not allowed to move across countries, consumption rises to follow the temporary blip in output. Under free capital mobility, however, there are two conflicting forces at work: consumption smoothing (manifest through an increase in saving as a fraction of the additional output is put away [itself a consequence of the productivity shock]) and the tilting of the consumption path from future to current periods, resulting from the fall in the world rate of interest. Whether or not capital mobility reduces the volatility of consumption in this case depends on the relative magnitude of these conflicting effects.

To sum up, when shocks are common across countries, the role that capital mobility plays in reducing consumption volatility is likely to be relatively weak.

Id: Output

Trade theory predicts that barriers to trade (whether "artificial" tariffs ("NTBs"), or "natural" transport costs) lead to greater diversification in production (by establishing a range of commodities that are not traded); specialization is encouraged by market broadening. To highlight this effect, we consider the familiar one-period many-commodity Ricardian trade model of Dornbusch, Fischer, and Samuelson (1977).

We assume a continuum of goods and arrange the unit labor requirement ratio $a(z)/a^*(z)$ in order of diminishing home-country comparative advantage (where $a(z)$ is the domestic unit labor requirement associated with commodity z, and a^* is the corresponding foreign requirement). In trade equilibrium, goods will be produced where it is cheapest to make them; given a ratio of domestic to foreign wages w/w^*, commodity z will be produced at home so long as:

$$a(z)/a^*(z) > w/w^*.$$

The range of commodities produced by the home country will be between the commodity with the lowest relative unit labor requirement and the border-line commodity, z', for which the wage ratio is just equal to the relative unit labor requirement. This is portrayed in figure 3.

In this one-period model, trade must be balanced. Assuming constant expenditure shares, the trade balance equilibrium condition is:

$$[1-l(z')]wL = l(z')w^*L^*$$

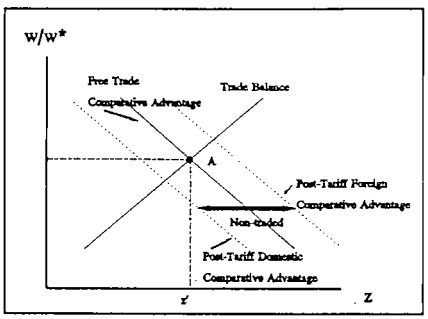


Figure 3: Goods Mobility and Output

where z' is the border line commodity and l(z') is the fraction of income spent on home produced goods. The fraction of income spent on domestic goods will be larger, the larger is z' because a larger fraction of the total range of commodities is produced domestically. Consequently, one can draw an upward-sloping schedule in figure 3 to portray the relationship between the border-line commodity and the relative wage which maintains trade balance equilibrium. Point A in figure 3 indicates the unique relative wage at which simultaneously the world is efficiently specialized and trade is balanced.

A country-specific increase in productivity shifts the relative productivity schedule up. The range of goods that the home country produces rises, and its relative wage rises as well. A global productivity shock, however, will have no effect on relative productivity, and therefore will not change the range of goods that the home country produces.

The introduction of trade barriers gives rise to a range of non-traded commodities. As a result of a tariff (or a NTB, measured in tariff-equivalent terms), the home country

produces commodities that are cheap relative to the (domestic) tariff-inclusive relative wage. Similarly, the foreign country's range of products will depend on the relative wage-ratio inclusive of the foreign tariff. Thus, two labor requirement schedules exist after the introduction of a trade barrier; the commodity range that separates them corresponds to the sector of non-traded goods. The trade balance condition on the demand side is also modified to account for the effect of changes in wages on the range of commodities that are domestically produced.

The post-tariff trade equilibrium has a larger range of commodities that are produced domestically, compared with the free trade equilibrium; trade barriers enhance product diversification. This implies that the imposition of trade barriers will reduce output volatility in the presence of idiosyncratic supply shocks.

II: Data

Our empirical work uses data drawn from three different sources. Our regressands are national accounts data taken from the Penn World Table; our measures of goods and capital mobility are taken from two different sources.

IIa: National Accounts

The national accounts data is taken from the Penn World Table (Mark 5), hereafter referred to as "PWT5". This data base is documented in Summers and Heston (1991). The PWT5 data span 1950 through 1988, though some of the 138 countries do not have data for the complete sample.1/ We use GDP per capita for our measure of output; this series is estimated using a chain index and computed in real terms at 1985 international prices. Our (real per capita) investment series includes both private and public investment. Our data have been transformed by natural logarithms throughout.

1/ We are forced to drop Comoros, Dominica, Grenada, Tonga, and Vanuatu altogether because of inadequate data.

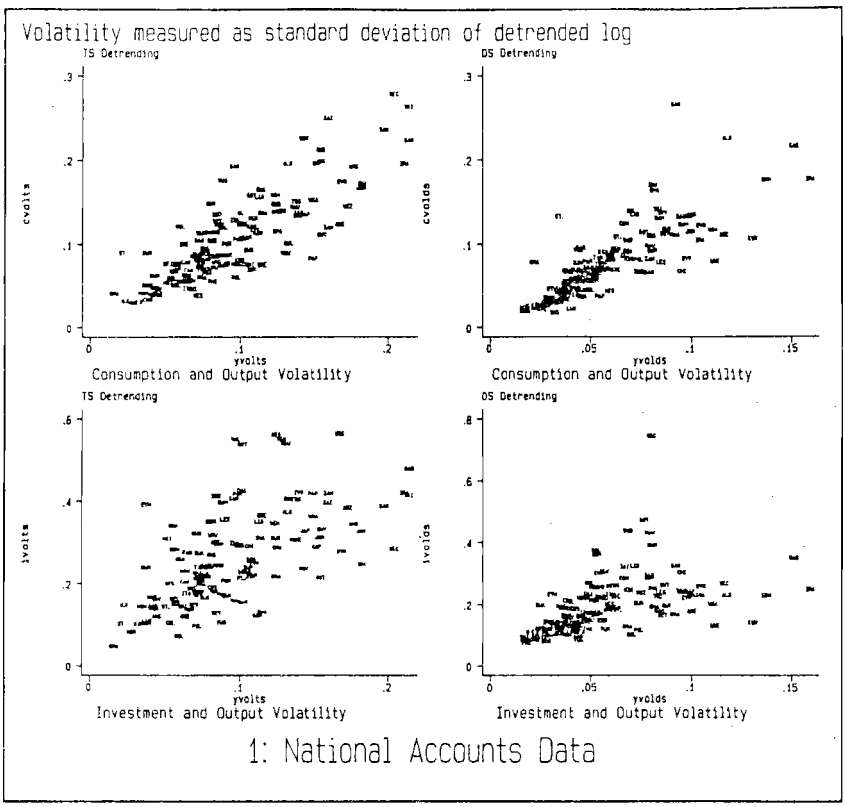
The theoretical arguments presented in section I deals with business cycle fluctuations, that is, deviations from long-run growth trends. As we are interested in linking estimates of business cycle volatility to measures of openness, we are forced to model long-run trends. We take a relatively agnostic view about appropriate statistical representations of long-run growth, and use two different but standard approaches. First, we examine residuals from a standard linear time trend, hereafter the "TS" model. We also look at first-differences, implicitly adopting a random walk model of trends, hereafter the "DS" model.

The raw volatility data is exhibited in graph 1. We use standard deviations (of detrended variables) as measures of volatility. The graphs on the top (bottom) plot consumption (investment) volatility against output volatility; the graphs on the left (right) use the TS (DS) detrending method. In each graph, the datum for each country is marked by the first three letters of the country's name.

A number of points can be gleaned from the graphs. Unsurprisingly, the method of detrending is important in that different techniques yield different results, especially with respect to the volatility of investment and output. Investment seems, unsurprisingly, much more volatile than output, but the volatility of consumption is comparable to that of output. This may reflect: durability of consumption goods; the fact that much of the sample is composed of developing countries with imperfect capital markets; or the nature and persistence of output shocks.

IIb: IMF Data on Trade and Capital Restrictions

We use two sources for most of our data on capital and trade flow restrictions. The first data set is extracted from the summary tables at the back of the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions*. This data is available from 1967 through 1990. The data takes the form of country-specific annual dummy variables for seven different variables. The variables are: 1) "Restrictions [in the form of quantitative



Graph 1: Raw Volatility Data for Investment and Consumption

limits, undue delay, or other official action which directly affects the availability or cost of exchange which] exist on payments [to IMF member countries] in respect of *current* (account) transactions [other than restrictions imposed for security reasons]" (italics added); 2) "Restrictions [in the form of quantitative limits, undue delay, or other official action which directly affects the availability or cost of exchange] exist on payments [of resident-owned funds to IMF member countries] in respect of *capital* (account) transactions" [other than restrictions imposed for security reasons]; 3) "*Bilateral* payments arrangements with

[IMF] *members*"; 4) "*Bilateral* payments arrangements with *nonmembers*"; 5) "Import surcharges"; 6) "Advance import deposits"; 7) "Surrender of export proceeds required". In addition, there are two other variables which we cannot use because of limited data availability: 8) "Prescription of currency" (a series which was discontinued after 1986); and 9) "Payments Arrears" (a series which is only available after 1986).

Table I: Descriptive Statistics on data from *Exchange Restrictions* ...

	1967		1975		1990	
	N	Mean	N	Mean	N	Mean
Current Account	104	.65	118	.53	136	.56
Capital Account	104	.77	118	.79	136	.79
Bilateral, Members	104	.41	118	.33	136	.27
Bilateral, Nonmembers	104	.43	118	.32	136	.18
Import Surcharges	104	.21	118	.30	136	.35
Import Deposit	104	.24	118	.22	136	.13
Export Surrender	104	.77	118	.74	136	.82
Prescribed Currency	104	.83	118	.70	0	n/a
Payments Arrears	0	n/a	0	n/a	136	.36

The data taken from *Exchange Restrictions* is summarized in Table I, which tabulates cross-country sample sizes and means for 1967, 1975 and 1990. It is worthy to note that the measures indicate that the majority of countries have both current account and (to an even larger degree) capital account restrictions throughout the sample. Other controls are less prevalent, with the exception of the fact that most countries require surrender of export proceeds.

This data set has a number of problems. First, the variables are binary indicators, and do not take into account the severity of the controls. Second, many countries entered

the sample relatively late, in a non-random fashion, leading to problems with missing data.1/ Latecomers were especially likely to be developing countries; clearly, simply truncating our cross-country sample by excluding countries with missing data might lead to non-trivial selection problems. Third, capital controls and/or trade barriers may be put in place as a result of business cycle shocks of unusual magnitude, so that controls clearly cannot be taken as exogenous with this respect to business cycle volatility. This potentially serious endogeneity issue will be addressed below.

IIc: Pritchett Openness Data

Our second source of data on trade and capital restrictions is the recent study by Pritchett (1991). Pritchett presents and discusses a number of different new and existing measures of outward orientation for a variety of both developing and industrial countries. As Pritchett convincingly demonstrates, these measures are very imperfectly correlated; there is no single good measure of trade openness. Among his measures are: 1) average total overall charges on imports; 2) NTB frequency; 3) a dummy variable for general foreign exchange licensing; 4) a general import license dummy; 5) openness, traditionally measured as the ratio of trade flows to GDP; 6) a measure of the overall rate of government intervention in international trade; 7) a measure of price distortion; and lastly 8) two measures (each for both 1982 and 1985) of import penetration, adjusted in different ways for country characteristics (e.g., endowments, geographic and economic size, etc). Pritchett (1991) provides a complete discussion of the data; some descriptive statistics are

---

1/ The following is a list of the countries which entered the sample after 1967, along with the date at which they entered: Angola (1990); Bahamas (1974); Bahrain (1973); Barbados (1971); Benin (1976); Botswana (1969); Cape Verde Islands (1979); China (1981); Comoros (1978); Dominica (1979); Fiji (1972); Grenada (1976); Guinea-Bissau (1978); Hungary (1982); Lesotho (1969); Malta (1969); Mauritius (1969); Mozambique (1985); Oman (1972); Papua New Guinea (1976); Poland (1987); St. Lucia (1980); St. Vincent (1980); Seychelles (1978); Solomon Islands (1979); Swaziland (1970); Tonga (1986); United Arab Emirates (1973); Vanuatu (1982); Western Samoa (1972); Yemen (1971); Zaire (1972); Zimbabwe (1981). In addition, data for Taiwan is not available after 1979.

provided in Table II. It should be noted that the country coverage varies dramatically from country to country.

Table II: Descriptive Statistics on data from Pritchett (1991).

Description	N	Mean	Std Dev
Total Overall Charges	73	30.5	21.7
Total Overall NTB Charges	73	47.0	35.7
General FX License Dummy	73	.178	.385
General Import License Dummy	73	.178	.385
Overall Openness Measure	45	.038	.152
Overall Intervention Rates	45	.296	.144
Overall Distortion Index	94	124.	42.1
'82 Overall Import Penetration	97	28.5	23.4
'85 Overall Import Penetration	97	27.2	20.8
'82 Adjusted Overall Import Penetration	96	56.2	81.7
'85 Adjusted Overall Import Penetration	97	49.7	36.3

The empirical strategy that we follow below is to combine the IMF and Pritchett data in a number of different ways to produce plausible overall measures of the degree of goods and capital mobility, explicitly recognizing that these measures will be imperfect.

III: Preliminary Diagnostics

IIIa: Persistence

As demonstrated in section I, the time-series nature of the shocks is of great importance to our analysis. For instance, capital mobility in the face of persistent shocks is of much less consequence for consumption volatility than it would be if most shocks were transitory, since persistent shocks result in much less consumption smoothing. Hence, we investigate the time-series nature of our variables as a preliminary diagnostic exercise.

We computed simple Dickey-Fuller tests for (the logs of) each of our variables.1/ Unsurprisingly, the data typically do not reject the hypothesis that a single unit-root exists

1/ We include a constant intercept so as to allow for a unit-root process with drift as the alternative. Further, we augment our regressions with a lag of the difference term.

in the univariate representation of output, consumption and investment at conventional levels of statistical significance. We computed three tests (one for each of consumption, output and investment) for each of our 133 countries; of these, eighteen (4.5%) tests reject the null hypothesis of a unit root at the 5% significance level, while five of these (1.3%) reject the null at the 1% significance level. These results are quite close to what would be expected under the null hypothesis, implying that the data are consistent with the hypothesis of unit-roots in the autoregressive representations of our variables.

It is well-known that such tests have low power against stationary alternatives, and that there are serious problems in interpreting our tests results as demonstrating a high degree of persistence (e.g., Quah (1992)). Thus, we view our findings as consistent with a high degree of persistence in shocks, but by no means definitive. It does not seem worthwhile to use more econometric fire power on our variables, in light of the maximal sample size of less than forty annual observations.

IIIb: Factor Analysis of Shocks

The theoretical arguments above indicate that many of our results should depend critically on whether shocks are common across countries, or country-specific. To get a handle on this issue, we used standard factor-analytic techniques to test for the nature of the shocks striking our economies. Our factor analysis is performed cross-country on our detrended measures of output, consumption and investment. Our results are displayed in Table III. Since the national accounts data in PWT5 are sometimes unavailable for the entire 1950-1988 period, table III tabulates results for two sets of countries: those with at least twenty annual observations, and those with at least thirty-five observations; results for different sets of countries (with different minimum sample lengths) are quite comparable.

Our results depend critically on the method of detrending. When the variables are detrended using the TS method, four factors (the factors corresponding to the largest four eigenvalues) typically account for around three-quarters of the variation in all three series;

Table III: Cross-Country Factor Analysis of Shocks

Proportions of Total Variance Explained

Countries with at least 20 annual observations

	Output		Consumption		Investment	
	TS	DS	TS	DS	TS	DS
1 Factor	43	20	37	16	35	19
4 Factors	85	49	80	45	78	53

Countries with at least 35 annual observations

	Output		Consumption		Investment	
	TS	DS	TS	DS	TS	DS
1 Factor	41	18	38	15	35	15
4 Factors	79	41	74	37	68	39

the first factor alone accounts for over a third of the total variation. This seems to indicate that there may be a small number of important global shocks that are common across countries. However, these fractions falls by approximately one-half when the DS method of detrending is employed. Further, for both methods of detrending, the factor loadings (on the important factors) are by no means uniformly positive; the mixed signs indicate that the factors are not consistent with a global business cycle shock which affects all economies in a similar fashion.

We interpret these results as implying that a significant fraction of the shocks in question are common, although the exact proportion is very far from clear. However, a large fraction of our shocks is also clearly idiosyncratic, especially when the DS method of detrending is used. We keep this characterization of the data in mind when we proceed on to our primary object of interest, namely the cross-country volatility work.

IIIc: Other Issues

The objective of this paper is to investigate the relationship between various indicators of business cycle volatility and measures of openness in both goods and capital markets. We are interested in establishing rough stylized facts rather than investigating structural parameters estimated from a well-grounded structural model. However, a

number of issues have to be addressed even before reduced-form empirical work can proceed.

One of the most striking features of our data is that much of it is missing, in clearly non-random ways. In particular, many developing countries have data gaps for the measures of capital and goods mobility. (Our problem is missing regressors rather than a censored regressand, so that sample selection of the traditional [Heckit] type is not the issue.) We attempt to test for the sensitivity of this issue by comparing our results with results which use imputed regressors, thereby allowing for a larger, more complete sample.

The omnipresent issue of simultaneity exists. We are interested in questions such as "Does freer access to international capital allow domestic agents to smooth their consumption more effectively?" However, it is plausible, especially in the case of developing countries, that unusually large shocks lead to the imposition of capital controls. We attempt to handle this potentially serious issue by using instrumental variable techniques. (As mentioned above, instrumental variables are also essential insofar as non-trivial measurement error issues are associated with our measures of openness (a point stressed by Pritchett (1991)). However, it is, as usual, difficult to choose plausible instrumental variables. We use a variety of sets of instrumental variables, discussing each explicitly, in order to check explicitly for the sensitivity of our results.

As should be clear from the discussion of the raw data in section II, no single measure of openness in either trade or capital flows seems to dominate the available alternatives. We choose not to use a single flawed measure of e.g., barriers to trade (such as the ratio of exports and imports to GDP, however adjusted). Instead, we use factor analysis to extract factors for goods and capital mobility which are correlated with our

various indicators of openness, and treat these as statistical measures of openness with measurement error.1/

We use eleven variables in constructing our current account openness factor: 1) the sample average value of the IMF dummy for current account restrictions; 2) the sample average value of the IMF dummy for import surcharges; 3) Pritchett's measure of total tariff charges; 4) Pritchett's NTB frequency variable; 5) Pritchett's measure of price distortions; 6) Pritchett's measure of import distortion; 7) Pritchett's traditional measure of openness; and 8)-11) the 1982 and 1985 measures of openness adjusted in two different ways for country-specific characteristics.

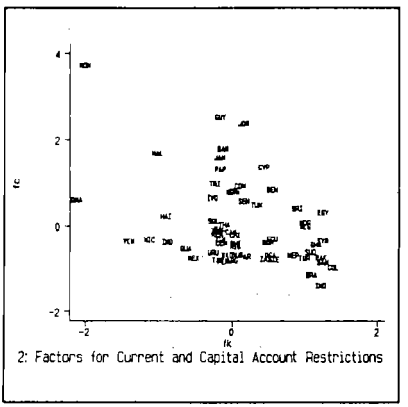
Seven variables were used to construct our factor measuring capital account openness: 1) Pritchett's dummy variable for general foreign exchange licensing; 2) the sample average of the IMF dummy for capital account restrictions; 3) the sample average of the IMF dummy for bilateral balance of payments arrangements with members; 4) the sample average of the IMF dummy for bilateral balance of payments arrangements with nonmembers; 5) the sample average of the IMF dummy for deposit restrictions; 6) the sample average of the IMF dummy for export surrender; and 7) the sample average absolute value of the current account imbalance as a percentage of GDP.

The factor analysis used to generate the measures of goods and capital mobility seems to work well in two senses. First, a high fraction of the variance is absorbed in the single estimated factor (65% in the case of barriers to goods mobility, 75% in the case of capital mobility). Second, the factor loadings seem sensible. For instance, the first six (and the last five) variables which are used to construct the goods mobility factor have the same signs. The only mysterious result is the fact that the general foreign exchange license

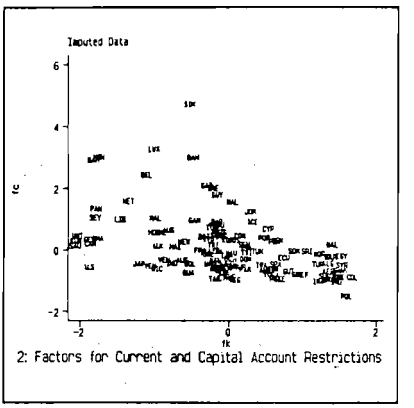
---

1/ Principal components delivers virtually identical factors.

dummy variable takes on a sign different from the next five measures of barriers to capital mobility.



Graph 2a: Factors, from Raw Data



Graph 2b: Factors, from Imputed Data

Our extracted factors for current and capital account openness are presented in graph 2 (there are two versions; one uses the data set which is complete, while the other uses imputed data). Higher value of either factor indicate more barriers to trade. As is clear (especially from the graph with imputed data) the extracted factors seem sensible. For instance, Canada, Germany, the United States and the United Kingdom have low barriers to both goods and capital mobility; developing countries tend to have high barriers to openness, especially on the capital side. The two measures of openness are negatively and significantly correlated (the simple correlation coefficient is -.41 for the sample of 60 countries with complete data; the correlation is -.48 for the complete sample of 133 countries with imputed data).

IV: Empirical Results on Cross-Country Volatility

IVa: Basic Results

We begin the discussion of our basic results by reporting estimates of a linear regression:

$$\sigma_{j,i} = \alpha + \beta_{j,C}FC_i + \beta_{j,K}FK_i + \epsilon_{j,i}$$

where: σ_j represents volatility for our three detrended variables, j=Y,C,I (for output, consumption, and investment); i denotes the country in question; FC and FK denote our factors for current and capital account mobility respectively; and ϵ represents a host of factors which determine country-specific volatility, and are hopefully orthogonal to our (included) measures of current and capital account mobility. Our theoretical arguments above lead us to the following hypotheses:

Ho: $\beta_{Y,C} < 0$

Ho: $\beta_{C,K} > 0$

Ho: $\beta_{I,K} < 0$

We are primarily interested in the effect of FK on investment and consumption volatility, and the effect of FC on output; however, given the preliminary, reduced-form nature of this work, we include both factors as regressors in all three equations. The inclusion of FK in the output equation and of FC in the investment equation can also be interpreted as specification tests.

We estimate this equation with instrumental variables. We use five sets of instrumental variables in an attempt to ensure that our results are insensitive to the exact choice of instrumental variables. The first set of instrumental variables is most extensive

and includes: 1) the logarithm of the level of real GDP in 1985; 2) dummy variables for African, Asian, Latin American and OPEC countries; 3) the CIF/FOB ratio; 4) the ratios of total, private and official external debt to GDP; 5) the ratios of credit, private credit, M1 and M2-M1 to GDP; and 6) the 1985 values of the IMF dummies for current and capital account restrictions, bilateral payments arrangements with both members and nonmembers, required deposit restrictions, required export surrender, and import surcharges. The second set of instrumental variables excludes: 1) the real GDP level; 2) the CIF/FOB ratio; and 3) the 1985 values of the IMF dummy variables. The third set includes: 1) the real GDP level; 2) the debt variables; and 3) the financial variables. The fourth set is the third set without the GDP variable, while the fifth set is merely the set of geographic (and OPEC) dummy variables.

Given the data series of different lengths which are used to construct our volatility (and other) measures, we use weighted procedures throughout, using weights which correspond to the extent of data coverage (i.e., the number of annual observations used to estimate the regressand).

Table IV contains estimates of our basic equation. Results are tabulated for all five sets of instruments; OLS estimates are also presented for comparison. These estimates are typically produced using 50-60 observations (the exact number depends on the list of instrumental variables). The clearest finding is the absence of any significant relationship either of the factors and either of the volatility series for each of our three variables; the coefficients are not significantly different from zero at the 5% significance level in any

Table IV: Basic Results

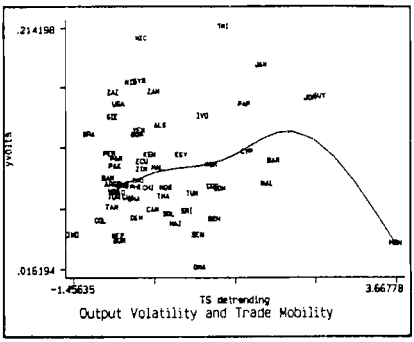
Basic Cross-Country Volatility Results (all estimates weighted)

	Output		Consumption		Investment	
	$\beta_{Y,C}$	$\beta_{Y,K}$	$\beta_{C,C}$	$\beta_{C,K}$	$\beta_{I,C}$	$\beta_{I,K}$
TS Detrending						
IV Set 1	.011	.001	.016	.014	.011	-.025
(se)	(.010)	(.010)	(.011)	(.011)	(.027)	(.027)
IV Set 2	.010	-.004	.019	.030	.033	.005
(se)	(.013)	(.016)	(.015)	(.020)	(.036)	(.047)
IV Set 3	.008	-.001	.014	.037	.012	-.034
(se)	(.012)	(.016)	(.016)	(.020)	(.035)	(.046)
IV Set 4	.008	.000	.016	.040	.034	.008
(se)	(.013)	(.017)	(.016)	(.022)	(.038)	(.050)
IV Set 5	-.013	.012	-.032	.054	-.153	.150
(se)	(.029)	(.036)	(.048)	(.059)	(.145)	(.177)
OLS	.007	-.001	.006	.005	-.006	-.011
(se)	(.006)	(.009)	(.008)	(.011)	(.015)	(.021)
DS Detrending						
IV Set 1	.007	.008	.008	.013	.001	-.001
(se)	(.005)	(.005)	(.008)	(.008)	(.019)	(.019)
IV Set 2	.009	.008	.017	.023	.007	-.006
(se)	(.007)	(.009)	(.010)	(.014)	(.025)	(.033)
IV Set 3	.004	.005	.012	.023	-.005	-.023
(se)	(.007)	(.009)	(.011)	(.014)	(.026)	(.034)
IV Set 4	.006	.008	.014	.029	.005	-.004
(se)	(.007)	(.009)	(.011)	(.015)	(.026)	(.035)
IV Set 5	-.007	.041	-.035	.063	-.117	.117
(se)	(.023)	(.028)	(.044)	(.054)	(.108)	(.132)
OLS	.005	.005	.008	.011	-.000	.004
(se)	(.003)	(.004)	(.004)	(.006)	(.010)	(.015)

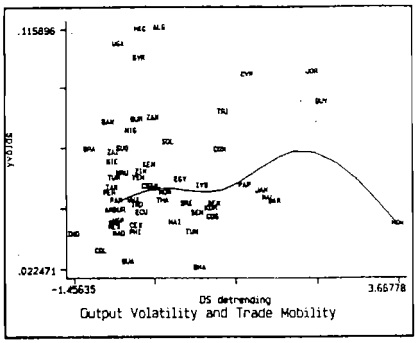
case, either jointly or individually.1/ The most positive results are the effects of barriers to capital mobility on consumption volatility; each of the coefficient estimates is positive, and they verge on statistical significance at conventional levels for some instrument sets.

1/ The Mundell-Fleming model (e.g., Frenkel and Razin (1987)) predicts that the effect of capital controls on output volatility depends on whether shocks affect goods or money markets, and whether exchange rates are floating or fixed. Our empirical work encompasses a mixture of exchange rate regimes and demand-side shocks. Thus it may not be surprising that the Mundell-Fleming model does not lead to an unambiguous prediction of the effects of capital controls on output volatility, nor that we do not observe very strong effects.

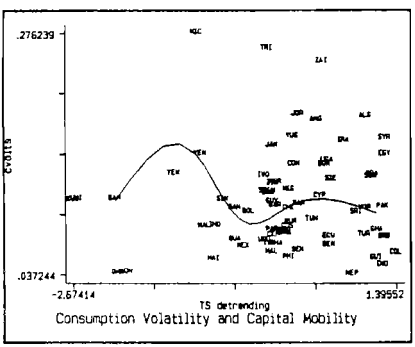
However, the results for output and investment volatility are not supportive of the null hypothesis. The effects of goods mobility on output volatility are typically positive, inconsistent with our theoretical priors, although the estimates are not statistically significant. Most of the coefficients linking capital mobility to investment volatility are negative (although insignificantly so), again inconsistent with the theoretical arguments advanced in Section I. Our results appear to be essentially independent of the detrending technique.



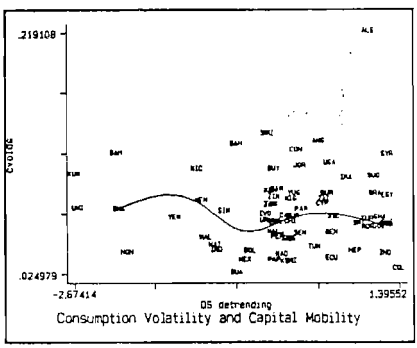
Graph 3a: σ_Y and FC, TS



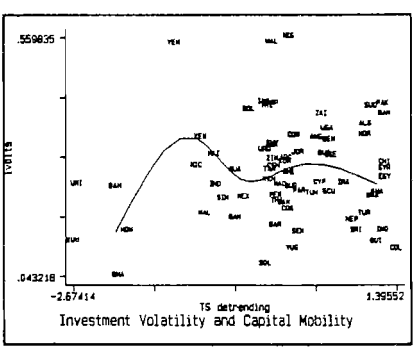
Graph 4a: σ_Y and FC, DS



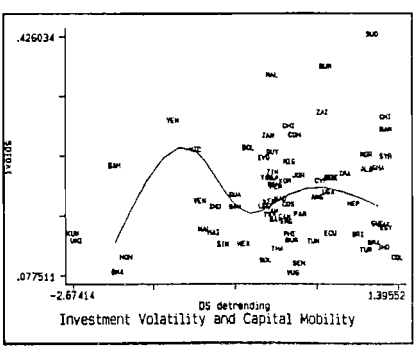
Graph 3b: σ_C and FK, TS



Graph 4b: σ_C and FK, DS



Graph 3c: σ_I and FK, TS



Graph 4c: σ_I and FK, DS

We are primarily interested in the bivariate relationships between FK on investment and consumption volatility, and FC on output. Graph 3a graphs the output volatility data against the goods mobility factor; graphs 3b and 3c are comparable graphs of consumption and investment volatility against the capital mobility factor. Graphs 4a-4c are the analogues to 3a-3c, but use data detrended with the DS technique (graphs 3a-3c use the TS technique). Non-parametric data-smoothers are also provided to assist in gauging the relationships between the variables. These graphs are quite consistent with the results in Table IV; there certainly does not appear to be a clear linkage between our measures of goods and capital mobility and business cycle volatility.

We now check the sensitivity of these mostly negative results to a variety of perturbations in our basic methodology, in order to ensure that our findings are robust.

IVb: Robustness

We have checked the sensitivity of our basic results by perturbing the methodology implicit in Table IV in a number of different ways. However, our negative results do not appear to be sensitive. For instance, if we estimate our basic equation without weighing observations, it is still true that the coefficients are not significantly different from zero at even the 5% significance level, either individually or jointly. Adding squared terms for both factors (which might be relevant if there were some non-linear relationship between the factors and volatility) does not deliver significant results. With one exception, conditioning the consumption and investment volatility equations on output volatility does not lead to significant coefficients on the either goods or capital mobility factor regressors.1/

1/ With one exception; the coefficient on the capital mobility is significantly positive and different from zero at the 5% level if the second through fourth sets of instrumental variables are used.

Table V: Basic Results

Sensitivity Analysis of Cross-Country Volatility Results (all estimates weighted)

	Output		Consumption		Investment	
	$\beta_{Y,C}$	$\beta_{Y,K}$	$\beta_{C,C}$	$\beta_{C,K}$	$\beta_{I,C}$	$\beta_{I,K}$
Imputed Data, TS Detrending						
IV Set 3	.002	.028	.002	.038	-.019	.092
(se)	(.009)	(.011)	(.011)	(.013)	(.026)	(.031)
IV Set 5	-.073	-.023	-.097	-.026	-.149	.084
(se)	(.036)	(.045)	(.048)	(.059)	(.010)	(.124)
Imputed Data, DS Detrending						
IV Set 3	.002	.024	.004	.040	-.019	.083
(se)	(.006)	(.007)	(.009)	(.011)	(.022)	(.026)
IV Set 5	-.034	.020	-.069	.023	-.101	.102
(se)	(.023)	(.029)	(.042)	(.052)	(.084)	(.104)
Fixed Effects, TS Detrending						
IV Set 1	.002	.011	.023	.032	-.049	.018
(se)	(.019)	(.015)	(.022)	(.018)	(.055)	(.043)
Fixed Effects, DS Detrending						
IV Set 1	.006	.010	.020	.022	-.025	.055
(se)	(.015)	(.012)	(.022)	(.018)	(.052)	(.041)
	C/acc	K/acc	C/acc	K/acc	C/acc	K/acc
IMF RHS TS	.001	.010	.026	.007	-.069	.088
(se)	(.027)	(.034)	(.031)	(.040)	(.076)	(.097)
IMF RHS DS	.013	.011	.026	.012	.025	.057
(se)	(.014)	(.017)	(.021)	(.027)	(.051)	(.065)

Table V presents a variety of other estimates which check the robustness of the results in Table IV. First, the cross-sectional sample is extended by imputing missing values; IV results (using the third set of instrument variables) are tabulated.1/ While some of the results are consistent with the hypotheses implied by our theoretical work (especially the positive effects of capital mobility on consumption volatility), these estimates are sensitive in that they depend both on the exact choice of instruments and on the use of imputed data; we view this as weak evidence consistent with our theoretical

1/ It should be noted that the instrumental variables (and the primitive variables required for the factor analysis) as well as the regressands were imputed.

priors. Next, "fixed effect" results are displayed; for these results, the estimating equation is first-differenced, so that the difference between e.g., 1970-1988 and 1950-1969 consumption volatility is regressed on the difference between the 1970-1988 and 1950-1969 factors (i.e., the factors derived from the time-varying data). The first set of instrumental variables are used; results are uniformly insignificantly different from zero. Finally, results are displayed when the sample averages of the IMF dummy variables for current account and capital account restrictions are used as regressors instead of the estimated factors.1/ There are no strong indications of statistically significant correlations between these measures of goods and capital mobility and the indicators of business cycle volatility. (Consistent with Pritchett (1991), the use of different "raw" measures of mobility leads to wildly varying results depending on the mobility measures chosen.)

We conclude that our negative results are relatively robust.

V: Conclusion

In this paper we have done a preliminary cross-country analysis of the effects of restrictions of goods and capital mobility on business cycle volatility. Given that we find that many shocks are persistent, common across countries, or both, it is perhaps unsurprising that we have been unable at this stage to find significant correlations between openness and volatility.

A definitive test of the theory relies on a persuasive four-way delineation of shocks by their nature, which is either global or idiosyncratic, and temporary or persistent. The preliminary diagnostics we conducted indicate pervasive signs of commonality and

---

1/ The instrumental variables includes: the sample averages of the IMF dummy values for import surcharges, required import deposits, surrender of exports revenues, and bilateral arrangements both with members and nonmembers; the measure of price distortion; the general import license deposit; the conventional measure of openness, and the 1985 adjusted import penetration level; the log of real 1985 GDP; dummy variables for Africa, Asia, Latin America, and OPEC status; and ratios of total debt and private credit to GDP.

persistence. Nevertheless, our techniques seem to us to be too crude to deliver a trustworthy algorithm with which to categorize shocks. We hope that future research may correct this inadequacy.

References

Backus, David K., Patrick J. Kehoe, and Finn E. Kydland (1992) "International Real Business Cycles" *Journal of Political Economy* 100-4, 745-775.

Dornbusch, Rudiger, Stanley Fischer and Paul A. Samuelson (1977) "Comparative Advantage, Trade and Payments in a Ricardian Model with a Continuum of Goods" *American Economic Review* 67-5, 823-839.

Frenkel, Jacob A. and Assaf Razin (1987) "The Mundell-Fleming Model: A Quarter Century Later" *IMF Staff Papers* 34-4, 567-620.

Glick, Reuven and Kenneth Rogoff (1992) "Global versus Country-Specific Productivity Shocks and the Current Account" NBER working paper #4140.

International Monetary Fund *Annual Report on Exchange Arrangements and Exchange Restrictions*, various issues.

Krugman, Paul R. (1992) "Lessons of Massachusetts for EMU" MIT mimeo.

Leiderman, Leonardo and Assaf Razin (1991) "Determinants of External Imbalances: The Role of Taxes, Government Spending, and Productivity" *Journal of the Japanese and International Economies*, 5, 421-450.

Pritchett, Lant (1991) "Measuring Outward Orientation in Developing Countries" IBRD WPS 566.

Quah, Danny (1992) "The Relative Importance of Permanent and Transitory Components" *Econometrica* 60-1, 107-118.

Summers, Robert and Alan Heston (1991) "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950-1988" *Quarterly Journal of Economics* CVI-2, 327-368.

World Bank (1987, 1991) *World Development Report.*