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Vol. 51, Special Issue

Thirty Years of Current Account Imbalances, Current Account Reversals, and Sudden Stops

SEBASTIAN EDWARDS*

In this paper I analyze the anatomy of current account adjustments in the world economy during the past three decades. The main findings may be summarized as follows: (i) Major reversals in current account deficits have tended to be associated with "sudden stops" of capital inflows. (ii) The probability of a country experiencing a reversal is captured by a small number of variables that include the (lagged) current account to GDP ratio, the external debt to GDP ratio, the level of international reserves, domestic credit creation, and debt services. (iii) Current account reversals have had a negative effect on real growth that goes beyond their direct effect on investments. (iv) There is persuasive evidence indicating that the negative effect of current account reversals on growth will depend on the country's degree of openness. More open countries will suffer less—in terms of lower growth—than countries with a lower degree of openness. (v) I was unable to find evidence supporting the hypothesis that countries with a higher degree of dollarization are more severely affected by current account reversals than countries with a lower degree of dollarization. And (vi) the empirical analysis suggests that countries with more flexible exchange rate regimes are able to accommodate the shocks stemming from a reversal better than countries with more rigid exchange rate regimes. [JEL F30, F32]

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Recent discussions on international macroeconomic policy have centered on the large current account imbalances experienced by a number of countries, including the United States with a deficit of 5 percent of GDP and China with a surplus of almost 3 percent of GDP.[1] Policymakers, analysts, and academics have focused on the international adjustment process, and have discussed the way in which the correction of these current account imbalances is likely to affect exchange rates, job creation, and economic growth.[2] The source of financing of the U.S. current account deficit has also become a source of concern. A number of analysts have argued that by relying on foreign—and particularly Asian—central banks' purchases of treasury securities, the United States has become particularly vulnerable to sudden changes in expectations and economic sentiments.[3] The IMF's former Director of Research, Ken Rogoff, has made a similar point. In a press conference given in September 18, 2003, a few days before stepping down from the position, he said:[4]

> [L]ooking . . . to the second half of 2004 and beyond, there are still many risks . . . These include the disturbing pattern of global current account imbalances, which is likely to get worse before it gets better, with the United States continuing to absorb a large share of world savings, and Asia providing much of it. (Rogoff, 2003.)

And from here Rogoff went on to argue that the effects of these imbalances on currency values are likely to be significant:

> [W]hen the dollar falls, the question is, where is the burden of adjustment going to be? It is going to be a serious problem regardless of how the fall in the dollar is distributed although the more slowly it happens, the better. But, clearly, if the euro has to bear the lion's share of the adjustment in the dollar, that is going to create a lot more difficulties than if it is more evenly distributed; than if the Asian currencies—not just China but all the Asian currencies—also appreciate, allowing themselves to appreciate significantly against the dollar. (Rogoff, 2003.)

Discussions on current account imbalances and on the burden of the adjustment process are not new in international policy circles. Indeed, in the 1940s John Maynard Keynes was clearly aware of the issue, and his proposal for an international

[1]Although it has attracted less international attention, Russia's current account surplus, in excess of 8 percent of GDP, is also becoming the subject of some debate.

[2]During his much-publicized trip to China and Japan in September 2003, U.S. Treasury Secretary John W. Snow tried to persuade the Japanese and Chinese authorities that they should allow their currencies to appreciate relative to the U.S. dollar. An appreciation of the yen and the yuan, he implied, would allow for a gradual correction of international imbalances and for a fairer distribution of the burdens of adjustment. Indeed, many analysts have argued that a strengthening of the Asian currencies is required to lift some of the pressure from the euro, whose appreciation during the past year and a half has seriously affected European competitiveness. See, for example, Hughes (2003).

[3]See, for example, Martin Wolf's October 1, 2003, article in the *Financial Times,* "Funding America's Recovery Is a Very Dangerous Game," (page 15).

[4]The complete press conference is available via the Internet at: *http://www.imf.org/external/np/tr/2003/tr030918.htm.*

"Clearing Union" was based on the notion that in the face of large payments imbalances both deficit and surplus nations should share the burdens of adjustment.[5]

In recent years there have also been concerns regarding current account behavior in the emerging and transition countries. In particular, a number of authors have asked whether large current account deficits have been associated with the currency crises of the 1990s and 2000s. While some authors, including Fischer (2003), have argued that large current account deficits are a sign of clear (and future) danger, others have argued that significant deficits do not increase the probability of a currency crisis (Frankel and Rose, 1996). Recently, much of the discussion on the emerging and transition nations has moved towards the implementation of appropriate "crisis prevention" policies. In that spirit, a number of analysts have developed models of current account sustainability and have asked what determines the sustainable level of international financing that a particular country is able to secure over the medium and long run.[6] Some authors have also analyzed episodes of current account reversals, or large reductions in the current account deficit in a short period of time (Milesi-Ferretti and Razin, 2000; and Edwards, 2002).

Modern macroeconomic models of open economies have emphasized the fact that the current account is an intertemporal phenomenon. These models recognize two basic interrelated facts. First, from a basic national accounting perspective the current account is equal to savings minus investment. Second, since both savings and investment decisions are based on intertemporal factors—such as life cycle considerations and expected returns on investment projects—the current account is necessarily an intertemporal phenomenon. Sachs (1981) emphasized forcefully the intertemporal nature of the current account, arguing that to the extent higher current account deficits reflected new investment opportunities, there was no reason to be concerned about them. An important and powerful implication of intertemporal models is that, at the margin, changes in national savings should be fully reflected in changes in the current account balance (Obstfeld and Rogoff, 1996). Empirically, however, this prediction of the theory has been systematically rejected by the data.[7] Typical analyses that have regressed the current account on savings have found a coefficient of approximately 0.25, significantly below the hypothesized value of 1.

Numerical simulations based on the intertemporal approach have also failed to account for current account behavior. According to these models a country's optimal response to negative exogenous shocks is to run *very high* current account deficits, indeed much higher than what is observed. Obstfeld and Rogoff (1996), for example, develop a model of a small open economy where under a set of plausible parameters the steady state trade surplus is equal to 45 percent of GDP, and

[5]See, for example, the discussion in Chapter 6 of Skidelsky's (2000) third volume of Keynes' biography, and the papers, reports, and memoranda by Keynes cited in that chapter.

[6]Some of the most influential work on this subject has been done at the IMF by Gian Milesi-Ferretti and his associates. See Milesi-Ferretti and Razin (1996, 1998, 2000), Ostry (1997), Adedeji (2001), McGettigan (2000), and Knight and Scacciavillani (1998).

[7]See, for example, Ogaki, Ostry, and Reinhart (1995), Ghosh and Ostry (1995), and Nason and Rogers (2002).

the steady state debt to GDP ratio is equal to 15.[8] According to a model developed by Fernandez de Cordoba and Kehoe (2000) the optimal response to financial reform in an industrial country such as Spain is to run a current account deficit that peaks at 60 percent of GDP.[9]

In trying to explain the lack of empirical success of intertemporal models a number of authors have compiled a list of (inadequate) assumptions that can account for the observed discrepancies between theory and reality. These include nonseparable preferences, less than perfect international capital mobility, fiscal shocks, and changing interest rates (Nason and Rogers, 2002). In a series of recent papers Kraay and Ventura (2000, 2002) and Ventura (2003) have proposed some amendments to the traditional intertemporal model that go a long way in helping bridge theory with reality. In their model portfolio decisions play a key role in determining the evolution of the current account balance. When investors care about both return and risk, changes in savings will not be translated into a one-to-one improvement in the current account. In this case investors will want to maintain the composition of their portfolios, and only a proportion of the additional savings will be devoted to increasing the holdings of foreign assets (i.e., bank loans). In addition, they argue that when short-run adjustment costs in investment are added to the analysis, the amended intertemporal model traces reality quite closely. In this setting the behavior of countries' net foreign assets play an important role in explaining current account behavior. In particular, and as pointed out by Lane and Milesi-Ferretti (2002, 2003), changes in foreign asset valuation stemming from exchange rate adjustments will tend to affect the adjustment process and the evolution of current account balances.

Models that emphasize portfolio balance are also promising for understanding current account behavior in emerging countries. In particular, shifts in portfolio allocations driven by changes in perceived risk in the emerging countries can explain some of the large changes in current account deficits observed in these countries, including major current account reversals. As pointed out by Edwards (1999), a reduction in foreigners' (net) demand of an emerging country's assets will result in a decline in the country's sustainable current account deficit, forcing it into adjusting. Indeed, if this reduction in foreigners' demand for the country's assets is abrupt and significant—that is, if the country faces what has become to be known as a "sudden stop"—we are very likely to observe a major current account reversal. The magnitude of the current account adjustment will be particularly large during the transition from the "old" to the "new" foreign (net) demand for the country's assets. Although portfolio-based models of the current account are powerful and show considerable promise, there are still a number of questions that need to be addressed. As Ventura (2003) has argued, these include understanding better the role of trade in contingent financial claims, and understanding why international risk sharing is limited and why countries do not buy insurance.

[8]Obstfeld and Rogoff (1996) do not claim that this model is particularly realistic. In fact, they present its implications to highlight some of the shortcomings of simple intertemporal models of the current account.

[9]Their analysis is carried on in terms of the trade account balance. In their model, however, there are no differences between the trade and current account balances.

The purpose of this paper is to analyze the historical behavior of current account imbalances, and the patterns of adjustment followed by countries with large payments disequilibria.[10] Since the focus of the discussion is on adjustment, the analysis mostly deals with extreme observations or episodes when countries have experienced *large* deficits and, to some extent, large surpluses. I am particularly interested in understanding the connection between current account adjustments and exchange rates. I am also concerned with the costs of current account deficit reversals, and their connection to sudden stops of capital inflows.[11] I analyze whether openness, the extent of dollarization, and the exchange rate regime affect the costs of reversals. Broadly speaking, in addressing these issues I am interested in tackling the question of whether the current account *matters.* More specifically, I ask whether economic authorities should be concerned if the country in question runs (large) current account deficits. In the past, authors that have dealt with this issue have reached different conclusions. Sachs (1981), for example, argued that to the extent that a (large) deficit was the result of an increase in investment, there was *no* cause for concern or for policy action. In an important article Corden (1994) argues that "[a]n increase in the current account deficit that results from a shift in private sector behavior—a rise in investment or a fall in savings—*should not be a matter of concern at all*" (p. 92, emphasis added). This view that large current deficits don't matter if they stem from private sector behavior has been associated with former U.K. Chancellor of the Exchequer Nigel Lawson, and is sometimes referred to as *Lawson's Doctrine.* In a series of papers Fischer (1988, 1994, 2003) has taken a different position. For example, in Fischer (1988, p. 115) he argued that the "primary indicator [of a looming crisis] is the current account deficit." And, in 1994, months before the Mexican crisis, he said: "[t]he Mexican current account deficit is huge, and it is being financed largely by portfolio investment. Those investments can turn around very quickly and leave Mexico with no choice but to devalue . . . And as the European and especially the Swedish experiences show, there may be no interest rate high enough to prevent an outflow and a forced devaluation" (Fischer, 1994, p. 306).[12]

In terms of the current literature, this paper is (somewhat) in the tradition of the work by Milesi-Ferretti and Razin (1998, 2000) and Edwards (1999, 2002, 2003) on sustainability, and of the recent work by Ventura (2003), Kraay and Ventura (2000, 2003), and Edwards (2002) that emphasizes the role of portfolio asset allocation in understanding current account behavior. The paper is eminently empirical; readers interested in models of the current account are referred to Obstfeld and Rogoff (1996) and Ventura (2003).

[10]This paper is part of a research project on adjustment in open economies. Other papers in this project include Edwards (1999), De Gregorio, Edwards, and Valdes (2000), Edwards and Susmel (2003), and Edwards (2003).

[11]On sudden stops see Dornbusch and others (1995) and Calvo (2003).

[12]In Edwards (2002) I argue that there is evidence suggesting that large current account deficits increase the probability of a balance of payments crisis. For results that point in the opposite direction see Frankel and Rose (1996).

I. Three Decades of Current Account Imbalances

In this section I analyze the distribution of current account balances in the world economy during the past 32 years. The data are taken from the World Bank data set (World Development Indicators) and cover all countries—advanced, transition and emerging—for which there is information.[13] In order to organize the discussion I have divided the data into six regions: (1) industrialized countries, (2) Latin America and the Caribbean, (3) Asia, (4) Africa, (5) Middle East and Northern Africa, and (6) Eastern Europe. The data set covers 157 countries during the 1970–2001 period. There are over 3,600 observations, and it is the largest data set that can be used in empirical work on the current account. There are 643 observations for the industrial countries, 808 for Latin America and the Caribbean, 513 for Asia, 1,108 for Africa, 297 for the Middle East and North Africa, and 286 for Eastern and Central Europe. As will be explained later, in some of the empirical exercises I have restricted the data set to countries with a population above 500,000, and income per capita above US$500 in 1985 purchasing power parity (PPP) terms. For a list of the countries included in the analysis see the appendix.

International Distribution of Current Account Imbalances

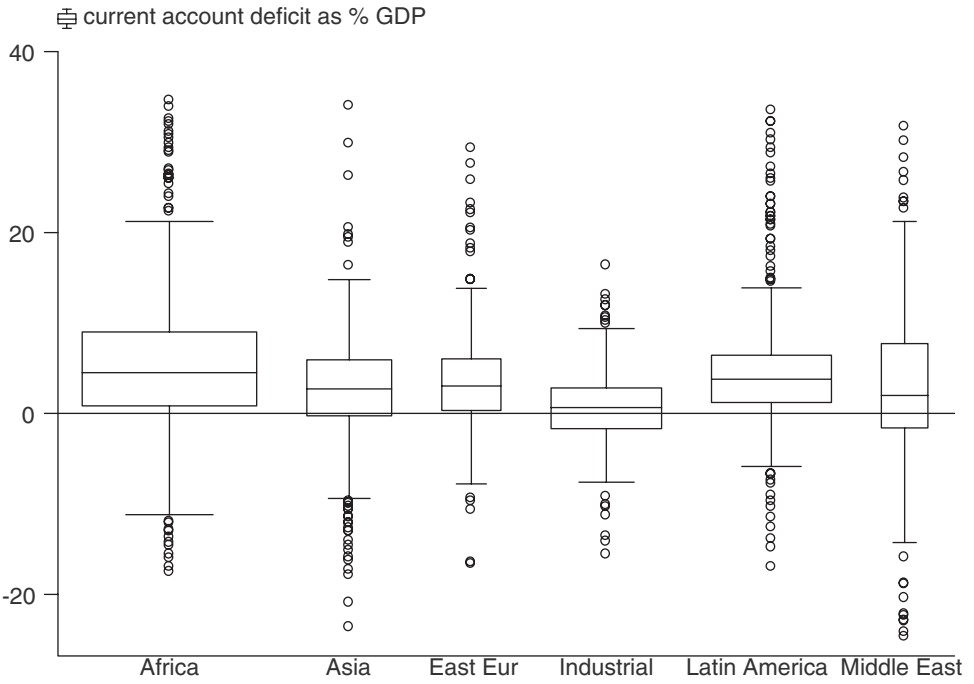
The data on current account imbalances during the past three decades are summarized in Figures 1 and 2. In these figures, as in all tables in this paper, a positive number denotes a current account deficit; surpluses have a negative sign. Figure 1 contains "box-and-whisker" plots that summarize the distribution of current account deficits for each of the six regions. The lines in the middle of each box represent the median of the current account balance for that particular region. Each box extends from the 25th percentile of the distribution to the 75th percentile, thus covering the interquartile range (IQR). The lines that come out from each box are called the whiskers, and extend to the largest data point up to 1.5 times the corresponding edge of the IQR. The whiskers capture the so-called "adjacent values." Observations beyond the end of the whiskers are depicted individually. Finally, the width of each box reflects the number of observations in each region.[14] In Figure 2, on the other hand, I present the evolution of the average current account deficit to GDP ratio by regions for the 1970–2001 period.

A number of interesting aspects of current account behavior emerge from these figures, and from the supporting data (see the appendix for details on the distributions by region and year). As Figure 1 shows, during this period the median balance was in every one of the six regions—including in the industrial countries—a *deficit.* For the complete 32 year period (1970–2001) more than one half of the countries had current account *deficits* in excess of 3.1 percent of GDP. For this 32 year period the third quartile corresponds to a current account deficit of 7.2 percent of GDP. Naturally, and as Figure 1 shows, the third quartile differs for each region, with the

[13]When data from the IMF's *International Financial Statistics* are used, however, the results are very similar.

[14]See Chambers and others (1983). The Stata manual provides a simple and useful explanation of box-and-whisker graphs.

Figure 1. Distribution of Current Account Deficits as Percentage of GDP, by Regions, 1970–2001
(Deficits are positive numbers)



largest values corresponding to Africa and Latin America, with current account deficits of 9.9 percent and 8 percent of GDP respectively. The industrial countries have the smallest third quartile, with a deficit of 3 percent of GDP. Figure 1 also shows that the lowest limit of the interquartile range—the first quartile—corresponds to a current account surplus in only three of the regions: Asia, industrial countries, and the Middle East. The overall value (for all countries and years) of the first quartile corresponds to a current account surplus of 0.28 percent of GDP.

Out of the 3,655 country-year observations in the sample, 923 correspond to current account surpluses, and 2,732 correspond to deficits. Moreover, for the period as a whole the number of deficit countries exceeds the number of surplus countries in every one of the regions. Naturally, since by construction the sum of all current account balances around the world should add up to zero, the smaller number of surplus countries have to run relatively large individual surpluses, when these are measured in currency terms.[15]

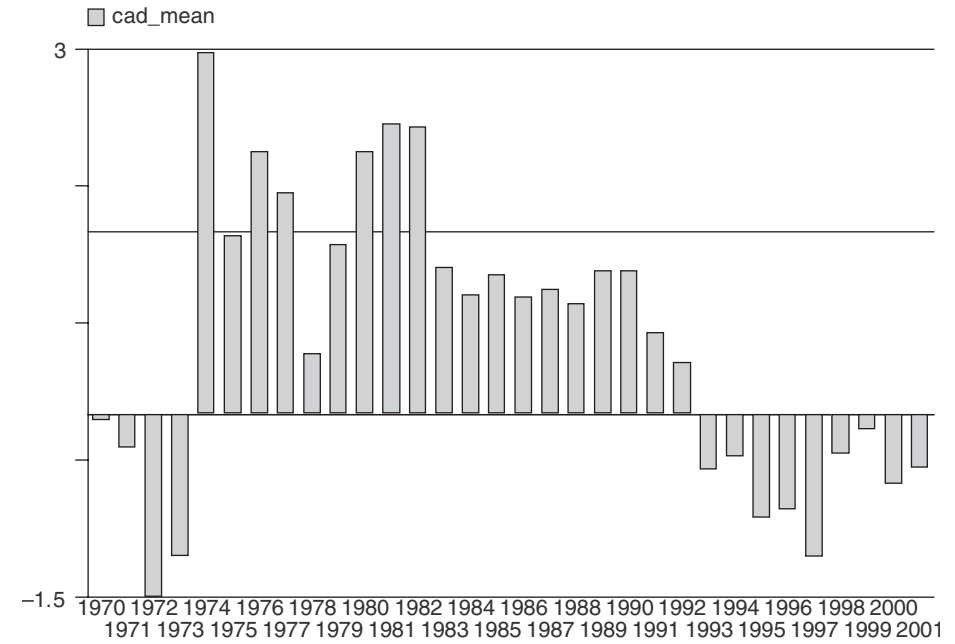
Figure 2 shows that after the 1973 oil-shock there were important changes in *average* current account balances in the industrial nations, the Middle East, and

(*text continues on page 11*)

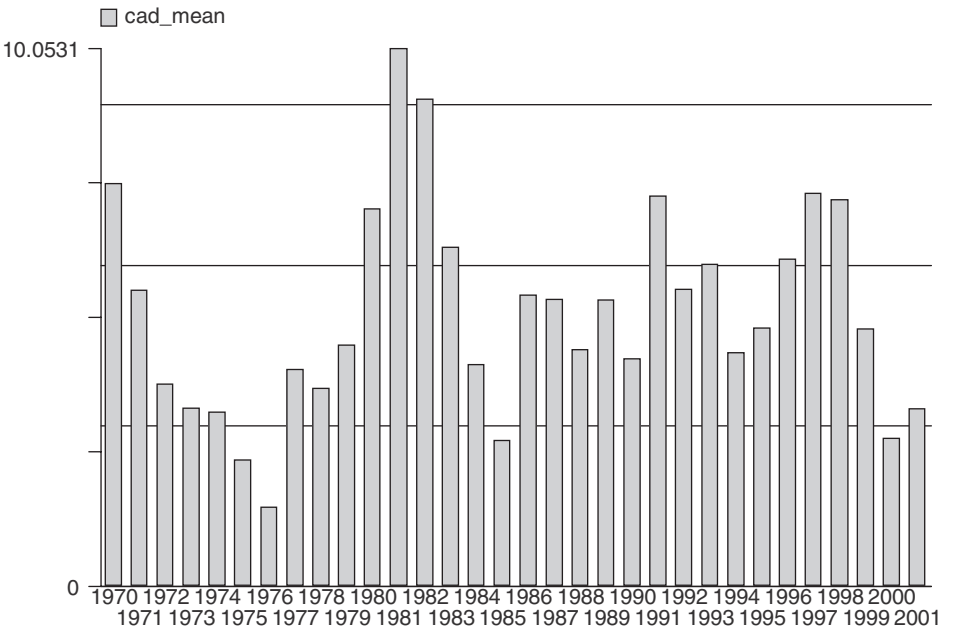
[15]An interesting recent puzzle is that the growing discrepancy between the sum of all recorded deficits and surpluses, as a practical matter the sum of all current account balances, is not equal to zero. Dealing with this (important) issue is beyond the scope of the current paper, however.

Figure 2. Average Current Account Deficits As Percentage of GDP by Region, 1970–2001

(Deficits are positive numbers)

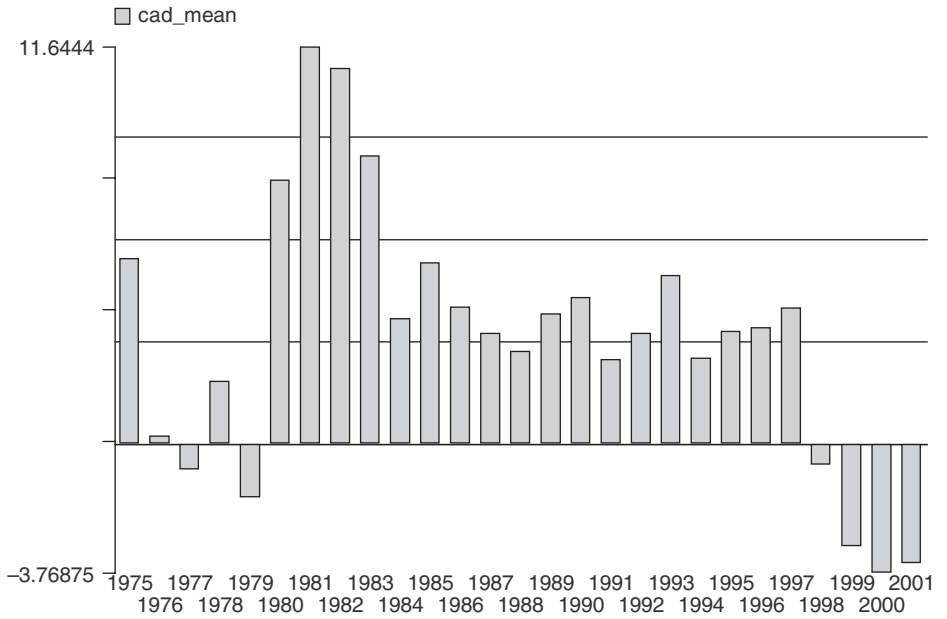


A. Industrial Countries

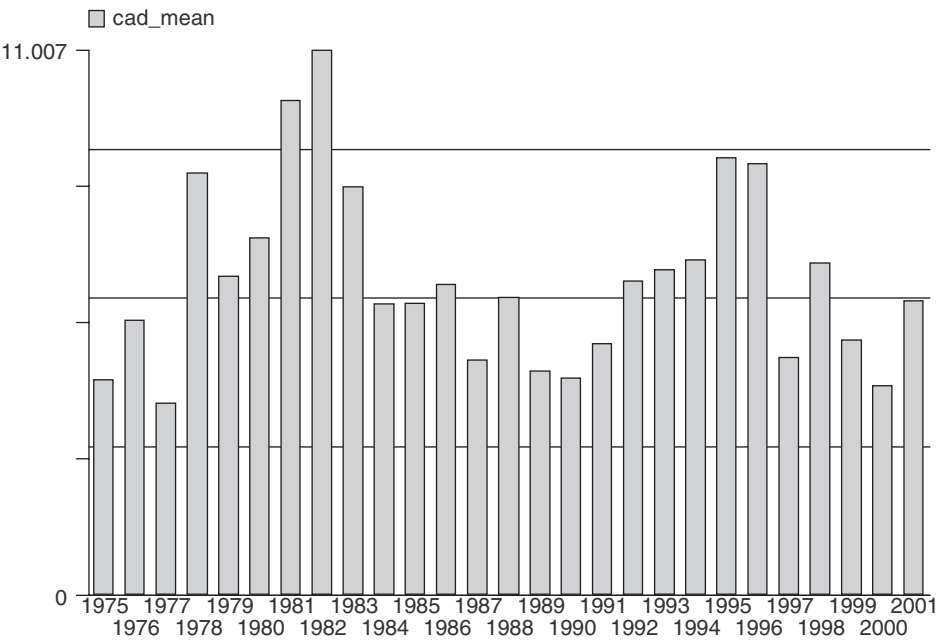


B. Latin America and the Caribbean

Figure 2. *(continued)*

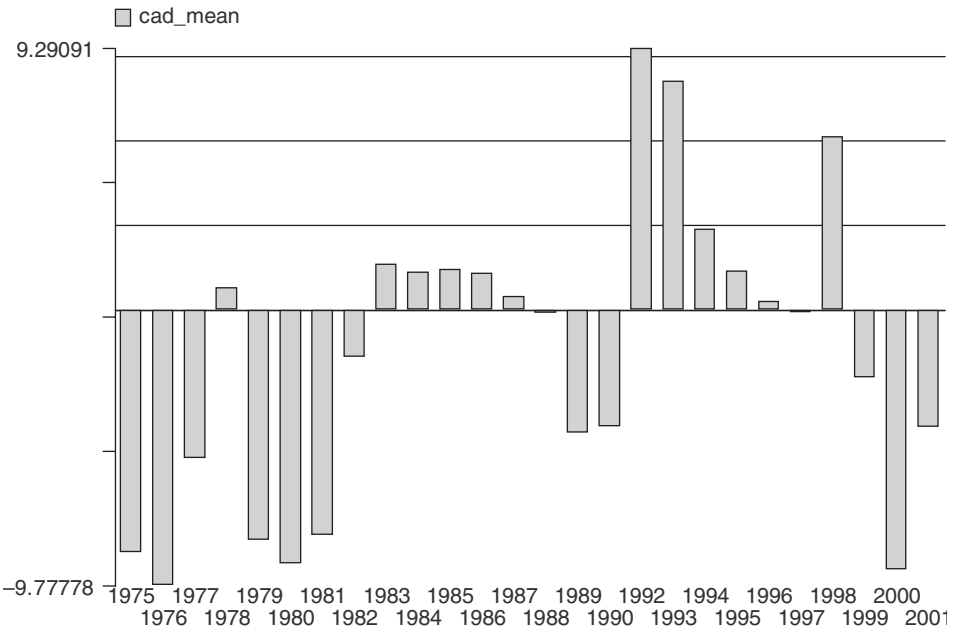


C. Asia

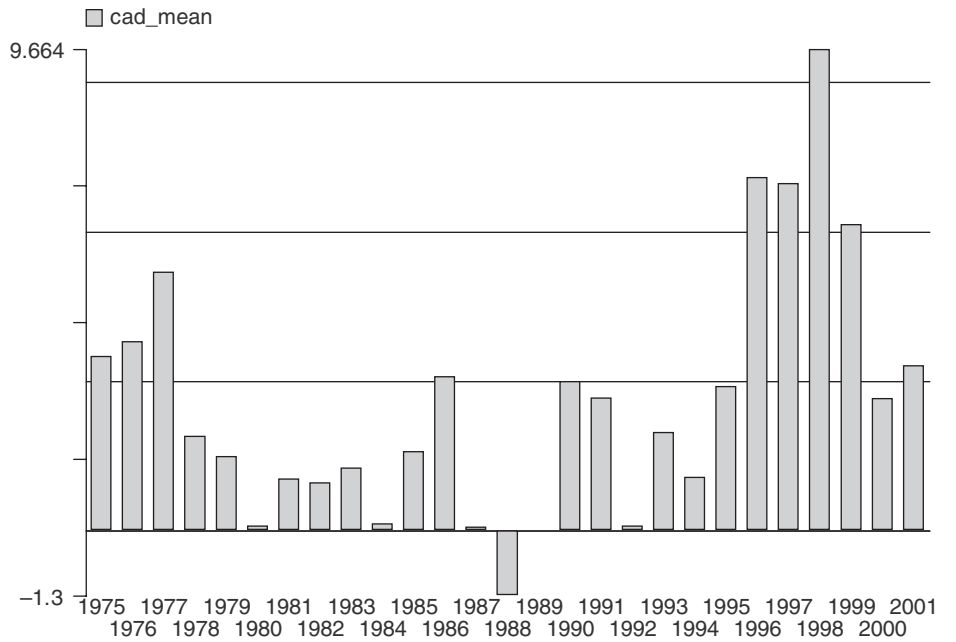


D. Africa

Figure 2. *(concluded)*



E. Middle East



F. Central and Eastern Europe

Africa. Interestingly, no discernible change can be detected in Latin America or Asia. An analysis of median and third-quartile balances, however, shows a different picture, and indicates that after 1973 there were significant shifts in the distribution of balances (see the appendix for year to year details). For example, the median balance climbs from a deficit of 1 percent to one of 4 percent in Latin America; in Asia it goes from less than 1 percent to 3 percent of GDP. Interestingly, the median and third quartile deficits for Africa experience a *decline* after 1973, reflecting the region's inability to finance these large shocks. In contrast with the first oil shock, the 1979 oil shock affected both the means and medians of current account balances in every region in the world. The impact of this shock was particularly severe in Latin America, where the deficit jumped from an average of 3.7 percent of GDP in 1978 to over 10 percent of GDP in 1981.

Figure 2 captures vividly the magnitude of external adjustment undertaken by emerging economies during the debt crisis of the 1980s. In Latin America, for example, reduction in the average current account deficit amounted to 7.3 percent of GDP between 1981 and 1985. As may be seen from Figure 2, during the 1980s adjustment was not confined to the Latin American region. Indeed, other emerging regions also experienced severe reductions in their deficits during this period. In Asia, for instance, the current account adjustment was almost 8 percent of GDP between 1981 and 1984. As Figure 2 shows, the late 1990s and early 2000s have also been characterized by very large adjustments in the emerging and transition countries. These adjustments have been related to the recurrent currency crises of the second half of the 1990s and early 2000s, and have been particularly severe in Asia and Eastern Europe, where average balances adjusted by 7.5 percent and 6.3 percent of GDP, respectively. These tables also show that the industrialized countries went back to having sustained surpluses only after 1993.[16]

High and Persistent Current Account Deficits and Surpluses

According to modern intertemporal models of the current account, including the portfolio-based models of Kraay and Ventura (2000, 2002) and Edwards (1999, 2002), countries will tend to experience short-term deviations from their long-run *sustainable* current account levels.[17] This implies that large current account imbalances—or

[16]From the perspective of current controversies on the international adjustment process, it is interesting to compare the historical behavior of the U.S. current account to the distribution of current accounts for the industrial countries as a group. During the 1970s, the United States ran either small surpluses or small deficits, and the country's current account was very close to the median of the distribution for industrial nations. During most of the 1980s the United States ran a current account deficit. However, in every year but one (1987) the deficit was *below* the third quartile threshold for industrial countries. In 1987 an adjustment process began; the deficit declined steadily until in 1991 the United States ran a small current account surplus. Starting in 1992, a long period of deficits began, which continues until today. In 1999, 2000, and 2001, the U.S. current account deficit was among the 25 percent largest deficits of all industrial countries. There is little doubt that once data for 2002 and 2003 are collected, the United States will again be among the highest deficit countries for those two years. This will make the United States the first large industrial country to have persistently *large* current account deficits for five or more consecutive years. See the discussion below on persistent deficits.

[17]In these models changes in current account balances are (largely) the result of efforts by domestic economic agents to smooth consumption. The sustainable level of the current account balance will, in turn, depend on portfolio decisions both by foreign and domestic investors.

large deviations from sustainability—should not be persistent through time. Once the temporary shocks that trigger the large imbalances have passed, the current account will return to its long-run sustainable level. In this subsection I use the data set described above to analyze the degree of persistence through time of large current account imbalances. I am particularly interested in finding out whether the degree of persistence is similar for large deficits and for large surpluses. I do this by estimating a number of probit regressions on the probability of countries' having a high deficit (or surplus) in a particular year. Although this analysis is *not* a test of the basic intertemporal models, or their portfolio-based versions, it does provide information on the important issue of persistence of large current account imbalances. As a first step I constructed two measures of "high deficits" and two measures of "high surpluses."

- High Deficit 1: This index takes the value of 1 if, in a particular year, a country's deficit is higher than its region's third quartile. The index takes a value of zero otherwise.[18]
- High Deficit 2: This index takes the value of 1 if, in a particular year, a country's deficit is higher than its region's ninth percentile. It takes a value of zero otherwise. Notice that this definition is "stricter" than the High Deficit 1 definition.
- High Surplus 1: This index takes the value of 1 if, in a particular year, a country's surplus is among its region's 25 percent highest surpluses. The index takes a value of zero otherwise.
- High Surplus 2: This index takes the value of 1 if, in a particular year, a country's surplus is among its region's 10 percent highest surpluses. It takes a value of zero otherwise.

In order to investigate the degree of persistence of high current account imbalances I estimated a number of panel probit regressions of the following type:

$$high_{jt} = \alpha + \sum \beta_k high_{jt-k} + \gamma X_{jt} + \varepsilon_{jt}, \qquad (1)$$

where $high_{jt}$ is a dummy variable that takes a value of 1 if country j has a high surplus (deficit) in period t; X_{jt}, refers to other covariates including time, country, and/or region fixed effects. ε_{jt} is an error term with the usual properties.[19] My main interest is on the β_k coefficients on lagged high surpluses (deficits): I am interested in finding out whether having had a high deficit in the past (up to four years) affects the probability of having a high deficit in the current period. The results are in Table 1, where as is customary I report the estimated (dF/dx) coefficients, which capture the change in the probability of a high surplus (deficit) in period t, if there is a high deficit in period $t–k$.[20] As may be seen, the coefficients of all four years' lagged high surpluses' indicators are significantly different from zero at conven-

[18]Notice that the thresholds for defining *high* deficits and surpluses are year-specific. That is, for every year there is a different threshold for each region.

[19]An alternative strategy would be to estimate regressions using the quintiles themselves as the dependent variable. However, the results convey the same message as those reported here.

[20]The dF/dx have been computed for a discrete change in the dummy variables from 0 to 1, and have been evaluated for the mean values of all the regressors.

Table 1. Probit Regressions: Deficits and Surpluses Persistence

Variable	(1) High surplus	(2) High deficit
First lag	0.543	0.403
	(12.15)**	(12.25)**
Second lag	0.169	0.082
	(3.54)**	(3.81)**
Third lag	0.143	0.026
	(2.77)**	(1.50)
Fourth lag	0.153	0.006
	(3.15)**	(0.38)
Pseudo-R^2	0.36	0.39
Observations	2,381	2,381

Notes: absolute value of z statistics in parentheses; **significant at 1 percent; and region and year dummies are included, but not reported.

tional levels, indicating a certain degree of persistence of high surpluses. Interestingly, when regressions of this type were estimated for the case of high deficits—equation 2 in Table 1—the results were quite different, and only the first two lagged coefficients are significantly different from zero. These estimates suggest that during the past three decades the international adjustment process has tended to be asymmetric: high current account surpluses have tended to be more persistent than current account deficits. This conclusion is supported by an analysis of the number of countries that have experienced high deficits or surpluses for at least five consecutive years. Table 2 contains such a list for the case of deficits; the case of surpluses is in Table 3.

As may be seen from Table 2 a rather small number of countries has experienced long periods of high deficits. Consider the case of Latin America, a region with a reputation for macroeconomic mismanagement: according to the first definition, only three countries have had persistently high deficits, and only one of these—Nicaragua—has had a high deficit for more than 10 consecutive years.[21] According to the data in Column A, only 7 out of the 49 African countries are persistent high deficit countries. Interestingly, New Zealand is the only country in the sample that according to the first definition has had two episodes of high persistent deficits—1982–88 and 1994–2001. Column A in Table 2 shows that only four countries in the sample—Australia, Nicaragua, Guinea-Bissau, and Mauritania—have had high deficits that have persisted for more than 10 consecutive years.[22]

[21]Nicaragua's severe crisis is largely the result of the economic mismanagement during the Sandinista rule during the 1980s.

[22]When different and a stricter definition of high and persistence deficits is used—those countries with deficits in the tenth decile of the distribution for at least five consecutive years—the results are broadly consistent with those discussed here—see Column B of Table 2 for details.

Table 2. Countries with Persistent High Current Account Deficits by Region, 1970–2001

Region	(A) High deficit 1	(B) High deficit 2
Industrialized Countries		
Australia	1981–2000	—
Canada	1989–94	—
Ireland	1976–84	1978–84
New Zealand	1982–88 and 1994–2001	1984–88
Portugal	1996–2001	—
Latin America and Caribbean		
Guyana	1979–85	1979–85
Honduras	1975–80	—
Nicaragua	1981–2000	1984–90 and 1992–2000
Asia		
Bhutan	1981–99	1982–89
Lao P.D.R.	1994–98	—
Nepal	1996–2000	—
Papua New Guinea	1980–84	—
Singapore	1972–80	—
Africa		
Congo, Rep. of	1900–96	—
Guinea-Bissau	1982–96	1982–93
Lesotho	1995–2001	1995–2000
Mali	1984–90	—
Mauritania	1975–88	—
Mozambique	1987–98	—
Swaziland	1978–85	—
Middle East		
Cyprus[1]	1977–81	—
Egypt	1972–77	—
Lebanon	1992–98	—
Saudi Arabia	1983–91	—
Eastern Europe		
Armenia	1994–98	—
Azerbaijan	1995–99	1995–99

[1]Although Cyprus is considered a European country by the IMF, the author has listed it under Middle East in an effort to present more accurately the country's current level of economic development.

Source: Author's elaboration based on *World Development Indicators.*

As Column A in Table 3 shows, there are 30 episodes of persistently high surpluses during the period under study.[23] Of these, 9 correspond to advanced nations. Four of the 30 persistently high surplus episodes took place in major oil producers—Trinidad and Tobago, Nigeria, Kuwait, and Russia—and five episodes correspond to countries belonging to the South African currency union (Lesotho,

[23]Notice that I am referring to "episodes." Some countries have had more than one episode of high and persistent surpluses.

Table 3. Countries with Persistent High Current Account Surpluses by Region, 1970–2001

Region	(A) High surplus 1	(B) High surplus 2
Industrialized countries		
Switzerland	1980–2001	1987–2001
Belgium	1986–2001	—
Finland	1995–2001	—
Japan	1983–1992	—
Netherlands	1972–77, 1981–91 and 1993–2000	—
Latin America and Caribbean		
Trinidad and Tobago	1990–96	—
Asia		
China	1994–98	—
Fiji	1985–89	—
Hong Kong SAR	1971–78 and 1980–94	1984–90
Singapore	1988–2001	1994–2001
Papua New Guinea	1992–96	—
Africa		
Algeria	1980–85	—
Botswana	1985–2001	1985–89 and 1991–2001
Chad	1980–84	—
Gabon	1978–84 and 1993–97	1979–84
Gambia, The	1984–1994	—
Lesotho	1980–84 and 1989–94	1990–94
Mauritania	1995–2001	1995–2001
Namibia	1990–2000	—
Nigeria	1984–92	—
South Africa	1985–95	—
Swaziland	1986–91	1987–91
Middle East		
Kuwait	1975–89	1980–89
Eastern Europe		
Russian Federation	1995–2001	—
Kuwait	1980–2001	1987–2001

Source: Author's elaboration based on *World Development Indicators.*

Namibia, South Africa, and Swaziland). Interestingly, neither China nor Japan have been among the persistent high surplus countries during the past few years—that is, after 1998. Of the 30 high surplus episodes in Column A of Table 3, 9 have lasted for more than 10 years, and four countries have had more than one five-year episode with high surpluses. Both of these figures are significantly higher than the equivalent ones for the case of high deficits; indeed, as Table 2, Column A shows, only four countries had high *deficits* for 10 or more consecutive years, and only one had more than one five-year episode with high deficits (New Zealand).

II. Anatomy of Current Account Adjustments

In this section I investigate the anatomy of the adjustment processes in high deficit countries, investigating as many of the main aspects of the adjustment process as possible, and report empirical results that deal with the following questions:

- Has adjustment tended to be gradual, or rather abrupt?
- How common have large deficit reversals been during the past three decades?
- Has the incidence of current account deficit reversals been similar across regions?
- Following deficit reversals, have the current account adjustments tended to be lasting, or have current account balances deteriorated shortly after the reversal episode?
- Historically, have major current account deficit reversals been associated with sudden stops of capital inflows?
- To what extent have current account deficit reversals been associated with balance of payments and/or currency crises?
- Have current account deficit reversals been associated with banking crises?
- Have current account reversals tended to take place within the context of IMF programs?
- Have current account deficit reversals had a negative effect on growth or other forms of real economic activity? The analysis of this particular question is the subject of Section III.

The analysis presented in this section differs from other work on the subject, and in particular from studies on current account deficit reversals such as Milesi-Ferretti and Razin (2000), Edwards (2002), and Guidotti and others (2003), in several respects. First the coverage, both in terms of countries and time period, is greater in this paper than in previous work. Second, I use a methodology based on the calculation of nonparametric tests and frequency tables. And, third, I analyze aspects of reversals—including their possible connection to banking crises and "sudden stops" of capital inflows—that have not been addressed in previous work.

Current Account Deficit Reversals: Incidence and Duration

I define current account deficit reversals—reversals, in short—in two alternative ways: (i) Reversal A is defined as a reduction in the current account deficit of at least 4 percent of GDP in one year; and (ii) Reversal B is defined as a reduction in the current account deficit of at least 6 percent of GDP in a three-year period.[24]

In Table 4 I present tabulation tables on current account reversals by region as well as for the complete sample. These tables include two versions of the Pearson tests for the independence of the frequency of reversals across the six

[24]In both cases the timing of the reversal is recorded as the year when the episode ends. That is, if a country reduces its current account deficit by 7 percent of GDP between 1980 and 1982, the episode is recorded as having taken place in 1982. Also, for a particular episode to classify as a current account deficit reversal, the initial balance has to be indeed a *deficit.* Notice that these definitions are somewhat different from those used in other studies, including Freund (2000), Milesi-Ferretti and Razin (2000), Edwards (2002), and Guidotti and others (2003).

Table 4. Incidence of Reversals

Panel A. *Reversal A*

Region	No reversal	Reversal
Industrial countries	98.0	2.0
Latin America and Caribbean	87.7	12.3
Asia	87.7	12.3
Africa	83.4	16.6
Middle East	85.0	15.0
Eastern Europe	88.9	11.1
Total	**88.2**	**11.8**
Observations	2,678	
Pearson		
Uncorrected χ^2 (5)	65.41	
Design-based $F(5, 13385)$	13.08	
p-value	0.00	

Panel B. *Reversal B*

Region	No reversal	Reversal
Industrial countries	97.3	2.7
Latin American and Caribbean	92.0	8.0
Asia	88.3	11.7
Africa	88.3	11.7
Middle East	86.6	13.4
Eastern Europe	90.7	9.3
Total	**90.8**	**9.2**
Observations	2,501	
Pearson		
Uncorrected χ^2 (5)	37.31	
Design-based $F(5, 12500)$	7.46	
p-value	0.00	

regions.[25] Panel A includes the results for the Reversal A definition, while Panel B has the results for the Reversal B definition. As may be seen, for the complete sample the incidence of Reversal A was 11.8 percent of all country-year observations, while it was only 9.2 percent for the Reversal B definition. The lowest incidence of deficit reversals occurs in the advanced countries, with 2 percent and 2.7 percent incidence for Reversals A and B respectively; the region with highest incidences is Africa with 16.6 percent and 11.7 percent respectively. As the χ^2 and the F statistics indicate, the incidence of deficit reversals is statistically different among the six different regions. Homogeneity tests also indicate that once the industrial countries' group is excluded, the incidence of reversals is still significantly different among the emerging and transition economies.

[25]The first one is the traditional Pearson χ^2 test. The second one is an F-test, which makes a correction in case the data in the sample are not identically and independently distributed.

This finding differs from what was found by Milesi-Ferretti and Razin (2000, p. 292), who found that the occurrence of reversals was similar across groups of countries.

From a policy point of view an important question is whether these reversals have been sustained through time, or whether they have been short lived. I address this issue by investigating whether at horizons of three and five years after each reversal the current account deficit was still lower than what it was the year before the reversal. The results obtained are reported for in Table 5. As may be seen, these results suggest that in a vast majority of cases—between 68 percent and 83 percent of cases, depending on the definition of reversal—the current account deficit was lower three or five years after the reversal than what it was the year before the reversal started.

Current Account Deficits Reversals and Sudden Stops

Since the currency crises of the 1990s international economists have had a renewed interest in the behavior of capital flows around the world. In particular, a number of authors have argued that in a world of high capital mobility sudden stops of capital inflows can be highly disruptive, forcing countries to implement costly adjustments (Dornbusch and others, 1995; Calvo, 2003; Calvo and others, 2003; and Mody and Taylor, 2002). In this subsection I investigate the connection between sudden stops and current account reversals. The results indicate that, as expected, these two phenomena have been closely related. However, the relationship is less than one-to-one; historically there have been many major current account deficit reversals that have not been related to sudden stops, and there have been numerous sudden stops that have not been associated to reversals. This indicates that when facing a sudden stop of capital inflows many countries have been able to effectively use their international reserves in order avoid an *abrupt* and major current account reversal. At the same time, these results suggest that a number of countries have gone through large current account reversals without having faced a sudden stop in capital inflows. Most of the countries in this group were not receiving large inflows to begin with, and had financed their large deficits by drawing down international reserves.

Table 5. Sustainability Through Time of Current Account Reversals

	Sustainability		
	Not sustained	Sustained	Total
		At 3 years	
Reversal A	16.9	83.1	272
Reversal B	23.7	76.3	198
		At 5 years	
Reversal A	19.8	80.2	247
Reversal B	32.4	67.6	179

Table 6. Incidence of Sudden Stops

Region	No sudden stop	Sudden stop
Industrial countries	96.5	3.5
Latin America and Caribbean	95.5	4.5
Asia	96.1	3.9
Africa	93.1	6.9
Middle East	89.4	10.6
Eastern Europe	92.9	7.1
Total	**94.4**	**5.6**
Observations	2,193	
Pearson		
Uncorrected χ^2 (5)	18.59	
Design-based F (5, 12500)	3.72	
p-value	0.002	

I defined a sudden-stop episode as an abrupt and major reduction in capital inflows to a country that up to that time had been receiving large volumes of foreign capital. More specifically, I imposed the following requirements for an episode to qualify as a sudden stop: (i) the country in question must have received an inflow of capital larger than its region's third quartile during the previous two years prior to the sudden stop; and (ii), net capital inflows must have declined by at least 5 percent of GDP in one year.[26] In Table 6 I present a tabulation of the incidence of sudden stops for the complete sample as well as by region. As may be seen, the historical occurrence is less than 6 percent for the complete sample, and ranges from 3.5 percent for the advanced nations to 10.6 percent for the Middle Eastern countries. When alternative and stricter definitions of sudden stops were used, the incidence for the complete sample declined to 3.9 percent of all observations. Notice that the nonparametric χ^2 and the F statistics indicate that the incidence of sudden stops is statistically different among the six different regions in our analysis.

In Table 7 I present two-way frequency tables for the sudden stops and the current account deficit reversal definition Reversal A, both for the complete sample as well as for each one of our six regions. The table shows that for the complete sample (2,228 observations) 46.1 percent of countries subject to a sudden stop also faced a current account reversal. At the same time, 22.9 percent of those with reversals also experienced (in the same year) a sudden stop of capital inflows. The regional data show that joint incidence of reversals and sudden stops has been highest in Africa, where approximately 62 percent of sudden stops happened at the same time as current account reversals, and almost 30 percent of reversals coincided with sudden stops. Notice that for every one of the regions, as well as for the

[26]In order to check for the robustness of the results, I also used two alternative definitions of sudden stops, which considered a reduction in inflows of 3 and 7 percent of GDP in one year. Due to space considerations, however, I don't report detailed results using these definitions.

Table 7. Reversals and Sudden Stops

All countries

	No sudden stop	Sudden stop	Total
No reversal	1,892	69	1,961
	96.5	3.5	100
	90.2	53.1	88.0
Reversal	206	61	267
	77.1	22.9	100
	9.8	46.9	12.0
Total	2,098	130	2,228
	94.2	5.8	100
	100	100	100

Pearson χ^2 (1) = 159.78 p-value = 0.000

Industrial countries

	No sudden stop	Sudden stop	Total
No reversal	539	18	557
	96.8	3.2	100
	98.2	81.8	97.6
Reversal	10	4	14
	71.4	28.6	100
	1.8	18.2	2.5
Total	549	22	571
	96.2	3.8	100
	100	100	100

Pearson χ^2 (1) = 21.14 p-value = 0.000

Latin America and Caribbean

	No sudden stop	Sudden stop	Total
No reversal	578	23	601
	96.2	3.83	100
	87.2	44.2	84.1
Reversal	85	29	114
	74.6	25.4	100
	12.8	55.8	15.9
Total	663	52	715
	92.7	7.3	100
	100	100	100

Pearson χ^2 (1) = 18.35 p-value = 0.000

Table 7. *(continued)*

Asia			
	No sudden stop	Sudden stop	Total
No reversal	294	12	306
	96.1	3.9	100
	87.5	48.0	84.8
Reversal	42	13	55
	76.4	23.6	100
	12.5	52.0	15.2
Total	336	25	361
	93.1	6.9	100
	100	100	100

Pearson χ^2 (1) = 9.55 p-value = 0.002

Africa			
	No sudden stop	Sudden stop	Total
No reversal	579	21	600
	96.5	3.5	100
	85.8	37.5	82.1
Reversal	96	35	131
	73.3	26.7	100
	14.2	62.5	17.9
Total	675	56	731
	92.3	7.7	100
	100	100	100

Pearson χ^2 (1) = 60.63 p-value = 0.000

Middle East			
	No sudden stop	Sudden stop	Total
No reversal	193	12	205
	94.2	5.8	100
	87.7	50.0	84.0
Reversal	27	12	39
	69.2	30.8	100
	12.3	50.0	16.0
Total	220	24	244
	90.2	9.8	100
	100	100	100

Pearson χ^2 (1) = 22.38 p-value = 0.000

Table 7. *(concluded)*

Eastern Europe			
	No sudden stop	Sudden stop	Total
No reversal	159	8	167
	95.2	4.8	100
	91.4	57.1	88.8
Reversal	15	6	21
	71.4	28.6	100
	8.6	42.9	11.2
Total	174	14	188
	92.6	7.4	100
	100	100	100

Pearson χ^2 (1) = 10.80 *p*-value = 0.001

complete sample, the Pearson χ^2 tests have very small p-values, indicating that the observed differences across rows and columns are significant. That is, these tests suggest that although there are observed differences across these phenomena, the two are statistically related. Interestingly, these results do not change in any significant way if different definitions of reversals and sudden stops are used, or if alternative configurations of lags and leads are considered.

Current Account Deficit Reversals, Adjustment, and Currency Crises

In this subsection I investigate the nature of the adjustment associated with a current account deficit reversal. I am particularly interested in finding out whether current account reversals have been associated with broadly defined currency crises. Authors that have previously looked into this issue have focused on rather narrow definitions of "crisis." For example, Milesi-Ferretti and Razin (2000) considered abrupt devaluations to construct several indexes of crisis. Edwards (2002), on the other hand, focused on changes in an external condition index, as well as on discrete and large devaluations. In this paper, and in contrast with previous work on the subject, I distinguish between two type of crises: *international reserves* crises, and *exchange rate* crises. The starting point for this analysis is the construction of an index of "external pressures" along the lines suggested by Eichengreen and others (1996):

$$I_t = \Delta e/e - (\sigma_e/\sigma_R) * (\Delta R/R), \tag{2}$$

where $(\Delta e/e)$ is the rate of change of the nominal exchange rate, and $(\Delta R/R)$ is the rate of change of international reserves. σ_e is the standard deviation of changes in exchange rates, and σ_R is the standard deviation of changes in international reserves. Traditional analyses define a crisis (C_t) to have taken place when the index in equation (2) exceeds the mean of the index plus k standard deviations.

The crisis indicator C_t takes a value of 1 (crisis) or zero (no crisis) according to the following rule:[27]

$$C_t = \begin{cases} 1 \; if \; I_t \geq mean(I_t) + k\sigma_I \\ 0 \qquad otherwise \end{cases}. \tag{3}$$

Instead of focusing on this single traditional index, I construct two alternative crisis indicators that help clarify the nature of the adjustment process. These alternative indicators make a distinction between changes in C_t that stem from large reductions in reserves, and changes in C_t that are the result of massive devaluations. In the construction of both of these indexes I take the value of k to be equal to 2. These crisis indicators are specifically defined as follows:[28]

- ***International Reserves Crisis*** (*Crisis_Res*): In this case the decline in reserves by itself accounts for triggering the crisis indicator C_t. That is, in this case, while the country experiences a major loss in international reserves, its nominal exchange rate does not go through a major adjustment.
- ***Exchange Rate Crisis*** (*Crisis_Er*): In this case it is the nominal exchange rate by itself that triggers the C_t crisis indicator. Here the country lets the exchange rate depreciate significantly *before* it has experienced a major loss in international reserves.

Table 8 presents a summary of the occurrence of the two types of crises for the complete sample, as well as for each one of the regions. The table also includes the Pearson tests for independence. Three conclusions emerge from this table: (i) crises have been a rather infrequent event;[29] (ii) The occurrence of both types of crises is statistically different across regions (see the χ^2 statistic); and (iii) the incidence of *Crisis_ER* has been, in every region, greater than the incidence of *Crisis_Res.*[30]

I use nonparametric tests based on a *stratified case-control* methodology to analyze whether current account reversals have been associated to the two types of crises defined above.[31] This approach consists of formally testing—using a χ^2 statistic—whether there is a significant relationship between a particular outcome (the case) and another variable to which both case and control variables have been "exposed." The first step is to separate observations into a "case group" and a

[27]The pioneer work here is Eichengreen and others (1996), who suggested that the index (2) also included changes in domestic interest rates. Most emerging and transition economies, however, don't have long time series on interest rates. For this reason, most empirical analyses are based on a restricted version of the index, such as 2.

[28]For details see the discussion in Edwards and Magendzo (2003).

[29]This is, in a way, by construction, since k was chosen to be equal to 2.

[30]As it has been usually been done in empirical work on crises I also built alternative indicators that considered a three-year window after each crisis. The results, however, are very similar to those obtained when the basic definitions are used. For this reason, and due to space considerations, I don't report them in this paper.

[31]This approach is used frequently by epidemiologists. I became interested in statistical techniques used by epidemiologists in doing research on financial crisis contagion across countries—see Edwards (2000). See Fleiss (1981) for details on the actual case-control method.

Table 8. Incidence of "International Reserves" and "Exchange Rates" Crises

Region	Exchange-rate crises	Reserves crises
Industrial	2.8	2.4
Latin America	8.6	2.1
Asia	8.2	6.3
Africa	10.4	8.1
Middle East	4.7	2.3
East Europe	12.7	3.8
Total	**8.0**	**2.6**
Observations	2,528	2,528
Pearson		
Uncorrected χ^2 (5)	32.86	31.26
Design-based F (5, 12565)	6.57	6.24
p-value	0.00	0.00

"control group." Countries that for a given year have experienced a "crisis" are considered to be a "case." Noncrisis observations constitute the control group. The second step consists of calculating how many observations in both the case and control groups have been subject to a current account reversal—these are the exposed countries. From this information an odds ratio is calculated, and a χ^2 test is computed in order to determine whether the odds ratio is significantly different from 1. If the hypothesis that the odds ratio is equal to 1 is rejected, then there is evidence supporting the hypothesis that countries that are subject to a reversal have a significant probability of experiencing a crisis.

The results are presented in Table 9 for the *Reversal A* definition of current account reversals (4 percent of GDP in one year)—when the *Reversal B* definition (6 percent of GDP in three years) was used the results were very similar and, thus, are not reported here due to space considerations. These results may be summarized as follows: (1) the hypothesis that the odds-ratios are the same across regions cannot be rejected for any of the two definitions of crisis (see the test for homogeneity). This means that computing a single χ^2 statistic is appropriate for the sample as a whole. (2) The hypothesis that the odds-ratio is equal to one is rejected at conventional levels for the exchange rate definition of crises, *Crisis_Er.* This means that, statistically speaking, countries subject to current account reversals have a significant probability of suffering a major devaluation of their currency, even if international reserves do not decline massively. And (3) the hypothesis that the odds ratio is equal to one cannot be rejected for the reserves definition of crisis *Crisis_Res.* This means that the occurrence of current account reversals does not appear to increase the probability of a country facing a reserve crisis, as defined above.

Current Account Reversals, Banking Crises, and IMF Programs

In this subsection I investigate two final aspects of current account adjustment processes: (i) whether current account reversals have historically been related to

Table 9. Current Account Reversals and Occurrence of Crises

Panel A. *Reversal A* and reserves crises

Region	Odd ratio	95 percent conf. interval	
Industrial countries	0.000	0.000	16.025
Latin American and Caribbean	1.578	0.162	7.877
Asia	0.681	0.075	2.974
Africa	0.995	0.021	9.006
Middle East	1.336	0.026	14.064
Eastern Europe	3.689	0.325	24.370
Test of homogeneity			
χ^2 (5)	2.86		
p-value	0.72		
Test odds ratio = 1			
Mantel-Haenszel χ^2 (5)	0.20		
p-value	0.65		

Panel B. *Reversal A* and exchange-rate crises

Region	Odd ratio	95 percent conf. interval	
Industrial countries	9.864	0.906	57.612
Latin American and Caribbean	2.716	1.159	5.939
Asia	3.006	1.068	7.678
Africa	1.160	0.578	2.193
Middle East	0.000	0.000	1.972
Eastern Europe	1.693	0.376	5.917
Test of homogeneity			
χ^2 (5)	4.80		
p-value	0.44		
Test odds ratio = 1			
Mantel-Haenszel χ^2 (5)	8.13		
p-value	0.004		

banking crises; and (ii), the relationship between current account reversals and IMF programs. A number of authors have argued that one of the costliest effects of external shocks is that they tend to generate banking crises and collapses. Most of the analyses on this subject have focused on the joint occurrence of devaluation crises and banking crises—see, for example, the discussion in Kaminsky and Reinhart (1999). In this subsection I take a slightly different approach, and I investigate whether major reversals in current account deficits—not all of which end up in devaluation crises, as established above—have been associated with banking crises. I address this issue in Table 10, where I present two-way tabulations for the *Reversal A* definition of current account reversals and a dummy variable that takes the value of 1 if that year there has been a banking crises.[32] The three panels in

[32]The data on banking crises are from Glick and Hutchison (1999). When the *Reversal B* definition is used the results are similar to those reported above.

Table 10. Current Account Reversals and Banking Crisis*

Panel A. Contemporaneous

Reversal A	No banking crisis	Banking crisis	Total
No reversal	2,220	112	2,332
	95.2	4.8	100
	88.1	86.2	88.0
Reversal	299	18	317
	94.3	5.7	100
	11.9	13.9	12.0
Total	2,519	130	2,649
	95.1	4.9	100
	100	100	100

Pearson χ^2 (1) = 0.458 *p*-value = 0.498

Panel B. Lagged bank crises

Reversal A	No banking crisis	Banking crisis	Total
No reversal	2,332	110	2,442
	95.5	4.5	100
	88.2	85.3	88.1
Reversal	312	19	331
	94.3	5.7	100
	11.8	14.7	11.9
Total	2,644	129	2,773
	95.4	4.6	100
	100	100	100

Pearson χ^2 (1) = 1.00 *p*-value = 0.316

Panel C. Lagged *Reversal A*

Reversal A	No banking crisis	Banking crisis	Total
No reversal	2,161	110	2,271
	95.2	4.8	100
	88.2	85.3	88.1
Reversal	288	19	307
	93.8	6.19	100
	11.8	14.7	11.9
Total	2,449	129	2,578
	95.0	5.0	100
	100	100	100

Pearson χ^2 (1) = 1.03 *p*-value = 0.31

Table 10 present two-way tabulations under different structures of lags: while in Panel A both variables are contemporaneous, in Panel B the dummy for banking crises is lagged one year. This allows us to consider situations were a banking crisis follows in time a current account reversal episode. Finally, in Panel C the *Reversal A* dummy has been lagged one year. All three Panels—see, in particular,

the Pearson χ^2 tests for independence of rows and columns—show that there has not been a significant relation, at any lag or lead, between reversals and major banking crises.

In Table 11 I present two-way tabulation tables for the *Reversal A* indicator and dummy variable (*imfprog*) that takes the value of 1 if during that year the

Table 11. Current Account Reversals and IMF Programs

Panel A. Contemporaneous variables

Reversal A	No IMF programs	IMF programs	Total
No reversal	890	761	1,651
	53.9	46.1	100
	86.2	84.6	85.5
Reversal	142	138	280
	50.7	49.3	100
	13.8	15.4	14.5
Total	1,032	899	1,931
	53.4	46.6	100
	100	100	100

Pearson χ^2 (1) = 0.98 *p*-value = 0.32

Panel B. IMF programs lagged

Reversal A	No IMF programs	IMF programs	Total
No reversal	866	784	1,650
	52.5	47.5	100
	84.5	86.6	85.5
Reversal	159	121	280
	56.8	43.2	100
	15.5	13.4	14.5
Total	1,025	905	1,930
	53.1	46.9	100
	100	100	100

Pearson χ^2 (1) = 1.78 *p*-value = 0.18

Panel C. *Reversal A* lagged

Reversal A	No IMF programs	IMF programs	Total
No Reversal	912	768	1,680
	54.3	45.7	100
	86.0	85.3	85.7
Reversal	149	132	281
	53.0	47.0	100
	14.0	14.7	14.3
Total	1,061	900	1,961
	54.1	45.9	100
	100	100	100

Pearson χ^2 (1) = 0.15 *p*-value = 0.69

country in question had an IMF program, and a value of zero otherwise.[33] As before, the tabulations are presented for three different lag-lead structures. The results indicate that, at least within the leads and lags considered here, there has not been a strong historical relation between reversals and IMF programs. Indeed, the χ^2 tests for independence of rows and columns have relatively high *p*-values.

III. Costs of Current Account Reversals

In this section I investigate the extent to which current account reversals have had an effect on real economic performance. I am particularly interested in analyzing if the impact of current account reversals on real economic activity depends on variables such as the country's degree of openness, its degree of dollarization, and its exchange rate regime. According to a variety of models stemming from many different traditions—including models in the Mundell-Fleming tradition, as well as recent ones based on the sudden-stop framework—the real costs of foreign shocks are inversely proportional to the degree of openness of the economy.[34] According to these models, countries that are less open internationally will have to make a greater effort, in terms of reducing aggregate demand (absorption) and/or in terms of real devaluations, than counties with a larger external sector. In models in the Mundell-Fleming tradition, this phenomenon is reflected in the fact that the *expenditure reducing* effort, for any given level of expenditure switching, is inversely proportional to the marginal propensity to import—see Frenkel and Razin, 1987.

In a recent analysis of the 2001–02 Argentine crisis, Calvo and others (2003) have developed a model where a sudden stop of capital inflows results in an abrupt current account reversal, and in a major real exchange rate depreciation. In this model the "required" real depreciation depends on the country's degree of openness. Calvo and others (2003) argue that in Chile—one of the most open countries in Latin America—a sudden stop would require a 32 percent real depreciation to reestablish external equilibrium.[35] The authors' calculations suggest that in relatively closed Argentina the depreciation required for eliminating the current account deficit is, at 46 percent, significantly higher than in Chile. In this model the real depreciation that stems from the sudden stop—and concomitant current account reversal—has a more negative effect on real performance in countries with a higher degree of dollarization. This effect takes place through two channels. First, countries with corporate dollarized liabilities will experience massive jumps in indebtedness and will be unable to service their debts. Moreover, as Caballero and Krishnamurthy (2000) have argued, the value of collateral provided by producers of nontradables will decline significantly, further amplifying the costs of the crisis. The second channel is related to fiscal policy and fiscal sustainability.

[33]The variable *imfprog* takes a value of one if in that year the country has any of the following types of programs: Stand-by, ESAF, EFF and SAF. The raw data for constructing this dummy were taken from Evrensel (2002) and from the IMF web page: *http://www.imf.org/external/np/tre/tad/exfin1.cfm.*

[34]See, for example, Part II of Frenkel and Razin (1987) and Calvo and others (2003).

[35]The authors define "new equilibrium" as a situation in which the current account deficit is completely eliminated.

To the extent that a proportion of the public sector debt is denominated in foreign currency, the real depreciation will increase the ratio of public sector debt to GDP.[36] In order to maintain fiscal sustainability the authorities will have to run a higher primary surplus, thus, reducing aggregate demand and economic activity.

For a long time economists have argued that the exchange rate regime plays an important role in the adjustment process. Meade (1951, pp. 201–2) argued early on that countries with a flexible exchange rate regime are able to accommodate better external shocks, including terms of trade and capital account shocks.[37] This suggests that current account reversals will have a smaller (negative) effect on real economic activity countries with more flexible regimes. In this section I use a treatment regressions framework to investigate empirically if these three factors—openness, the extent of dollarization, and the exchange rate regime—have indeed affected the way in which current account reversals affect real economic activity.

Previous empirical work on the (potential) real effects of reversals have reached different conclusions. Milesi-Ferretti and Razin (2000), for example, used both *before* and *after* analyses as well as cross-country regressions to deal with this issue and concluded that "reversal events seem to entail substantial changes in macroeconomic performance between the period before and the period after the crisis but *are not systematically associated with a growth slowdown* (p. 303, emphasis added)." Edwards (2002), on the other hand, used dynamic panel regression analysis and concluded that major current account reversals had a negative effect on investment, and that they had "a negative effect on GDP per capita growth, even after controlling for investment (p. 52)." Neither of these papers, however, analyzed the interaction between openness, dollarization or the exchange rate regime and the costs of current account reversals.[38]

Current Account Reversals and Growth: An Empirical Model

Changes in investment constitute, almost by definition, the main channel through which current account reversals affect economic activity. Since the current account deficit is equal to investment minus savings, a major reversal will imply, with a high degree of probability, a decline in investment and, thus, in economic activity. An important question is whether reversals affect growth through channels other than investment. In this section I tackle this issue by using panel data to estimate jointly growth equations and current account reversal equations.

My main interest is to understand what is the conditional effect—if any—of a current account reversal on real macroeconomic performance. In order to do this, I use a "treatment effects" model to estimate jointly an "outcome equation" on real GDP growth and a probit equation on the probability that a country experiences a

[36]See Edwards (2003) for an analysis of the relationship between fiscal sustainability and the real exchange rate in very poor HIPC countries.

[37]For a discussion and empirical analysis of this proposition see Edwards and Levy-Yeyati (2003).

[38]In a recent paper, Guidotti and others (2003) consider the role of openness in an analysis of imports and exports behavior in the aftermath of a reversal. The spirit of their analysis, however, is somewhat different from that of the other works discussed here.

current account reversal. The empirical treatment effects model may be written as follows:

$$y_{tj} = \boldsymbol{x}_{tj}\beta + \gamma\delta_{tj} + \theta(\delta_{tj} \times Openness_{tj}) + \mu_{jt} \tag{4}$$

$$\delta_{jt} = \begin{cases} 1, \text{ if } \delta^*_{jt} > 0 \\ 0, \text{ otherwise} \end{cases} \tag{5}$$

$$\delta^*_{jt} = \boldsymbol{w}_{jt}\alpha + \varepsilon_{jt}. \tag{6}$$

Equation (4) is the real growth equation, where y_{jt} stands for real GDP growth in country j and period t; $\boldsymbol{x}_{jt}$ is a vector of covariates that capture the role of traditional determinants of growth, such as investment, openness, and government consumption; δ_{jt} is a dummy variable (i.e., the treatment variable) that takes a value of one if country j in period t experienced a current account reversal, and zero if the country did not experience reversal. Accordingly, γ is the parameter of interest: the effect of the treatment on the outcome. Whether the country experiences a current account reversal is assumed to be the result of an unobserved latent variable δ^*_{jt}, described in equation (5). Openness is a variable that measures the extent to which country j in period t is open to international trade. θ is the coefficient of the interaction between openness and the reversal dummy. δ^*_{jt}, in turn, is assumed to depend linearly on vector $\boldsymbol{w}_{jt}$. Some of the variables in $\boldsymbol{w}_{jt}$ may be included in $\boldsymbol{x}_{jt}$ (Maddala 1983, p. 120).[39] β and α are parameter vectors to be estimated. μ_{jt} and ε_{jt} are error terms assumed to be bivariate normal, with a zero mean and a covariance matrix given by:

$$\begin{pmatrix} \sigma & \varsigma \\ \varsigma & 1 \end{pmatrix} \tag{7}$$

If equations (4) and (6) are independent, the covariance term ς in equation (7) will be zero. Under most plausible conditions, however, it is likely that this covariance term will be different from zero.

Greene (2000) has shown that if equation (4) is estimated by least squares, the treatment effect will be overestimated. Traditionally, this problem has been tackled by estimating the model using a two-step procedure (Maddala, 1983). In the first step, the treatment equation (5) is estimated using probit regressions. From this estimation a hazard is obtained for each j t observation. In the second step, the outcome equation (4) is estimated with the hazard added as an additional covariate. From the residuals of this augmented outcome regression, it is possible to compute consistent estimates of the variance-covariance matrix (7).

[39]It is assumed, however, that δ^*_{jt} does not depend on y_{jt}. Otherwise, as discussed below, the model cannot be identified.

An alternative to the two-step approach is to use a maximum likelihood procedure to estimate the model in equations (4) through (7) jointly.[40] As shown by Greene (2000), the log likelihood for observation k is given by equations (8) and (8′):

$$L_k = \log \Phi\left\{\frac{w_k\alpha + (y_k - x_k\beta - \delta)\,\varsigma/\sigma}{\sqrt{1-\varsigma^2}}\right\} - \frac{1}{2}\left\{\frac{y_k - x_k\beta - \delta}{\sigma}\right\}^2 - \log\sqrt{2\pi}\sigma, \qquad (8)$$

if $\delta_k = 1$

$$L_k = \log \Phi\left\{\frac{-w_k\alpha - (y_k - x_k\beta)\,\varsigma/\sigma}{\sqrt{1-\varsigma^2}}\right\} - \frac{1}{2}\left\{\frac{y_k - x_k\beta}{\sigma}\right\}^2 - \log\sqrt{2\pi}\sigma, \qquad (8')$$

if $\delta_k = 0$.

The model in equations (4)–(7) will satisfy the consistency and identifying conditions of mixed models with latent variables if the outcome variable y_{jt} is not a determinant (directly or indirectly) of the treatment equation—that is, if y is not one of the variables in $\boldsymbol{w}$ in equation (6).[41] For the cases of per capita GDP growth this is a reasonable assumption.

Since I am interested in understanding if openness (among other variables) plays a role in the effect of reversals on growth, one of the $\boldsymbol{x_{jt}}$ variables in equation (4) is a term that interacts the dummy variable δ_{tk} and an openness variable. The latter is defined as the ratio of imports plus exports over the country's GDP. Since the presence of such an interactive term makes the estimation of the system (4)–(8) somewhat complex, the results reported here correspond to the two-steps procedure described above. In the estimation I also impose some exclusionary restrictions; that is, a number of the $\boldsymbol{w_{jt}}$ covariates included in equation (6), are not included in the outcome equation (4). These exclusionary restrictions are not required for identification of the parameters, but they are generally recommended as a way of addressing issues of collinearity.[42]

Basic Results: Reversals and Openness

In this section I report the results obtained from the estimation of the treatment effects model given by equations (4) through (7). I proceed as follows: I first discuss the specification used for the first-stage probit equation on the probability of experiencing a current account reversal. I then discuss the specification for the outcome equations on GDP growth. Finally, I present the results from the estimation of the treatment models. In the subsections that follow I discuss some extensions and robustness issues.

[40]The two-steps estimates yield similar results and are available from the authors on request.

[41]Details on identification and consistency of models with mixed structures can be found in Maddala (1983). See, also, Heckman (1978), Angrist (2000), and Wooldridge (2002).

[42]Wooldridge (2002).

Equation specification

The treatment equation. Following work done by Frankel and Rose (1996), Milesi-Ferretti and Razin (2000), and Edwards (2002), among others, in the estimation of the first-step probit regressions I included the following covariates: (i) the ratio of the current account deficit to GDP lagged one, two, and three periods. It is expected that, with other things equal, countries with a larger current account deficit will have a higher probability of experiencing a reversal. The best results were obtained when the one-year deficit was included. (ii) The one-year lagged external debt over GDP ratio. Its coefficient is expected to be positive in the estimation of the first-step probit equation (6). (iii) The ratio of net international reserves to GDP, lagged one year. Its coefficient is expected to be negative, indicating that with other things equal, countries with a higher stock of reserves have a lower probability of experiencing a current account reversal. (iv) Short term (less than one year maturity) external debt as a proportion of external debt lagged one period. Its coefficient is expected to be positive. (v) The one-year lagged rate of growth of domestic credit. Its coefficient is expected to be positive. (vi) The lagged ratio of external debt service to exports. Again, its coefficient is expected to be positive. (vii) Year dummies, and (viii) country-specific dummies. In some of the probit regressions I also included the ratio of FDI to GDP and the public sector deficit (both lagged). Their coefficients were not significant, however. Since these variables were available for a relatively smaller number of observations than the other variables, they were not included in the final specification of the probit equations (6).

Growth outcome equations. The dependent variable was real GDP growth obtained from the *World Development Indicators.* In specifying the growth equation I followed the by-now-standard empirical growth literature (Barro and Sala-ì-Martin, 1995; Barro, 1996). As is customary I included the following covariates: (i) the logarithm of initial GDP; its coefficient is expected to be negative and capture (conditional) convergence. (ii) The investment to GDP ratio; its coefficient is expected to be positive. (iii) The rate of growth of population, as a proxy for the rate of growth of labor. (iv) An openness index defined as the ratio of exports plus imports over GDP. As Sachs and Warner (1995) have argued, its coefficient is expected to be positive. (v) The ratio of government consumption to GDP, whose coefficient is expected to be negative (Barro and Sala-ì-Martin, 1995). (vi) Year dummies, and (vii) country specific dummies.[43]

In addition to the covariates discussed above, the outcome growth equation also includes the two variables of interest: the current account reversal dummy, and the current account reversal dummy interacted with the openness variable. If current account reversals have a negative impact on economic activity, beyond their effects on investment, we would expect the coefficient of the reversals'

[43]These country specific dummies capture the effect of structural variables that do not change (significantly) through time.

dummy to be significantly negative in the estimation of equation (4). Moreover, if this effect is inversely proportional to the country's degree of openness, the coefficient of the interaction between reversals and openness should be significantly positive.

Main results

In Table 12 I summarize the basic results obtained from the estimation of number of treatment models for GDP growth (the coefficients of the time-specific and country specific dummy variables are not reported due to space considerations). The table contains two panels. The upper panel includes the results from the growth outcome equation; the lower panel contains the estimates for the "treatment equation," or probit equation on the probability of experiencing a current account reversal. As pointed out above, the treatment observations correspond to current account reversal episodes, and the untreated group is comprised of all country-year observations were there have been no reversals. Table 12 also includes the estimated coefficient of the hazard variable in the second step estimation, as well as the estimated elements of the variance-covariance matrix (7). The first two equations in the table include current values of the reversal dummy and of the interactive variable. The last two equations also include lagged values for these variables. Due to space considerations I only report the results for the *Reversal A* definition of current account reversals; those for the alternative *Reversal B* definition are similar.

Probability of experiencing a current account reversal. The probit estimates are presented in the lower panel of Table 12. As may be seen, the results are similar across models and are quite satisfactory. All of the coefficients have the expected signs, and are statistically significant at conventional levels. These results indicate that the probability of experiencing a reversal is higher for countries with a large (lagged) current account deficit, a high external debt ratio, and a rapid rate of growth of domestic credit. Countries that have a higher level of net international reserves have a lower probability of experiencing a reversal. The coefficients of the short-term debt and total debt service have the expected signs, but tend not to be significant.

GDP growth models. The results from the estimation of the growth equation are reported in Panel A of Table 12. The first equation (12.1) includes the current account reversal dummy, but does not include a term that interacts the reversals dummy with openness. The second equation (12.2) includes the interactive term. Equations (12.3) and (12.4) include lagged terms of the reversal dummy and of the reversal-openness interactive term. As the Table shows, the lagged values were not significant. Thus, in the discussion that follows I concentrate on equations (12.1) and (12.2).

As may be seen, the growth equation results presented in Table 12 are interesting: The traditional covariates have the expected signs, and with the exception of *openness* they are significant at conventional levels. More important for the topic of this paper, in equation (12.2) the coefficients of the current account

Table 12. Growth and Current Account Reversals
(Treatment effects model—two-step estimates)

Variable	(12.1)	(12.2)	(12.3)	(12.4)
		Panel A		
Population growth rate	0.299	0.294	0.241	0.274
	(1.64)	(1.59)	(1.32)	(1.48)
Investment to GDP	0.176	0.168	0.189	0.173
	(6.98)**	(6.58)**	(7.35)**	(6.68)**
Government consumption to GDP	–0.162	–0.146	–0.172	–0.170
	(4.81)**	(4.28)**	(4.95)**	(4.84)**
Openness	0.006	0.002	–0.006	–0.007
	(0.57)	(0.24)	(0.60)	(0.70)
Log initial GDP per capita	–2.688	–2.733	–2.542	–2.472
	(2.73)**	(2.72)**	(2.59)**	(2.48)*
Reversal A	–1.82	–4.32	–1.714	–3.931
	(2.59)**	(4.11)**	(2.44)*	(3.73)**
*Reversal A** Openness		0.028		0.028
		(3.12)**		(3.03)**
Reversal A (–1)			0.253	–0.033
			(1.01)	(0.04)
Reversal A (–1)* Openness (–1)				0.007
				(0.77)
		Panel B		
Current account deficit to GDP (–1)	0.128	0.128	0.131	0.131
	(12.01)**	(12.01)**	(11.92)**	(11.94)**
External debt to GDP (–1)	0.004	0.005	0.006	0.006
	(2.82)**	(2.95)**	(3.52)**	(3.54)**
Net int. reserves to GDP (–1)	–14.26	–15.07	–14.16	–14.25
	(1.83)	(1.97)*	(1.82)	(1.83)
Short term ext. debt to exports (–1)	0.003	0.003	0.003	0.003
	(0.50)	(0.43)	(0.45)	(0.43)
Domestic credit growth (–1)	0.0002	0.0002	0.0001	0.0002
	(1.45)	(1.42)	(1.53)	(1.53)
External debt service / exports (–1)	0.002			
	(0.45)			
Hazard lambda	0.917	1.122	0.865	0.906
	(2.07)*	(2.48)*	(1.96)*	(2.01)*
rho	0.214	0.256	0.203	0.209
sigma	4.282	4.377	4.268	4.325
Wald χ^2 (215)	637.24	683.31	650.12	638.34
Observations	1540	1544	1504	1502

Notes: Absolute value of *z*-statistics in parentheses; *significant at 5 percent; **significant at 1 percent; (–1) denotes a one-period lagged variable; country-specific and year dummies are included, but not reported.

reversal dummy is always significantly negative and the coefficients of the term that interacts openness and reversals is significantly positive. According to these results, the effects of reversals on growth depend significantly on the degree of openness of the economy—measured as the ratio of imports plus exports to GDP—and may be expressed as follows:

$$\textit{Growth Effects of Reversals} = -4.323 + 0.028\ \textit{openness}. \tag{9}$$

The variable *openness* in the data set varies significantly across countries. Its mean for the complete period is 64 percent, its standard deviation is 35 percent, and its median is 57.4 percent. The first quartile is 29.3 percent, and the third quartile is 84.5 percent. This means that for a country with a degree of openness equal to the mean, the point estimate of the effect of a current account reversal on growth is: −2.531 percent ($-4.323 + 0.028 \times 64 = -2.531$). If the country's degree of openness is equal to the first quartile, the (negative) effect of a reversal on growth is significantly higher at −3.50 percent. But if the country is very open to international trade, and its degree of openness corresponds to the third quartile, the effect of a reversal on growth is much smaller, at −1.96 percent. To make the point more vividly, consider the case of two neighboring countries in Latin America: Argentina and Chile. While Argentina is relatively closed—the average value for *openness* variable in the 1995–2001 period is 20 percent—Chile is quite open, with an average for the openness variable of 60 percent during the same period. This implies that a reversal in Argentina will tend to have a negative effect on growth equal to −3.763 percent; in Chile, on the other hand, the effect of the reversal on growth would only be −2.64.

In the rest of this section I report results from a number of extensions to the analysis presented in Table 12. In particular I analyze three issues: (i) whether the effects of reversals on growth depend on the level of external debt of the country in question; (ii) if reversals affect GDP growth differently in countries with different exchange rate regimes; and (iii) whether the reduction in growth depends on the actual magnitude of the reversal.

Dollarization and Current Account Reversals

As pointed out above, many recent discussions on macroeconomic instability in the emerging economies have centered on the role of dollarized liabilities. According to a number of authors countries with a high level of dollarized liabilities will be severely affected by reversals.[44] The argument is based on the notion that reversals tend to result (or be associated) with large exchange rate changes. To the extent that the real exchange rate indeed depreciates, the ratio of foreign currency denominated debt to GDP will increase massively, forcing the country to

[44]Strictly speaking this argument has been made in terms of sudden stops. As I argued above, sudden stops and reversals are distinctly different phenomena. The analysis in this section is in terms of reversals. On dollarization and the Argentine crisis see Calvo and others (2003). On a general discussion on the extent of dollarization in Latin America see Savastano (1992).

implement a deep(er) and costly adjustment. In order to investigate whether this conjecture is supported by the data I estimated systems of the type of (4)–(7) where in addition to the regressors described above, I also included the reversals dummy interacted with the country's total external debt (both public and private) denominated in foreign currency. Since (most) advanced countries are able to issue debt denominated in their own currency they are excluded from the analysis. If countries with higher dollarized liabilities suffer more from a reversal we would expect the coefficient of the interactive term to be significantly negative. However, the results from these regressions (not reported here due to space considerations, but available on request) indicate that the interactive term is positive (rather than negative) and not significant at conventional levels. This result was maintained when alternative estimation methods and different samples were used.

There are several possible explanation for these results, including that total external debt is not the best indicator of the extent of dollarized liabilities; that the channels through which the presence of dollarized liabilities affect growth are complex, and not captured by a model such as the one estimated in this paper; and that what matters is the extent of currency mismatches in the financial sector, rather that the actual extent of dollarization.

In order to further investigate this issue I included a variable that interacted *Reversals* with the ratio of foreign debt to the sum of imports and exports.[45] This interactive variable would be high in countries with a high external debt to GDP and/or a low degree of openness. If the presence of dollarized liabilities and the lack of openness jointly amplify the costs of reversals, we would expect the estimated coefficient of this interactive variable to be significantly negative. This, however, was not the case. Its estimated coefficient was 0.023 with a z-test statistic of 0.23.

Unfortunately, there are no data for a large panel of countries on the extent of dollarization of the financial sector. It is possible, however, to use a more limited data set—both in terms of years and countries' coverage—to further investigate this issue. I use the data set recently assembled by Reinhart, Rogoff, and Savastano (2003b), which covers 117 countries for the period 1996–2001. As before, the results obtained from this analysis did not provide support to the hypothesis that current account reversals result in higher real costs in countries with a greater degree of dollarization (detailed results available on request).[46]

The results reported above refer to whether the extent of dollarization affects the costs associated with current account reversals. An alternative question, and one that is also important in the current policy debate is whether countries with a higher degree of dollarization have a higher probability of experiencing a current account reversal, or a sudden stop for that matter. This would indeed be the case

[45]Of course, this is equivalent to a ratio of two ratios: (i) the foreign debt to GDP ratio, relative to (ii) the imports plus exports to GDP ratio (openness).

[46]In investigating this issue I used three procedures. First, I included in the estimation of the treatment equations a term that interacts Reinhart and others (2003b) composite index of dollarization with the reversal dummy. Second, I split the sample according to their classification of very high, high, moderate, and low degree of dollarization. And third, I split the sample according to the authors' four types of dollarization. In neither of these cases did I find support for the hypothesis that dollarization amplifies the effects of current account reversals.

if countries with dollarized financial systems are particularly vulnerable to external shocks (Calvo, Izquierdo, and Mejia, 2003). In order to investigate this issue I reestimated the propensity probit equation on the probability of experiencing a reversal with Reinhart and others (2003b) dollarization index as an additional regressor. The following results were obtained (z-statistic in parenthesis; time and country specific fixed effects not reported):

$$\delta_{jt} = \underset{(8.52)}{0.146}\ \textit{Current Account} + \underset{(4.72)}{0.214}\ \textit{dollarization} + \underset{(2.18)}{0.005}\ \textit{external debt}$$

$$\underset{(-0.91)}{-0.116}\ \textit{reserves} + \underset{(0.94)}{0.001}\ \textit{credit growth}$$

$$N = 892$$

All in all, I consider these results to be preliminary in nature. I believe that further research on the subject is required to come to a firmer conclusion on the effect of dollarization on the adjustment process. This additional research should include an effort to increase the coverage of the dollarization variables, both in terms of time-span as well as in terms of countries. Indeed, the fact that the best measure available—calculated by Reinhart, Rogoff, and Savastano (2003b)—covers only 1996–2001 means that the regression analysis reported above was undertaken on a limited number of observations.[47]

Exchange Regimes and Current Account Reversals

A number of recent policy discussions on the future of the international financial architecture have focused on the role of alternative exchange regimes in helping countries cope better with the vicissitudes of the international economy. In this section I investigate whether current account reversals have a different real effect on growth in countries with different exchange rate regimes. In particular, I analyze whether, as supporters of flexibility have argued, countries with flexible exchange rates have a greater capacity to absorb external shocks. If this were the case we would expect that the real costs of current account reversals would be smaller in countries with flexible regimes than in those with more rigid one.

I use the exchange rate regime classification devised by Levy-Yeyati and Sturzenegger (2003), that considers the *actual* rather than the *official* regime for each individual country at a particular moment in time.[48] Countries are classified into four regimes:

- ***Hard pegs*** (*Hard*): This group includes counties with currency boards, members of currency unions, and dollarized countries.

[47]In fact, when I used the Reinhart and others (2003b) dollarization index on the complete sample, the results were encouraging, and suggested that dollarized liabilities may indeed amplify the costs of reversals. Naturally, this conclusion is only valid to the extent that the 1996–2001 index also captures the extent of dollarization during the longer period. At this point, however, I am not prepared to make that claim.

[48]See also Reinhart and Rogoff (2002).

- ***Pegged regimes*** (*Peg*): This definition includes all alternative versions of pegged regimes, including pegged-but-adjustable. It also includes the hard regimes described above.
- ***Intermediate regimes*** (*Intermediate*): This group includes crawling pegs, managed floats, and other forms of intermediate regimes.
- ***Flexible rates:*** (*Flexible*): This group includes countries with flexible exchange rates, including free floating.

I proceeded as follows: For each of the four regimes I estimated treatment regression systems of the type (4)–(7). I then compared the estimates of both the reversals treatment dummy, as well as the term that interacts reversals and openness. Formal χ^2 tests for the equality of coefficients across regimes were then performed. If more flexible regimes act as shock absorbers, as their supporters have argued, we would expect that their coefficient of reversals would be smaller, in absolute value, than that of the more rigid exchange rate arrangements. In the actual estimation countries were classified according to the regime they had the year before the reversal was initiated. This was done as a way of dealing with countries that switched regimes during the sample period, and to properly classify those countries that as a consequence of—or in conjunction with—the reversal moved from one regime to a different one.

The results obtained are presented in Table 13, where I only report the estimates for the *Reversal A* dummy and for the interactive term. As may be seen, the point estimates for the *Reversal A* dummy are significantly negative for *Hard, Pegged,* and *Intermediate* exchange rate regimes. Moreover the point estimate of this dummy strictly declines (in absolute value) as the exchange rate regime becomes more flexible. As may be seen, its estimated coefficient for the *Flexible* regime group is not significantly different from zero, suggesting that while reversals are indeed costly (in terms of reduced GDP growth) under rigid and semi-rigid

Table 13. Exchange Rate Regimes and Current Account Reversals: Selected Estimated Coefficients*
(Treatment regressions)

Exchange rate regime	*Reversal A* dummy	Interactive term (*Reversal A* * openness)
Hard Peg	–9.114	0.075
	(–2.61)	(3.20)
Pegged	–6.770	0.053
	(–4.48)	(4.15)
Intermediate	–4.710	0.027
	(–2.79)	(1.71)
Flexible	2.060	–0.025
	(1.07)	(–1.05)

Note: Each equation was specified as explained in the text.
*Numbers in parentheses are *z*-statistics.

regimes, they are not significantly so in countries with exchange rate flexibility. A formal χ^2 test on the equality of these coefficients across different regimes' equations indicates that the null hypotheses is rejected: the χ^2 had a value of 21.1 for the *Reversal A* dummies, and 17.9 for the interactive terms.

Since, as the results in Table 13 indicate, the point estimates of the interactive term also vary across regimes, the actual effect of reversals on growth should be compared for given degrees of openness. The results indicate that for a variety of degrees of openness—up to 100 percent of GDP—the costs, in terms of a decline in GDP growth, of current account reversals has been higher in countries with more rigid exchange rate regimes, than in countries with more flexible ones.

Magnitude of the Reversals

The empirical results presented in this section has focused on current account reversals as a phenomenon that can be analyzed using a treatment-based analysis, where reversal events are captured by a "treatment" dummy variable. A potential limitation of this analysis is that it does not consider the actual magnitude of the reversal, and considers that a reversal of 5 percent of GDP is equal to one of 8 percent of GDP. In order to deal with this issue I estimated a number of treatment regressions systems that included terms that interacts the reversal dummy with the actual magnitude of the reversal. To the extent that the magnitude of the reversals matters—with higher reversals being more costly—the coefficient of this interacted term should be significantly negative. The results obtained from this analysis indicate that the estimated coefficient was indeed negative, with a point estimate of –0.015. However, it was not significant (z-statistic equal to –0.21), indicating that once reversals reach a certain level, their effects on growth are similar.

IV. Concluding Remarks

In this paper I have analyzed the anatomy of current account imbalances in the world economy during the past three decades. The analysis proceeded from a general picture of the distribution of deficits and surpluses, to a detailed investigation of the most important characteristics of major current account adjustments. The approach followed has been a combination of graphical displays, tabulation tables, nonparametric tests, and treatment effects regressions. I believe that by combining these different tools, I have been able to convey a clear and broad picture of the main characteristics of the adjustment process.

The main findings of the analysis of the anatomy of current account imbalances may be summarized as follows: (i) throughout the sample period the vast majority of countries have run current account deficits. Only in three regions has the median of current account balances been a surplus—industrial countries, the Middle East, and Asia—and in all of them this surplus has been small. (ii) *Large* current account deficits have not had a significant degree of persistence through time. Only a few countries have run persistently large deficits. (iii) The degree of persistence of *large surpluses* has been higher. A larger number of countries have run persistently large surpluses, indicating that under the current "rules of the

game" the nature of the adjustment process is asymmetrical. (iv) Major reversals in current account deficits have tended to be persistent through time, and strongly associated with sudden stops of capital inflows. (v) There is a high probability that reversals lead to an exchange rate crisis; the evidence also indicates that countries that try to face reversals by running down reserves significantly usually do not succeed. (vi) There has been no statistically significant relationship between reversals and banking crises. (vii) Within a three-year window there has been no statistically significant relation between reversals and IMF programs.

The main results from the econometric analysis of the probability of countries experiencing a reversal, and of their effects on real economic activity may be summarized as follows. (i) The probability of a country experiencing a reversal is appropriately captured by a small number of variables that include the (lagged) current account to GDP ratio, the external debt to GDP ratio, the level of international reserves, domestic credit creation, and debt services. (ii) Current account reversals have had a negative effect on real growth that goes beyond their direct effect on investments. (iii) There is persuasive evidence indicating that the negative effect of current account reversals on growth will depend on the country's degree of openness. More open countries will suffer less—in terms of lower growth—than countries with a lower degree of openness. (iv) I was unable to find evidence supporting the hypothesis that countries with a higher degree of dollarization are more severely affected by current account reversals than countries with a lower degree of dollarization. And, (v) the empirical analysis suggests that countries with more flexible exchange rate regimes are able to accommodate the shocks stemming from a reversal better than countries with more rigid exchange rate regime.

APPENDIX

Table A.1. List of Countries by Region

		Industrial countries		
Australia	Finland	Ireland	New Zealand	Switzerland
Austria	France	Italy	Norway	United Kingdom
Belgium	Germany	Japan	Portugal	United States
Canada	Greece	Malta	Spain	
Denmark	Iceland	Netherlands	Sweden	
		Latin America and Caribbean		
Antigua and Barbuda	Brazil	El Salvador	Mexico	St. Vincent and the Grenadines
Argentina	Chile	Grenada	Nicaragua	Suriname
Aruba	Colombia	Guatemala	Panama	Trinidad and Tobago
Bahamas, The	Costa Rica	Guyana	Paraguay	Uruguay
Barbados	Dominica	Haiti	Peru	República Bolivariana de Venezuela
Belize	Dominican Republic	Honduras	St. Kitts and Nevis	
Bolivia	Ecuador	Jamaica	St. Lucia	
		Asia		
Bangladesh	Hong Kong SAR	Lao P.D.R.	Pakistan	Solomon Islands
Bhutan	India	Malaysia	Papua New Guinea	Sri Lanka
Cambodia	Indonesia	Maldives	Philippines	Thailand
China	Kiribati	Nepal	Singapore	Vietnam
Fiji				
		Africa		
Angola	Comoros	Guinea-Bissau	Mozambique	Sudan
Benin	Congo, Rep. of	Kenya	Namibia	Swaziland
Botswana	Côte d'Ivoire	Lesotho	Niger	Tanzania
Burkina Faso	Djibouti	Madagascar	Nigeria	Togo
Burundi	Ethiopia	Malawi	Rwanda	Tonga
Cameroon	Gabon	Mali	Senegal	Tunisia
Cape Verde	Gambia, The	Mauritania	Seychelles	Uganda
Central African Republic	Ghana	Mauritius	Sierra Leone	Zimbabwe
Chad	Guinea	Morocco	South Africa	
		Middle East		
Bahrain	Iran, I.R. of	Kuwait	Oman	Syrian Arab Republic
Cyprus[1]	Israel	Lebanon	Saudi Arabia	Yemen
Egypt	Jordan			
		Eastern Europe		
Albania	Czech Republic	Latvia	Romania	Turkmenistan
Armenia	Estonia	Lithuania	Russian Federation	Ukraine
Azerbaijan	Hungary	Moldova	Slovak Republic	Uzbekistan
Belarus	Kazakhstan	Mongolia	Slovenia	
Bulgaria	Kyrgyz Republic	Poland	Turkey	

[1]Although Cyprus is considered a European country by the IMF, the author has listed it under Middle East in an effort to present more accurately the country's current level of economic development.

Table A.2. Mean Current Account to GDP Ratios by Region, 1970–2001

Year	Industrial	Latin America	Asia	Africa	Middle East	Eastern Europe	Total
1970	−0.05	7.52	0.26	0.90	6.67	…	2.62
1971	−0.28	5.53	0.64	5.25	2.23	…	2.05
1972	−1.50	3.78	2.43	6.20	−3.40	…	0.75
1973	−1.17	3.33	1.35	7.20	0.23	…	1.13
1974	2.97	3.26	4.56	−3.07	−8.04	1.50	0.44
1975	1.47	2.36	5.44	4.35	−8.62	3.50	2.17
1976	2.16	1.48	0.25	5.55	−9.78	3.80	1.46
1977	1.82	4.05	−0.74	3.88	−5.25	5.19	2.09
1978	0.50	3.70	1.85	8.53	0.80	1.90	4.23
1979	1.40	4.51	−1.57	6.44	−8.16	1.50	2.76
1980	2.16	7.05	7.74	7.21	−9.02	0.10	4.92
1981	2.39	10.05	11.64	10.00	−8.00	1.05	7.35
1982	2.36	9.10	11.01	11.01	−1.68	0.97	7.82
1983	1.20	6.33	8.44	8.25	1.63	1.26	5.91
1984	0.98	4.14	3.69	5.88	1.34	0.15	3.78
1985	1.15	2.72	5.32	5.90	1.45	1.60	3.79
1986	0.96	5.44	4.02	6.28	1.30	3.09	4.41
1987	1.03	5.36	3.25	4.75	0.48	0.08	3.59
1988	0.91	4.42	2.73	6.01	−0.10	−1.30	3.63
1989	1.18	5.35	3.82	4.52	−4.36	0.04	3.21
1990	1.18	4.25	4.31	4.39	−4.13	3.00	3.04
1991	0.67	7.29	2.48	5.08	28.84	2.67	6.24
1992	0.43	5.55	3.25	6.34	9.29	0.10	4.45
1993	−0.46	6.01	4.94	6.58	8.13	1.98	4.71
1994	−0.35	4.36	2.52	6.77	2.87	1.08	3.52
1995	−0.85	4.83	3.31	8.84	1.39	2.90	4.30
1996	−0.78	6.12	3.42	8.71	0.32	7.09	5.09
1997	−1.18	7.34	4.00	4.80	−0.09	6.97	4.20
1998	−0.33	7.22	−0.63	6.71	6.16	9.66	5.12
1999	−0.13	4.81	−2.99	5.16	−2.40	6.14	2.76
2000	−0.57	2.76	−3.77	4.23	−9.22	2.66	0.84
2001	−0.45	3.32	−3.51	5.95	−4.16	3.31	1.98
Total	0.62	5.36	3.19	6.34	−0.04	3.87	3.96

Table A.3. Median Current Account to GDP Ratios by Region, 1970–2001

Year	Industrial	Latin America	Asia	Africa	Middle East	Eastern Europe	Total
1970	–0.40	4.10	0.90	0.90	5.90	…	0.90
1971	–0.50	4.60	1.00	5.25	7.25	…	1.05
1972	–1.00	1.45	1.55	6.20	1.25	…	0.40
1973	0.15	1.05	0.70	7.20	2.25	…	0.85
1974	2.90	4.00	3.00	2.40	–0.80	1.50	2.90
1975	1.35	4.10	3.65	6.50	–3.80	3.50	3.30
1976	2.65	1.40	0.20	5.05	–3.20	3.80	3.30
1977	2.05	3.95	–0.70	4.10	–1.65	5.20	2.80
1978	0.65	3.95	2.55	9.90	3.00	1.90	3.50
1979	0.70	4.70	2.70	6.40	–8.90	1.50	3.20
1980	2.30	5.55	4.80	8.40	–3.95	0.10	4.35
1981	2.70	9.05	8.55	10.00	1.45	1.05	6.85
1982	1.95	7.60	7.80	9.50	–1.55	1.50	6.55
1983	0.90	4.70	7.30	6.40	5.10	0.90	4.30
1984	0.25	3.30	2.10	4.10	4.90	0.65	2.50
1985	1.00	2.10	3.85	4.20	2.60	1.70	2.95
1986	–0.10	3.00	2.40	3.60	2.30	3.30	2.85
1987	0.40	4.15	1.70	5.00	2.45	0.90	2.60
1988	1.15	2.25	2.75	6.00	1.55	1.30	2.60
1989	1.50	4.40	3.45	3.65	–0.50	1.70	2.80
1990	1.40	2.80	4.45	3.80	–1.00	3.65	2.80
1991	0.90	4.80	3.20	3.70	10.10	0.70	3.10
1992	0.80	4.40	2.00	5.80	9.30	–0.10	3.25
1993	0.50	4.70	4.50	6.60	7.15	1.95	3.45
1994	–0.40	3.50	4.60	5.70	4.70	1.60	2.90
1995	–0.75	3.20	4.65	5.50	0.60	1.85	2.70
1996	–0.95	4.60	3.90	4.60	–0.35	5.40	3.65
1997	–0.65	4.90	4.10	5.20	–0.20	6.20	3.60
1998	0.20	4.90	0.70	5.60	3.30	7.00	3.80
1999	–0.50	3.60	–1.60	4.15	–0.30	4.30	2.70
2000	0.50	3.40	–1.75	3.30	–7.30	4.20	2.80
2001	–0.05	3.30	–2.60	3.95	–4.80	4.60	2.10
Total	0.70	4.10	2.70	5.30	1.40	3.00	3.10

Table A.4. Third Quartile Current Account to GDP Ratios by Region, 1970–2001

Year	Industrial	Latin America	Asia	Africa	Middle East	Eastern Europe	Total
1970	0.60	6.90	1.30	1.90	11.50	…	4.10
1971	0.40	7.80	1.70	8.30	9.30	…	5.70
1972	0.30	2.40	3.60	12.00	4.15	…	2.50
1973	1.30	4.10	1.30	10.00	5.75	…	2.90
1974	4.40	10.00	5.60	4.60	12.40	1.50	5.30
1975	4.40	6.80	9.40	8.40	14.80	3.50	7.60
1976	4.30	4.00	6.20	8.35	3.30	3.80	5.40
1977	3.60	7.30	4.15	7.70	2.60	5.20	5.90
1978	2.50	7.60	3.85	12.40	9.20	1.90	8.90
1979	2.70	6.70	5.80	12.30	5.30	1.50	7.10
1980	3.60	11.60	10.90	13.00	2.60	5.00	10.50
1981	4.30	13.45	13.00	12.90	5.90	2.70	12.20
1982	4.00	11.75	13.10	13.70	8.30	2.30	10.70
1983	2.40	7.45	11.00	12.40	7.70	3.10	8.10
1984	3.00	6.60	4.95	8.80	8.20	1.95	6.35
1985	3.60	6.40	6.65	8.40	7.50	2.05	6.60
1986	3.30	7.80	5.70	8.20	9.40	5.20	6.40
1987	3.20	8.75	5.60	9.65	5.40	2.50	6.30
1988	3.00	7.65	5.80	9.75	4.10	1.70	6.60
1989	3.60	7.10	7.90	7.25	5.20	2.00	5.70
1990	3.40	7.65	6.85	9.00	2.15	8.30	6.40
1991	2.80	12.40	6.75	9.60	20.00	3.50	7.70
1992	2.70	8.00	4.70	8.90	17.20	3.50	7.10
1993	1.70	8.90	7.90	8.30	13.00	4.20	7.90
1994	1.70	7.30	6.20	9.20	6.70	3.70	6.30
1995	1.15	5.50	7.95	11.20	5.05	5.65	7.10
1996	1.85	7.80	7.50	10.40	4.20	9.20	8.10
1997	2.10	10.50	8.10	7.85	2.10	10.80	7.20
1998	2.50	8.90	5.40	10.15	12.35	11.30	8.90
1999	2.80	5.60	2.10	10.75	1.90	8.00	5.90
2000	3.10	5.20	0.60	8.50	1.20	5.90	5.50
2001	2.60	4.65	1.70	8.30	0.00	6.60	4.80
Total	3.00	8.00	6.40	9.90	6.40	6.10	7.20

Table A.5. First Quartile Current Account to GDP Ratios by Region, 1970–2001

Year	Industrial	Latin America	Asia	Africa	Middle East	Eastern Europe	Total
1970	–0.70	2.80	0.10	–0.10	2.60	…	0.76
1971	–1.30	0.10	0.10	2.20	–4.85	…	0.08
1972	–1.70	0.60	–1.20	0.40	–10.95	…	–1.27
1973	–2.70	–0.20	–0.70	4.40	–5.30	…	0.28
1974	–0.10	2.80	0.90	–17.40	–10.90	1.50	–4.75
1975	–0.30	1.30	0.70	0.40	–30.80	3.50	–1.57
1976	0.75	–1.10	–3.40	3.05	–12.90	3.80	–0.39
1977	–0.10	0.40	–4.95	0.60	–12.80	5.20	–0.95
1978	–1.40	0.25	–0.35	4.20	0.70	1.90	1.26
1979	0.00	0.40	–4.40	0.00	–13.70	1.50	–1.58
1980	0.50	0.55	1.20	2.20	–15.80	–4.80	–0.93
1981	–0.40	5.35	2.70	5.40	–17.00	–0.60	1.50
1982	–1.00	5.00	3.40	4.70	–6.50	–0.90	2.08
1983	–0.40	1.70	0.90	3.40	–2.70	–0.20	1.12
1984	–0.80	1.20	0.50	0.10	–3.40	–1.65	–0.26
1985	–1.60	–0.50	1.95	1.10	–1.10	1.15	0.38
1986	–1.60	0.60	–0.15	0.60	0.60	1.00	0.22
1987	–1.00	1.25	0.20	0.45	0.20	–0.20	0.26
1988	0.10	0.50	–2.15	1.65	1.40	–1.80	0.07
1989	–0.20	0.70	0.25	0.95	–12.40	–0.90	–0.71
1990	–1.00	–1.65	2.15	0.90	–12.40	–1.10	–1.00
1991	–1.50	0.75	1.10	0.40	2.10	–1.20	0.25
1992	–2.00	–0.30	0.40	1.60	1.30	–0.90	0.15
1993	–3.10	0.60	1.30	1.80	–0.10	–0.95	0.27
1994	–2.80	0.20	0.30	0.30	–4.25	–2.00	–0.83
1995	–2.95	1.55	1.85	2.10	–4.05	0.15	0.48
1996	–3.55	1.60	0.40	1.30	–3.20	2.40	0.31
1997	–4.15	2.60	1.80	1.35	–1.35	2.50	0.84
1998	–3.20	2.40	–3.00	1.80	0.35	2.50	0.37
1999	–2.60	2.50	–7.10	0.25	–4.80	1.90	–1.15
2000	–2.90	3.00	–6.55	0.10	–22.40	2.80	–2.34
2001	–2.80	1.95	–6.75	0.05	–11.70	1.20	–1.93
Total	–1.45	1.22	–0.58	0.95	–6.75	0.56	–0.28

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A Gravity Model of Sovereign Lending: Trade, Default, and Credit

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One reason why countries service their external debts is the fear that default might lead to shrinkage of international trade. If so, then creditors should systematically lend more to countries with which they share closer trade links. We develop a simple theoretical model to capture this intuition, then test and corroborate this idea.
[JEL F15, F33]

While the age of gunboat diplomacy as a mechanism of credit enforcement has long passed, sovereign default is still an exceptional event. This stylized fact indicates that while the source of a sovereign default penalty is still controversial, sovereigns behave as if they consider default costly. Many models of sovereign debt in the literature (e.g., Bulow and Rogoff, 1989a, 1989b) introduce explicit default penalties to rationalize this fact. These sanctions are primarily considered to be methods of inhibiting trade. Bulow and Rogoff (1989a) discuss the difficulties countries would experience in their trade subsequent to default, including complications associated with avoiding seizure and the interruption of short-term trade credit.

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Nevertheless, there are a number of reasons why one might doubt the existence of default penalties. Bulow and Rogoff (1989b) themselves admit that it is unclear whether private creditors enjoy the ability to induce their governments to enforce claims on sovereign borrowers. Kletzer and Wright (2000) argue that most penalties in models of sovereign lending are not "renegotiation-proof." That is, Kletzer and Wright argue that both parties could do better subsequent to a full or partial sovereign default, if the creditor resists levying a destructive penalty from which (s)he would receive no immediate benefit. In brief, there is considerable uncertainty concerning the viability of penalties for sovereign default. Thus, empirical evidence regarding such penalties warrants attention.

Unfortunately, there are only a limited number of empirical studies concerning such penalties. Ozler (1993) provides evidence of positive, albeit small, premia charged to countries with default histories. Cline (1987) notes that Bolivia and Peru experienced interruptions in their flows of short-term trade credits subsequent to debt renegotiation. In a recent paper, Rose (2002) provides empirical support for the role of trade as a sovereign enforcement mechanism. His paper shows that sovereign Paris Club reschedulings are followed by economically and statistically significant reductions in international trade.

The evidence of Cline and Rose centers on the interruption of international trade as a mechanism for sovereign debt repayment. If one believes that the primary penalties for enforcing sovereign debt obligations are trade related, then creditors originating from nations with strong bilateral trade ties with a debtor nation should have a comparative advantage in lending to that nation.

In this short paper, we explore this idea. We first present a theoretical model of international lending where a debtor optimally chooses its borrowing from different creditors. These creditors are identical except that they are located in countries that differ by the strength of their bilateral trade ties with the debtor. We show that in equilibrium, the pattern of borrowing favors the creditor with higher bilateral trade volume with the debtor. We then test and corroborate this idea using an annual panel data set including bilateral trade and international banking claims from 20 creditor and 149 debtor countries from 1986 through 1999. Using instrumental variable (and other) techniques, we find a significantly positive effect of bilateral trade on bilateral lending patterns. That is, debtors tend to borrow more from creditors with whom they share more international trade ties.

While our empirical results support the trade sanction sovereign debt model derived in the paper, the evidence does not necessarily refute pure "reputation-based" models of sovereign debt in which the penalty for default is exclusion from access to future borrowing (e.g., Eaton and Gersovitz, 1981; Kletzer and Wright, 2000; or Wright, 2002), or with mixed models where some combination of direct sanctions and reputational penalties are applied, such as Kehoe and Levine (1993).[1] However, it appears that reconciling reputation-based models with the data without introducing new inconsistencies requires the introduction of some friction,

[1]While the Kehoe and Levine model allows for asset seizure, it does not consider interruptions of trade in spot markets, which might be considered analogous to the direct trade sanctions in our model below.

such as superior information sets to creditors from those countries engaged in greater bilateral trade.[2]

Our theoretical model is presented in the next section. We then present the data set and methodology and test the model. The paper ends with a brief summary.

I. A Model of Sovereign Borrowing with Trade-Related Default Penalties

In this section we develop a simple borrowing model in which a sovereign debtor allocates its borrowing across different creditor nations, when default penalties are based on proportional losses in bilateral gains from trade.

We assume that there are three countries: one borrower country, *i,* and two creditor countries, *a* and *b.* Let *r* represent one plus the world risk-free interest rate. All countries are assumed to be small and therefore take *r* as given. Lending banks in the creditor countries are risk-neutral and therefore willing to extend unlimited funds at levels consistent with an expected return equal to *r.*

The model has two periods. In the first period, the representative agent in lender country j ($j = a, b$) extends a loan of magnitude L_{ij} in return for the promise of a fixed payment D_{ij} in the second period. In the second period, the agent in debtor country i makes its default decisions. If the debtor chooses to service its country j debt it pays D_{ij}. If the debtor defaults, it suffers a penalty equal to a fraction θ of its gains from bilateral trade with country j, where $0 < \theta < 1$.

Bilateral gains from trade are exogenous and equal to γT_{ij}, where γ is a positive constant and T_{ij} is a random variable reflecting total trade between country i and country j in the second period. Expectations of T_{ij} are unbiased and satisfy

$$T_{ij} = E_1(T_{ij}) + \varepsilon_i, \tag{1}$$

where $E_1(T_{ij})$ represents the period one expected value of T_{ij} and ε_i is an i.i.d. disturbance term with expected value 0 and a symmetric and single-peaked distribution on the interval $\varepsilon_i \in [\underline{\varepsilon}, \bar{\varepsilon}]$. Let $F(\varepsilon)$ represent the distribution of ε, that is, the probability that $\varepsilon_i \leq \varepsilon$, and $f(\varepsilon)$ represent its density. The creditor nations are assumed to only differ in their expected trade volume with the debtor country, with $E_1(T_{ia}) > E_1(T_{ib})$.

The expected utility function of the representative agent in country i satisfies

$$E_1(U_i) = U(C_{i1}) + \beta E_1(C_{i2}), \tag{2}$$

where $U' > 0$, $U'' < 0$, C_{it} represents consumption in country i in period t ($t = 1,2$), and β represents the debtor's discount rate. The specification that debtor utility is linear in expected second-period consumption is made for analytic simplicity, but drives none of our results.

[2]See Wright's (2003) comments on our paper below. Wright argues that the assumption of superior information sets held by primary trading partners may give those partners comparative advantages in lending in pure reputation models with the additional assumption of continuous trade in goods to avoid the "excessive gross flows" problem.

Debtor income, Y_{it}, is exogenous in both periods. Debtor first-period consumption satisfies

$$C_{i1} = Y_{i1} + L_{ia} + L_{ib}. \tag{3}$$

Since no new funds are obtained in period 2, the debtor's default decision on debts from each creditor nation is based on maximizing expected second-period consumption. Conditional on service on its debt obligations to country *j,* debtor second-period consumption satisfies

$$C_{i2} = Y_{i2} + \gamma T_{ij} - D_{ij} - g(D_{ik}, \varepsilon_i), \tag{4}$$

where $j \neq k$ and $g\ (D_{ik}, \varepsilon_i)$ represents the gains from trade net of the cost of debt service on the debtor's country k debt obligations given that the debtor makes its utility-maximizing default decision on its obligations to that country.

Similarly, conditional on default on obligations to country *j,* debtor second-period consumption satisfies

$$C_{i2} = Y_{i2} + (1 - \theta)\gamma T_{ij} - g(D_{ik}, \varepsilon_i). \tag{5}$$

It follows that the debtor chooses to default on country j when $D_{ij} > \theta\gamma T_{ij}$.

Define ε_{ij}^* as the realization of ε_i that leaves the debtor indifferent between default and repayment. ε_{ij}^* satisfies

$$\varepsilon_{ij}^* = \frac{D_{ij}}{\theta\gamma} - E_1(T_{ij}). \tag{6}$$

Equilibrium in the model is defined as the pair of debt obligations (D_{ia}, D_{ib}) that maximize expected debtor utility subject to both creditors' zero-profit conditions. The creditors' zero profit conditions satisfy

$$D_{ij} = \frac{rL_{ij}}{1 - F\left(\varepsilon_{ij}^*\right)}, \tag{7}$$

where *j=a,b.*

Utility maximization for the debtor can be characterized in terms of two decisions, the overall borrowing level, L_i, and the allocation of debt across the two creditors, D_{ia} and D_{ib}. Consider first the allocation decision. Given total borrowing L_i, maximizing expected utility subject to the creditors' zero-profit conditions yields the first-order condition

$$\frac{L_{ia}}{L_{ib}} = \left[\frac{1 - F\left(\varepsilon_{ia}^*\right)}{1 - F\left(\varepsilon_{ib}^*\right)}\right]^2 \left(\frac{f\left(\varepsilon_{ib}^*\right)}{f\left(\varepsilon_{ia}^*\right)}\right). \tag{8}$$

Equation (8) demonstrates that the debtor skews its borrowing allocation toward the nation from which the impact of a marginal increase in borrowing on its probability of default is smaller. Since the creditors' risk premia are symmetric functions of default risk, equalizing the marginal cost of the last dollar borrowed in each country implies borrowing more from the country that would have a lower probability of default if borrowing levels were equal. Of course, doing so pushes up the probability of default in this country relative to the other, and narrows the difference between these probabilities.

This result implies that the optimal allocation of borrowing across countries mitigates the disparities in default risk across countries. This result fits well with historical experience, as countries typically default on all of their creditors simultaneously, or not at all. It should be stressed, however, that the result is an equilibrium outcome of the model, rather than simply assumed.[3]

Totally differentiating (8) with respect to L_{ia} and $E(T_{ia})$ yields

$$\frac{\partial L_{ia}}{\partial E(T_{ia})} = -\frac{r\left[E(T_{ia}) + \varepsilon_{ia}^*\right]\left\{\left[1 - F\left(\varepsilon_{ia}^*\right)\right]f'\left(\varepsilon_{ia}^*\right) + f\left(\varepsilon_{ia}^*\right)^2\right\}}{\dfrac{\partial^2 E(C_{i2})}{\partial L_{ia}^2}\left\{\left[1 - F\left(\varepsilon_{ia}^*\right)\right] - f\left(\varepsilon_{ia}^*\right)\left[E(T_{ia}) + \varepsilon_{ia}^*\right]\right\}^2} > 0, \tag{9}$$

where the denominator can be signed as negative by the debtor's second-order condition.

Equation (9) yields our first result. Holding total lending constant, the share of lending originating in country a is increasing in the expected volume of trade with country a.

We can now confront the debtor's overall borrowing decision. Maximizing expected utility in equation (2) over the choice of L_i subject to the creditors' zero-profit conditions and the debtor's optimal debt allocation rule yields the first-order condition

$$U' - \beta\left\{r + \theta\gamma\left\{\left[E(T_{ia}) + \varepsilon_{ia}^*\right]f\left(\varepsilon_{ia}^*\right)\frac{\partial \varepsilon_{ia}^*}{\partial L_{ia}}\right\}\right\} = 0, \tag{10}$$

where by (6) and (7), the partial term satisfies

$$\frac{d\varepsilon_{ia}^*}{dL_{ia}} = \frac{r}{\theta\gamma\left\{\left[1 - F\left(\varepsilon_{ia}^*\right)\right] - f\left(\varepsilon_{ia}^*\right)\left[E(T_{ia}) + \varepsilon_{ia}^*\right]\right\}} > 0. \tag{11}$$

Totally differentiating with respect to L_i and $E_1(T_{ia})$ yields

$$\frac{\partial \bar{L}}{\partial E(T_{ia})} = -\frac{\beta r\left[E(T_{ia}) + \varepsilon_{ia}^*\right]\left[f'\left(\varepsilon_{ia}^*\right)\left[1 - F\left(\varepsilon_{ia}^*\right)\right] + f\left(\varepsilon_{ia}^*\right)^2\right]}{\left[U'' + \beta\dfrac{\partial^2 E(C_{i2})}{\partial \bar{L}^2}\right]\left\{\left[1 - F\left(\varepsilon_{ia}^*\right)\right] - f\left(\varepsilon_{ia}^*\right)\left[E(T_{ia}) + \varepsilon_{ia}^*\right]\right\}^2} > 0, \tag{12}$$

[3]In the limiting case where the ε_{ij}'s are distributed uniformly, the equilibrium borrowing allocation results in the debtor defaulting on both creditors or none.

where the denominator can be signed as negative by the debtor's second-order condition.

Our results demonstrate that an increase in the expected volume of bilateral trade with an individual country is associated with both an increase in overall borrowing and an increase in the share of overall borrowing originating in that country. Consequently, the model predicts a positive correlation between expected bilateral trade volumes and bilateral lending. In the next section, we test this prediction.

II. Empirics

Gravity Methodology

We are interested in estimating the effect of international trade on international debt. However, international borrowing may itself encourage trade; alternatively, both borrowing and trade may be jointly driven by common factors. That is, it is important for us to consider the possibility that international borrowing and trade are simultaneously determined.

We solve this problem using instrumental variables. The popular "gravity" model of bilateral international trade provides a wealth of potential instrumental variables. Many variables that are known to be important determinants of international trade are unlikely to be important determinants of international lending patterns. For instance, a pair of landlocked countries engages in less international trade, while a pair of physically large countries or those that share a common land border trade more. But international lending patterns are unlikely to be affected by such features.[4] We use such variables as instrumental variables for trade in a model of bilateral lending.

Since conditions that lead two countries to be more integrated are likely to lead to more financial activity between them, our specification for bilateral international borrowing levels follows the gravity model of international trade closely:

$$\begin{aligned}\ln(C_{ijt}) = {} & \beta_1 \ln(Y_i Y_j)_t + \beta_2 \ln(Y_i Y_j / Pop_i Pop_j)_t + \beta_3 \ln D_{ij} + \beta_4 Lang_{ij} \\ & + \beta_5 Cont_{ij} + \beta_6 FTA_{ijt} + \beta_7 Landl_{ij} + \beta_8 Island_{ij} \\ & + \beta_9 \ln(Area_i Area_j) + \beta_{10} ComCol_{ij} + \beta_{11} CurCol_{ijt} \\ & + \beta_{12} Colony_{ij} + \beta_{13} ComNat_{ij} + \beta_{14} CU_{ijt} \\ & + \gamma_\tau \cdot T_\tau + \varphi \ln(X_{ijt}) + \varepsilon_{ijt}\end{aligned} \tag{13}$$

where i and j denotes countries, t denotes time, and the variables are defined as:

- C_{ijt} denotes the value of real lending from i to j at time t,
- X_{ijt} denotes the average value of real bilateral trade between i and j at time t,
- Y is real GDP,
- Pop is population,
- D is the distance between i and j,

[4]If bank lending reflects trade credits, coefficient estimates from our IV estimation may be biased upwards. As our estimated effect is large, however, it is unlikely that correction for this bias would eliminate our results.

- *Lang* is a binary variable that is unity if *i* and *j* have a common language,
- *Cont* is a binary variable that is unity if *i* and *j* share a land border,
- *FTA* is a binary variable that is unity if *i* and *j* belong to the same regional trade agreement,
- *Landl* is the number of landlocked countries in the country pair (0, 1, or 2).
- *Island* is the number of island nations in the pair (0, 1, or 2),
- *Area* is the land mass of the country,
- *ComCol* is a binary variable that is unity if *i* and *j* were ever colonies after 1945 with the same colonizer,
- *CurCol* is a binary variable that is unity if *i* and *j* are colonies at time *t,*
- *Colony* is a binary variable that is unity if *i* ever colonized *j* or vice versa,
- *ComNat* is a binary variable that is unity if *i* and *j* remained part of the same nation during the sample (e.g., the United Kingdom and Bermuda),
- *CU* is a binary variable that is unity if *i* and *j* use the same currency at time *t,*
- $T_{\tau t}$ is a comprehensive set of year-specific intercepts,
- β and γ are vectors of nuisance coefficients, and
- ε_{ij} represents the myriad other influences on bilateral credit, assumed to be well behaved.

The coefficient of interest to us is φ, the effect of bilateral trade between countries *i* and *j* on commercial bank claims by creditor country *j* on debtor nation *i.*

We estimate the model with a number of techniques below. We begin by using ordinary least squares (OLS) with standard errors that are robust to clustering (since pairs of countries are likely to be highly dependent across years). We then use instrumental variables, dropping some of the regressors from the right-hand side of the equation and using them as instrumental variables. Finally, we employ fixed- and random-effects panel data estimators, with and without instrumental variables. We use both fixed- and random-effects estimators extensively below.

The Data Set

We use a subset of the panel data set of Glick and Rose (2002); the interested reader is referred to Glick and Rose for more details.

For the regressand we use consolidated foreign claims of reporting banks on individual countries.[5] These bank loans are provided by the Bank for International Settlements (BIS) in millions of U.S. dollars for 20 creditor countries and almost 150 borrowing countries.[6] Not all of the areas covered are countries in the conventional sense of the word; we use the term "country" simply for convenience.

[5]Our measurement of cross-border obligations may contain errors from a number of sources. First, the use of consolidated data may not correctly assign the risk of banks' foreign branches. Second, "outward risk transfers" are sometimes used to transfer risks to residents of other countries, and our data set would not pick these up. Still, as these errors fall in the regressand of our model they only make the effect of trade harder to find and do not appear to introduce any bias issues.

[6]These data are available via the Internet at: *http://www.bis.org/publ/qcsv0206/hanx9b.csv* and are part of the International Banking Statistics published regularly in the *BIS Quarterly Review.* For technical reasons we usually ignore a few observations from Ireland and Spain; adding these makes little difference in general to our results.

Table 1. OLS Estimates of Effect of Trade on Claims

	φ
Default	0.54 (0.04)
Without controls	0.75 (0.02)
Levels	0.0001 (0.00003)
Levels without controls	0.0001 (0.00003)
1990	0.51 (0.05)
1995	0.53 (0.07)
Only industrial debtors	0.74 (0.04)

Equation estimated is $Claims_{i,j,t} = \varphi Trade_{i,j,t} + \beta X_{i,j,t} + \varepsilon_{i,j,t}$.
Robust standard errors (clustered by country-pairs) recorded in parentheses.
Intercepts and year effects not recorded.

(The creditor countries and debtor countries are listed in the appendix.) The data are provided semi-annually from 1986; we average the data to annual series by simple averaging. We convert nominal bank claims to a real series by deflating by the U.S. CPI (1982–1984 = 1). Almost half the claims are reported to be zero. This makes the log transformation potentially important and questionable; we investigate it further below.

The most important regressor is the level of international trade. We use bilateral trade flows taken from the IMF's *Direction of Trade Statistics* data set, deflated by the U.S. CPI.[7] To this we add population and real GDP data (in constant dollars).[8] We exploit the CIA's *World Factbook* for a number of country-specific variables. These include: latitude and longitude, land area, landlocked and island status, physically contiguous neighbors, language, colonizers, and dates of independence. We use these to create great-circle distance and our other controls. We obtain data from the World Trade Organization to create an indicator of regional trade agreements, and we include: EEC/EC/EU, US-Israel FTA, NAFTA, CACM, CARICOM, PATCRA, ANZCERTA, ASEAN, SPARTECA, and Mercosur. Finally, we add the Glick and Rose (2002) currency union dummy variable.

Descriptive statistics for the data set are tabulated in the appendix.

Results

We begin our investigation by estimating equation (12) with OLS. Our results appear in Table 1.

[7]Bilateral trade on FOB exports and CIF imports is recorded in U.S. dollars; we deflate trade by the U.S. CPI. We create an average value of bilateral trade between a pair of countries by averaging all of the four possible measures potentially available.

[8]Wherever possible, we use *World Development Indicators* (taken from the World Bank's *WDI 2000* CD-ROM) data. When the data are unavailable from the World Bank, we fill in missing observations with comparables from the Penn World Table Mark 5.6, and (when all else fails) from the IMF's *International Financial Statistics.* The series have been checked and corrected for errors.

Our default estimates include the entire set of regressors (i.e., all 14 coefficients are estimated, as well as the set of time-specific intercepts). In this specification, the estimate of the all-important φ coefficient is 0.54, with a robust standard error of 0.04. This elasticity is not only consistent with our theory, but is highly significant. With a *t*-statistic of over 15, the coefficient is different from zero at any reasonable level of statistical significance. The effect is also economically significant; an increase in trade of 1 percent is associated with an increase in bilateral lending of over 0.5 percent, all other things being equal. Of course, since there are capital flows above and beyond the bank lending that we consider (through, for example, stock and bond markets, as well as foreign direct investment), even this considerable elasticity should probably be considered a lower bound.

The rest of the table provides a series of robustness checks. For instance, the second row reports φ if the other controls are dropped from the equation (i.e., we set $\beta = \gamma = 0$); in this case, the effect is even more significant. Since many of the creditor countries have not extended loans to some of the debtor countries, many observations of the dependent variable are zero and are thus dropped from the equation estimated in natural logarithms. Therefore, the third and fourth rows of the table report comparable estimates of φ when both trade and bank claims are included in untransformed levels. Yet φ remains statistically significant when the key relationship is estimated in levels.[9]

The fifth and sixth rows of the table move away from panel data analysis to cover only cross sections for two years in the middle of the sample, 1990 and 1995. However, the results are essentially unchanged from the default specification. The seventh and final row includes only observations between industrial countries (i.e., those with IFS country codes less than 200). If anything, the results become mysteriously larger; they certainly remain positive and highly significant in both the economic and statistical senses.[10]

To summarize, the effect of international trade on bank claims seems positive, significant, and robust in simple OLS estimation. The question is whether this result stands up to greater econometric scrutiny.

III. Results

We now proceed to instrumental variables estimation. We use five instrumental variables for (the log of) trade: (the log of) distance between the countries; the land border dummy; the number of landlocked countries; the number of island nations; and the log of the product of the countries' area. We accordingly set the appropriate β coefficients to zero (i.e., drop them from the equation, leaving the remaining variables as controls). The estimates are tabulated in Table 2a.

Despite the use of instrumental variables that are both plausibly exogenous and correlated with trade, the key results do not change with IV estimation. The

[9]Box-Cox tests imply that the natural logarithmic transformation is quite reasonable, and that the level transformation is rejected in favor of the log transform.

[10]Though if we include only developing country borrowers, our estimate remains significant at 0.53 (standard error of 0.04).

Table 2a. IV Estimates of Effect of Trade on Claims, Geographic Instruments

	φ
Default	0.41 (0.07)
Without controls	0.50 (0.04)
Levels	0.00006 (0.00001)
Levels without controls	0.00007 (0.00002)
1990	0.52 (0.10)
1995	0.40 (0.10)
Only industrial debtors	1.03 (0.07)

Equation estimated is $Claims_{i,j,t} = \varphi Trade_{i,j,t} + \beta W_{i,j,t} + \varepsilon_{i,j,t}$.
Robust standard errors (clustered by country-pairs) recorded in parentheses.
Intercepts and year effects not recorded.
Instrumental variables for trade are: distance; land border; number landlocked; number of island nations; log of area.

Table 2b. IV Estimates of Effect of Trade on Claims, Excludable Instruments

	φ
Default	0.80 (0.40)
Without controls	0.83 (0.07)
Levels	0.00004 (0.00001)
Levels without controls	0.00005 (0.00001)
1990	0.59 (0.37)
1995	1.13 (0.49)
Only industrial debtors	0.79 (0.29)

Equation estimated is $Claims_{i,j,t} = \varphi Trade_{i,j,t} + \beta Z_{i,j,t} + \varepsilon_{i,j,t}$.
Robust standard errors (clustered by country-pairs) recorded in parentheses.
Intercepts and year effects not recorded.
Instrumental variables for trade are: common language; regional trade agreement; same nation.

default estimate is somewhat smaller, averaging perhaps 0.4. But it remains economically and statistically significant; it is also robust to a number of econometric perturbations.[11]

Table 2b reports sensitivity analysis with respect to the set of instrumental variables. Instead of the five geographic variables, we use three whose coefficients are usually insignificant in OLS estimates of equation (14): the common language dummy; the regional trade agreement dummy; and the same nation dummy. Again, the estimates of φ seem economically and statistically significant.[12]

[11]Again, if we include only developing country borrowers, our estimate remains significant at 0.38 (standard error of 0.08).

[12]If we use lags (e.g., of the GDP terms) as instrumental variables, our key result of a positive effect of trade on borrowing is not changed.

Table 3. IV Estimates of Effect of Trade on Claims, Controlling for Total Claims/Debt

Control	Total Claims	Total Debt
Default	0.40 (0.07)	0.42 (0.07)
Without controls	0.42 (0.04)	0.27 (0.04)
Levels	0.00005 (0.000004)	0.00006 (0.00002)
Levels without controls	0.00005 (0.000006)	0.00006 (0.00002)
1990	0.47 (0.10)	0.56 (0.09)
1995	0.37 (0.10)	0.42 (0.10)
Only industrial debtors	0.48 (0.23)	1.10 (0.20)
OLS	0.29 (0.03)	0.39 (0.02)

Equation estimated is $Claims_{i,j,t} = \varphi Trade_{i,j,t} + \beta W_{i,j,t} + \varepsilon_{i,j,t}$.
Robust standard errors (clustered by country-pairs) recorded in parentheses.
Intercepts and year effects not recorded.
Instrumental variables for trade are: distance; land border; number landlocked; number of island nations; log of area.

The middle column of Table 3 adds a control for the (log of the) total credit extended by the creditor country, as suggested by our theoretical analysis; the right-hand column controls for the (log of) total debt incurred by the debtor country. Again, the results remain economically and statistically significant.

Finally, Table 4 reports results when panel estimators are used instead of more traditional regressions. The middle columns report OLS fixed- and random-effects estimates of φ for a variety of different specifications. The former takes into account all country-pair factors that influence trade whether measured or not, and is thus an exceptionally good robustness check. The right-hand column reports instrumental variables estimates using a random effects estimator (the fixed-effect estimator is infeasible since the geographic variables are time-invariant). Yet despite all the econometric firepower, the estimate of φ remains significant; it has a *t*-statistic of almost 9 and an economically large effect.[13]

We conclude that our hypothesis that bank credit is extended across international borders along the lines of international trade is corroborated.

IV. Summary

It is plausible to believe that countries service their foreign debts at least in part to avoid the reduced trade that typically follows international default. If so, sovereign borrowers will enjoy superior credit terms from creditor countries for which this

[13]Lending may be motivated by servicing FDI, rather than the sovereign risk issues considered in the theory above. To test this, we add a control in the form of the natural logarithm of FDI sourced from the creditor country. We obtained the bilateral FDI data from the OECD's *International Direct Investments Yearbook 1980–2000.* This data set is annual and unavailable for many countries in our sample, containing only some 2,600 observations. When we add this control to our default IV regression (in logs, with controls) its coefficient is indeed positive and significant. Still, the log of trade retains an economically and statistically significant coefficient of 0.62 (with a robust standard error of 0.11).

Table 4. IV Estimates of Effect of Trade Level on Claims, Panel Estimators

Estimator	OLS, RE	OLS, FE	IV, RE
Default	0.31 (0.01)	0.19 (0.02)	0.52 (0.06)
Without controls	0.38 (0.01)	0.19 (0.01)	0.52 (0.03)
Levels	0.00003 (0.000001)	0.00002 (0.000001)	0.00006 (0.00001)
Levels without controls	0.00003 (0.000001)	0.00002 (0.000001)	0.00007 (0.000003)
Only industrial debtors	0.46 (0.06)	0.28 (0.07)	0.96 (0.19)

Equation estimated is $Claims_{i,j,t} = \varphi Trade_{i,j,t} + \beta W_{i,j,t} + \varepsilon_{i,j,t}$.
Robust standard errors (clustered by country-pairs) recorded in parentheses.
Intercepts and year effects not recorded.
Instrumental variables for trade are: distance; land border; number landlocked; number of island nations; log of area.

penalty is disproportionately high. In this paper we have provided a simple theoretical model that formalizes this intuition. We have also empirically investigated and confirmed the hypothesis that international trade patterns determine lending patterns.

In future work it would be interesting to extend this analysis to other forms of international lending, above and beyond bank loans. We think this is a good place to pass the torch to others.

APPENDIX
Descriptive Statistics

	Sample	Mean	Std. Dev.	Min	Max
Claims	31,787	561	3529	0	146061
Log real claims	19,769	3.69	2.53	−1.20	11.5
Log real trade	28,809	11.6	2.81	−0.55	20.3
Controls: Log distance	28,809	8.32	0.59	5.37	9.41
Log real GDP	25,126	49.6	2.50	42.3	58.0
Log real GDP per capita	25,102	17.3	1.07	14.1	21.1
Common land border	28,809	0.003	0.053	0	1
Common language	28,809	0.173	0.379	0	1
Log areas	28,809	23.8	3.25	12.20	32.3
Number landlocked	28,809	0.286	0.496	0	2
Number of islands	28,809	0.301	0.489	0	2
Regional trade agreement	31,787	0.009	0.094	0	1
Same nation	28,809	0.003	0.054	0	1
Colonial history	28,809	0.051	0.221	0	1
Current colony	28,809	0.003	0.057	0	1
Currency union	28,809	0.003	0.055	0	1

Creditor Countries with Claims Reported

United States	United Kingdom	Austria	Belgium
Denmark	France	Germany	Italy
Netherlands	Switzerland	Sweden	Canada
Japan	Finland	Greece	Iceland
Ireland	Malta	Portugal	Spain

Debtor Countries with Claims Reported

Afghanistan, Islamic State of	Ecuador	Madagascar
Albania	Egypt	Malawi
Algeria	El Salvador	Malaysia
Angola	Equatorial Guinea	Maldives
Argentina	Ethiopia	Mali
Australia	Falkland Islands	Malta
Bahamas, The	Fiji	Mauritania
Bahrain	French Polynesia	Mauritius
Bangladesh	Gabon	Mexico
Barbados	Gambia, The	Mongolia
Belize	Ghana	Morocco
Benin	Gibraltar	Mozambique
Bermuda	Greece	Myanmar
Bhutan	Grenada	Namibia
Bolivia	Guatemala	Nauru
Botswana	Guinea	Nepal
Brazil	Guinea-Bissau	Netherlands Antilles
Brunei Darussalam	Guyana	New Caledonia
Bulgaria	Haiti	New Zealand
Burkina Faso	Honduras	Nicaragua
Burundi	Hong Kong SAR	Niger
Cambodia	Hungary	Nigeria
Cameroon	Iceland	Oman
Cape Verde	India	Pakistan
Cayman Islands	Indonesia	Panama
Central African Republic	Iran, Islamic Republic of	Papua New Guinea
Chad	Iraq	Paraguay
Chile	Israel	Peru
China	Jamaica	Philippines
Colombia	Jordan	Poland
Comoros	Kenya	Portugal
Congo, Dem. Rep. of	Kiribati	Qatar
Congo, Rep. of	Korea, Rep. of	Romania
Costa Rica	Kuwait	Rwanda
Côte d'Ivoire	Laos	São Tomé and Príncipe
Cuba	Lebanon	Saudi Arabia
Cyprus	Lesotho	Senegal
Djibouti	Liberia	Seychelles
Dominica	Libya	Sierra Leone
Dominican Republic	Macau SAR	Singapore

Solomon Islands	Syrian Arab Republic	Uruguay
Somalia	Tanzania	Vanuatu
South Africa	Thailand	Venezuela, República Bolivariana de
Sri Lanka	Togo	Vietnam
St. Lucia	Tonga	Western Samoa
St. Vincent	Trinidad and Tobago	Yemen, Republic of
St. Helena	Tunisia	Yugoslavia, Federal Republic of
Sudan	Turkey	Zambia
Surinam	Uganda	Zimbabwe
Swaziland	United Arab Emirates	

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New Empirical Results on Default: A Discussion of "A Gravity Model of Sovereign Lending: Trade, Default and Credit"

MARK L.J. WRIGHT*

Sovereign default, while by no means ubiquitous, is still all too common. Moreover, as illustrated in Figure 1, sovereign debt *crises,* in which multiple debtor countries get into payments difficulties at roughly the same time, occur with surprising regularity. When this is combined with the fact that defaults appear to be very costly, to both the creditors who lose money on their investments and also to the defaulting country itself, it is natural that discussion turns to questions such as if and how the international financial system might be "reformed" to minimize the incidence and costs of these crises.

However, before policymakers can talk sensibly about "reforming the international financial architecture," it is necessary that they have a clear understanding of both the incentives faced by creditors and defaulting countries, and the ways in which institutions and governments affect these incentives. In this regard, economists have developed no shortage of interesting and clever *theories,* both formal and informal, of the incentives governing the default process. Much has been written about the incentives of defaulting countries to repay their debts, and about the punishments creditors can use to deter default, including the use of legal sanctions since the passage of the (U.S.) Foreign Sovereign Immunities Act in 1976, the loss of access to credit markets (the so-called "reputation" models of Eaton and Gersovitz, 1981, and many others), the loss of a country's reputation

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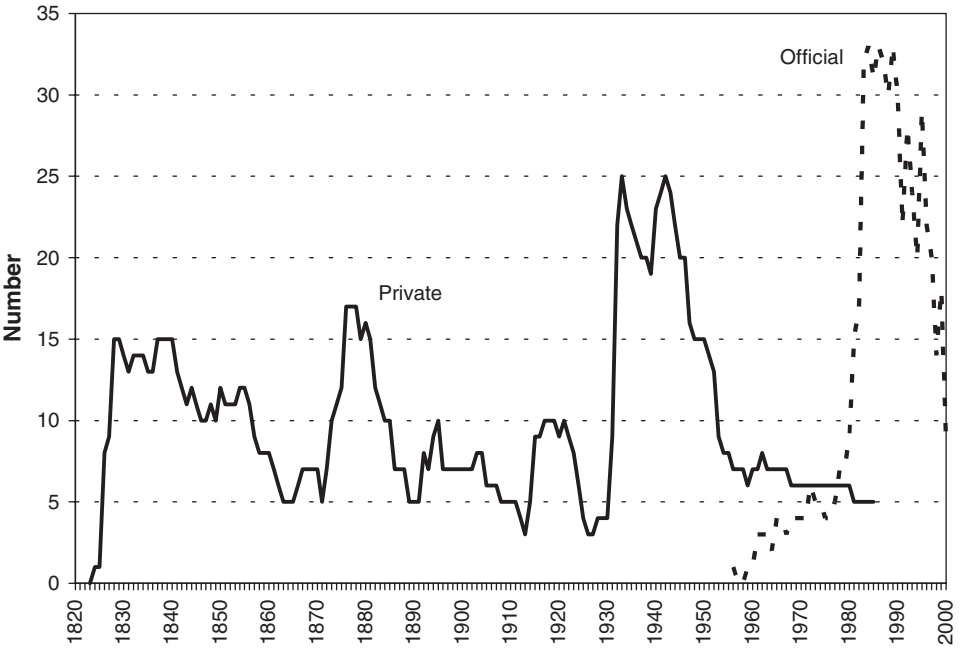
Figure 1. Two Centuries of Default and Rescheduling



Source: See Appendix.

outside of the credit market (Cole and Kehoe, 1998), and the imposition of trade and trade credit sanctions (Bulow and Rogoff, 1989; Kaletsky, 1985; and Rose, 2002). There has also been some theoretical work on incentives of creditors, chiefly focusing on the credibility of coordinated lending embargoes (Bulow and Rogoff, 1989; Kletzer and B. Wright, 2000; and M. Wright, 2003a), and on the operation of institutions aimed at facilitating cooperation among creditors (Eichengreen and Portes, 1989; Mauro and Yafeh, 2003; and M. Wright, 2003c). However, there has, on the whole, been much less *empirical* work aimed at disentangling the importance of these various theories.

Viewed from this perspective, the contribution of Rose and Spiegel (2004) is especially welcome. Together with a small number of other recent papers, Rose and Spiegel are contributing toward constructing a body of evidence about the nature and form of sovereign lending and default that can be used to, first, discriminate between theories and, second, to build a framework within which potential reforms can be assessed. In particular, their finding that bilateral bank debt stocks are larger between countries that have larger bilateral trade flows, even after controlling for the usual suspects, is consistent with an important role for trade and/or trade credit sanctions in enforcing repayment by sovereign debtors along the lines of the model outlined in their paper.

This discussion, after critically reviewing the methodology and findings of Rose and Spiegel, takes these findings as given and asks the question: to what extent

do these results allow us to distinguish between different theories of default? To answer this question, we write down a simple off-the-shelf model of sovereign lending in which repayment is enforced by threatened loss of future capital market access (that is, the loss of the debtor's reputation) and show that this model makes similar predictions for the direction of lending as does a model in which trade sanctions enforce repayment. However, we go on to show that this prediction depends crucially on the assumed nature of the trading environment and that it comes at the cost of dramatically underpredicting the level of gross capital flows. In summary, the Rose and Spiegel finding on the direction of lending, should it prove to be robust and *when combined with evidence about the level of gross capital flows,* constitutes a substantial challenge for reputation models of repayment. The discussion concludes by speculating as to how this challenge may be answered and by outlining some open empirical questions on default that await answers.

I. Trade, Default, and Credit

The centerpiece of the Rose and Spiegel empirical strategy is to estimate a gravity equation. However, unlike the typical gravity equation in which the dependent variable is bilateral flows of *real trade,* in this implementation it becomes the bilateral stock of financial assets held by banks. The data come from the Bank for International Settlements data on bank balance sheets on a consolidated basis. The independent variables in the analysis span the usual range of variables. In addition, the flow of bilateral real trade is added as an independent variable. The key result is the finding that the higher the flow of real trade between two countries, the higher the stock of bilateral assets held by banks in the creditor country. The result is both statistically and economically significant—typically on the order of a 5 percent increase in stocks resulting from a 10 percent increase in trade—and is robust across a number of specifications, possible sets of instruments, and robustness checks.

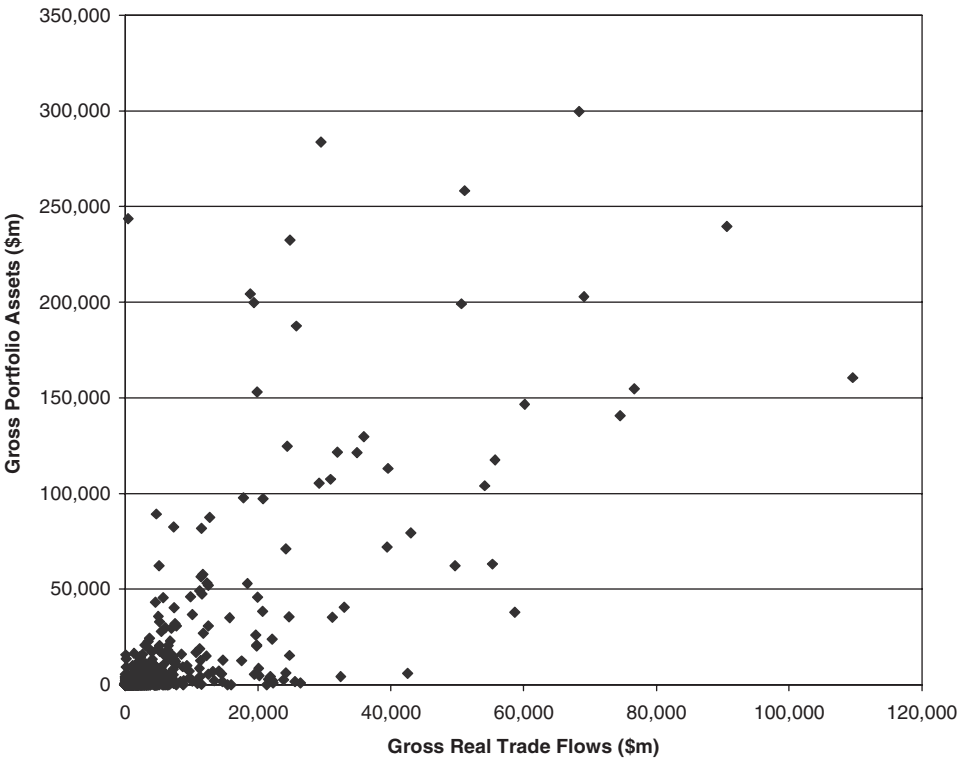
What is interesting, and perhaps a little surprising, about this result is that it holds despite controlling for the usual list of gravity variables. One might certainly have expected two large neighboring countries to have substantial cross holdings of assets/liabilities due, among other reasons, to the fact they had more real trade and hence more trade credit. They may also have had greater cross holdings of assets—in particular equities—due to better flows of information, as suggested by Portes, Rey, and Oh (2001). However, the results suggest that trade is important above and beyond that component that is suggested by the usual explanators of trade. The question then becomes to what extent is this extra importance evidence of the importance of trade and trade credit sanctions in enforcing repayment?

Before turning to a direct discussion of this question, it is first useful to note a couple of potentially important caveats to the empirical analysis. One question concerning the implementation of the strategy is whether or not the focus upon bank debt, as opposed to the assets and liabilities of a country more generally, affects the results? The lack of good data for other forms of assets and liabilities makes this impossible to answer definitively—Rose and Spiegel had to look where the

light was shining—but it begs the question of whether other forms of capital flows have very different patterns. Moreover, this issue is becoming increasingly important due to the increasing shift of sovereign lending away from bank loans and toward bonds, and the recent rise in private foreign direct investment. The usage of bank lending is perhaps most troubling because it has the potential to be contaminated by trade credit extended by these banks, a feature that quite reasonably could be expected to be correlated with trade patterns, even after controlling for the usual explanators of trade: a pair of countries that trades an unusually high amount might also be expected to have an unusually high amount of trade credit.

One way to assess the importance of the above criticism empirically is to examine data on other forms of international investment. A first cut at such an exercise is contained in Figure 2, which plots an estimate of the stock of bilateral portfolio investment assets in 2001 from the IMF's *Coordinated Portfolio Investment Survey* against bilateral trade flows for almost 2,000 country pairs. As was the case for bank debt stocks, the figure shows that there is a positive correlation between the two series, with a correlation coefficient of roughly 0.75. This is comforting, and suggests that portfolio investments such as equities behave roughly similarly to bank debt. Perhaps foreign direct investment does as well?

Figure 2. Bilateral Portfolio Assets, 2001



Source: See Appendix.

A second caveat associated with the implementation concerns the usage of the bank loan data on a consolidated basis. These data allocate bank assets to the country within which the bank is headquartered. The trade sanction story advanced by Rose and Spiegel postulates that a country will restrict trade as a punishment against any country that defaults on loans made by its citizens. But in this age of multinational banking, a default on loans made by the foreign branch of a British bank could plausibly have its largest effect upon foreign depositors. If so, should we expect British trade to decline? If not, then why is British trade (and not the trade of the foreign country in which the branch is located) the relevant determinant of lending flows?

As regards the interpretation of the results, one question that arises concerns the estimates that result when attention is restricted to industrial countries. If, as seems plausible, the risk of default in lending to an industrial country is much lower than for emerging market economies—say because of superior institutions, the availability of other diplomatic punishments, or what have you—one might have expected that the relationship between trade and lending would be weaker for the industrial countries. The results, however, are often stronger.

Another obvious objection to the hypothesis that it is trade sanctions (although perhaps not *trade credit* sanctions) that enforce repayment is that we do not seem to observe trade sanctions being imposed in any instances of default. Moreover, it is not obvious whether international obligations through the World Trade Organization would allow the usage of trade sanctions in the event of a default today. The idea that trade sanctions were important in history, and in particular in averting a possible default in Argentina in the 1930s, also seems doubtful, especially in the light of recent work by Tomz (2003). Finally, debt settlements in practice do not seem to discriminate between groups of creditors on the basis of trading relationships, in contrast to the model put forward in the paper.

All of the above questions, in principle, cast some shadows on the thesis put forward by Rose and Spiegel. But all of them are very hard to answer in light of the available data. The rest of this discussion punts on these questions entirely, takes the Rose-Spiegel result at face value, and proceeds to ask whether this fact can be explained by a model of credit market reputation. The answer, it will turn out, is yes, although possibly not without creating further problems for the reputation story.

II. A Simple Model

To explore the ability of a reputation-based model of repayment incentives to match this fact, we will begin with a version of the well-known model of Kletzer and B. Wright (2000), although in fact the results hold for a much broader class of models. In this version of the model there are two risk-neutral creditor countries (indexed by $j = 1,2$) and one risk-averse debtor country with utility function U and discount factor β. International capital flows occur to smooth consumption and to reallocate consumption over time at a price q, defined to be the inverse of the gross international interest rate R. The absence of any international system of contract enforcement means that in equilibrium, lending patterns must be designed to reduce (in fact, eliminate) the possibility of default.

The key to the result is, intuitively, that in this model, default possibilities are minimized by keeping gross capital flows as small as possible, and in fact equal to net capital flows. Loosely speaking, the reason is that if gross flows are larger than net flows, the debtor can strategically default at the point when the most resources are under its control: default has become more tempting. But this implies that financial flows (and hence their corresponding stocks) should follow trade flows, which is enough to give us the direction of lending result discussed above.

To see this result, let y_t be the identically and independently distributed level of the endowment that the debtor country receives at the start of the period. The nature of the interaction between the debtor and the two creditors is modeled as a game in which, at the start of each period and after observing the level of the debtor's endowment, the debtor and creditors simultaneously make transfers of goods to each other. As there are no gains from trade between creditors, we can without loss focus on transfers of goods to the debtor $\{\tau_t^{C_j}\}$ from each creditor $j = 1,2$, and from debtor $\{\tau_t^{D_j}\}$ to each creditor $j = 1,2$.

It is by now well known that there are many subgame perfect equilibria of such a game, the worst of which is autarky and produces an expected welfare for the debtor of V^A. Because autarky is the worst possible outcome, a threat to place the debtor in autarky—that is, exclude the debtor from financial markets—is the worst possible threat that can be made, and so serves to support the most lending possible. It then follows that any equilibrium level of transfers $\{\tau_t^{C_j}, \tau_t^{D_j}\}$ must satisfy

$$U\left(y_t + \sum_{j=1,2}\left(\tau_t^{C_j} - \tau_t^{D_j}\right)\right) + \beta V_{t+1} \geq U\left(y_t + \sum_{j=1,2}\tau_t^{C_j}\right) + BV^A$$

$$\left(\tau_t^{D_j} - \tau_t^{C_j}\right) + q\Pi_{t+1}^j \geq -\tau_t^{C_j}$$

for all j and t, where V_{t+1} denotes the expected future welfare of the debtor under the equilibrium strategies, and $q\Pi_{t+1}^j$ denotes the expected present value of any future profits that the jth creditor expects to make in the future. That is, $q\Pi_{t+1}^j$ denotes the net (and as we will see below, also gross) value of any assets held by creditor country j against the debtor.

If we restrict attention to those equilibria that are constrained efficient (that is, efficient but for the threat of default, which is the convention) and in which default is tempting for the agents (so that the constraints bind), then it is easy to show that the equilibrium features a minimal level of gross capital flows: in equilibrium, if the debtor makes a transfer (that is, if $\tau_t^{D_j} > 0$ some j), then no creditor makes a transfer ($\tau_t^{C_j} = 0$ all j). In other words, gross flows are equal to net flows, which are defined as the current account deficit of the country. The proof follows from the above equations: if the debtor transfers resources and the constraint binds, the constraint can be made less binding, and hence efficiency can be increased, by reducing the transfers from the creditors on the right hand side of the inequality.

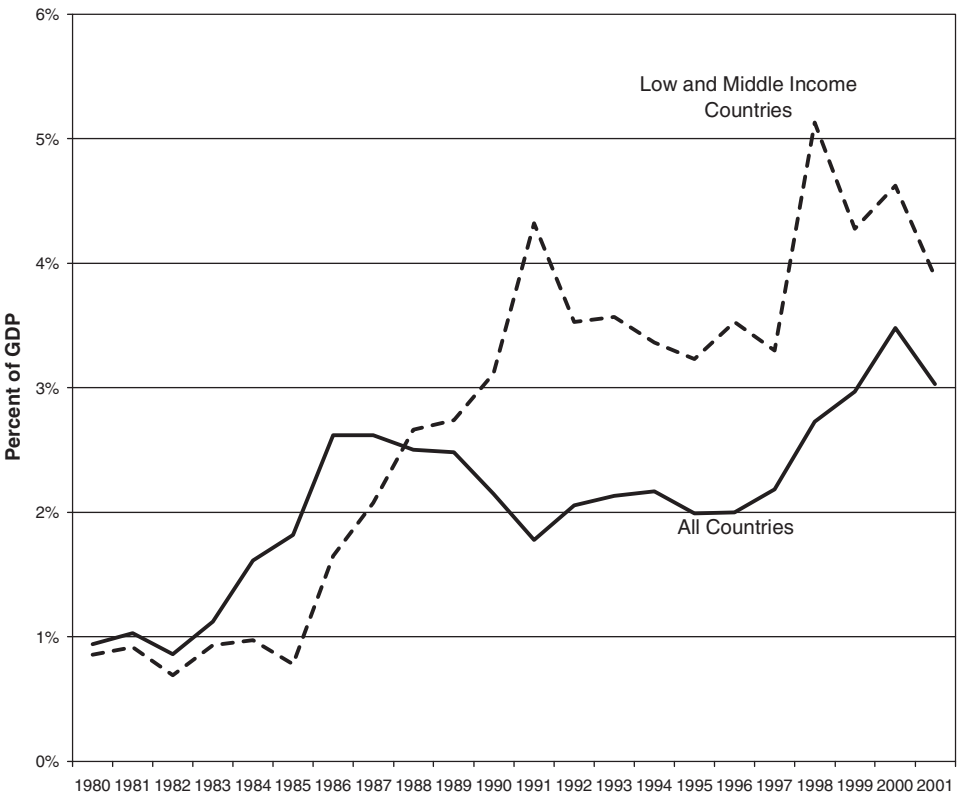
This result is sufficient to imply that the countries with the largest asset holdings are also the countries with the largest trade flows. This follows from the second sequence of equations: in a constrained efficient equilibrium at which the

constraints bind, the larger is current bilateral exports to the debtor (that is, the larger is $\tau_t^{C_j}$), the larger is the present value of bilateral assets $q\Pi_{t+1}^j$. Again the intuition is straightforward: for a given value of trade, the larger are gross asset holdings, the more tempted some party will be to default. This temptation is minimized by keeping gross assets equal to net assets, which in turn requires that the largest traders hold the most assets.

The above model of sovereign debt enforced by a country's concern for its reputation, is thus able to produce the result found by Rose and Spiegel. However, the result comes at a price: it also predicts that gross capital flows should be small and, in fact, no larger than net capital flows. As can be seen in Figures 3 and 4, whereas gross capital flows to developing countries in 1980 were not much larger than net capital flows, today they are almost five times larger. A related observation for developed economies is often cited (see, for example, Obstfeld and Rogoff, 2000) as evidence against the importance of default risk for these countries.

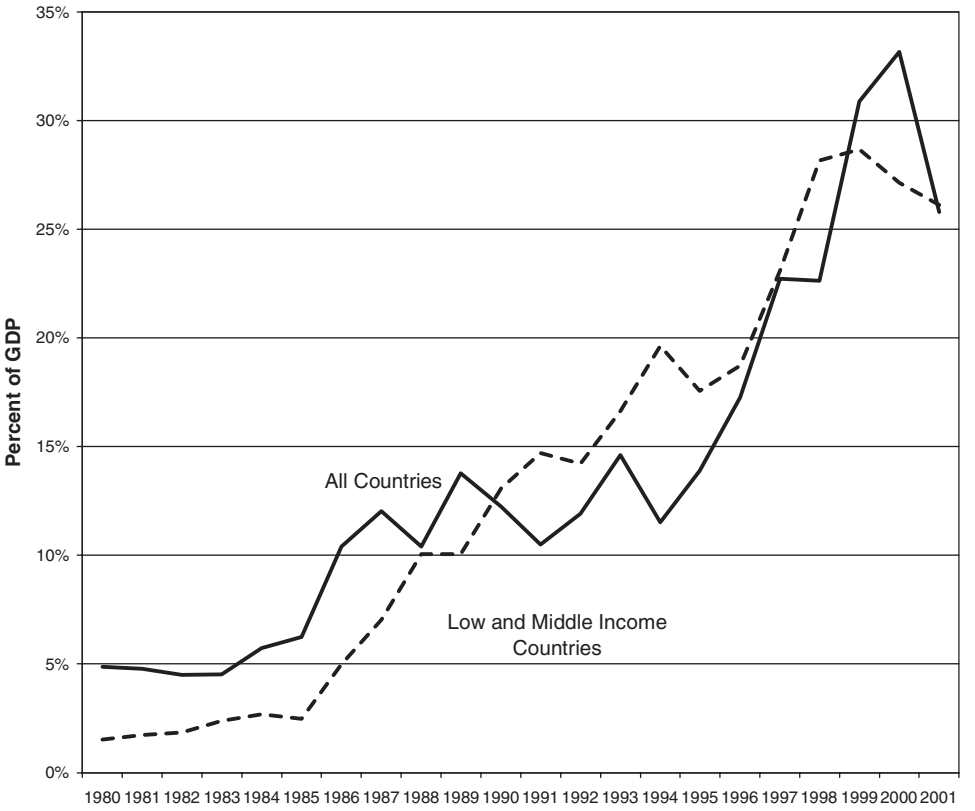
This begs the question of whether or not a reputation model can explain simultaneously both the level of gross capital flows, and the direction those flows (and hence corresponding asset stocks) take. One avenue that could be taken would be

Figure 3. Net Capital Flows



Source: See Appendix.

Figure 4. Gross Capital Flows



Source: See Appendix.

to abandon the focus on constrained efficient allocations. When allocations are not even constrained efficient, then gross flows can exceed net flows. However, the level of net capital flows that can be sustained declines in the amount by which gross capital flows exceed net flows. Consequently, it is difficult to see how such an explanation could explain simultaneous increases in both net and gross capital flows displayed in Figures 3 and 4. Another possibility is that default is not really a constraint, so that like any other complete markets model we are free to "gross up" portfolios in any way we choose. But such an approach places no restriction on the direction of gross flows and, moreover, begs the question of why we should be concerned about default in the first place.

Yet a third response is to note that it is not default and reputations per se, but rather their interaction with the trading technology, that produces the result that gross flows must be small in the face of default risk in this model. In particular, the above results were all derived under a specification of trade that involves all countries simultaneously exchanging goods. Suppose instead that trade takes place continuously throughout a period, and that a default consists of an early termination of the period of trade. To be concrete, suppose that trade takes place continuously

over an interval of time normalized to length one, and that either a creditor or a debtor can terminate trade at any point $s \in [0,1]$ along that interval.

Under these assumptions, the relevant participation constraints become

$$U\left(y_t + \sum_{j=1,2}\left(\tau_t^{C_j} - \tau_t^{D_j}\right)\right) + \beta V_{t+1} \geq U\left(y_t + s\sum_{j=1,2}\left(\tau_t^{C_j} - \tau_t^{D_j}\right)\right) + BV^A$$

$$\left(\tau_t^{D_j} - \tau_t^{C_j}\right) + q\Pi_{t+1}^j \geq s\left(\tau_t^{D_j} - \tau_t^{C_j}\right)$$

for all $s \in [0,1]$ all j and t. Then, with a little work, it can be shown that gross capital flows are unconstrained for any level of net capital flows: simply fix the net level of transfers $\sum_{j=1,2}\left(\tau_t^{C_j} - \tau_t^{D_j}\right)$ and vary the level of gross transfers keeping the level of net transfers constant. In this case, default is always most tempting to an agent at the start of a period (that is, $s = 0$) and the temptation to default is invariant to the level of gross flows. This shows that a reputation model can produce arbitrarily high levels of gross flows. Moreover, the implications of this model for net capital flows, consumption, default, and welfare are exactly the same as for the earlier model presented above. However, now it is also true that there is no reason for gross asset positions to be correlated with gross trade flows: the argument used before now only works for net trade flows and net asset positions.

To summarize: a reputation model of debt is capable of explaining the Rose and Spiegel finding that gross asset positions are correlated with gross trade flows. Such a model is also capable of explaining arbitrarily large gross capital flows. However, the versions of these models that have presently been devised are not capable of simultaneously explaining both of these facts. The Rose and Spiegel finding on the direction of debts, in combination with the presence of large gross capital flows, therefore constitutes a challenge to reputational models of debt.

IV. Concluding Remarks

This discussion began by arguing that economists and policymakers still lack answers to some of the most fundamental questions concerning the incentives of debtors and creditors in the repayment of debt. In terms of providing answers to these questions, theory is still ahead of empirical work. However, thanks to the work of Rose and Spiegel, empirical work is catching up. In particular, their finding that bilateral asset holdings follow bilateral trade flows, should it prove to be robust, and when combined with evidence about the magnitude of gross flows, is a substantial challenge to the traditional reputation models of debt.

This does not necessarily constitute the final word on reputation models. As the discussion in the last section shows, the implications of reputation models for the level and direction of asset flows depend not only on the nature of contract enforcement but also on the details of the trading environment. Indeed, the discussion of the last section hints that a resolution of the two facts may lie in the way in which trade and financial frictions interact. In some recent work, M. Wright (2003b) shows that when default is deterred by a concern for preserving one's reputation,

and that when a country's trading partners have an information advantage in reacting to a default, a model of this sort can produce large gross flows that closely follow trade patterns. Whether similar models of both trade and financial frictions can explain this and other facts about debt and repayment remains an open question.

Nor does this constitute the final empirical word on default. Not only are there many other aspects of the default process that are not well understood, but economists still lack good answers to the other question posed at the beginning: how do changes in government policy and institutions affect the incentives to repay debts? In part, the lack of good answers to this question reflects the fact that a study of variations in institutions of this scope inevitably involves studying the behavior of sovereign debt over the course of many decades, if not centuries. Some recent work by Klingen, Weder, and Zettelmeyer (2003), which examines rates of return on lending over three decades from 1970 to 2000, finds that returns on sovereign debt following the Brady restructuring deals were abnormally high, which is consistent with a positive role for some types of government intervention in resolving default. However, the interventions in the early years of the 1980s debt crisis were associated with very low returns. One thing is certain: with further empirical and theoretical work, the prospects of realizing positive welfare gains from the reform of the international financial system become stronger.

APPENDIX

Two Centuries of Default

Data on the incidence of default are taken from Suter (1992) up to 1989, and are extrapolated forward to 2000 using data from various issues of the World Bank's *Global Development Finance.*

Portfolio Assets

Data on bilateral holdings of portfolio investment assets for 2001 come from the IMF's *Coordinated Portfolio Investment Survey.* Bilateral pairs for which data were not available were omitted. The corresponding real trade flows data come from the IMF's *Direction of Trade Statistics.*

Gross and Net Capital Flows

Gross capital flows are notoriously difficult to measure. The measure we construct is no more than a coarse lower bound, and is based on summing the absolute value of each debit and credit category within the capital and financial account for each country, and then aggregating over countries. These data came from the IMF's *International Financial Statistics.* Note that not all countries report capital flows at the same level of disaggregation. For the purpose of constructing this series, the level of disaggregation was to include data from the capital account, for which credits and debits are recorded separately, as well as credits and debits from within the financial account for direct investment, portfolio investment, financial derivatives, and other investments. That is, the breakdown of portfolio investment into equity and debt, and of other investments by sector (central bank, government, banks, and other), was not included. The subset of developed economies was defined as the membership of the OECD in 1991, excluding Turkey. Net capital flows are defined as the average current account deficit of a country, in absolute value.

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Monetary Sovereignty, Exchange Rates, and Capital Controls: The Trilemma in the Interwar Period

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The interwar period was marked by the end of the classical gold standard regime and new levels of macroeconomic disorder in the world economy. The interwar disorder often is linked to policies inconsistent with the constraint of the open-economy trilemma—the inability of policymakers simultaneously to pursue a fixed exchange rate, open capital markets, and autonomous monetary policy. The first two objectives were linchpins of the pre-1914 order. As increasingly democratic polities faced pressures to engage in domestic macroeconomic management, however, either currency pegs or freedom of capital movements had to yield. This historical analytic narrative is compelling—with significant ramifications for today's world, if true—but empirically controversial. We apply theory and empirics to the interwar data and find strong support for the logic of the trilemma. Thus, an inability to pursue consistent policies in a rapidly changing political and economic environment appears central to an understanding of the interwar crises, and the same constraints still apply today. [JEL F33, F41, F42, N10]

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In the present era of globalization, one of the most difficult challenges for governments—and for those who advise them—is to understand the constraints under which policies must be designed in a world of increasing economic interdependence. Nowhere are these constraints more pressing than in the arena of monetary policy design in open economies, where the recent spate of economic crises in developing countries, from Mexico in 1994 to East Asia in 1997 to Argentina in 2001, highlighted the costs to be paid when the exchange rate regime unravels. In this paper we place the current quandary in a longer run context, and ask what lessons history has for contemporary problems. Our approach brings together theory, empirics, and history.

The theoretical foundation of this paper casts the choices faced by policymakers in terms of the classic macroeconomic trilemma: the idea that of the three policy objectives of a fixed exchange rate, open capital markets, and autonomous monetary policy, only two can be mutually consistent and, hence, tenable as stable features of the policy regime. The intuition is simple: when a country credibly and permanently pegs its exchange rate to some base country, and when capital is freely mobile, simple interest parity pins down the domestic interest rate, forcing it to be equal to the interest rate in the base country. We do not study what might be driving the intent of the authorities to manipulate nominal interest rates in the short run, but we take as given their desire to engage in active macroeconomic management over the business cycle and their belief that, due to short-run nominal rigidities, such intervention might be effective.

We will also take it as given—even uncontroversial—that the defining role of a sovereign monetary authority is that it will exercise such powers, when feasible and desirable, and this will affect liquidity, and hence interest rates, at the short end of the market. Some deeper questions intrude, however, especially with regard to feasibility and desirability. On feasibility, in contrast to the stark prescriptions of the trilemma, we know that intervention can be more continuous than dichotomous, sometimes as a result of authorities' decisions not to peg to a fixed rate, but instead to limit exchange rate movements to a band or "target zone." As has been recognized in the literature at least since the writings of Goschen (1861), this can leave some wiggle room for monetary policy—but how much? On desirability, we also have to be careful about the intent (or objectives) of policymakers, versus their constraints (or choice set). Under some policy systems, such as the gold standard, intent was not really a matter of debate in theory, although economic historians have noted that substantial deviations were witnessed in practice (Bloomfield, 1959; and Scammell, 1965). Under alternative systems, such as inflation targeting or other nominal anchors, authorities may have varying degrees of freedom depending on the regime in place, and depending on the regime of the partner country. Thus convergence, or divergence, from international monetary regimes or operating rules—a function of history, politics, and ideology—may lead to greater or lesser degrees of synchronization in policymakers' actions.

Our approach to these difficulties is to develop a formal model as a benchmark to guide our interpretation of the empirical findings. Using a target-zone model, one can compute the extent to which policymakers create a divergence between

short-term domestic and base-country interest rates under various policy scenarios. Different parameterizations allow such a model to capture both tight pegs (a narrow band) and nonpegs (an infinite band width), as well as varying degrees of activism on the part of policymakers as they seek to smooth out, or reinforce, monetary shocks from abroad.

The goal of the subsequent empirical work is to measure the extent to which changes in the relevant foreign "base" nominal interest rate pass through into the domestic nominal interest rate. The data provide some challenges. Sometimes care is needed to ensure that the correct base country is chosen, because at certain times in history this choice is not necessarily obvious. Furthermore, the status of a country with respect to the fixity of its exchange rate against any base currency is not always clear. Another difficulty arises from the near-nonstationarity of nominal interest rates in many historical periods. That feature of the data narrows our choice of techniques for both time series and panel estimation. With these problems addressed, however, the empirical method allows us to concentrate on the central predictions of the trilemma. To what extent do countries that peg and have open capital markets lose their monetary sovereignty? And do they recoup it when they resolve the trilemma in other ways—either by allowing the exchange rate to float, or by imposing capital controls? By dividing our sample according to exchange rate regime and capital control criteria, we can examine these questions.

The trilemma is not necessarily an easy proposition to test, but we view our approach as one of the more direct ways to explore its validity. Previous empirical tests of the trilemma have produced mixed results. Often the test has been indirect, as with the literature on the so-called "exchange rate disconnect" (Baxter and Stockman, 1989; and Flood and Rose, 1995). These authors saw very little difference in the statistical properties of real and nominal economic fluctuations in fixed versus floating rate episodes, *except* for the volatility and comovement of real and nominal exchange rates. As a corollary it could be inferred that the trilemma trade-offs might not impinge so tightly. Yet such an inference would clearly depend on additional maintained assumptions, in particular about the horizon over which autonomy can be presumed to have an effect. Further, since the data used for these analyses was of low frequency, it could very well understate the ability of monetary authorities to exert some high-frequency autonomy, even if they are subject to other constraints, such as real interest rate equality, at longer horizons.[1]

A more direct approach to testing the trilemma was taken by Rose (1996) who compared the predictions of a monetary model of exchange rates, based on money aggregates and outputs, with actual exchange rate movements, conditional on capital controls and the exchange rate regime. His results were somewhat consistent with the trilemma, but still weak. It could be argued that one source of weakness was the use of the monetary model, which seems to perform poorly at higher frequencies,

[1]Indeed, the one "robust result" cited by Flood and Rose is a negative relationship between exchange rate and output variability (Flood and Rose, 1995, p. 18). That pattern is consistent with a role for exchange rate flexibility in dampening output fluctuations.

due to unstable money demand, and which is therefore unable to cleanly capture the high-frequency content of the trilemma. A natural alternative is to measure monetary policy not by a quantity, money stocks, but by a price, namely the actual instrument used by most central banks to impose their policy—the short-term interest rate. Ours is one of several recent studies to follow this tack (Frankel, Schmukler, and Servén, 2002; Obstfeld, Shambaugh, and Taylor, 2004; and Shambaugh, 2004).

We choose to bring these theoretical and empirical tools to bear on one of the most turbulent periods in the history of the international macroeconomy—the interwar period. In the next section we explore the history of that period, where the narratives tell of a crisis in which the implications of the trilemma were suddenly more apparent than ever before. Subsequent sections discuss our theoretical simulations, describe the data we employ, and present the empirical results. A concluding section sums up the lessons learned and their relevance today.

I. Trilemma in the Interwar Period

After introducing our footholds in theory and empirics, we now turn to history and the interwar period, which is the object of study in this paper. The period's relevance is clear: arguably it was in this epoch that the trilemma forcefully made its presence felt for the first time in the great debate over the political economy of macroeconomics. For that reason, the trilemma idea resonates strongly with economic historians, who tend to understand the evolution of the global macroeconomic order in those terms. In the interwar period, all the key ingredients of the trilemma came into collision (Eichengreen, 1996; and Obstfeld and Taylor, 1998, 2004).

In 1913, the ideology of the classical gold standard still held sway, and international capital market integration had reached its zenith, leaving the authorities with little room for maneuver. The rise of more democratic polities led policymakers to seek greater autonomy than the old "rules of the game" permitted. Conventional wisdom argues that such a combination of inconsistent elements set the gold standard up for its swift demise following a brief reconstruction in the 1920s, a key part of the wider collapse of globalization seen during the interwar years (Temin, 1989; and James, 2001). Some have further argued that this crisis reflected a fundamental conflict between economic globalization, or at least its macroeconomic manifestation in the gold standard, and the advance of democracy, a tension that would perhaps henceforth place limits on the role of markets under the modern nation-state, although the recent so-called return to globalization has seemingly reversed that trend (Polanyi, 1944; Yergin and Stanislaw, 1998; Lindsey, 2002; and Tortella, 2003). This is the history, therefore, not of a far-removed past but a close precursor of the present, and the same trilemma clearly has relevance for the choices facing policymakers today. Once again, capital markets are increasingly fluid, an air of experimentation surrounds exchange rate regime choice, and the loss of monetary sovereignty is an issue of burning interest, especially to emerging-market countries.

Thus, the interwar period stands as a defining moment in the history of modern political economy and macroeconomics, and the trilemma was the issue at the very center of events. The historical record provides plenty of examples and anecdotes consistent with this story. Witness the heated debate over gold resumption at par in Britain, pitting Keynes against conventional opinion, as general labor unrest simmered in the background; or, under conditions of equal or greater social foment, consider the tortured compromises by French politicians in the run-up to Poincaré's resumption at a devalued parity, and the continuing policy uncertainty as France clung to gold until 1936. Yet, despite all of this suggestive evidence, we are unaware of any research that formally and directly tests for the presence of the trilemma, and examines its potency, in the macroeconomic crucible of the interwar years.

Unfortunately, this is to some degree understandable given the chaotic nature of the period. Serious empirical work of the kind we envisage requires high-frequency data collection for interest rates and clear records of the capital control and exchange rate regimes for each country. The task is daunting for the years between the wars, as data can be collected only with difficulty and with substantial noise. Regime definition is often imprecise and certainly volatile. Many countries changed their peg and capital control status several times. Some countries were off gold but really "shadowing" the gold standard in a desperate attempt eventually to rejoin. Capital control policies varied by country in their degree of strictness. Our own work has previously examined the trilemma empirically in the pre-1914 and post-1945 periods, where the empirical challenges are somewhat fewer (Obstfeld, Shambaugh, and Taylor, 2004). We have since, however, constructed an interwar database that allows us to put the trilemma to the test at perhaps its most critical historical moment.

Looking on the bright side, the extreme variation in conditions during the interwar sample period is, of course, good news from the econometric standpoint. Whereas our previous work compared economic experiences separated by many decades, and sometimes a century or more, the interwar period supplies all the variation we could hope for in the space of 10 or 15 years. In that brief window, fixes and floats, controls and free markets were all tried here and there. We therefore find ample power to identify the effects we study, although sometimes the extremely short duration of peg and float episodes makes univariate time-series analysis difficult. The interwar period also follows hard on the heels of an ideal benchmark era against which we can compare our results—the classical pre-1914 gold standard. Accordingly, we shall refer back to results for that period as a basis for judging the behavior of the interwar regimes. Along the way, we also gain an opportunity to consider some related hypotheses, for example, the much-discussed switch of the world financial center from London to New York after World War I, considered essential to the hegemony theory of an evolution from a British- to a U.S.-led world order (Kindleberger, 1986).

The central aim, however, is to test the power of the trilemma as an explanatory tool. To lay the groundwork for that test, we now turn to some important theoretical considerations that help buttress our econometric approach and subsequent interpretations of the results.

II. Empirical Methodology and Rationale

The starting point for our econometric analysis is a panel regression of the form

$$\Delta R_{it} = \beta \Delta R_{bit} + u_{it}, \tag{1}$$

where R_{it} is the nominal interest rate in country i on date t, R_{bit} is the interest rate in the "base" country, and u_{it} is a random shock.[2] Under perfect international capital mobility and an exchange rate credibly pegged with a zero fluctuation band, we would expect to find ordinary least squares (OLS) estimates of $\hat{\beta} = 1$ and $R^2 = 1$. In practice, however, the actual estimates differ from this hypothetical benchmark case, and we wish to know if there are systematic differences in the size of $\hat{\beta}$ between pegged exchange rate regimes and nonpegs. Our claim is that such divergences inform us about the scope for interest rate management, and therefore for monetary policy independence, under alternative exchange rate regimes. As an alternative way to measure the impact of a peg on the sensitivity of domestic to foreign interest rates, we pool data from peg and nonpeg regimes and look at the magnitude of $\hat{\beta}_2$ in the regression

$$\Delta R_{it} = \beta_1 \Delta R_{bit} + \beta_2 (\Delta R_{bit} \times PEG_{it}) + u_{it}, \tag{2}$$

where PEG_{it} takes the value 1 if country i pegs to the base currency at time t and 0 otherwise.

We focus our theoretical discussion on the key slope coefficient β in equation (1), though we also consider the fit of that equation in our empirical results. A convenient starting point for interpreting estimates of equation (1) is the generalized uncovered interest parity relationship

$$R = R_b + \varepsilon + v, \tag{3}$$

where ε is the expected depreciation rate of the domestic currency (over a horizon corresponding to that of the interest rates R and R_b) and v is a random, mean-zero, excess return or risk premium that, for convenience, we take to be exogenous. Given the model of equation (3), the OLS estimate of β in the difference regression (1) satisfies

$$\begin{aligned} \operatorname{plim} \hat{\beta}_{\text{DIFFS}} &= \operatorname{plim} \frac{\sum_t (\Delta R_t \cdot \Delta R_{bt})}{\sum_t (\Delta R_{bt})^2} = 1 + \operatorname{plim} \frac{\frac{1}{T}\sum_t (\Delta \varepsilon_t \cdot \Delta R_{bt})}{\frac{1}{T}\sum_t (\Delta R_{bt})^2} \\ &= 1 + \rho(\Delta \varepsilon_t, \Delta R_{bt}) \frac{\sigma(\Delta \varepsilon_t)}{\sigma(\Delta R_{bt})}, \end{aligned} \tag{4}$$

[2]Variants of this methodology are followed in the precursor papers by Frankel, Schmukler, and Servén (2002), Obstfeld, Shambaugh, and Taylor (2004), and Shambaugh (2004). We omit fixed effects from the preceding equation on the grounds that deterministic trends in nominal interest rates are implausible; and, in practice, when we include such fixed effects they are estimated to be indistinguishable from zero.

where ρ is a correlation coefficient, σ is a standard deviation, and T is sample size. The second term on the right-hand side of equation (4) captures the average response of exchange rate expectations to changes in the base interest rate. Under interest parity, if a rise in the foreign base interest rate is accompanied by a smaller absolute rise in the domestic interest—as would be the case under a system of domestic interest rate smoothing by the monetary authority—then the expected rate of currency depreciation, ε, must simultaneously *fall.* This could be accomplished by allowing the domestic currency to depreciate sufficiently in the foreign exchange market to induce a higher expected rate of future appreciation (that is, a lower expected rate of future depreciation). In that case, the average $\Sigma_t(\Delta\varepsilon_t \cdot \Delta R_{bt})/T$ is negative for large enough T, as is the correlation coefficient $\rho(\Delta\varepsilon_t, \Delta R_{bt})$, and $\hat{\beta} < 1$. Alternatively, were the home monetary authority to reinforce the effect of foreign interest shocks, one would expect $\hat{\beta} > 1$. Thus, the coefficient β measures the extent to which domestic monetary policy has (and uses) the scope to respond to foreign interest rate shocks.

An alternative specification would be the analog of equation (1) in interest rate *levels* rather than differences,

$$R_{it} = \alpha + \beta R_{bit} + \eta_{it}. \tag{5}$$

Such a strategy seems inadvisable in light of the persistence of nominal interest rates in our data. For the interwar period, the monthly series of U.S. interest rates displays an autocorrelation coefficient of 0.99 in monthly data, and for the vast majority of other interest rates in our sample the presence of a unit root cannot be rejected statistically.[3] Thus, the assumption of a unit root in interest rates is a good approximation to the data.

Under a unit root, however, estimation in levels of interest rates yields

$$\text{plim}\ \hat{\beta}_{\text{LEVELS}} = \text{plim}\ \frac{\sum_t (R_t \cdot R_{bt})}{\sum_t (R_{bt})^2} = 1 + \text{plim}\ \frac{\sum_t (\varepsilon_t \cdot R_{bt})}{\sum_t (R_{bt})^2} = 1,$$

assuming the expected depreciation rate is statistically stationary. Because the stochastic trends in the interest rates dominate, levels estimates are not well suited to yield information about interest rate independence. If international interest rates are not cointegrated, the spurious regression problem stressed by Shambaugh (2004) can arise. In the data, we find that the residual terms in equation (1) are approximately serially uncorrelated.

To evaluate these claims, as well as to aid in interpreting the empirical results, we perform Monte Carlo experiments using simulated data based on a formal model of exchange rate target zones. The basic model comes from Krugman (1991) and has been extended by Flood and Garber (1991), Froot and Obstfeld (1991), Svensson (1991), and others. To generate interest rates of noninstantaneous maturity, we utilize Svensson's (1991) account of the term structure of interest rates

[3]In contrast, under the pre-1914 gold standard, nominal interest rates appear stationary. Apparent nonstationarity is the rule after World War II, as during the interwar period.

within a target zone. We compare the results of interest rate regressions under a narrow target zone (bands of ±1 percent) and a freely floating exchange rate.

It is helpful to give a brief description of the model that we use in these simulations.[4] The time-t log exchange rate, $e(t)$, is defined as the home price of foreign currency. It is determined by the forward-looking pricing equation

$$e(t) = x(t) + \eta \frac{\mathrm{E}_t\{\mathrm{d}e(t)\}}{\mathrm{d}t},$$

where $x(t)$ is a "fundamental" economic variable driving currency value (for example, the home less the foreign money supply) and $\eta > 0$. The fundamental x follows a mean reverting process of the form

$$\mathrm{d}x = -\xi x \mathrm{d}t + \sigma \mathrm{d}z, \tag{6}$$

where $\mathrm{d}z$ is Gaussian noise.[5] Under these assumptions, and an allowable (reflecting) fluctuation band $[\underline{e},\bar{e}]$ for the exchange rate, there is a unique price solution $e = s(x)$, from which the expected depreciation rate of the domestic currency,

$$\frac{\mathrm{E}_t\{\mathrm{d}e\}}{\mathrm{d}t} = -\xi x s'(x) + \frac{\sigma^2}{2} s''(x),$$

follows from Itô's Lemma.[6]

The preceding equation defines an *instantaneous* expected depreciation rate. The interest rates available for empirical analysis apply, however, to finite maturities. Svensson (1991) shows that when uncovered interest rate parity holds, we can approximate the international interest differential at maturity m by

$$\delta(m,x) = \frac{f(m,x) - s(x)}{m},$$

where $f(m,x)$ is the exchange rate expected to prevail after an interval of positive length m has elapsed.[7] We specify the base foreign interest rate R_b^m of the relevant maturity to follow a random walk, constrained only by a lower bound of zero. In

[4]A more detailed description of the model and methodology can be found in Obstfeld, Shambaugh, and Taylor (2004).

[5]In Krugman's (1991) original model, $\xi = 0$. Under that assumption, however, exchange rates would follow a random walk under a free float, minimizing international interest differentials. To get a better sense for the scope for interest rate independence under a float, we therefore consider the case $\xi > 0$ in our simulations, following Froot and Obstfeld (1991).

[6]The exchange rate solution under a free float, such that $[\underline{e},\bar{e}] \to [-\infty, +\infty]$, is simply:

$$e = \frac{x}{1 + \eta\xi}.$$

[7]Of course, $f(0,x) = s(x)$. Think of m as a fraction of a year.

line with equation (3), which incorporates a deviation v from interest parity, the domestic nominal interest rate of maturity m is then modeled as

$$R^m = R_b^m + \delta(m,x) + v.$$

We interpret the error v as an empirical, serially uncorrelated and exogenous departure from the underlying economic model. Svensson (1991) shows how to solve for the term expected depreciation rate $\delta(m,x)$. In our simulations, R^m has a lower bound of zero. We further constrain the noise v to preclude pure arbitrage profits in the target zone case (that is, we rule out interest differentials larger than the maximum capital loss allowed by the bands). That further constraint is necessary when the bands are permanent and fully credible, as we are assuming.

In practice we approximate equation (6) by a discrete-time process sampled at intervals of $h = 10$ minutes. The base interest rate's level is generated as a random walk modified by a nonnegativity constraint. Innovations in the base interest rate and the domestic fundamentals are drawn from a bivariate normal distribution. A key parameter in the simulated data is $\rho(\Delta z,\Delta R_b)$, defined as the instantaneous correlation between the innovation in the base interest rate $R^m_{bi,t} - R^m_{bi,t-h}$ and the innovation in fundamentals, $z_t - z_{t-h}$. To interpret $\rho(\Delta z,\Delta R_b)$, think again of $z_t - z_{t-h}$ as the innovation in the home less foreign money supply (in logs). In that case, a positive $\rho(\Delta z,\Delta R_b)$ signifies a tendency for domestic money to increase relative to foreign money when the foreign interest rate rises, an outcome that would dampen the response of the home to the foreign interest rate. In contrast, when $\rho(\Delta z,\Delta R_b) = 0$ that response is one-for-one, whereas for $\rho(\Delta z,\Delta R_b) < 0$, instead of interest rate smoothing by the domestic central bank, we have the opposite: policy action to reinforce the domestic impact of the foreign interest rate movement.

Because expected depreciation ε is *decreasing* in the fundamental x,[8] the correlation coefficient $\rho(\Delta\varepsilon,\Delta R_b)$ in equation (4) is an *inverse* function of $\rho(\Delta z,\Delta R_b)$. As a result, setting $\rho(\Delta z,\Delta R_b) > 0$ results in $\rho(\Delta\varepsilon,\Delta R_b) < 0$ and, by equation (4), in $\hat{\beta} < 1$. Conversely, setting $\rho(\Delta z,\Delta R_b) < 0$ yields $\hat{\beta} > 1$.

Table 1 shows the mean estimates and dispersion based on 1,000 replications of a 30-year history. We consider both a target zone with quite narrow bands (±1 percent, that is, $[\underline{e},\bar{e}] = [-0.01,0.01]$) and a floating regime.[9] The simulation analysis produces three-month rates of interest under alternative policy settings of $\rho(\Delta z,\Delta R_b) = 0.8$, 0.5, 0, and –0.5.[10]

[8]The validity of the last claim follows from both the mean reversion in the fundamentals process and the curvature of the exchange rate solution function, $s(x)$.

[9]We note that a target-zone width of ±1 percent corresponds to the Bretton Woods fluctuation bands against the U.S. dollar, and is considerably narrower than the bands that have characterized the European Exchange Rate Mechanisms. A band width of ±1 percent also is not far off estimates of the target zone induced by gold points prior to 1914.

[10]Table 1 reports results for three-month rates because that maturity is typical in our empirical analysis. We examined overnight rates in simulations that are not reported here. At that maturity the international linkage is somewhat weaker, as one would expect, although the differences from the numbers in Table 1 are not huge. For the simulations, we calibrate the annual standard deviation of the innovation in R_b^m to that in the annual average end-of-month Federal funds rate (1975–2001). We calibrate the annual standard deviation of the innovation in fundamentals, x, to that in the annual average end-of-month dollar-

Table 1. Simulated Estimates of β and θ
(Three-month interest rates)

Regime	$\hat{\beta}_{DIFFS}$	R^2_{DIFFS}	$\hat{\beta}_{LEVELS}$	R^2_{LEVELS}	$\hat{\theta}$
$\rho(\Delta z, \Delta R_b) = 0.8$					
Target Zone (±1%)	0.50	0.13	0.83	0.83	–0.22
	(0.07)		(0.12)		(0.07)
Float	0.16	0.02	0.61	0.52	–0.10
	(0.07)		(0.22)		(0.05)
$\rho(\Delta z, \Delta R_b) = 0.5$					
Target Zone (±1%)	0.69	0.20	0.89	0.84	–0.21
	(0.08)		(0.12)		(0.06)
Float	0.46	0.05	0.76	0.49	–0.09
	(0.08)		(0.26)		(0.04)
$\rho(\Delta z, \Delta R_b) = 0$					
Target Zone (±1%)	0.99	0.33	1.00	0.86	–0.20
	(0.08)		(0.13)		(0.06)
Float	0.97	0.27	0.98	0.67	–0.09
	(0.10)		(0.26)		(0.04)
$\rho(\Delta z, \Delta R_b) = -0.5$					
Target Zone (±1%)	1.28	0.43	1.10	0.86	–0.20
	(0.10)		(0.13)		(0.06)
Float	1.44	0.47	1.19	0.77	–0.10
	(0.17)		(0.25)		(0.04)

For policy regimes ranging from $\rho(\Delta z, \Delta R_b) = 0.5$ (partial interest rate smoothing) to $\rho(\Delta z, \Delta R_b) = 0.8$ (more aggressive interest rate smoothing), Table 1 shows that the mean slope estimate $\hat{\beta}_{DIFFS}$ from the differences specification, equation (1), is in a range of 0.7 to 0.5. An intermediate figure is 0.6—far below unity despite the rather narrow target zone. In the corresponding floating-rate regimes, $\hat{\beta}_{DIFFS}$ is considerably below its value in the target-zone cases, suggesting substantially more interest rate independence at the short end. For $\rho(\Delta z, \Delta R_b) = 0.8$ the mean estimate is only 0.16. Nonetheless, for $\rho(\Delta z, \Delta R_b) = 0.5$, the mean estimate of $\hat{\beta}_{DIFFS} = 0.46$ under a float remains sizable. As expected, the average measure of fit, R^2_{DIFFS}, also varies across regimes with target zones generating a range of 0.13 to 0.20 and floats 0.02 to 0.05. The fact that these are so far from the predicted value of 1 if there is no smoothing provides important context for the empirical results.

When $\rho(\Delta z, \Delta R_b) = 0$, meaning that interest rates are not smoothed at all, the estimate of $\hat{\beta}_{DIFFS} \approx 1$ reflects that domestic interest rates now are moving basically in tandem with the base rate, under both the target zone and the float. For $\rho(\Delta z, \Delta R_b) = -0.5$, $\hat{\beta}_{DIFFS}$ exceeds 1 because foreign interest rate movements are reinforced, not

mark (starting in 1999, dollar-euro) exchange rate (1975–2001). Finally, we take the standard deviation in the exogenous noise v to be 20 basis points for interest rates expressed on an annual basis. The behavioral parameter η, the implicit (absolute) interest semielasticity of money demand, is set to 4. At a nominal interest rate of 5 percent per year, the implied interest elasticity of money demand would be –0.2, the value cited by Romer (2001, p. 470). We set $\xi = 1.5$.

offset, by domestic policy. The effect is stronger under a float than under a target zone. Under a float, the effects of fundamentals on the exchange rate, and hence, the interest rate responses, are not muted by expected intervention at the band edges.

The results of estimating the levels specification, equation (5), are reported in the column of Table 1 labeled $\hat{\beta}_{\text{LEVELS}}$. These results are as expected when the base interest rate, R_{bit}, has a unit root. The levels estimates $\hat{\beta}_{\text{LEVELS}}$ are much closer to unity than $\hat{\beta}_{\text{DIFFS}}$ under all policy settings, and as a result, the estimated differences between the target zone and the float are much less evident than in the less compressed differences estimates. We have experimented with simulated sample periods out to 100 years and find that while the differences estimates remain quite stable, the levels estimates (as one would expect) move markedly in the direction of unity as the sample period is lengthened. The levels estimates obscure the contrasts between regimes in finite samples, and will hide them entirely as the time-series sample grows arbitrarily long. The values of R^2_{LEVELS} are high due to the common trend in foreign and domestic interest rates.

In practice we estimate equation (1) on a panel of annual year-average interest rate changes, so as to minimize international asymmetries caused by different short-term dynamic adjustment patterns to foreign interest rate changes. We pursue an additional estimation strategy, however, that focuses directly on the dynamics of adjustment. If the interest rate data are indeed statistically nonstationary, an error-correction specification can be used to analyze the dynamics of monthly data. In practice one cannot be sure the data are $I(1)$ rather than $I(0)$. To maintain an agnostic view on stationarity, we employ a technique proposed by Pesaran, Shin, and Smith (2001), henceforth PSS, in which an error-correction form is estimated but different critical values are applied to the $I(1)$ and $I(0)$ cases.[11] Only when test statistics lie in an intermediate range must inference rely on an assumption about the order of integration.

The PSS technique relies on the specification

$$\Delta R_{it} = \alpha + \beta \Delta R_{bit} + \theta(c + R_{it-1} - \gamma R_{bi,t-1}) + u_{it}, \tag{7}$$

where lags of ΔR_{it} and ΔR_{bit} are included as necessary and γ is a cointegrating coefficient. The significance and absolute magnitude of the coefficient θ, which we expect to be *negative,* if local interest rates adjust back toward the base rate after a shock, reflect the strength of the adjustment forces. In the monthly data we use, a coefficient of $\theta = -0.5$ would imply a half-life of one month. Other things being equal, faster adjustment is an indicator of a less autonomous monetary policy. For nonstationary data we would expect $\gamma = 1$, in which case one could impose that equality on the equation before estimating θ.

The final column of Table 1 reports mean simulated values of the estimate $\hat{\theta}$ from equation (7). The estimates average to around -0.2 under a target zone and about -0.1 under a float, with the result fairly insensitive to the extent of short-run interest rate smoothing. The implied half-lives of shocks are under three months for a target zone but roughly seven months for floats.

[11]This technique is also used by Frankel, Schmukler, and Servén (2002).

III. Data

Interest Rate Data

To test the trilemma's predictions, we must describe the different policy options countries are pursuing. As noted above, we view the short-term nominal interest rate as the instrument of a country's monetary policy and the extent of comovement of the local nominal interest rate with a nominal base-country interest rate as an (inverse) expression of monetary policy autonomy.

Our core data are all monthly. Short-term nominal interest rates for 16 countries in the years 1919–38 come from Global Financial Data (GFD, *www.globalfindata.com*). In general these data were originally reported in League of Nations sources. The data are listed as "bills" or "banker's bills" (typically of three-months' maturity). We add data for Switzerland, available in the Federal Reserve's *Banking and Monetary Statistics* (1943). The League of Nations *Statistical Yearbooks* reported annual averages of monthly interest rates for Chile and Denmark, and we use these data as well. All three added series are market rates of discount. When available in both sources, the GFD interest rate series match almost exactly the data for private discount rates listed in the Federal Reserve's *Banking and Monetary Statistics.* As noted earlier, in the differences regressions, monthly interest rates for a particular year are averaged to yield annual observations. Table 2 lists the countries and data that are available.

All interest rates are expressed in the form $\ln(1 + R)$. While this transformation has a trivial impact for moderate interest rates, it does shrink the impact of

Table 2. Countries in Sample

	Frequency	Dates Available	
Austria	monthly	1/1923	6/1931
Belgium	monthly	5/1919	12/1938
Bulgaria	monthly	1/1928	12/1938
Chile	annual	1929	1936
China	monthly	1/1928	12/1938
Czechoslovakia	monthly	1/1926	12/1938
Denmark	annual	1926	1938
France	monthly	1/1922	12/1938
Germany	monthly	1/1919	12/1938
Hungary	monthly	7/1924	12/1938
India	monthly	4/1921	12/1938
Italy	monthly	1/1922	12/1938
Japan	monthly	1/1919	12/1938
Netherlands	monthly	1/1919	12/1938
Romania	monthly	1/1929	12/1938
Sweden	monthly	1/1926	12/1938
Switzerland	monthly	1/1924	12/1938
United Kingdom	monthly	1/1919	12/1938
United States	monthly	1/1919	12/1938

outliers. In addition, the German hyperinflation is removed to prevent the massive interest rate swings during that relatively short episode from overwhelming the rest of the data. Thus, observations for Germany from 1923–25 are eliminated.

Because we are interested in comovements with the base interest rate, an important choice is that of the center-country or base nominal interest rate. Under typical post–World War II fixed exchange rate regimes, countries have pegged to other countries, thereby revealing their particular bases. In theory, however, a multilateral gold standard regime differs, in that monetary changes in any country affect the system as a whole, and there is symmetric adjustment. More practically, however, one thinks of a de facto center country, namely, Great Britain, at least under the pre-1914 gold standard. In contrast to the classical gold standard, though, there is no clear base country for the system as a whole during the interwar years. While the United States returned fully to the gold standard immediately after World War I, it is not clear that the United States was the sole base for the system. Indeed, the U.S. dollar itself did not remain fixed against gold throughout the entire era (Franklin Roosevelt devalued the dollar-gold exchange rate in 1933). Sterling was not convertible into gold for much of the period; Britain remained on gold only for about 77 months, so Britain is not an ideal base country either. France played a major role in the setting of policies because of its successful attempt to amass large quantities of gold reserves, but it did not repeg to gold on a de jure basis until 1928, two years after the Poincaré macroeconomic stabilization, making it an inappropriate choice as a base country early on in the time period that we study. Because the United States and France held the majority of gold reserves, our default procedure is to use the U.S. interest rate for the early and late periods, and a combination of U.S. and French rates for the years France is on a de jure gold standard.[12] This base interest rate will be referred to below as the *gold interest rate.*[13]

Due to the lack of a clear center country, we consider a variety of base country interest rates as robustness checks. We checked all cases using the U.S. interest rate alone, as well as considering the British interest rate as the base rate, as a way of checking the assumption that Britain had ceased to be the center country. We also tried varying the base by local country to allow for the fact that, especially after 1931, the system broke down into smaller spheres of influence. We followed the coding that Eichengreen and Irwin (1995) use to describe currency blocs, dividing countries into Sterling countries (Denmark, India, Japan, and Sweden, using Britain as the base), Gold Bloc countries (Belgium, Italy, Netherlands, and Switzerland, using France as the base), Reichsmark countries (Austria, Bulgaria, Czechoslovakia, Hungary, and Romania, using Germany as the base), and other countries (China and Chile, using the United States as base).[14] While the cross-base

[12]Mouré (2002) discusses how many view France's gold policies as having had a strong impact on the system as a whole. This source also reports that France and the United States had the two largest national gold reserves and that, combined, they held 50 to 60 percent of the world's total stock of gold reserves.

[13]For annual differences regressions, this is simply the average of the change in the U.S. and French rates. For the levels analysis on monthly data, the U.S. rate is used up to 1928, and then that rate is adjusted going forward by the average change in the U.S. and French rates until 1936, after which it is adjusted by changes in the U.S. rate alone.

[14]In addition, we tried both simply eliminating the base countries or including them using the United States as the base rate for France, Germany, and Britain.

comparisons are discussed below, we feel in general that the gold interest rate is the most appropriate choice for the base rate.

Exchange Rate Regime Coding

The exchange rate regimes are classified based on both the legal commitment of countries to gold (the de jure status) as well as the de facto behavior of the exchange rate. De jure coding is based on the dates given by Obstfeld and Taylor (2003). The de jure status is in some sense a combination of the exchange rate regime and capital control regime sides of the trilemma as countries are considered to be off gold if they restricted convertibility in any way. The de facto standard follows the coding for the post–Bretton Woods era developed in Shambaugh (2004). We ask whether the monthly exchange rate stayed within ±2 percent bands over the course of a year. In addition, single realignments are not considered breaks in the regime as long as the transition is immediate from one peg to another. Finally, single-year pegs are dropped as they are quite likely a simple lack of volatility and it is unlikely that there exists either commitment on the government's part or confidence in the market that the rate will not change.[15] We use the categories "peg" and "nonpeg" to classify currency regimes so as to emphasize that countries without pegged rates may not be "pure" floats in which exchange rate management is eschewed. Countries with nonpegs simply do not peg completely (according to our metric).

Because there is no single base country to which countries peg, exchange rates are tested for stability against gold by examining the exchange rate against the dollar during the dollar's peg to gold, and against the French franc in the two-year period (1933–34) of dollar instability against gold. This provides a full series of codes for the countries that stayed pegged to gold on a de facto basis.[16] Exchange rate data come from GFD.

Capital Control Status

To conduct our empirical analysis of the trilemma, we also need to code countries as to their use of capital controls. As mentioned, the de jure exchange rate regimes automatically incorporate this criterion. De facto capital control classifications have been created for more recent eras, but most are available only for a limited number of countries and a limited amount of time. Furthermore, some measures rely on interest differentials (the variable upon which we focus) and thus are not appropriate for the present study. No other clear source has been used to describe

[15]When pursuing differences regressions, we also drop the first year of a peg to avoid differencing interest rates across nonpegged and pegged observations. Shambaugh (2004) provides an extensive discussion of different de facto classifications. Recent work by Reinhart and Rogoff (2004), which uses data on parallel exchange rates, is not directly relevant to the present paper. Countries with parallel exchange markets employ capital controls to separate commercial from financial transactions, and for that reason alone are likely to enjoy some degree of monetary independence.

[16]As an alternative, we also looked at the years the League of Nations listed a country as pegging to gold. The results are consistent with those reported below.

capital controls in this era before. We turn to two sources to generate our own coding of capital controls. The League of Nations publication *Legislation on Gold* (1930) gives a history of when countries returned to gold convertibility, so we are able to code at what point after World War I countries opened their capital markets to gold flows. In addition, the League of Nations' *Monetary Review* (1938) provides a table that describes when countries put in place exchange controls in the 1930s (Appendix Table 1, p. 107). Combining these sources gives us our measure of capital controls. Clearly, this binary measure is imperfect in capturing the range of effectiveness that various controls may have had, but we feel that it provides a useful indication of the countries trying to create breathing room by limiting cross-border financial flows.

Individual Country Episodes

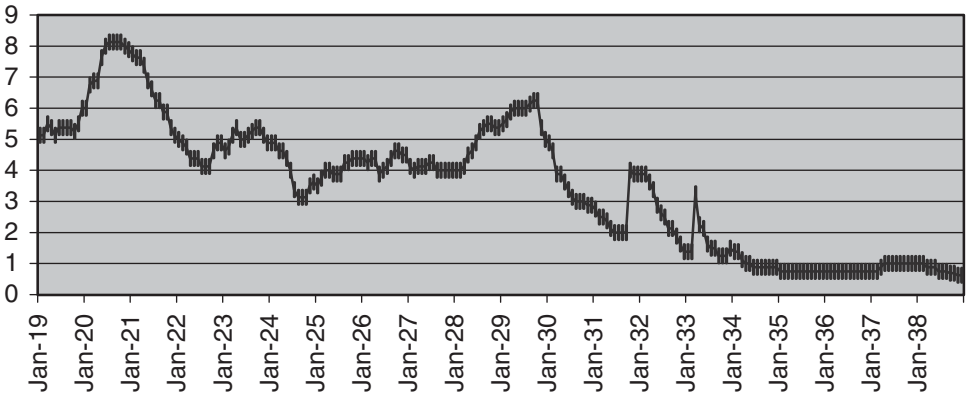
For the dynamic time-series analysis based on specification (7), we study monthly data on individual country/regime episodes. Two types of episodes are examined. First we look at the de jure coding, which gives us 13 pegged episodes and 21 nonpegged episodes (half of them occurring prior to the reconstituted gold standard, and half after). We also use our exchange rate regime coding methodology to generate a monthly classification of the currency regime in effect. We follow much the same method as for annual data, checking that the exchange rate has stayed within ±2 percent bands over the preceding 12 months. We then combine this information with our dates for capital controls to generate four types of episode: open pegs, closed pegs, open nonpegs, and closed nonpegs. Brief episodes of less than three years are excluded as too short to allow informative time-series inference. There are 11 open pegs, 3 closed pegs, 4 open nonpegs, and 3 closed nonpegs.

Unit Roots in Interest Rates

While the methodology section considers the fact that many time series of nominal interest rate data are difficult to distinguish from unit roots, this is not necessarily true for the classical gold standard era. While showing persistence, the British interest rate, the clear base rate under the classical gold standard, is relatively stable as are the interest rates of most other gold standard countries. On the other hand, the interwar years appear to resemble the Bretton Woods or post–Bretton Woods eras, in that the interest rates of most countries show very strong serial correlation. Figures 1a, 1b, and 1c show the interest rates for the United States, France, and the combined gold interest rate. For comparison, Figure 1d shows Britain's interest rate during the classical gold standard.

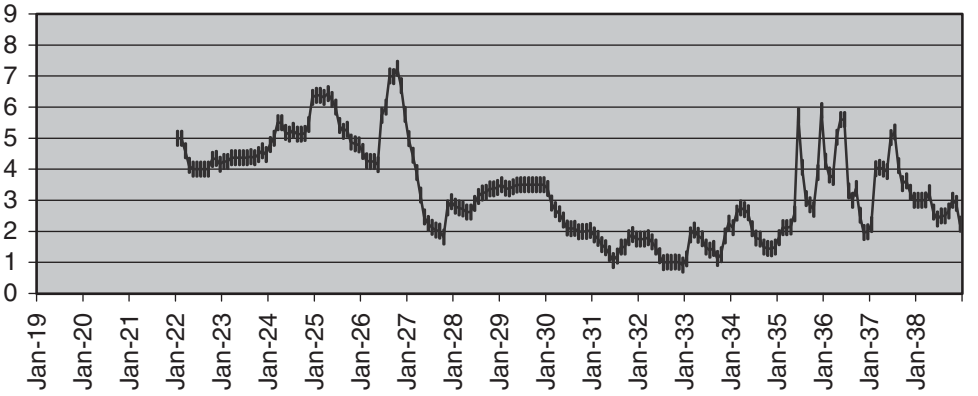
Simple tests on monthly base and local interest rates back up this ocular evidence that interwar interest rates are highly persistent. The autocorrelation coefficient for the U.S. rate is 0.99. The average autocorrelation coefficient for the other countries is 0.96. More formally, we apply the unit root test suggested by Elliott, Rothenberg, and Stock (1996), using the modified Akaike Information Criterion of Ng and Perron (2001) to determine the appropriate number of lags to include. In addition, we test for stationarity using the KPSS test of Kwiatkowski, Phillips,

Figure 1a. United States' Interest Rate in the Interwar Years



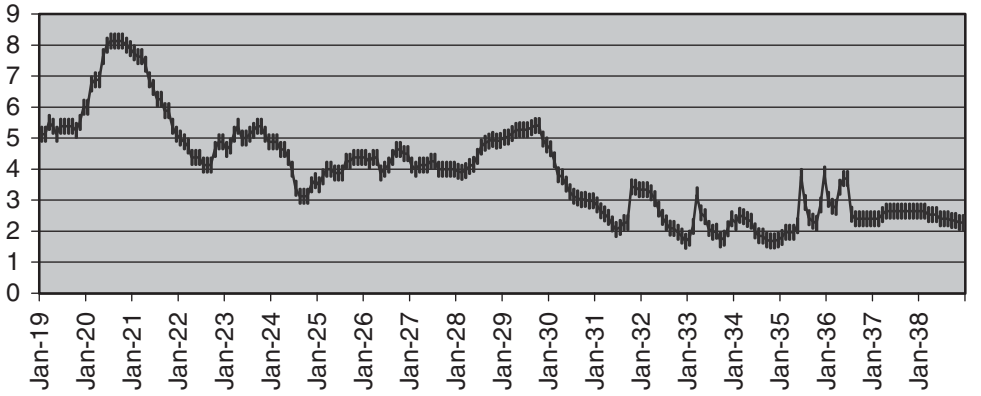
Source: Global Financial Database.

Figure 1b. French Interest Rate in the Interwar Years



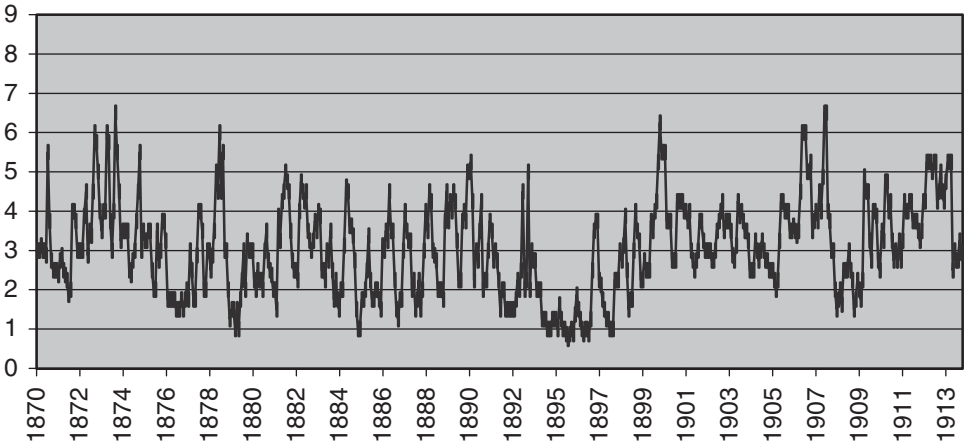
Source: Global Financial Database.

Figure 1c. "Gold Interest Rate" (Gold R) in the Interwar Years



Source: Global Financial Database and author's calculations (described in text).

Figure 1d. United Kingdom Interest Rate in the Classical Gold Standard



Source: Neal and Weidenmier (2003).

Schmidt, and Shin (1992), in which the null is stationarity rather than nonstationarity. For 12 countries, we cannot reject a unit root, but we can reject stationarity, implying that the interest rates are either nonstationary or very close. For three countries the data reject a unit root and cannot reject stationarity, while in one case the data can reject both, and in one case neither. As a general conclusion, the very high persistence in the data suggests that inference will be more reliable if they are treated as if they contain unit roots.

IV. Results

Results Based upon Pooled Differences

We begin by presenting results for the differences equation (1), based on the de facto currency regime coding and using the gold interest rate as the base rate. Additional specifications show results for alternative classifications and alternative base interest rates.

The core empirical result of the paper is shown in Table 3, which reports estimates of equation (1). The results are obtained by OLS, using robust standard errors clustered at the country level. This procedure, along with the use of differenced data, removes problems of both serial correlation and heteroskedasticity that could be present in the panel. Also, because the data are in panel form, one may consider using fixed effects; but as the data are differenced, a constant fixed effect would imply an implausible constant rate of change over time. In any event, allowing for fixed effects has no impact on the estimates in practice, and the estimated fixed effects are always zero.[17] Examining Table 3, we see a difference between the way pegged

[17]Observations for France are dropped for years in which its interest rate is a component of the base interest rate. Dropping France altogether has no substantial impact on the results. The United States is dropped in all years, as its rate is always a component of the base interest rate.

Table 3. Core Results
(Uses gold interest rate as the base interest rate)

Dependent Variable: ΔR_{it}

	1 Full	2 df Pegs	3 df Nonpegs	4 dj Pegs	5 dj Nonpegs
β ($\Delta goldR_{it}$)	0.300	0.567	0.128	0.720	0.072
std error	(0.116)*	(0.134)**	(0.178)	(0.144)**	(0.185)
Observations	240	109	106	66	163
R-squared	0.04	0.16	0.01	0.33	0.00

Notes:
df = de facto classification, dj = de jure classification.
Robust standard errors in parentheses.
*significant at 5 percent; **significant at 1 percent.

countries and those that are not pegged react to the base interest rate. Countries, on average, move with the base interest rate to some degree: β equals 0.30. However, pegs shadow the base rate much more closely than nonpegs: β for pegs is 0.57 (0.13) versus 0.13 (0.18) for nonpegs. These results are quite similar to the results for the classical gold standard, where the coefficient on pegs and nonpegs are, respectively, 0.52 (0.04) and 0.05 (0.09) (see Table 4). The estimates also are quite close to the earlier simulation results for the $\rho(\Delta z, \Delta R_b) = 0.8$ case (recall Table 1).

There is also a difference in the R^2 for pegs and nonpegs during the interwar years, as one would expect. The R^2 for the pegged sample is 0.16 versus 0.01 for the nonpegs. This difference matches the predictions of the trilemma, as the base country interest rate is a more important factor determining the local country inter-

Table 4. Results for Other Eras

Dependent Variable: ΔR_{it}

	Gold Standard Pegs	Gold Standard Nonpegs	Post BW Pegs	Post BW Nonpegs
β ($\Delta baseR_{it}$)	0.52	0.05	0.46	0.27
std error	(0.04)**	(0.09)	(0.04)**	(0.08)**
Observations	399	85	748	1103
R-squared	0.41	0.00	0.19	0.01

Notes:
Robust standard errors in parentheses.
*significant at 5 percent; **significant at 1 percent.

est rate for pegs than for nonpegs. Again, these differences in R^2 are quite close to those in the simulation results.

While the coefficients are somewhat close in the two gold standard eras, there is a clear difference in the explanatory power of the regressions. The difference in R^2 across pegs and nonpegs is far less striking than the classical gold standard (0.41 versus 0.00), and is much closer to the results found in the post–Bretton Woods era (0.19 versus 0.01). This difference is likely in part a result of the increasing use of capital account restrictions in the interwar years, perhaps partly a result of the very large shocks hitting interwar economies, and also possibly a result of countries' taking more interest in using monetary policy for domestic stabilization.

The results are further bolstered by looking at the alternative definitions of the gold standard described earlier. The de jure classification, which essentially only codes countries as pegged if the currency is fully convertible, shows stronger results. These pegs are the countries operating under the full constraints of the trilemma, ones we would expect to have very little autonomy. Here, the β coefficient for pegs is even larger than during the classical gold standard [0.72 (0.14)], and the β coefficient for nonpegs is essentially zero [0.07 (0.18)]. The R^2 on the pegged group also goes up to 0.33, suggesting that during the relatively well-functioning portion of the interwar gold standard, gold adherence did operate as a strong constraint, nearly as strong as during the classical period.

We also separate out the two legs of the trilemma, exchange rate regimes and capital controls, again using de facto exchange rate regimes, but now combined with our capital control measure. As expected, the group of observations that represents pegs with open capital markets shows the strongest connection to the base country (see Table 5). No other group generates a β significantly different from zero or an R^2 even half the size of the open market pegs. The R^2 suggests that over 20 percent of the movement in local interest rates can be tied to the base rate.

Table 5. Splitting Sample by Exchange Rate Regime and Capital Controls
(Using de facto coding)

Dependent Variable: ΔR_{it}

	1 Peg Open	2 Peg Closed	3 Nonpeg Open	4 Nonpeg Closed
β ($\Delta goldR_{it}$)	0.647	0.183	–0.315	0.307
std error	(0.153)**	(0.349)	(0.277)	(0.21)
Observations	79	30	40	66
R-squared	0.21	0.02	0.03	0.07

Notes:
Robust standard errors in parentheses.
*significant at 5 percent; **significant at 1 percent.

Thus, we see it is the combination of a fixed exchange rate and open capital markets that seems to generate the loss of autonomy. When countries either float or close their capital markets, they cease to follow the base as closely.[18]

Our interpretation is not without caveats, however. We cannot state clearly that the trilemma is forcing countries to follow the base because these results could be the consequence of pegged countries simply choosing to follow the base or experiencing shocks highly correlated with those hitting the base country. Previous work on the post–Bretton Woods era assumes a variety of base interest rates in a given time period, and thus allows the inclusion of time controls; distance and trade-share controls have been included as well. The currency regime and capital control regime variables still show strong impacts on the degree to which a country follows the base (Shambaugh, 2004).

Table 5 contains an apparent anomaly, though. The closed capital market nonpegs should be the group with the greatest monetary freedom. While all groups except open pegs should be able to pursue autonomous monetary policy to some degree, both conventional wisdom and results from other eras (see Obstfeld, Shambaugh, and Taylor, 2004) would suggest that the closed market nonpegs should be the *least* linked to the base. There should be very little pressure on them to respond to the base interest rate, as they should have achieved substantial autonomy both through shutting capital markets and by not pegging. We find, though, that this group has a larger (though still statistically insignificant) estimated β coefficient than do open nonpegs or closed pegs, and an R^2 of 0.07. This pattern indicates a stronger connection for this group than for the closed pegs or the open capital market nonpegs, and it is robust across a wide variety of base interest rate definitions and regime classifications. We return to this curious finding when we examine different time periods within the interwar sample.

We can further explore the results by pooling the data across regimes and including an interaction term for pegging times the change in the base interest rate (see equation (2), p. 80). The coefficient on peg times the change in the base rate is both large (0.43) and statistically significantly different from zero at the 95 percent level (see Table 6, column 1). The coefficient is even larger under the de jure coding (0.62 (0.22)). This pooled estimation procedure allows us to show that the results across samples are statistically significant, though it removes the ability to test differences in the explanatory power of the regression across subsamples. The procedure also summarizes the results in a more compact manner, allowing us to display sensitivity across a variety of base interest rates.

Results using the U.S. interest rate instead of the gold interest rate are similar on the whole, but weaker. Results using the British interest rate are weaker still, with relatively low and insignificant coefficients on the sterling interest rate alone or when interacted with the peg dummy. Given the importance of France in the

[18]The results on this point are even stronger than for other eras (see Obstfeld, Shambaugh, and Taylor, 2004). A similar table, pooling data across the gold standard, Bretton Woods, and post–Bretton Woods eras, generates significant coefficients for both pegs with capital controls and nonpegs without, though in both cases the coefficients are smaller and the R^2 much lower than for open pegs. In those results, it seems that either closing capital markets or eliminating a peg restores some autonomy, but not as much as doing both. In the interwar years, either action seems to restore autonomy.

Table 6. Pooling Across Pegs and Nonpegs

Dependent Variable: ΔR_{it}

	1 DF/GoldR	2 DJ/GoldR	3 DF/USR	4 DF/UKR	5 Bloc
β1 ($\Delta goldR_{it}$)	0.134	0.076	0.206	0.098	0.129
std error	(0.177)	(0.185)	(0.148)	(0.145)	(0.134)
β2 ($peg\Delta goldR_{it}$)	0.425	0.62	0.217	0.18	0.219
std error	(0.174)*	(0.217)*	(0.135)	(0.178)	(0.144)
Observations	215	229	224	207	219
R-squared	0.08	0.1	0.09	0.06	0.09
β1+β2	0.559	0.696	0.423	0.278	0.348

Robust standard errors in parentheses.
*significant at 5 percent; **significant at 1 percent.
DF = de facto coding; DJ = de jure coding; bloc = different bases using currency bloc coding.

system and the fact that the United States broke from gold at one point, it is not surprising that the gold interest rate shows a stronger sway over pegged countries' interest rates than does the dollar rate alone. Likewise, given Britain's relatively brief tenure in the interwar gold standard, it is not surprising that the country does not appear to have provided a base interest rate for the system. The weak international connections to Britain's interest rate do, however, support the view that after World War I, London was no longer the unrivaled center of global financial power. This finding is therefore consistent with Kindleberger's (1986) argument that a shift in hegemonic financial power was in progress during the interwar years. The regressions breaking the base interest rate into different rates for different countries are reported in column 5 of Table 6. It seems that either the U.S. rate alone or the U.S.-French rate in combination holds a much stronger sway over countries than the various bases that may have been regional or historical leaders.[19] With each interest rate base, the divided sample results (analogous to those in Table 3) yield a significant coefficient on the peg sample and an insignificant one on the nonpeg sample. The coefficients on nonpegs are sometimes estimated so imprecisely, however, that the differences across groups are not statistically significant for every different base interest rate when the data are pooled.

Next, we may wonder whether the system behaved differently before and after its descent into crisis. We use 1931 as the watershed year, as it featured the departure of sterling from the system. We thus divide our sample into pre-1931 and post-1931. Table 7 shows that the pre-1931 results (the first three columns) look much like our results for the overall sample, reported in the first table. Pegs generate

[19]Using the U.S. rate for the first half of the sample and the bloc-based interest rates after Britain's 1931 departure from gold yields even weaker results than in column 5 of Table 6. Thus, one cannot attribute the results to the fact that regionalization did not become pronounced until the system started to break down.

Table 7. Examining Pre- and Post-1931
(Uses de facto coding and gold interest rate as base)

Dependent Variable: ΔR_{it}

	Pre31 Full	Pre31 Pegs	Pre31 Nonpegs	Post31 Full	Post31 Pegs	Post31 Nonpegs	Post31 Nonpeg clsd
$\beta(\Delta goldR_{it})$	0.292	0.576	0.122	1.146	1.218	1.304	1.353
std error	(0.147)	(0.144)**	(0.220)	(0.206)**	(0.483)*	(0.359)**	(0.341)**
Observations	111	56	46	112	42	54	35
R-squared	0.05	0.21	0.01	0.14	0.15	0.19	0.23

Notes:
Robust standard errors in parentheses.
*significant at 5 percent; **significant at 1 percent.

higher coefficients and higher R^2 than nonpegs and the predicted target-zone coefficients in the neighborhood of 0.6 still arise. On the other hand, the post-1931 results are radically different. Both pegs and nonpegs show coefficients significantly different from zero and in fact greater than 1, although we cannot reject that they are different from the frequently seen baseline estimate of 0.6. In addition, the source of the anomaly in Table 5, which we discussed earlier, comes to light. The closed capital market nonpegs show a coefficient significantly different from zero, indeed well above 1, and an R^2 exceeding 0.2. When splitting the data into such narrow groups, we arrive at a small number of observations (35 in the case of the closed nonpegs after 1931). Still, despite the small number of observations, this result is statistically significant at the 99 percent level.

As for the question of why closed nonpegs would follow the base so closely, one may hypothesize that the shock of the depression provoked similar responses in all countries, and thus all countries show a strong correlation with the gold interest rate.[20] Alternatively, one might think that the chaos of the era left countries desperate to cling to any anchor they could find in order to restore stability. One strategy might have been to close off capital markets to avoid further attacks while following the base interest rate zealously in the hope of regenerating credibility. As it turns out, this latter explanation seems to have some plausibility, as all the countries that are closed market nonpegs repeg relatively quickly. Ten countries produce observations in this group, and all of them repeg before the end of the sample. Thus, at least for some countries, the 1930s seem not so much an era of pure monetary nationalism, as a time of desperate attempts to repeg. Table 8 shows the countries in this group and the years they are considered closed nonpegs. None stays nonpegged straight through

[20]Results on individual countries, presented next, show that not all countries moved together. That finding suggests that not all the results are due simply to common shocks. The results are not driven strictly by the choice of a base country. Results for pre- and post-1931 look broadly similar for the U.S. interest rate as a base. Using the British interest rate as a base, though, shows very weak results, with pegs generating a coefficient of 0.25 (0.11) versus 0.27 (0.16) for nonpegs.

Table 8. Observations That Are Closed Nonpegs Post-1931

Country	Years
Bulgaria	1933–36
China	1934–35, 1938
Czechoslovakia	1933–36
Germany	1933
Hungary	1933, 1936
Italy	1934–36
Japan	1932–35, 1938
Romania	1933–36
Chile	1932–36
Denmark	1932–34, 1938

to 1938; all restore a peg at some point. Many—for example, Czechoslovakia—appear to be freer than they were in reality, as they peg briefly during some of the years they are listed as nonpegs, but not consistently enough to be considered a peg in those years. We return to these questions in the levels analysis.

Time-Series Levels Analysis

We can explore these issues further by examining individual country relationships with the base interest rate. To do so we use the PSS methodology to test for the existence of levels relationships between interest rates, simultaneously examining the dynamics of adjustment.

Table 9 shows the individual results grouped by type of episode. The de jure results have the advantage of only having to group countries by one measure. We examine 3 groups, pegs, nonpegs before 1931, and nonpegs starting in 1931. It appears that the relationship seen at the pooled panel level still holds at the individual level. By and large, the pegs seem to follow the base rate (Table 9a shows the gold interest rate results). Six out of the 13 episodes are significant at both the $I(1)$ and $I(0)$ critical values, the average cointegrating coefficient is 0.53 and the average half-life of adjustment is 5 months. In addition, only 1 episode (Germany) has a backwards level relationship (that is, $\gamma < 0$) and only one other (Italy) has a half-life of over 12 months. Nine out of the 13 have a levels relationship of the correct sign and half-lives below six months.

Nonpegs do not show such a close relationship. Of the pre-1931 nonpegs, only 1 has a levels relationship that is both significant and in the correct direction. The average coefficient is –0.01, and the average adjustment half-life is 29 months. Also, 2 of the 8 cases have backwards levels relationships, and 3 more, have adjustment half-lives in excess of 12 months. Only China and the United Kingdom show much of a connection to the base rate. Post-1930 nonpegs show almost no connection at all with the gold interest rate. While 2 of the 11 have significant levels rela-

(*text continues on page 104*)

Table 9a. De Jure Pegs to Gold Interest Rate

	Lag	θ	γ	tstat θ	sig at 0	sig at 1	half-life	<3	3 to 12	>12	#obs
Austria 3/25–9/31	1	–0.10	0.31	–3.47	1	1	6.31	0	1	0	76
Belgium 10/26–2/35	1	–0.23	0.61	–5.14	1	1	2.71	1	0	0	101
Bulgaria 4/28–12/31	0	–0.12	0.60	–1.64	0	0	5.37	0	1	0	44
Czechoslovakia 1/29–12/31	5	–0.72	0.40	–2.81	0	0	0.54	1	0	0	36
Germany 10/24–6/31	3	–0.18	–0.75	–4.48	1	1	3.51	0	1	0	81
Hungary 4/25–7/31	0	–0.12	0.43	–4.10	1	1	5.47	0	1	0	76
India 3/27–8/31	1	–0.30	0.72	–3.76	1	1	1.97	1	0	0	54
Italy 2/28–11/34	1	–0.05	1.18	–1.76	0	0	13.24	0	0	1	83
Netherlands 4/25–8/36	2	–0.23	1.03	–3.39	1	1	2.69	1	0	0	137
Romania 1/29–12/32	0	–0.16	0.98	–2.08	0	0	3.98	0	1	0	44
Sweden 3/24–8/31	0	–0.26	0.53	–2.72	0	0	2.32	1	0	0	67
Switzerland 1/25–12/36	1	–0.06	0.52	–2.31	0	0	11.20	0	1	0	144
United Kingdom 4/25–8/31	0	–0.15	0.40	–1.81	0	0	4.36	0	1	0	77
Averages		–0.21	0.53	–3.03	0.46	0.46	4.90	0.38	0.54	0.08	78.46

Notes:

Lag	lag chosen based on Akaike information criteria
θ	the adjustment speed to shocks in the levels relationship
γ	the levels relationship
tstat θ	the t-stat on the adjustment speed, which is used to determine the significance of the levels relationship
sig at 0	signifies whether we can reject no levels relationship if we assume stationary data
sig at 1	signifies whether we can reject no levels relationship if we assume nonstationary data
half-life	the half-life of the shock based on the adjustment speed
#obs	number of observations for the episode

Table 9b. De Jure Pre-1931 Nonpegs

	Lag	θ	γ	tstat θ	sig at 0	sig at 1	half-life	<3	3 to 12	>12	#obs
Belgium pre-10/26	0	–0.02	0.17	–0.68	0	0	29.79	0	0	1	88
China pre-1931	0	–0.16	0.79	–1.20	0	0	3.95	0	1	0	35
India up to 2/27	1	–0.24	–0.54	–3.86	1	1	2.49	1	0	0	69
Italy up to 1/28	1	–0.03	–1.78	–1.50	0	0	25.32	0	0	1	70
Japan up to 12/29	0	–0.01	0.20	–0.28	0	0	138.28	0	0	1	131
Netherlands up to 3/25	1	–0.41	0.13	–5.05	1	1	1.32	1	0	0	73
Switzerland up to 12/24	0	–0.03	0.29	–2.07	0	0	22.01	0	0	1	71
United Kingdom up to 3/25	0	–0.08	0.58	–1.33	0	0	8.77	0	1	0	74
Averages		–0.12	–0.02	–2.00	0.25	0.25	28.99	0.25	0.25	0.50	76.38

Notes:

Lag	lag chosen based on Akaike information criteria
θ	the adjustment speed to shocks in the levels relationship
γ	the levels relationship
tstat θ	the t-stat on the adjustment speed, which is used to determine the significance of the levels relationship
sig at 0	signifies whether we can reject no levels relationship if we assume stationary data
sig at 1	signifies whether we can reject no levels relationship if we assume nonstationary data
half-life	the half-life of the shock based on the adjustment speed
#obs	number of observations for the episode

Table 9c. De Jure Post-1930 Nonpegs

	Lag	θ	γ	tstat θ	sig at 0	sig at 1	half-life	<3	3 to 12	>12	#obs
Bulgaria post-12/31	0	–0.03	0.53	–2.14	0	0	22.76	0	0	1	84
China post-12/30	0	–0.16	–0.14	–2.77	0	0	4.03	0	1	0	96
Czechoslovakia post-12/31	8	–0.08	–0.25	–3.50	1	1	8.65	0	1	0	84
Germany post-6/31	1	–0.07	–2.45	–1.59	0	0	9.14	0	1	0	90
Hungary post-7/31	6	–0.08	–0.27	–2.93	1	0	8.42	0	1	0	89
India post-8/31	6	–0.36	–0.04	–2.87	1	0	1.53	1	0	0	88
Italy post-11/34	1	–0.19	0.42	–3.56	1	1	3.39	0	1	0	49
Japan post-11/31	3	–0.09	0.16	–4.30	1	1	7.71	0	1	0	85
Romania post-12/32	0	–0.09	–1.54	–2.60	0	0	7.26	0	1	0	72
Sweden post-8/31	2	–0.06	–0.44	–1.84	0	0	11.81	0	1	0	88
United Kingdom post-8/31	2	–0.10	–0.62	–4.00	1	1	6.58	0	1	0	88
Averages	2.64	–0.12	–0.42	–2.92	0.55	0.36	8.30	0.09	0.82	0.09	83.00

Notes:

Lag	lag chosen based on Akaike information criteria
θ	the adjustment speed to shocks in the levels relationship
γ	the levels relationship
tstat θ	the t-stat on the adjustment speed, which is used to determine the significance of the levels relationship
sig at 0	signifies whether we can reject no levels relationship if we assume stationary data
sig at 1	signifies whether we can reject no levels relationship if we assume nonstationary data
half-life	the half-life of the shock based on the adjustment speed
#obs	number of observations for the episode

Table 9d. De Facto Open Capital Market Pegs

	Lag	θ	γ	tstat θ	sig at 0	sig at 1	half-life	<3	3 to 12	>12	#obs
Austria 1/24–9/31	5	–0.03	1.15	–1.36	0	0	20.04	0	0	1	90
Belgium 8/27–2/33	0	–0.12	0.57	–2.00	0	0	5.33	0	1	0	67
Czech 2/27–9/31	1	–0.14	0.10	–1.46	0	0	4.70	0	1	0	56
France 8/28–9/36	0	–0.06	0.47	–1.79	0	0	11.40	0	1	0	98
Germany 11/25–6/31	0	–0.21	0.15	–3.89	1	1	2.88	1	0	0	68
Hungary 11/26–6/31	6	–0.38	0.87	–3.45	1	1	1.45	1	0	0	56
India 12/25–8/31	2	–0.34	0.89	–4.51	1	1	1.68	1	0	0	69
Italy 12/28–3/34	1	–0.05	1.50	–1.24	0	0	12.98	0	0	1	64
Netherlands 10/25–9/36	2	–0.22	1.00	–3.21	1	0	2.82	1	0	0	132
Sweden 1/26–8/31	0	–0.26	0.53	–2.72	0	0	2.32	1	0	0	67
Switzerland 8/25–8/36	1	–0.05	0.44	–1.85	0	0	14.09	0	0	1	134
United Kingdom 1/26–8/31	0	–0.12	0.16	–1.37	0	0	5.52	0	1	0	68
Switzerland (orig) 8/25–9/36	3	–0.06	0.14	–2.25	0	0	10.65	0	1	0	134
Averages	1.64	–0.17	0.67	–2.46	0.36	0.27	6.71	0.45	0.27	0.27	79.18

Notes:

Lag	lag chosen based on Akaike information criteria
θ	the adjustment speed to shocks in the levels relationship
γ	the levels relationship
tstat θ	the t-stat on the adjustment speed, which is used to determine the significance of the levels relationship
sig at 0	signifies whether we can reject no levels relationship if we assume stationary data
sig at 1	signifies whether we can reject no levels relationship if we assume nonstationary data
half-life	the half-life of the shock based on the adjustment speed
#obs	number of observations for the episode

Table 9e. De Facto Other Regimes

	Lag	θ	γ	tstat θ	sig at 0	sig at 1	half-life	<3	3 to 12	>12	#obs
Closed nonpegs											
Belgium 1/20–7/26	6	0.03	−1.27	0.43	0	0	−27.00	1	0	0	79
Japan 12/23–4/27	5	0.07	−4.01	1.01	0	0	−10.24	1	0	0	41
United Kingdom 1/20–11/24	0	−0.12	0.92	−1.86	0	0	5.47	0	1	0	59
Closed pegs											
Bulgaria 1/28–3/33	0	−0.10	0.90	−1.84	0	0	6.38	0	1	0	62
Germany 8/34–12/38	7	−0.08	0.36	−2.33	0	0	7.90	0	1	0	53
Romania 6/29–3/33	0	−0.16	0.91	−2.14	0	0	4.03	0	1	0	46
Open nonpegs											
India 9/31–11/34	3	−0.49	0.62	−3.57	1	1	1.03	1	0	0	39
Italy 1/22–11/27	1	−0.03	−1.86	−1.47	0	0	24.41	0	0	1	69
Sweden 9/31–11/34	0	−0.07	0.47	−0.76	0	0	10.15	0	1	0	39
United Kingdom 9/31–11/34	2	−0.09	−1.20	−1.21	0	0	7.62	0	1	0	39

Notes:

Lag	lag chosen based on Akaike information criteria
θ	the adjustment speed to shocks in the levels relationship
γ	the levels relationship
tstat θ	the t-stat on the adjustment speed, which is used to determine the significance of the levels relationship
sig at 0	signifies whether we can reject no levels relationship if we assume stationary data
sig at 1	signifies whether we can reject no levels relationship if we assume nonstationary data
half-life	the half-life of the shock based on the adjustment speed
#obs	number of observations for the episode

Table 9f. French Episodes with the United States As a Base Interest Rate

	Lag	θ	γ	tstat θ	sig at 0	sig at 1	half-life	<3	3 to 12	>12	#obs
Open peg/de jure peg											
France 8/28–9/36	7	−0.06	−0.41	−1.02	0	0	11.40	0	1	0	98
Closed Nonpeg											
France 1/22–11/26	0	−0.08	−1.28	−1.41	0	0	8.42	0	1	0	58

Notes:

Lag	lag chosen based on Akaike information criteria
θ	the adjustment speed to shocks in the levels relationship
γ	the levels relationship
tstat θ	the t-stat on the adjustment speed, which is used to determine the significance of the levels relationship
sig at 0	signifies whether we can reject no levels relationship if we assume stationary data
sig at 1	signifies whether we can reject no levels relationship if we assume nonstationary data
half-life	the half-life of the shock based on the adjustment speed
#obs	number of observations for the episode

tionships in the expected direction, 8 of the 11 have levels relationships that imply they move against the base country interest rate.[21]

While the results for pegs and the results for pre-1931 nonpegs are broadly the same if one uses the U.S. interest rate instead of the gold interest rate, the post-1930 nonpeg results look quite different based on the U.S. interest rate.[22] Three of the 11 have a significant levels relationship in the expected direction and another 4 have insignificant relationships in the expected direction, with adjustment half-lives below 7 months, leaving only 4 rates that run opposite to the U.S. rate. This pattern suggests that by the end of the era, when the gold standard had largely fallen apart, France's role as a center country had diminished. As discussed above, we are not surprised to see some of the de jure nonpegs follow the United States from 1931 on. Many of these countries are in the process of reestablishing their exchange rate pegs or at the very least are in desperate straits, struggling for some credibility. On the other hand, some countries clearly are not following the United States, so it seems that common global shocks are not the sole factor behind the strong post-1931 relationships seen in the pooled data. Britain, China, India, and Romania all have negative relationships with the United States in their nonpegs of the 1930s.

When we classify the episodes by both exchange rate regime and capital control status, we have 11 open pegs, 4 open nonpegs, 3 closed pegs, and 3 closed nonpegs. Thus, there are too few country episodes to speak meaningfully about averages across groups, but we do see some suggestive patterns. By and large, the open pegs show a fairly strong connection with the gold interest rate. Three of the 11 show statistically significant positive relationships with an overall average of 0.67 and an adjustment half-life of 7 months. No episodes show a negative levels relationship and only 2 have adjustment half-lives above 12 months. Once again, it appears that the countries we expect to be constrained by the trilemma show evidence of that constraint.

Alternatively, in the episodes of closed nonpegs, countries do not appear to follow the Unites States. Two of the 3 show negative levels relationships. Only Britain prior to its return to gold shows a strong connection at all, with an insignificant (but close to unity) levels relationship and an adjustment half-life below 6 months. Britain in the years 1921–24 was intent on returning to gold and, thus, was following the United States quite closely; it was not trying to pursue an independent course, but it lacked credibility and reserves sufficient to rejoin the gold standard. The pre-1925 British result supports our contention that closed nonpegs in the post-1931 era show strong comovements with the base rate because they were hoping to repeg. Interestingly, there are no closed nonpegged episodes from the post-1931 era because no country in our sample maintained a nonpeg and

[21]The average adjustment speeds match our simulations as well, with mean θ equal to roughly –0.2 for pegs and –0.1 for nonpegs. However, the average θ for post-1931 nonpegs is not very informative regarding autonomy because in most cases, countries are adjusting interest rates away from the base.

[22]The results for the pegs are slightly weaker when using the U.S. rate, dropping the levels relationship to roughly 0.36 with an adjustment half-life of roughly 5 months. The pre-1931 nonpegs are as unconnected to the U.S. rate alone as to the gold interest rate, with a negative average levels relationship, an average adjustment half-life of over 28 months, 3 out of 8 with negative levels relationships, 2 more slower than 12 months, and only 1 significant positive relationship.

closed capital markets for as long as three years (our criterion for consideration as a distinct "episode"). Countries either briefly returned to pegs to break up strings of nonpegging, or repegged within 3 years of leaving gold.

The results for the closed pegs are fairly close to those for open pegs, suggesting that perhaps closing capital markets does not entirely insulate a country if it intends to maintain a peg for a considerable length of time. None of the 3 levels relationships is significant, but they are all positive, and 2 are quite close to 1. The adjustment half-lives are all estimated to be between 4 and 8 months. Our data comprise only 3 examples, though, of countries that maintained closed pegs for any extended period, so it is difficult to conclude much about them. The open nonpegs are split, with 2 (Britain, 1931–34 and Italy, 1922–27) showing insignificant negative levels relationships; 1 (Sweden, 1931–34) showing an insignificant, slowly adjusting, positive relationship; and 1, (India, 1931–34) showing a significant positive relationship with an adjustment half-life of 1 month.[23]

A final point worth noting is that interest rates in France and the United States were never that closely related. Both during France's prepegging episode from 1922 to 1926, and during its peg from 1928 to 1936, a negative levels relationship prevailed. Thus, one sees part of the great tension in the system as a whole during this era: the 2 center countries with the bulk of the gold reserves were moving their interest rates independently, making it difficult for countries to follow a single base.

Summary

The 2 types of econometric analysis broadly support the predictions of the trilemma. The pooled analysis shows that short-run interest rate movements in the pegged countries, especially when they have open capital markets, follow the base interest rate. The levels analysis shows that on average, it is the open pegs or de jure pegs that follow the base the most closely over time. Notably, many nonpegs seem to show considerable independence from the base interest rate at many points in the sample. A number of countries that are briefly floating do combine to generate a high average response of closed nonpegs to the base rate during the Great Depression, but this is largely an anomaly in our sample and the result is not significant.

Thus, we see that "fear of floating" type of behavior, while present in some cases, was not at all universal in our sample period as a whole. Many nonpeg countries were able to move their interest rates in ways quite distinct from the base country. On the other hand, in times of crisis, more floating rate countries may have chosen to follow the base in an attempt to repeg, may have been forced to follow the base or risk further speculative attack, or may simply have been following the base because of globally synchronized responses to large common shocks.

The trilemma finds considerable empirical support in this era, and the empirics generate results that are numerically consistent with theoretical, model-based

[23]The patterns when the U.S. interest rate is the base are similar, with the open pegs showing similar results episode by episode, though with a slightly lower average half-life (in particular, Austria, Hungary, and India are somewhat weaker against the U.S. interest rate than against the gold interest rate). In other groups, Germany shows a weaker relationship to the dollar rate as compared with the gold interest rate. Sweden's interest rate during its open nonpeg has a significant levels relationship with the dollar rate despite its insignificant relationship with the gold interest rate.

simulations. The trilemma was a constraint on policy for countries that fixed their exchange rate and maintained open capital markets. They lost much of their monetary autonomy compared with countries that adopted alternative regimes. The results also show why the architects of Bretton Woods were so concerned to create a system that would allow for some monetary autonomy notwithstanding stable exchange rates. The fact that some floaters did not pursue autonomy (as they could have), and instead managed interest rates with an eye toward returning to a peg, may have convinced contemporaries like Keynes and Nurkse that the potential instability of floating rates was not effectively compensated by any meaningful policy freedom. That view, in turn, led to the Bretton Woods consensus in favor of fixed exchange rates coupled with capital account control.

V. Conclusion

Up until now, the empirical content of the trilemma and, hence, its practical relevance, have remained largely untested. Our work seeks to show that the trilemma is a central feature of the macroeconomic world we have lived in for a century or more. Understood in a target-zone context, the real world content of the trilemma does deviate from the simplistic idea of full international interest rate equalization, but only in degree. It is true that this deviation confers a little independence on policymakers even under hard gold standard rules (Bordo, 2003; Bordo and Flandreau, 2003; and Bordo and MacDonald, 1997, 2003). But that independence is very limited indeed, we would argue. Under open capital markets and pegged exchange rates, the half-lives of interest rate deviations can be counted in months, and interest rate pass-through is very strong whether before or after World War I, or even today. It is not clear that such meager room for maneuver can offer any significant scope for purposeful macroeconomic management, especially when compared to the far slower adjustment and lower pass-through seen in floating or closed capital-market countries. Only a move to floating or the imposition of capital controls can free monetary policy to pursue domestic aims, and in practice they seem to do so.

Spanning, as it does, a century or more of experience, our empirical work in this and other papers highlights the enduring power of this principle. In this sense, we would argue that the trilemma is alive and well. As a working proposition, it merits attention from a wide audience, if our work is found to be persuasive. As a narrative hook, historians and political scientists have often invoked or criticized its applicability, but with little empirical evidence to guide interpretation. International economists will find an old familiar part of their toolkit now has been sharpened up by use in the field. Last, but not least, policymakers may better comprehend the true nature of the constraints under which they must operate in an open economy.

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Accounting for Consumption Volatility Differences

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In the wake of emerging market turmoil, the role and welfare consequences of volatility have attracted renewed attention. An emerging consensus points to various types of volatility being both a consequence and a determinant of longer-term growth performance. The linkages appear to be context dependent. This paper employs classification tree analysis to explore determinants of consumption volatility taking account of context dependence. The results suggest output volatility, measures of input volatility, and measures of economic development are best able to differentiate between countries with high and low consumption volatility. [JEL E21, E32]

Following the recent spate of emerging market turmoil, the role and welfare consequences of volatility have attracted renewed attention. While it may be too early to draw firm conclusions, an emerging consensus points to various types of volatility being both a consequence and a determinant of longer-term growth performance and of income distribution.

The academic and policy research has, with some exceptions, divided along this demarcation. A sizable literature, briefly summarized in Box 1, explores the role of volatility as a determinant of a variety of outcomes.[1]

A smaller literature, to which this papers belongs, examines the determinants of volatility in cross-country perspective. Among the core questions explored here are the impacts of economic development, increased trade, and financial integra-

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[1]See Aizenman and Pinto (2004), Buch (2002), and Prasad, Rogoff, Wei, and Kose (2003) for in-depth critical analyses.

Box 1. Volatility As a Determinant of Growth

Early postwar macroeconomics, aiming to better understand business cycle fluctuations, treated (trend) growth and (business cycle) volatility as largely distinct fields of study (exceptions apply, as always). The distinction slowly softened over time to the extent that recent macro models treat both features as jointly determined.

A variety of channels potentially give rise to a growth-volatility linkage. Some of these suggest a positive relation. Thus a simple aggregation of project-specific risk-return tradeoffs leads to a prediction of positive association between average return (growth) and average risk (volatility). Dynamically, Schumpeterian "cleansing recessions" may generate faster growth following recessions, be it due to increased R&D or greater survival chances of stronger firms.

Other channels suggest a negative link, notably in emerging markets. In the absence of complete markets, notably for long-term domestic currency debt, recessions can lead to lower investment in physical and human capital and reduced long-term growth, or a preference toward less specialized (and lower return) investments. A different line of argument treats volatility as a proxy for uncertainty which, under some assumptions, maps into lower investment and thus, ceteris paribus, growth.

Theory thus does not provide a clear overall prediction on the link between (growth) volatility and growth itself. On the empirical side, a rich literature, invigorated by an influential paper by Ramey and Ramey (1995), has fairly consistently pointed to a negative and causal link between the volatility of GDP growth and the mean GDP growth rate in broad cross-country studies. The result may be specific, however, to the cross-country perspective: across sectors within countries, the positive risk-return association suggested by investment theory appears to emerge (Imbs, 2002). The elasticity of growth with respect to volatility also appears to vary across country groups; in particular the link appears to be much weaker for mature economies. The relative importance of alternative (likely complementary) explanations for such differences—ranging from structural characteristics, such as financial market development and international integration, to active policy measures and the role of the political system in aggravating or offsetting shocks—remains an active research agenda.

tion on volatility. Theory does not provide a clear answer to these questions as far as output volatility is concerned, though predictions for consumption volatility are clearer. On the empirical side, only few robust results have emerged. One possible explanation is the presence of nonlinearities in many of these linkages. This paper, focusing on consumption volatility, employs a classification tree methodology, particularly suited to detecting both context dependence and threshold effects, to explore these nonlinearities in depth.

I. A Capsule Literature Review

While the evidence increasingly points to a two-sided causality linking volatility and growth, and thus to the need for an integrative treatment, from a conceptual perspective it is useful to split the literature into studies using volatility as, respectively, an explanatory and as the dependent variable. The first literature was briefly summarized in Box 1 (above); the following analysis concentrates on some core issues explored in the literature on the determinants of volatility.

A Framework

On the level of the individual household, the volatility of income depends on the size of shocks to which the economy or local area is exposed, on the steps the household has taken in anticipation of such shocks, and on public policies affecting the impact of shocks on household income, primarily the existence and structure of the social safety net. While all of these can be treated as given at a point in time, they become endogenous over time. Moving from household income to household consumption introduces another layer. Whether temporary income shocks map into consumption shocks depends on the ability and on the willingness of households to smooth consumption, and thus on a set of features ranging from private choices such as precautionary savings to public in-kind assistance programs.

The volatility of private consumption is thus driven by a complex array of factors. On a first level are the shocks influencing the national economy. On a second level are the determinants of the elasticity of household income to these shocks, and on a third level the determinants of the elasticity of household consumption with respect to household income shocks. Cross-country differences in aggregate consumption volatility can thus alternatively arise from differences in the size and frequency of shocks and from differences in the availability and usage of coping mechanisms, reflected in different elasticities of income and of consumption with respect to given shocks. The following paragraphs review some of the national features that have attracted particular attention in this context.

Economic Size

Large economies with diverse sectoral structures are more immune to both sector-specific shocks and—reflecting the negative association between size and openness—to external shocks, reducing aggregate output volatility. Domestic sectoral diversification also provides individuals with good domestic diversification options, potentially reducing consumption volatility even in the absence of international integration. Exploring this avenue, Crucini (1997) compares a sample of 68 smaller economies with the G-7 countries, finding the standard deviation of consumption rates to be significantly higher in the former group. Head (1995) and Kose and Prasad (2003) likewise detect a negative link between volatility and economic size.

Financial Deepening

Theory is ambiguous as to the linkage between financial development and output volatility. Empirical work (Denizer, Iyigun, Owen, 2002; and Buch and Pierdzioch, 2003) suggests that domestic financial development is associated with reduced output volatility. The link appears to be strongest for high-income countries and may depend on the extent of international financial integration. The link between financial development and consumption volatility is clearer: expanded diversification options suggest a negative link.

Fiscal Policy

Fiscal policy can be used to offset shocks, smoothing aggregate consumption. Whether it is used in this manner in practice remains an active area of inquiry (Kose, Prasad, and Terrones, 2003; and Agénor, McDermott, and Prasad, 2000). While there is some evidence for a smoothing use of fiscal policy in mature economies, fiscal policy in some emerging markets appears to be procyclical, possibly reflecting a procyclical access to borrowing.

International Aspects

Theory suggests that the effect of shocks on macroeconomic volatility depends on the extent to which participation in international goods and asset markets allows for specialization and for risk diversification. Alas, this is where theoretical clarity ends; the exact nature of the linkages, and indeed their sign, are far from obvious, motivating a very active literature exploring these linkages (Kose, Prasad, and Terrones, 2003).

Financial linkages

The recent spate of emerging market crises renewed interest in the nexus between international financial integration and macroeconomic volatility. On the output side, theory suffers from an embarrassment of riches. Apart from its ambiguous effects on sectoral concentration—and thus exposure to sectoral shocks—integration creates new transition channels for external shocks and may, depending on the exact structure of financial markets, magnify or reduce the effect of domestic distortions.[2] The net effect likely depends on both country characteristics and on the nature of shocks.

As was the case with domestic financial development, the predictions for consumption volatility are clearer: enhanced diversification opportunities should permit a reduction of consumption volatility following financial integration. In line with the arguments discussed above, the effect should be most pronounced in smaller and in more specialized economies with fewer domestic diversification options.

To date, empirical evidence supporting the strong theoretical implication for consumption volatility across diverse country samples remains scarce, though some evidence points to the predicted negative link for higher-income countries. The unconditional correlation of consumption growth rates across countries does not appear to substantially exceed the correlation of output growth rates. The volatility of consumption growth does not appear to be substantially smaller than the volatility of output growth in a sizable number of countries.[3] Regression analysis has yielded diverse results: while some authors do not detect a stable link,

[2]Recent work in this field includes Sutherland (1996), Faia (2001), and Buch and Pierzioch (2003).

[3]See Kose, Prasad, and Terrones (2003) and Hnatkovska and Loayza (2003). Imbs (2003) shows that for financially integrated economies consumption patterns are more correlated; however, so are GDPs.

others have found financial integration to be an important determinant of volatility.[4] The sample composition appears to matter. In particular, the predicted negative link appears to be stronger among OECD economies than among emerging markets.[5]

Trade linkages

The literature on trade openness and volatility likewise combines theoretical ambiguity with varied empirical findings. Enhanced real integration can lead to greater sectoral specialization but also provides greater diversification across demand sources.[6] On the empirical side, while a higher volatility of the terms of trade appears to be robustly linked to a higher volatility of output,[7] the relationship between generic measures of openness and output volatility is less settled.

Assessment

The brief review reveals that factors robustly linked to volatility across country samples are the exception rather than the rule; the most notable exception is country size. A number of studies have detected apparent breaks in the linkages. In particular, it appears that mature economies find it easiest to avail themselves of the diversification opportunities theory suggests will arise from greater financial development and international integration.

In principle, context dependence can be accommodated in the framework of regression analysis, in particular if theory yields guideposts as to the likely nature of such nonlinearities (Hnatkovska and Loayza, 2003). The challenge is, however, hard. There are rarely exact empirical guideposts even for first-level splits[8] while the ordering of splits for deep context dependence is often even outside the scope of educated guesses.

This paper sidesteps these problems, instead using classification tree analysis to explore patterns in consumption volatility. The results—essentially an in-depth description of the pattern linking the independent variables in the data set with the dependent variable—provide a complementary perspective to regression analysis. The next section briefly introduces the technique; the following sections present the results and conclude.

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[4]Among the studies exploring these aspects are Razin and Rose (1994), O'Donnell (2001), Bekaert, Harvey, and Lundblad (2002), Kose, Prasad, and Terrones (2003), and Buch and Pierdzioch (2003).

[5]O'Donnell (2001), Bekaert, Harvey, and Lundblad (2002), Kose, Prasad, and Terrones (2003).

[6]See for example Krugman (1993), Razin and Rose (1994), Kraay and Ventura (2001), and Kose, Prasad, and Terrones (2003).

[7]See for example Mendoza, 1995; and Agénor, McDermott, and Prasad, 2000. One exception is Buch and Pierdzioch (2003), who find no significant effect though they employ real exchange rate variability as a proxy for the terms of trade.

[8]At what level does a country become a member of the "mature economy" club? If its GDP per capita (or output per worker) places it in the top 10/20/X percent of all countries? If its manufacturing share in GDP exceeds X percent? If more than X percent of its trade is intra-industry? If it becomes a member of the OECD? Each of these criteria is reasonable, yet yields different groupings.

II. Methodology, Data and Caveats

A binary classification tree consists of a sequence of rules for allocating a binary dependent variable y to its two value-classes on the basis of a vector of explanatory variables x_j, $j = 1, \ldots . J$. In this application, the binary split is based on the recorded consumption volatility. Starting with a sample of 103 countries, the 35 countries with the highest consumption volatility are classified as belonging to the "high volatility" group ($VOL = 1$), while the 35 countries with the lowest volatility are classified as belonging to the "low volatility" group ($VOL = 0$). The middle 33 countries are discarded in order to create a discrete difference between the two groups. The binary dependent variable is thus given by *VOL,* taking the values of 0 and 1 respectively for "low" and "high" volatility observations.

A rule consists of an explanatory variable and a threshold. The rules are applied sequentially. The initial application generates the first rule, splitting the original sample into two subsamples. The algorithm is then applied separately to the two subsamples, and so on, resulting in a decision tree with multiple branches, each defined by an allocation rule. Specifically, a rule takes the following form:

> If, for a particular observation of the dependent variable *y,* the explanatory variable *x* is above threshold *z,* allocate the observation for the dependent variable *y* to the first binary class; otherwise allocate it to the second binary class.

At each node, there exists a large set of feasible rules, composed of all variables and all values each variable takes in the sample. The selection of the preferred rule among this set is based on the rule's ability to allocate observations correctly to the two classes. Rarely, particularly at the deeper nodes, a perfect rule may correctly allocate all observations to the correct value class. More typically, all candidate rules misallocate some observations. The rule chosen at a particular node is the candidate rule with the smallest error.[9] In principle, the process can continue until each observation is correctly classified, at the cost of highly complex trees. For the trees reported below, a depth of five to seven branches was used.[10]

The algorithm is particularly well suited to detecting both threshold effects and context dependence. As regards the former, the algorithm searches for the numerical value that, applied as a rule, minimizes the allocation error; it thus avoids the need to define groups such as high/low income a priori. The algorithm by construction also allows for a variable to become an important explanatory factor only once a number of prior conditions on other variables have been met, and thus automatically incorporates deep context dependence.

As the algorithm searches across all variables, it generates a ranking of each variable at each node in terms of its ability to split the observations at that node into the two groups. These rankings can in turn be used to compute an overall measure of the explanatory power of variables for the entire tree. This global

[9]Depending upon the question examined, different weights can be attached to type I versus type II errors. No such asymmetry arises in the present application; the errors are hence weighted equally.

[10]Alternatively, automatic termination rules based on a trade-off between the number of nodes and the fit can be selected.

importance rank, which takes full account of context dependencies, will be the main empirical focus of the analysis reported below.[11] The classification trees were calculated using the CART® program of Salford Systems.

Data[12]

The private consumption data used to compute the dependent variable are taken from the Penn World Tables.[13] Countries are included if a complete data series from 1960/61 to 1999 is available.[14] The volatility measure, $VOL(C)$, is calculated as the standard deviation of the growth rate of real per capita consumption.[15] A number of studies suggest that volatility patterns may have changed over time.[16] To allow for time variation, the data, covering the period 1960 to 1999, are split into four equal-sized decade groups.

As the algorithm disregards variables that are not helpful in allocating observations to one of the two groups, a broad set of potential explanatory variables can be included. These divide into several broad categories. The first comprises a set of (relatively) time invariant "structural" features such as location, the export orientation of the economy, and the quality of institutions. A second group contains features with a somewhat faster rate of change, such as GDP per capita, enrollment ratios, the size of the labor force, life expectancy, and the urbanization rate; as a group, these variables aim to capture the broadly defined development level of the economy. The third group encompasses measures of openness to trade and finance, of financial development and monetary policy, and of the role of government spending. On the trade/external finance side, the group includes openness relative to the world and to the OECD, the presence of current and capital account restrictions, the level of external debt, the concentration of exports, the exchange rate regime, and the level of real overvaluation. On the financial side, it includes the ratio of M2 to GDP, the mean inflation rate, and the central banker turnover rate.

The fourth group comprises measures of the political system: the type of regime, a proxy for political instability, and the Freedom House measures for political rights and civil liberties. Finally, a fifth group contains direct proxies for volatility in inputs and output. Apart from the volatility of GDP per capita growth, this group includes the exposure of countries to banking and currency crisis and

[11]As the ranking takes account of the set of discriminants at all nodes, a variable that never appears as part of a rule may still rank high in terms of overall importance.

[12]See also the detailed data appendix.

[13]Alan Heston, Robert Summers, and Bettina Aten, Penn World Table Version 6.1, Center for International Comparisons at the University of Pennsylvania (CICUP), October 2002.

[14]Data availability for the year 2000 remains spotty; hence, the sample was ended in 1999.

[15]Some authors (Agénor, McDermott, and Prasad, 2000) have used alternative detrending mechanisms. While different methods yield different numerical values, they do not in most cases appear to affect the ranking of countries substantially (Razin and Rose, 1994; and Hnatkovska and Loayza, 2003). As the volatility measure used in this paper takes just two values—high and low, with the middle group being dropped—the detrending method used is likely to be of secondary importance.

[16]Hnatkovska and Loayza (2003), Kose, Prasad, and Terrones (2003), and Buch (2002).

the volatility of the terms of trade, of the real exchange rate, of the black market premium, of inflation, and of the government current expenditure share.

Caveats

The data and methodology are subject to several caveats. First, the focus is on aggregate private consumption in cross-country comparison. The mappings obtained will likely differ, possibly sharply, among groups within each country, a feature not captured here. Second, the results do not directly link to welfare. As the focus is on private consumption, no attention is given to the potential smoothing role played by public consumption (Kose, Prasad, and Terrones, 2003). Also ignored are consumption-leisure trade-offs and any issues arising from the distinction between durable and nondurable expenditures; furthermore, no distinction is made between consumption movements reflecting permanent shocks to income, and changes reflecting an inability (or unwillingness) to smooth in the face of temporary shocks.[17]

III. Results

For each of the four decades, two trees were calculated. The first tree is based on the full set of explanatory variables, including the various volatility measures. The second tree excludes all volatility measures. Trees were capped at five to seven branches unless a complete allocation was achieved with fewer nodes. Table 1 reports the ten explanatory variables with the highest explanatory power for the full data set.[18]

The volatility of GDP p.c. growth is the best discriminant for the volatility of consumption growth, placing in the top two for all decades. The result confirms prior findings. Despite the apparently much greater scope for domestic and international diversification provided by financial development and increasing financial integration, the volatility of consumption continues to be very closely associated with the volatility of national output.

Table 2 reports the number of times that each variable has appeared in the top five and top ten for the four decades (only variables with at least two appearances in the top ten are reported). Overall, the best explanatory variable for consumption growth volatility is output growth volatility, appearing three times at the first rank, once at second rank. Two measures of input volatility, the volatility of the terms of trade and of the black market premium, together enter a further six times.

Measures of economic development are also useful in distinguishing between high and low consumption volatility observations. GDP per capita and output per worker together appear seven times among the top ten; life expectancy and

[17]The problem can be partly addressed by looking at the volatility of consumption relative to income Kose, Prasad, and Terrones, 2003.

[18]As mentioned above, the coverage in terms of variables is comparable for the last three decades, while for 1960 several variables do not exist; differences between the 1960s and the other decades are thus less meaningful.

Table 1. Ranking of Variables by Explanatory Power, All Variables

	1960s	1970s	1980s	1990s
1	Volatility (GDP Growth)	Volatility (GDP Growth)	Life Expectancy	Volatility (GDP Growth)
2	Urbanization	Vol. (Black Market Premium)	Volatility (GDP Growth)	Life Expectancy
3	Primary Enrollment	Urbanization	Vol. (Black Market Premium)	GDP p.c.
4	GDP p.c.	Volatility (ToT)	Gini Coefficient	Volatility (ToT)
5	Output per Worker	Vol. of Gov. Current Exp.	Political Rights	M2/GDP
6	Vol. (Black Market Premium)	Overvaluation	Civil Liberties	Vol. of REER
7	OECD Trade	Life Expectancy	GDP p.c.	Vol. (Black Market Premium)
8	Secondary Enrollment	Volatility of Inflation	Output per Worker	Banking Crisis
9	Labor Force Size	GDP p.c.	Debt to GDP	Exchange Rate Crisis
10	—	Output per Worker	—	Civil Liberties

urbanization another five times. Civil liberties rounds out the list, though at a low rank. Measures of the extent of trade and financial integration do not play an important role, though they are, of course, correlated with economic development.

Dropping the volatility indicators permits an assessment of the relative importance of structural factors. Tables 3 and 4 report, respectively, the ten most important discriminants for each of the four decades and the most frequently appearing discriminants across all four decades, analogous to Tables 1 and 2.

The tables are dominated by indicators of the development level: GDP p.c., life expectancy, output per worker, urbanization, and the enrollment ratios all appear repeatedly among the top ten. Measures of trade integration appear

Table 2. Frequency Among Top Five and Top Ten, All Variables

Discriminant	Occurrences in Top Five	Occurrences in Top Ten
Volatility (GDP p.c. Growth)	4	4
Volatility (Black Market Premium)	2	4
Volatility (Terms of Trade)	2	2
GDP per Capita	2	4
Output per Worker	1	3
Life Expectancy	2	3
Urbanization	2	2
Civil Liberties	0	2

Table 3. Ranking of Variables by Explanatory Power, Tree 2

	1960s	1970s	1980s	1990s
1	Output/Worker	Avg. Gov. Cur. Exp.	Life Expectancy	Life Expectancy
2	GDP p.c.	Political Rights	GDP p.c.	M2/GDP
3	Life Expectancy	Military/Population	Output/Worker	Average Inflation
4	Secondary Enrollment	Life Expectancy	Civil Liberties	Political Rights
5	Primary Enrollment	Secondary Enrollment	Urbanization	GDP p.c.
6	Urbanization	Urbanization	Avg. Gov. Current Exp.	Overvaluation
7	Labor Force Size	Primary Enrollment	Political Rights	OECD Trade
8	OECD Trade	Overvaluation	Overvaluation	Debt/GDP
9	Openness	GDP p.c.	Linguistic Fragmentation	Capital Account Restrictions
10	Military/ Population	Output/Worker	Labor Force Size	Openness

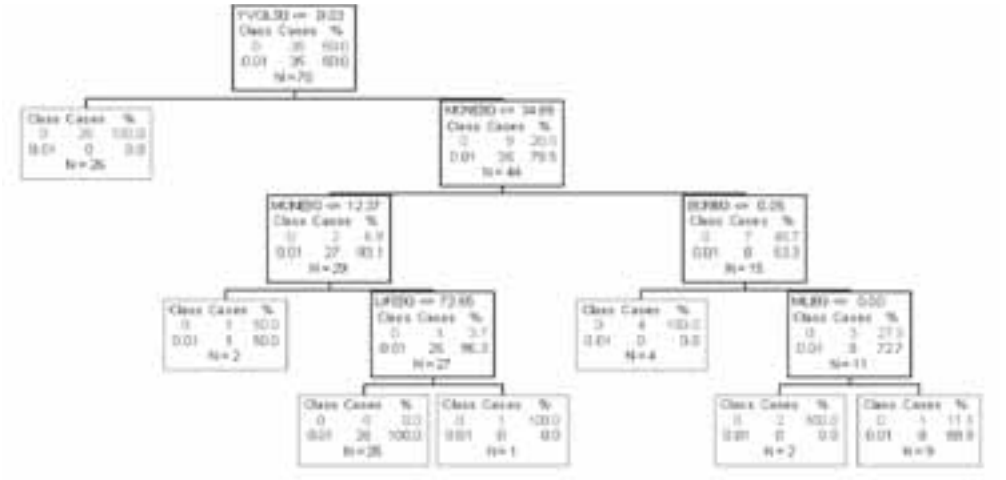
somewhat useful, while measures of financial integration and crisis do not enter systematically.

In conjunction, the results point to the primary importance of output and input volatility in explaining consumption volatility in cross section, consistent with the prior literature. Beyond output volatility, the development level emerges as the second important discriminant between countries with high and low consumption

Table 4. Frequency Among Top Five and Top Ten, Excluding Volatility Measures

Discriminant	Occurrences in Top Five	Occurrences in Top Ten
Life Expectancy	4	4
GDP per Capita	3	4
Output/Worker	2	3
Urbanization	1	3
Secondary Enrollment	2	2
Primary Enrollment	1	2
Overvaluation	0	3
OECD Trade	0	2
Openness	0	2
Political Rights	2	3
Military/Population	1	2
Labor Force Size	0	2
Average Current Expenditure	1	1

Figure 1. Tree for the Full 1990s Dataset



volatility.[19] Other features, notably real and financial openness, while of course correlated with development, appear to be of only secondary direct importance for the distinction between high and low consumption growth volatility.

Classification Trees

In terms of an aggregate measure of importance, the "top ten" lists presented above convey the most accurate impression, as they evaluate the relative importance of the variable at each node. While the trees themselves focus only on the best discriminant at each node, they convey additional information about the precise value of the threshold, and the sign of linkage. Space constraints prevent complete discussion of all eight trees. Figure 1 depicts the tree for the full data set for the 1990s.

The original sample divides equally into 35 high volatility (class = 0.01) and 35 low volatility (class 0) observations. The top box reports this split, with the number of observations as well as the percentages (here trivially 50 percent and 50 percent) and the total number of remaining observations (here $N = 70$). The first splitting rule is reported at the top of the box. In this case, the 26 observations ($N = 26$) for which the volatility of output growth is equal to or less than 0.03 are allocated to the left node; the 44 remaining observations ($N = 44$) are allocated to the right node.

Within the left node, the fit is perfect: all 26 observations are correctly classified as low volatility; the branch consequently ends at this node, yielding the first (unconditional) result: low output growth volatility is strongly associated with low

[19]As mentioned above, the first and second moment of output growth are themselves negatively related across broad country sets, with at least part of the causality apparently running from higher output volatility to lower output growth.

consumption growth volatility, where the threshold for low output growth volatility is a standard deviation of output growth of 0.03 or less.

Within the right node, 35 out of the 44 observations fall into the high consumption growth volatility group, the remaining 9 observations into the low volatility group. While high output volatility is thus associated with a greater likelihood of high consumption volatility (almost 80 percent versus 50 percent for the full sample), the link is not perfect. Pushing the search one level deeper reveals that within the group of countries with high output growth volatility, the degree of monetization matters for allocating observations to the high versus the low consumption volatility group. Specifically, observations fulfilling the dual condition of output growth volatility above the threshold of 0.03 and monetization ratios below the threshold of 35 percent fall overwhelmingly into the high volatility group (27 of 29 observations).

The 15 countries characterized by output growth volatility above 0.03 and monetization ratios above 34.85 percent divide roughly equally into high and low volatility observations. Within this subgroup, all countries without exchange rate crisis experienced low volatility, versus only 27 percent of countries with at least some incidence of an exchange rate crisis. This finding illustrates the benefit of the context dependent search: based on the overall usefulness of the discriminants, the presence of an exchange rate crisis is an also-run, yet within the (sizable) subgroup of countries defined by relatively high output volatility and a relatively developed monetary system, it becomes an important discriminant.

IV. Conclusions and Outlook

The literature on the determinants of volatility suggests that linkages between particular variables and volatility may depend on other country characteristics. This paper employed classification tree analysis to delve more deeply into such context dependence. The results indeed suggest important context dependence; they also clearly establish output volatility and measures of input volatility, followed by measures of economic development, as the variables best able to account for the presence of high versus low consumption growth volatility. In contrast, financial development and integration, which on theoretical grounds might be expected to drive a wedge between income and consumption volatility, do not appear to play a prominent role beyond their link to the development level.

APPENDIX
Data

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5. POLITY IV. Variable used: POLITY2. Defined as ranging from –10 to +10. Data available via the Internet at: *http://www.cidcm.umd.edu/inscr/polity/refuselicense.asp.* (Data for the successor states of the Soviet Union and Yugoslavia prior to their dissolution were set equal to values of the Soviet Union and Yugoslavia. Values for Czech Republic and Slovakia prior to their split set equal to the value for Czechoslovakia.)
6. UNU/WIDER–UNDP World Income Inequality Database. Data available via the Internet at: *http://www.wider.unu.edu/wiid/dowm/pad.htm.* (For Gini coefficient. The Gini coefficient used in the data set is the median of all values reported for a particular country.)

Fixed Factors

Variable	Source		Note
Transition Country	ES	TRAN	0–1 dummy
Landlocked Countries	ES	LAND	0–1 dummy
Export Focus: Manufacturing	ES	EMAN	0–1 dummy
Export Focus: Non Fuel Primary	ES	ENFP	0–1 dummy
Export Focus: Fuels	ES	EFUE	0–1 dummy
Export Focus: Services	ES	ESER	0–1 dummy
Export Focus: Diversified	ES	EDIV	0–1 dummy
Ethnic Fractionalization	A	EFRA	0–1 range
Language Fractionalization	A	LFRA	0–1 range
Religious Fractionalization	A	RFRA	0–1 range
Institutional Quality	SW	IQUA	
Location: Tropical	ES		0–1 dummy

Time-Varying Factors

Variable	Source	Name	Notes
Primary Enrollment	ES	PRIMxx[1]	1960, 1970, 1980, 1990, Year
Secondary Enrollment	ES	SECOxx	1960, 1970, 1980, 1990, Year
Life Expectancy at Birth	ES	LIFExx	1962, 1970, 1980, 1990, Year
Military/Population	ES	MILIxx	1960, 1970, 1980, 1980 data also used for 1990
Real GDP per Capita, Real U.S. Dollars, U.S. = 1	ES	GDPRxx	1960, 1970, 1980, 1990, Year
Workers (China = 1)	ES	WORKxx	1960, 1970, 1980, 1990, Year
Output per Worker, US$ U.S. = 1	ES	LRPOxx	1960, 1970, 1980, 1990, Year
Urbanization Rate	ES	URBAxx	1960, 1970, 1980, 1990, Year
Non-OECD Trade (percent of GDP)	ES	TRAAxx	1960, 1970, 1980, 1990, Year
Openness Total (percent of GDP)	ES	OPENxx	Decadal average 1960s, 1970s, 1980s, 1990s
External Debt (percent of GDP)	ES	DEBTxx	Decadal average 1970s, 1980s, 1990s (1960s: all NA)
Current Account Restrictions	GGW	CURRxx	Decadal average of dummy variable (0–1), 1970s, 1980s, 1990s only
Capital Account Restrictions	GGW	CAPRxx	Decadal average of dummy variable (0–1), 1970s, 1980s, 1990s only
Export Concentration (top 3)	GGW	TCONxx	Decadal average (2 obs/decade), 70s, 80s, and 90s
Fixed Exchange Rate Regime	GGW	PEGGxx	Fraction of decade spent under pegged regime
Intermediate Exchange Rate Regime	GGW	INTMxx	Fraction of decade spent under intermediate regime
Floating Exchange Rate Regime	GGW	FLOAxx	Fraction of decade spent under floating regime
Real Overvaluation	ES	OVERxx	Decadal average
M2/GDP	ES	MONExx	Decadal average
Average CPI Inflation	ES	MINFxx	Decadal average

Central Bank Turnover Ratio	GGW	TURNxx	Decadal average
Government Current Exp. on Goods/Services (percent of GDP): Mean (82n)	ES	MGOVxx	Decadal average (1960s missing)
Regime Type 1: Civilian, 2: Military-Civilian, 3: Military, 4: Other	ES	REGIxx	1960, 1970, 1980, 1988 (used for 1990)
Political Instability X = Sum of # of coups, # of revolutions # of riots, # of purges, # of assassinations, # of gu. warfare activities	ES	PINSxx	= 0 if X = 0 = 1 if X = 1 or X = 2 = 2 if X = 3 or X = 4 or X = 5 = 3 if X > 5 1960, 1970, 1980, 1988 (used for 1990)
Political Rights 1 (lowest) to 7	FH	PRIGxx	Mid-decade, no data for 1960s
Civil Liberties 1 (lowest) to 7	FH	CLIBxx	Mid-decade, no data for 1960s
Volatility of Terms of Trade	ES	VTOTxx	Decadal SDEV, 1960s, 1970s, 1980s, 1990s
Volatility of Black Market Premium	ES	BLMKxx	Decadal SDEV, 1960s, 1970s, 1980s, 1990s
SD of REER	GGW	REERxx	Decadal average of the annual SDEVs of monthly obs.
Currency Crisis	GGW	ECRIxx	Fraction of decade with currency crisis
Volatility of CPI Inflation	ES	VINFxxx	By decade
Government Current Exp. on Goods/Services (percent of GDP): SDEV (82n)	ES	VGOVxx	By decade (1960s missing)
Banking Crisis	GGW	BCRIxx	Number of years in decade with banking crisis

[1]"xx" refers to the decade.

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Exchange Rate Policy and the Management of Official and Private Capital Flows in Africa

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During the 1990s a number of African central banks succeeded in bringing inflation to relatively low levels while maintaining a market-determined exchange rate. These central banks were generally reluctant to fully subordinate exchange rate targets to monetary targets, however, particularly in the face of large external shocks. We focus on the management of highly persistent shocks to aid flows, including PRSP-related increases in net flows, in the presence of currency substitution by the domestic private sector. Such shocks have beneficent long-run effects, but when currency substitution is high they can produce dramatic macroeconomic management problems in the short run. What is the appropriate mix of money and exchange rate targeting in such cases, and the role of temporary sterilization? We analyze these and related issues in an intertemporal optimizing model that allows a portion of aid to be devoted to reducing the government's seigniorage requirement. This creates a strong link between official aid flows and private capital flows, giving rise to tradeoffs reminiscent of the literature on private capital inflows in emerging markets. When the credibility of policymakers' commitment to low inflation is firm, some degree of dirty floating, with little or no sterilization of increases in the monetary base, is the most attractive approach. [JEL D23, E52, F31, F35]

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Since the early 1990s, African central banks have struggled to find the appropriate mix of money and exchange rate targeting when faced with highly persistent shocks to aid inflows (including PRSP- and HIPC-related increases in net flows).[1] Such shocks have beneficent long-run effects, but when foreign currency balances compete actively with domestic currency they can produce dramatic monetary management problems in the short run. Thus a large inflow initially draws the central bank into foreign exchange intervention, in a pattern consistent with the "fear of floating" widely exhibited by countries operating nominally flexible exchange rate regimes (Calvo and Reinhart, 2000a). But the implied reserve accumulation then expands the monetary base, generating fears of inflation and "overheating." Bond sales may be used to sterilize the liquidity injection, but this leads to large increases in real interest rates. In the end, policymakers have to make a difficult decision: what combination of changes in inflation, nominal and real exchange rates, and real interest rates should be used to absorb the aid shock?

This paper develops a theoretical framework that can shed light on the tradeoffs associated with alternative policies for managing large official and private capital inflows to low-income African economies. Although a large literature relates to this topic, we believe it needs more work. The literature on capital inflows to emerging market economies has wrestled with many of the issues that concern us. Few precise results have emerged from this literature, however, and controversy persists regarding the efficacy of bond sterilization, the appeal of alternative approaches to absorbing domestic liquidity, and the relevance of underlying concerns about overheating. Moreover, in an African context, the problem has its own distinctive features: the initiating inflows are official rather than private; the "officially pronounced" nominal anchor is money rather than the exchange rate; and the economies in question are low-income rather than emerging-market economies, with correspondingly less developed financial markets. The problem requires a fresh analytical treatment, and one that is tailored to the particular circumstances of the countries at hand.

In the next section, we review recent experiences in Uganda, Tanzania, and Mozambique. As official inflows into these countries began to rise in the late 1990s, the policy dialogue between their central banks and the IMF focused increasingly on the appropriate path for domestic liquidity. On a continuum ranging in principle from full sterilization to full accommodation, the IMF consistently favored greater exchange rate flexibility and tighter bounds on liquidity expansion than did the central banks. In practice, the central banks chose to lean heavily against nominal appreciation and quickly abandoned attempts to control liquidity through extensive bond sales. The central message of this paper, is that the central banks got it right. When the credibility of policymakers' commitment to low inflation is firm, a heavily managed float with little or no sterilization is indeed the most attractive approach to managing a large and persistent aid inflow.

[1]The Poverty Reduction Strategy Paper (PRSP) articulates a country's medium-term macroeconomic and public expenditure program. In the majority of countries the PRSP anticipates increased public expenditures financed in part by sustained increases in net aid flows, including from debt relief payments arising from the Heavily Indebted Poor Countries (HIPC) initiative.

Since the central bank approach generates rapid nominal money growth, its appeal must rest on a view that persistent aid inflows generate a large increase in real money demand. While the evidence to date favors such a view (Section I), the literature provides little guidance as to the mechanisms involved or the structural features underlying such a response. In our model, two features of poststabilization low-income countries prove decisive. The first is that a portion of aid ends up reducing domestic budgetary financing rather than supporting an increase in government spending or a reduction in taxes. This agrees with the data. In sub-Saharan Africa (SSA) between 1990 and 2001, 21 cents of each aid dollar substituted, on average, for domestic financing.[2] A persistent aid inflow therefore reduces expected seigniorage and expected inflation, thereby generating a potentially substantial increase in real money demand.

The second decisive feature of our analysis is an active private capital account. While private capital flows have largely been ignored in discussions of aid management, this is no longer appropriate. Foreign-denominated assets constitute an important share of private financial wealth in low-income Africa, and a growing body of evidence suggests that foreign currency competes actively with domestic currency in the countries we are studying (Collier, Hoeffler, and Pattillo, 2002; Asea and Reinhart, 1996; and Bhindra and others, 1999). Our simulation results suggest that portfolio adjustments already confront central bankers with tradeoffs that, while less spectacular than those facing their emerging-market counterparts, hold similar perils for short-term macroeconomic stability. In particular, a fall in expected inflation triggers a portfolio adjustment that even under modest substitutability generates an outright reduction in desired foreign balances. The incipient capital inflow places acute short-run pressure on the foreign exchange market, dramatically undermining the case for a floating exchange rate.

In Sections II–IV, we develop the core structure of our model and calibrate it to the countries under study. Following Buffie (2003) we use a two-sector, perfect foresight model with imperfect asset substitutability. Aid accrues directly to the public sector, where the bulk of it is spent, but a portion may be devoted to reducing the government's seigniorage requirement. To quantify the macroeconomic tradeoffs we begin by solving the model under the polar exchange rate arrangements of a pure float (Section V) and a predetermined crawling peg (Section VI). The long-run response is identical, and we assume throughout the paper that the monetary authority accepts the moderate real appreciation that is required to absorb the long-run spending effect of aid.[3] A comparison of short-run responses, how-

[2]In our working paper we use data from Gupta and others (2002), covering a sample of 39 low-income countries from 1991 to 2000, to assess the contribution of aid (grants plus net loan disbursements) to the fiscal deficit and the domestic financing requirement. The *ex post* budget financing component rises to nearly 30 percent in sub-Saharan Africa in the second half of the 1990s.

[3]If the inflow is known to be temporary, it may be welfare-improving for the monetary authority to target the real exchange rate, letting inflation and/or the real interest rate increase in order to prevent "Dutch disease" or other adverse effects of a temporary real appreciation (Prati, Sahay, and Tressel, 2003; and Calvo, Reinhart, and Végh, 1995). But when the inflow is persistent, there is little to recommend a delayed real exchange rate adjustment. Monetary management should concentrate, instead, on avoiding short-run volatility around the new long-run real exchange rate. A successful monetary response is one that avoids an overshooting of the real exchange rate, a burst of inflation, a slump in real activity, or a run-up in the real exchange rate.

ever, generates a result reminiscent of the broader literature on exchange rate regimes: when government spending rises by the full amount of aid, portfolio shifts play a minor role, and we find that floating rates deliver a superior outcome, with near-immediate adjustment to the steady state and little short-run volatility in the real exchange rate or interest rate. When a portion of aid is used to reduce the seigniorage requirement, in contrast, portfolio adjustment plays a major role and the crawling peg delivers greater short-run stability.

A clean float is even more unappealing if domestic wages and prices are downwardly rigid in the short run, because in this case the deflationary impact of nominal appreciation creates a strong bias toward economic contraction.[4] The advantages of the crawling peg, however, are not unambiguous: they are bought at the price of an initial burst of inflation, unless—implausibly in our view—domestic wages and prices are rigid in the upward direction. In Sections VIII and IX, therefore, we consider alternative strategies for neutralizing these short-run effects, including temporary bond sterilization of foreign exchange intervention and a managed float that targets the new long-run equilibrium real exchange rate. While a crawling peg with bond sterilization fails badly, generating intolerable increases in interest rates and government debt, the managed float delivers an unambiguously favorable outcome.

Section X concludes the paper with suggested extensions of the analysis.

I. Country Experiences

The experiences of Uganda, Tanzania, and Mozambique since the late 1990s illustrate well the policy problems confronting central banks in many low-income countries (see Box 1 and Tables 1 and 2). For at least the previous two decades monetary policy was subordinated to fiscal imperatives, initially to the financing of large (and ultimately unsustainable) fiscal deficits and, since the early 1990s, in support of decisive fiscal consolidations, which, in turn, ushered in an era of historically low inflation (Honohan and O'Connell, 1997). With each country resorting to fiscal rules to manage the growth in domestic credit to government, there was little or no role for active monetary policy.

Successful stabilization has been associated with large and persistent increases in aid and private capital flows, most notably into Uganda and Tanzania. Given the priorities embedded in countries' PRSPs, the public expenditure financed by these aid flows has been biased toward nontradables, creating pressure for the real exchange rate to appreciate at the same time that private capital flows caused the monetary base to expand rapidly. In this environment the central banks have wrestled with the problem of how much (if at all) domestic liquidity growth needs to be neutralized, over what time period, and by what means.

Two issues have complicated the question of the required scale of intervention. The first is a lack of clarity on the part of the authorities as to whether concerns about the exchange rate relate more to its volatility than its level (and even

[4]Calvo and Reinhart (2000b) cite debt deflation as a risk in floating exchange rate systems. Our own interpretation here emphasizes the traditional demand contraction channel.

Box 1. Monetary and Exchange Rate Policy in Uganda, Tanzania, and Mozambique, 1999–2002[1]

Since the mid-1990s, Uganda, Tanzania, and Mozambique have enjoyed rapid economic growth based around broad overall macroeconomic stability and structural reforms that have included exchange rate unification and the de facto liberalization of the capital account; each now classifies itself as operating a floating exchange rate regime. All three have seen inflation drop sharply compared to levels experienced in the early 1990s.[2] Three key characteristics have helped shaped the countries' current policy choices: low levels of domestic debt and thin domestic debt markets; low domestic monetization; and widespread currency substitution. At the end of the 1990s, on the eve of the episodes we examine here, domestic debt averaged between 2 and 4 percent of GDP, reflecting in part the legacy of high inflation and administered interest rates on nominal debt and, more recently, a sequence of domestic budget surpluses. Moreover, markets in government debt are relatively new and dominated by short-dated instruments. Hence, changes in domestic public borrowing, which would otherwise be considered modest relative to the size of the fiscal deficit or GDP, end up being large relative to the domestic bond market and entail correspondingly large movements in domestic interest rates.

Money demand in all three countries is also low and appears to be strongly influenced by currency substitution. Reserve money averages little more than 4 percent of GDP, and narrow money is 10 percent. By contrast, foreign currency constitutes a large and rising share of private sector money. Foreign currency deposits account for between one-quarter (Uganda and Tanzania) and one-half (Mozambique) of total deposits of the banking sector, and an unknown volume of foreign currency circulates in parallel with domestic currency outside the banking sector. Consistent with the broader literature on Africa, it would appear that although some of this stock is accounted for by "passive" resident donor mission, embassy and NGO accounts, a substantial portion is actively managed as part of the private sector's wealth portfolio.[3]

Uganda

The recent surge in aid flows into Uganda, which began around 2000, occurred against the background of a slump in world coffee prices. Reflecting concerns about this sector, the initial response by the Bank of Uganda (BoU) was to accumulate foreign exchange reserves in order to forestall any exchange rate appreciation arising from increased aid-financed public expenditure on nontradables. Given the constraints of the program negotiated with the IMF—which envisaged only a modest growth in reserve money—the BoU therefore initially attempted to sterilize the domestic liquidity injection through domestic debt sales. Large relative to the initial size of the domestic debt, this intervention in the domestic debt market precipitated a rapid increase in the debt stock, interest rates, and debt service costs (since with a short average maturity the debt stock was turned over and repriced rapidly). So swift was this increase that the BoU abandoned its bond-sterilization strategy in early 2001 but without any offsetting change in its stance on the exchange rate. As a result, reserve money grew rapidly and by mid-2001 it was around 10 percent above its program target. Under pressure from the IMF and the Ministry of Finance, the BoU reverted to a sterilization strategy that relied more heavily on foreign exchange sales. With export earnings weakening and slower than anticipated implementation of public expenditure at the time, the nominal exchange rate did not in fact appreciate in response to BoU intervention (although the nominal and real exchange rates were arguably still more appreciated that the Bank would have wished at the time). Throughout this whole episode and despite the significant monetary overhang relative to the program, underlying nonfood inflation remained low and consistent with the BoU's inflation target.

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[1]These narratives are based on government documents, IMF Staff Reports, and program review documents and discussions with IMF staff. All interpretations of the evidence are our own.

[2]Inflation reached 250 percent a year in Uganda in the late 1980s and over 60 percent a year in Tanzania and Mozambique in the early 1990s.

[3]See, for example, the literature on private capital flows by Asea and Reinhart (1996), Bhindra and others (1999), Collier and others (2002), and Fedderke and Liu (2002) on private capital flows and

Tanzania

Tanzania's experience is similar to that of Uganda although perhaps more dramatic. Following a sequence of successful ESAF/PRGF arrangements through the late 1990s, tensions began to emerge in mid-1999 as aid and private capital flows increased. As in Uganda, the Bank of Tanzania (BoT) sought to resist the pressure on the exchange rate by targeting the nominal exchange rate which, despite the surge in inflows, remained virtually constant against the U.S. dollar for almost two years (mid-1999 to April 2001).[4] Sterilization of the shilling counterpart of these aid flows was initially achieved through domestic debt sales. As it happened, the start of this period coincided with a temporary shortfall in tax revenues which the authorities chose to fund through domestic debt sales, so that part of the surge in domestic borrowing and the rise in interest rates at this time reflected conventional deficit-financing requirements.[5] However, during the final quarter of 1999 and well into 2000, by which time the funding crisis had receded, BoT continued to rely on debt sales to sterilize the shilling counterpart to the aid inflow. By mid-2000 concerns about rising interest costs saw the Bank scale back its intervention in the domestic debt market. With both of the conventional instruments for neutralizing domestic liquidity pinned down, reserve money grew rapidly and quickly broached the ceiling implied by the targets for net international reserves (NIR) and net domestic assets (NDA) defined under the PRGF. Since 2001 the IMF has argued for a significantly tighter monetary stance, and secured the agreement of the Bank of Tanzania to supplement the existing performance criteria with an explicit program benchmark for reserve money growth in the 2002/03 PRGF arrangement. As in Uganda, however, inflation has remained low and stable, despite the volatility in interest rates and excess growth in reserve money.

Mozambique

In many respects, the experience of Mozambique is rather different from that of Uganda or Tanzania. One important difference is that the surge in private capital flows preceded the resurgence of official aid flows. The Bank of Mozambique's (BoM) initial response to the growth in private flows, from 1998 to roughly the end of 1999, was conventional. Although BoM did not appear to explicitly target the nominal and real exchange rate, it did allow its net international reserves to rise rapidly, so that over this period reserve coverage increased from 3.5 to 6.5 months of (a rising volume of) imports. This increase was offset by a fiscal sterilization—government deposits with BoM rose sharply and NDA fell one-for-one with the rise in NIR. Reserve money growth was thus almost entirely capped, with higher real money balances accommodated through an increase in the broad money multiplier and a steady rise in the share of foreign currency deposits—on which the domestic reserve requirement was zero at the time—in total private sector money balances.

By late 1999 and into 2000 reserve money growth began to exceed its program targets, even though these had been revised upward to accommodate the effects of the floods of 2000. By this stage aid flows had increased to finance nontradable PRSP-related public expenditure, and the previously tight fiscal stance had been loosened somewhat. Although the BoM was not attempting to offset an appreciation in the exchange rate, it was reluctant to use its instrument aggressively to control the growth in reserve money, arguing instead that the observed growth was noninflationary and reflected an underlying recovery in money demand. Initial sterilization efforts through the debt market were therefore relatively mild, and only in response to significant encouragement from the IMF and a sharp increase in inflation in the second half of 2001 did the BoM adopt more aggressive open market operations.

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the empirical work by, among others, Fielding (1994), Adam (1999), Henstridge (1999), and Nachega (2001), which finds significant currency-substitution effects on the demand for domestic monetary aggregates.

[4]However, given the sharp depreciation of the South African rand over this period, Tanzania's trade-weighted exchange rate appreciated over this period.

[5]This shortfall, which had been anticipated from early in 1999, reflected over-optimistic forecasts of revenue following tax reform measures implemented in 1989/99.

whether the argument that monetary policy cannot depreciate the real exchange rate on a permanent basis is fully accepted, Calvo, Reinhart, and Végh, 1995). The second is the absence of a consensus on the likely evolution of the demand for money and hence the sustainable noninflationary growth in domestic liquidity. As Table 1 indicates, velocity has declined in all three countries, and in both Uganda and Tanzania inflation has remained low and stable despite bursts of rapid growth in reserve money. In Mozambique, by contrast, a closer—or at least more rapid—link between reserve money and inflation has been evident. The central banks of Uganda and Tanzania, and to a lesser extent the Bank of Mozambique, have argued that the decline in velocity, which was consistently greater than the IMF had projected, reflected two factors: first, that the inflation-induced demonetization of the late 1980s and early 1990s was still in the process of being reversed; and second, that structural reforms had substantially increased permanent income and therefore the demand for money. The contrary view, articulated in IMF staff appraisals but apparently supported by the Ministry of Finance in Uganda, is more pessimistic. According to this view, structural reforms have generated, at best,

Table 1. Output, Aid, Inflation, and Reserve Money in Uganda, Tanzania, and Mozambique

Calendar Year	Real GDP Growth (in percent)	Net Aid Inflow (percent of GDP)	CPI Inflation (in percent)	Reserve Money Velocity (1997 = 1.00)
		Tanzania		
1997	3.5	3.1	15.4	1.00
1998	3.7	4.0	11.2	1.01
1999	3.5	4.5	7.0	0.92
2000	4.9	6.0	5.5	0.93
2001	5.7	5.0	4.9	0.98
2002	6.2	5.9	4.4	0.91
2003(proj)		6.4		
		Uganda		
1997	5.0	8.3	8.4	1.00
1998	4.5	7.9	–1.9	0.85
1999	8.0	7.9	9.3	0.88
2000	5.0	9.2	3.3	0.78
2001	5.5	11.7	–3.3	0.70
2002	6.6	12.5	–0.5	0.64
2003(proj)		10.5		
		Mozambique		
1997	11.2	14.8	6.9	1.00
1998	12.0	12.7	–1.1	1.15
1999	7.5	13.5	6.1	1.12
2000	1.5	14.4	11.6	1.01
2001	13.0	15.2	22.0	0.91
2002	7.7	15.4	9.1	0.90

Sources: IFS and IMF Staff Reports.

only a modest increase in money demand, while the history of inflation in these countries has permanently increased the elasticity of substitution between domestic and foreign money, reducing the demand for money at any inflation rate. Hence, while there may have been a structural shift in money demand between the 1980s and 1990s, the case for a further sustained increase in real money demand in the poststabilization period remains unproven. This pessimism, combined with a view that money supply growth is still taken as a signal of the credibility of government's commitment to fiscal discipline, underpins the "neutralize at all costs" position that appears to have dominated the IMF's perspective on the limit of monetary policy in these countries in recent years.

Turning next to the question of how sterilization is to be achieved—via traditional bond sterilization, foreign exchange sales, or delayed fiscal absorption of aid—it would appear the central banks have first and foremost been concerned with avoiding excessive nominal and real appreciation. The initial response to inflows in all three countries thus included a sharp accumulation of international reserves, and in Uganda and (especially) Tanzania the central bank intervened in the foreign exchange market to limit the pressure on the nominal exchange rate. To the extent that the underlying anxieties about the exchange rate are articulated, it is the adverse effect on traditional cash-crop exports that appears to have been of prime concern to the central banks. It is much less clear whether their concerns extend to nontraditional exports or the import-substituting sector, as stressed by the Dutch disease literature.

In the context of a reserve money program, this fear of floating suggests the use of sterilized intervention, and bond sterilization played a major role in all three countries, at least initially. The thinness of domestic debt markets, however, meant large increases in domestic interest rates which in turn, given the short maturity of debt instruments, led to a rapid pass through to debt-servicing costs (Table 2). It

Table 2. Bond Sterilization Episodes in Uganda, Tanzania, and Mozambique
(In percent)

	Before	Active OMO	After
Tanzania			
91-day yield	7.3	13.9	4.6
Ex post real yield	–1.1	6.9	–0.5
Uganda			
91-day yield	7.1	13.8	6.7
Ex post real yield	–2.2	9.6	4.1
Mozambique			
91-day yield	12.6	22.9	—
Ex post real yield	1.8	10.4	—

Sources: IFS and IMF Staff Reports.

Notes: "Active OMO" denotes periods of aggressive open market operations by the central bank. These periods are: Tanzania, July 1999–April 2000; Uganda, December 1999–July 2001; and Mozambique, July 2000 onward. "Before" refers to the six months prior to the Active OMO period and "After" to the full period since.

appears to have been these mounting fiscal costs of debt service, rather than the impact of high interest rates on credit to the private sector, that constituted the dominant constraint on central banks' willingness to continue bond sterilization, and it was this unwillingness that induced the authorities to switch toward more aggressive foreign exchange sales (in Uganda) and/or allow reserve money growth to exceed its program target (in Tanzania and Mozambique).

II. The Model

We work with a simple currency substitution model of a small open economy that produces a nontraded good and a composite traded good. Real output is fixed in both sectors and the world price of the traded good equals unity. The private sector divides its wealth between domestic currency, foreign currency, and government bonds. Notational conventions are as follows: P_n and γ denote the relative price of the nontraded good and its share in aggregate consumption; Q_i is output in sector *i; b* is the nominal stock of bonds deflated by the price level; and *m, F,* and *E* are real money balances, the stock of foreign currency, and aggregate real expenditure measured in U.S. dollars (i.e., units of the traded good).

Before turning to the equations, two remarks are in order about the general specification of the model. First, the assumption that the foreign asset does not earn interest is innocuous. What *is* critical, especially in the section on sterilization, is that the foreign asset and domestic bonds are not perfect substitutes; hence the domestic interest rate is not tied down by the interest-parity condition. Second, when aid spending shifts out the demand curve in the nontradable sector, the real exchange rate would appreciate less if the supply curve were not vertical. This does not substantively alter the results. The only change in the solutions is that the compensated elasticity of demand for the nontraded good, whenever it appears, is replaced by the sum of the demand elasticity and the general equilibrium elasticity of nontradables supply.

Prices

P_n adjusts to clear the goods market in the nontradables sector. This requires

$$D_n(P_n, E) = Q_n, \tag{1}$$

where $D_n(\cdot)$ is the Marshallian demand function for the nontraded good. The overall price level P is a geometric weighted average of the prices of the traded and nontraded goods. Since the nominal exchange rate e sets the domestic price of the traded good,[5]

$$P = eP_n^{\gamma}. \tag{2}$$

[5]For small changes, γ can be treated as a constant. In the numerical simulations, γ varies endogenously with P_n. (We do not assume Cobb-Douglas preferences.)

The Private Agent's Optimization Problem

All economic decisions in the private sector are controlled by a representative agent who possesses an instantaneous utility function of the form $V(P_n, E) + \phi(mP_n^{-\gamma}, FP_n^{-\gamma})$. $V(\cdot)$ is a standard indirect utility function that measures utility from goods consumption, while $\phi(\cdot)$ reflects liquidity services generated by holdings of domestic and foreign currency. To obtain concrete results and prepare the model for calibration, we assume $V(\cdot)$ and $\phi(\cdot)$ are nested CES-CRRA functions in which τ, β, and σ denote, respectively, the intertemporal elasticity of substitution, the elasticity of substitution between traded and nontraded consumer goods, and the elasticity of substitution between domestic and foreign currency.

The private agent chooses *m, b, F,* and *E* to maximize

$$U = \int_0^\infty \left[V(P_n, E) + \phi\left(mP_n^{-\gamma}, FP_n^{-\gamma}\right)\right] e^{-\rho t} dt, \tag{3}$$

subject to the wealth constraint

$$A = m + P_n^\gamma b + F \tag{4}$$

and the budget constraint

$$\dot{A} = P_n Q_n + Q_T + P_n^\gamma g + r P_n^\gamma b + (\pi - \chi) P_n^\gamma b - \chi m - E, \tag{5}$$

where ρ is the time preference rate; g is real lump-sum transfers; $\chi = \dot{e}/e$ is the rate of currency depreciation; r is the real interest rate; and $\pi = \dot{P}/P$ is the inflation rate. $P_n^\gamma = P/e$ multiplies g and b because wealth is measured in dollars but transfers and bonds are indexed to the price level. For the same reason, the artificial capital gains term $(\pi - \chi)P_n^\gamma b$ appears in the budget constraint (5).

On an optimal path, the marginal rate of substitution between consumption and m or F equals the income forgone from holding that type of money:

$$\phi_1 / V_E \, P_n^\gamma = r + \pi, \tag{6}$$

$$\phi_2 / V_E \, P_n^\gamma = r + \pi - \chi. \tag{7}$$

In addition, the path of real expenditure satisfies a standard Euler equation. Under the assumption of homothetic preferences, the Euler equation reads

$$\frac{\dot{E}}{E} = \frac{\tau(\eta + \gamma)}{\eta}(r - \rho), \tag{8}$$

where $\eta = \beta(1 - \gamma)$ is the compensated own-price elasticity of demand for the nontraded good.[6]

[6] η appears in equation (8) because the solution takes into account how the price of the nontraded good varies on the transition path.

The Public Sector Budget Constraint

Money is injected into the economy whenever the central bank accumulates foreign exchange reserves Z or runs the printing press to finance the fiscal deficit of the central government. For now, we ignore bond sales and open market operations. The *consolidated* public sector budget constraint is thus

$$\dot{m} = P_n^{\gamma}(g + rb) + \dot{Z} - X - \chi m, \tag{9}$$

where X is sale of aid dollars net of government imports and interest payments on the public sector foreign debt net.[7]

Net Foreign Asset Accumulation and the Balance of Payments

One last equation completes the core structure of the model. Summing the private and public sector budget constraints produces the accounting identity that foreign asset accumulation equals national saving or the current account surplus:

$$\dot{F} + \dot{Z} = P_n Q_n + Q_T + X - E. \tag{10}$$

Fixed versus Flexible Exchange Rates

In a pure float the central bank never intervenes in the foreign exchange market; with $\dot{Z} = 0$, equations (8)–(10) comprise a 3×3 dynamic system in which m and E are jump variables and F is predetermined. Under a crawling peg, on the other hand, the money supply adjusts endogenously through the capital account to satisfy money demand. But while domestic currency can be swapped for foreign currency at the central bank, the total dollar value of currency holdings J is predetermined. To bring J into view, add equations (9) and (10). After cancelling terms, we have

$$\dot{J} = P_n^{\gamma}(g + rb) + P_n Q_n + Q_T - E - \chi m. \tag{11}$$

Equations (8) and (11) then comprise a 2×2 system in which E is a jump variable and J is predetermined. This ends the formal, notation-intensive part of the paper.

Most of the space in the next seven sections is devoted to nontechnical, intuitive explanations of how aid affects the economy's equilibrium path. Additional equations appear only insofar as they are needed to state important results or describe extensions of the core model. All of the algebra involved in solving for the steady state outcome, deriving key conditions, and characterizing the dynamic systems associated with different policy regimes may be found in the IMF Working Paper version of the paper available via the Internet at *http://www.imf.org*.

[7]For simplicity, we ignore interest payments on reserves. This ensures that the long-run impact of aid on real income and the fiscal deficit is independent of the exchange rate regime.

III. The Steady State Outcome

The long-run equilibrium is independent of the exchange rate regime. It is not yet necessary therefore to specify whether the central bank operates a crawling peg, a clean float, or some type of managed float.

Across steady states, $\dot{m} = \dot{F} = \dot{Z} = \dot{E} = 0$ and $r = \rho$. Imposing these conditions produces the equilibrium depicted in Figure 1a. The R and F schedules in the first and fourth quadrants show how seigniorage ($R \equiv \pi m$) and holdings of foreign currency vary with inflation. The slopes of these two schedules are

$$dR/d\pi = m(1 - \varepsilon)$$
$$dF/d\pi = (\sigma - \tau)\,\theta_m F/i\,,$$

where $i = \rho + \pi$ is the nominal interest rate; θ_j is the share of liquidity services provided by currency j; and $\varepsilon = (\tau\theta_m + \sigma\theta_f)\pi/i$ is the elasticity of money demand with respect to inflation. In the ensuing analysis we assume $\varepsilon < 1$ and $\sigma > \tau$. Neither assumption is particularly restrictive. The first keeps the economy away from the slippery, downward-sloping portion of the seigniorage Laffer curve. (When $\varepsilon > 1$, long-run comparative statics results are perverse and the equilibrium path is indeterminate.) The second implies that lower inflation reduces the demand for foreign currency. Although theory does not guarantee this result, there is not much doubt that it is easier to substitute between the two currencies than to substitute intertemporally in consumption; hence some flight capital comes home when inflation declines.

The D schedule in the second quadrant summarizes the general equilibrium relationship between aid and the fiscal deficit after grants. (Hereafter we use the shorter term fiscal deficit and omit "after grants.") When more aid flows in, X rises and the government increases real transfers to the private sector by $d(P_n^\gamma g) = \psi dX$. Since aid also drives up the relative price of the nontraded good by the amount $dP_n/P_n = dX/\eta E$, the overall impact on the fiscal deficit D is

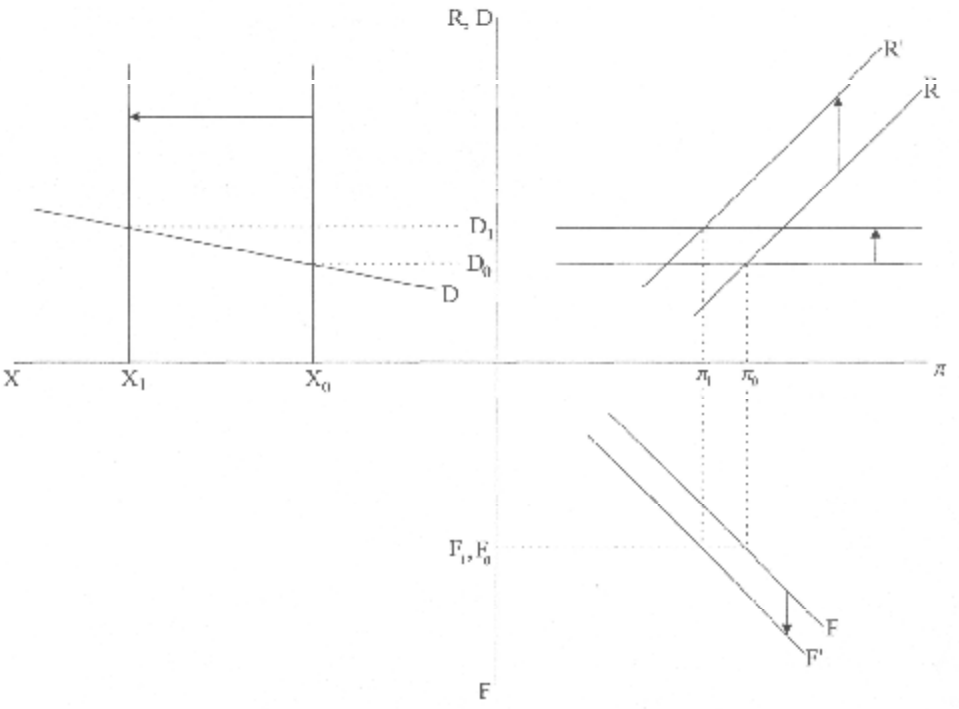
$$dD = (\psi - 1 + \gamma s\rho/\eta)dX \lesseqgtr 0,$$

where $s \equiv P_n^\gamma b/E$.

In the long run, π is pinned down by the requirement that revenue from the inflation tax cover the fiscal deficit. Much depends therefore on the slope of the D schedule. We distinguish here between aid that is fully spent and aid used partially for deficit reduction (PDR aid). Figure 1a applies when every dollar of aid is spent ($\psi = 1$). In this case, the fiscal deficit worsens because appreciation of the real exchange rate ($P_n \uparrow$) increases the size of the internal debt measured in dollars. But higher spending also shifts the R and F schedules upward by strengthening the demand for domestic and foreign currency. Consequently, despite the rise in the fiscal deficit, inflation falls when

$$\pi\mu > \frac{\rho s\gamma}{\eta + \gamma}\,, \tag{12}$$

Figure 1a. The Long-Run Outcome When All Aid Is Spent

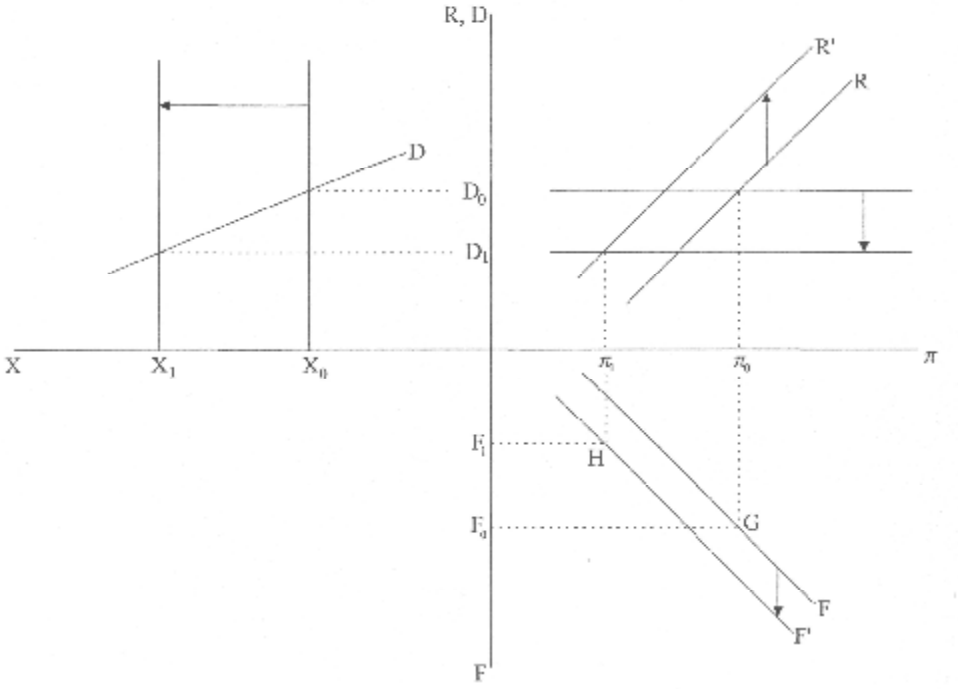


where $\mu \equiv m/E$. The term on the left side is seigniorage expressed as a percentage of national income, a number on the order of 0.005–0.02 in countries experiencing low/moderate inflation. On the right side, real interest payments on the internal debt (ρs) are equally small (in SSA), while $\gamma/(\eta + \gamma)$ is typically 0.5–0.8. (See the discussion in Section IV.) The sign of $d\pi$ is thus highly uncertain. This is irritating but unimportant; as will become apparent shortly, even large aid inflows do not change the inflation rate by more than half of a percentage point.[8]

PDR aid (Figure 1b) is different in that $(1 - \psi)$ percent of the external inflow is earmarked for reduction of the fiscal deficit. When analyzing this scenario, we assume $\psi < 1 - \rho s\gamma/\eta$ so that the seigniorage requirement does, in fact, decline. This ensures that inflation falls and that the real money supply increases. Private capital flows could go either way since lower inflation and higher consumption spending exert conflicting effects on the demand for foreign currency. Normally, however, the currency substitution effect dominates the outcome; point H lies to the north of point G provided σ is not unusually small.

[8]This statement assumes that ε is not too close to unity. Near the top of the seigniorage Laffer curve, small variations in the fiscal deficit have large effects on the inflation rate.

Figure 1b. The Long-Run Outcome in the Case of PDR Aid



IV. Model Calibration

To calibrate the model we chose units so that $P_{no} = E_o = 1$ and set

$$m_o = 0.08,\ b_o = 0.09,\ \pi_o = 0.10,\ \gamma_o = 0.50,\ X_o = 0.10$$
$$\beta = 0.50,\ \sigma = 0.75 - 3,\ \rho = 0.10,\ \tau = 0.25 - 50,\ F_o = 0.12.$$

The numbers assigned to m_o, π_o, b_o, γ_o, and X_o are rough averages of the values observed in Uganda, Mozambique, and Tanzania in the period 1999–2001 (see Table 3). We chose average values mainly to save space; the results do not change much when the model is calibrated separately to the data for each country. With respect to the other choices:

- *Elasticity of substitution in consumption between traded and nontraded consumer goods* (β). Fixing β at 0.50 implies that the compensated elasticity of demand for the nontraded good is 0.25 initially. This agrees with the finding in empirical studies that compensated elasticities of demand tend to be small at high levels of aggregation.[9]

[9]See Lluch and others (1977, chapter 3), Deaton and Muellbauer (1980, p. 71), Blundell (1988, p. 35), and Blundell, Pashardes, and Weber (1993, Table 3b, p. 581).

Table 3. Recent Economic Statistics for Uganda, Tanzania, and Mozambique

	Uganda	Tanzania	Mozambique
Reserve money[1] (average, 1999–2001)	0.055	0.096	0.077
Inflation[2] (range, 1998–2002)	0.05–0.10	0.05–0.10	0.10–0.15
Nontradables share in consumption (2001)[3]	0.51		
Net aid transfers[4]			
2000	0.09	0.06	0.144
2001	0.12	0.05	0.152
Foreign currency deposits[1]			
2000	0.049	0.045	0.13
2001	0.041	—	0.16

[1]Expressed as a percentage of private consumption.
[2]Nonfood inflation rate.
[3]Adam and Bevan (2003). Half of food consumption is assumed to be nontradable.
[4]Expressed as a percentage of GDP.

- *Elasticity of substitution between domestic and foreign currency* (σ). There are no reliable estimates of σ for the countries in our sample or any other country in Africa. For Latin America the numbers range from 1.5 to 7 (Ramirez-Rojas, 1985; Marquez, 1987; Giovannini and Turtleboom, 1994; and Kamin and Ericsson, 1993). Not trusting the high-end estimates, we decided to let σ vary from 0.75 to 3.
- *Time preference rate* (ρ). The time preference rate is 10 percent because the real interest rate on government debt—fixed by ρ across steady states—seems to be high in the countries we study.
- *Elasticity of intertemporal substitution* (τ). Most estimates for less-developed countries (LDCs) place τ between 0.20 and 0.50 (Agénor and Montiel, 1999, Table 12.1). We settled therefore on 0.25 and 0.50 as the low and high values for the intertemporal elasticity of substitution.[10] Occasionally, we also report results for the intermediate case of $\tau = 0.35$.
- *Ratio of foreign currency to national income* (F_o). Foreign currency deposits in the domestic banking sector range from 45 to 200 percent of reserve money in Mozambique, Uganda, and Tanzania.[11] This suggests $F_o = 0.086$, but the true value is higher because a good deal of foreign currency is held outside of the domestic banking system. We arbitrarily set F_o at 0.12. This is in line with dollarization ratios in other LDCs (Kamin and Ericsson, 1993; Savastano, 1996; and Baliño, Bennett, and Borensztein, 1999).

[10]The point estimate for τ is 0.25 for Tanzania in Ogaki, Ostry, and Reinhart (1996); 0.50 is slightly below their average point estimate (0.57–0.60) for middle-income countries.

[11]Evidence from Uganda, Tanzania, Mozambique, and elsewhere (e.g., IMF Staff appraisals for Zambia and Ghana) indicates that the overwhelming proportion of foreign currency deposits in the domestic banking system is held by domestic residents.

All simulations postulate an increase in aid (net of government imports) equal to 2 percent of initial national income. This causes the real exchange rate ($1/P_n$) to appreciate 7.5 percent in the long run. In every case, the steady state is a saddle point and the path that converges to the long-run equilibrium is unique.[12]

V. Flexible Exchange Rates

On paper, flexible exchange rates and strict targeting of the money supply are the norm in SSA. But the commitment to money-based stabilization and market-determined exchange rates is far from absolute, especially in periods of adjustment to large external shocks. Many countries have responded to large aid inflows by shifting to managed floats and partly accommodating monetary policy.

The decision about how much to manage the exchange rate is a decision about how much to move in the direction of a fixed exchange rate. Most of the information relevant to this decision is contained in the outcomes at the endpoints of the policy spectrum. Accordingly, we start by investigating the transition path associated with a pure float. Section VI analyzes the polar opposite case of a crawling peg.

All Aid Is Spent[13]

When all aid is spent the new steady state is very close to the old steady state. The fiscal deficit rises a trivial one-tenth of a percentage point, the equilibrium inflation rate drops from 10 percent to 9.4–9.8 percent, and holdings of foreign currency increase 2–6 percent (0.2–0.7 percent of GDP). While close proximity of the old and the new steady state does not preclude interesting dynamics, we have yet to discover a case (based on sensible parameter values) where any macro variable changes much on the transition path. The current account surplus peaks in the first year at a modest 0.2–0.4 percent of GDP, and most of the long-run appreciation of the real exchange rate is accomplished in a single downward jump of the nominal exchange rate at $t = 0$. In the run for $\tau = 0.25$ and $\sigma = 0.75$, the real interest rate jumps initially to 11 percent. This is mildly exciting, but in the rest of the parameter space r increases only one- to five-tenths of a percentage point. The most notable conclusion is that aid spending does *not* temporarily exacerbate inflationary pressures. Quite the contrary, thanks to sharp appreciation of the nominal exchange rate, the price level decreases 1.6–6.4 percent on impact.

PDR Aid

In the PDR-aid scenario, inflation and holdings of foreign currency decrease significantly across steady states when currency substitution is easy. Several results

[12]The paths for inflation, the real interest rate, the current account balance, etc., were generated by substituting the linearized solutions for the variables in the core dynamic system into the static nonlinear model. This retains more of the nonlinear structure of the model and thereby reduces linearization error (Novales and others, 1999).

[13]The IMF Working Paper version of the paper contains the numerical results for the case where all aid is spent. We summarize the results here in order to save space.

follow directly from the private sector's desire to run down its stock of foreign currency: at $t = 0$ expenditure increases *more* than aid, the current account worsens, and the real exchange rate *overshoots* its steady state level. Furthermore, since expenditure declines monotonically after its initial jump, the real interest rate is lower (see the Euler equation) and current account deficits persist throughout the adjustment process.

The spending boom that accompanies aid might seem to be a source of trouble for the price level in the short run. But this is not the case. When the private sector attempts to sell foreign currency at $t = 0$ the nominal exchange rate appreciates enough to fully neutralize the inflationary pressures of higher consumption spending. In the long version of the paper we demonstrate that the price level decreases on impact and that inflation is continuously lower on the transition path to the new steady state.

Numerical results

Table 4 shows how inflation, the real interest rate, the real exchange rate (RER), and the current account (CA) evolve during the first five years of the adjustment process. The number in parentheses in the cell for $t = 0$ states the initial percentage jump in the price level. In the column at the far right, Long Run refers to the steady state outcome.

The simulations assume, consistent with the African data for the 1990s, that the government spends 75 percent of the aid inflow.[14] This lowers the fiscal deficit by roughly half a percentage point (recall that aid increases by 2 percent of national income) and reduces the steady state inflation rate to 2.1–3.3 percent. Cumulative private capital inflows range from 0 to 6.6 percent of national income.

What happens on the way to the long-run equilibrium depends mainly on the currency substitution parameter σ. For $\sigma = 0.75$ private capital inflows are small and the economy moves quickly to the vicinity of the new steady state. But when $\sigma = 2 - 3$ the ride is a bit wild. Consumption spending strongly overshoots its steady state level; as a result, the real exchange rate appreciates 14–20 percent in the short run and the current account deficit, *inclusive of aid,* jumps to 1.8–3.5 percent of national income. There are also pronounced fluctuations in π and r in the runs where $\tau = 0.25$. The real interest rate decreases 1.8–2.2 percentage points at $t = 0$; it rises steadily thereafter but is still 1.3–1.7 percentage points lower at $t = 2$. Because of the temporary decrease in the real interest rate, the fiscal deficit and inflation also overshoot their steady state levels.

Sticky prices

We have saved the bad news for the end. Unfortunately, the results presume far too much flexibility of nominal prices. Consider how the economy adjusts in the short

[14] On average, governments in sub-Saharan Africa spend 79 cents of every aid dollar. Recall, however, that our analysis applies to aid net of government imports. When import purchases are netted out, far less than 79 percent of aid is spent. Our assumption that 25 percent of aid supports deficit reduction is therefore highly conservative.

Table 4. Transition Path in a Pure Float

	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
			$\tau = 0.25$ and $\sigma = 0.75$				
π	0.031 (–0.20)	0.032	0.032	0.032	0.033	0.033	0.033
r	0.093	0.096	0.098	0.099	0.099	0.10	0.10
RER	0.91	0.92	0.92	0.92	0.92	0.92	0.92
CA	–0.003	–0.002	–0.001	–0.001	0	0	0
			$\tau = 0.50$ and $\sigma = 0.75$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	0.031 (–0.24)	0.031	0.031	0.031	0.031	0.031	0.031
r	0.10	0.10	0.10	0.10	0.10	0.10	0.10
RER	0.92	0.92	0.92	0.92	0.92	0.92	0.92
CA	0	0	0	0	0	0	0
			$\tau = 0.25$ and $\sigma = 2$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	0 (–0.37)	0.013	0.019	0.022	0.024	0.025	0.026
r	0.078	0.082	0.087	0.092	0.095	0.097	0.10
RER	0.84	0.88	0.90	0.91	0.92	0.92	0.92
CA	–0.022	–0.013	–0.007	–0.004	–0.002	–0.001	0
			$\tau = 0.50$ and $\sigma = 2$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	0.014 (–0.42)	0.019	0.021	0.023	0.023	0.024	0.024
r	0.092	0.093	0.095	0.097	0.098	0.099	0.10
RER	0.86	0.88	0.90	0.91	0.92	0.92	0.92
CA	–0.018	–0.011	–0.006	–0.004	–0.002	–0.001	0
			$\tau = 0.25$ and $\sigma = 3$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	–0.023 (–0.45)	–0.001	0.011	0.017	0.020	0.021	0.023
r	0.082	0.079	0.083	0.088	0.093	0.096	0.10
RER	0.80	0.85	0.88	0.90	0.91	0.92	0.92
CA	–0.035	–0.020	–0.011	–0.006	–0.003	–0.002	0
			$\tau = 0.50$ and $\sigma = 3$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	–0.004 (–0.50)	0.008	0.015	0.018	0.019	0.020	0.021
r	0.095	0.092	0.093	0.095	0.097	0.098	0.10
RER	0.81	0.86	0.88	0.90	0.91	0.92	0.92
CA	–0.031	–0.018	–0.011	–0.006	–0.004	–0.002	0

run. According to our model, the nominal exchange rate appreciates 24–55 percent at $t = 0$ to forestall incipient capital inflows (F is predetermined). Since the real exchange rate appreciates "only" 8–20 percent, the nominal price in the nontradables sector has to immediately fall 16–44 percent to keep demand equal to supply. This strains belief to say the least. But if nominal price adjustment is incomplete, the economy slides into a recession—probably a deep recession given the magnitude of nominal appreciation at $t = 0$. To confirm this, we carried out simulations for a variant of the model in which nontradables output is demand-determined and prices are sticky à la Calvo and Végh (1983). The price of the traded good is still set by the exchange rate but firms in the nontradables sector adjust prices only when they receive a random "price-change signal." Firms that receive a signal choose a new price by forecasting the future paths of the price level and excess demand.[15] Price adjustment is thus forward-looking. Calvo (1983) shows that when the price-change signal obeys a Poisson process

$$\dot{P}_n = (\pi_n - \chi)P_n \tag{13}$$

$$\dot{\pi}_n = -\delta[D_n(P_n, E) - \bar{Q}_n], \qquad \delta > 0, \tag{14}$$

where $\bar{Q}_n$ denotes notional output (i.e., the level of output associated with a normal capacity utilization rate). Equation (13) follows from the fact that, at any given point in time, the nominal price of the nontraded good is fixed by past price quotations. (More precisely, at any time t the set of firms that adjust their prices is of measure zero.) Equation (14) is a higher-order Phillips Curve. It says that the *change* in π_n, the inflation rate in the nontradable sector, is a decreasing function of excess demand. The parameter δ is larger the shorter the length of the average price quote.

Table 5 shows the outcome when price adjustment is fast but not instantaneous.[16] Examine first the entries in the row for Q_n, which tracks the percentage difference between nontradables output at time t and its pre-aid level. Although the compensated elasticity of demand is only 0.25, substitution toward traded goods—induced by appreciation of the nominal exchange rate—easily dominates the expansionary income effect of higher aid flows. Consequently, Q_n declines in every case. When $\sigma = 2 - 3$, the recession in the nontradables sector is protracted and severe as large private capital inflows force the nominal exchange rate to appreciate 29–37 percent at $t = 0$. For $\sigma = 0.75$, capital inflows and nominal appreciation are comparatively modest; nevertheless, Q_n falls 4 percent on impact and is 1.4 percent lower at $t = 1$.

Recession is not the only problem policymakers face. The real exchange rate overshoots its steady state level much more than in the flex-price model, especially in the runs for $\sigma = 2 - 3$. Moreover, the impact on the real interest rate changes dramatically. When prices are flexible, the real interest rate decreases temporarily from 10 percent to 7.8–9.3 percent. With sticky prices, the rate jumps to 18–34 percent

[15]Forecasts are mathematically correct and weighted by the probability the price quote will be in force at time t.

[16]We assume fast price adjustment: $\delta = 5$ in Table 5 (and later Table 7). To solve the floating rate model, real money balances measured in units of the nontraded good had to be introduced as a state variable.

Table 5. Transition Path in a Pure Float When Nontradables Prices Are Sticky

	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
			$\tau = 0.25$ and $\sigma = 0.75$				
π	–0.006 (–0.08)	0.019	0.028	0.031	0.032	0.033	0.033
r	0.183	0.125	0.108	0.103	0.101	0.10	0.10
RER	0.83	0.89	0.91	0.92	0.92	0.92	0.92
CA	–0.006	–0.002	–0.001	0	0	0	0
Q_n	–0.040	–0.014	–0.005	–0.002	–0.001	0	0
			$\tau = 0.25$ and $\sigma = 2$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	–0.081 (–0.14)	–0.016	0.009	0.019	0.023	0.025	0.026
r	0.259	0.140	0.110	0.101	0.099	0.099	0.10
RER	0.71	0.82	0.88	0.90	0.91	0.92	0.92
CA	–0.025	–0.013	–0.007	–0.004	–0.002	–0.001	0
Q_n	–0.071	–0.030	–0.012	–0.005	–0.002	–0.001	0
			$\tau = 0.50$ and $\sigma = 2$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	–0.127 (–0.16)	–0.025	0.008	0.018	0.022	0.023	0.024
r	0.30	0.149	0.112	0.102	0.099	0.099	0.10
RER	0.69	0.82	0.87	0.90	0.91	0.92	0.92
CA	–0.016	–0.011	–0.007	–0.004	–0.003	–0.002	0
Q_n	–0.106	–0.040	–0.014	–0.005	–0.002	–0.001	0
			$\tau = 0.25$ and $\sigma = 3$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	–0.124 (–0.17)	–0.038	–0.002	0.012	0.018	0.021	0.023
r	0.305	0.150	0.111	0.10	0.098	0.098	0.10
RER	0.66	0.79	0.86	0.89	0.91	0.92	0.92
CA	–0.038	–0.020	–0.011	–0.006	–0.003	–0.002	0
Q_n	–0.082	–0.038	–0.016	–0.007	–0.003	–0.002	0
			$\tau = 0.50$ and $\sigma = 3$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	–0.172 (–0.18)	–0.044	–0.002	0.012	0.017	0.019	0.021
r	0.344	0.159	0.113	0.101	0.099	0.099	0.10
RER	0.63	0.78	0.85	0.89	0.90	0.91	0.92
CA	–0.028	–0.018	–0.011	–0.007	–0.004	–0.002	0
Q_n	–0.117	–0.046	–0.017	–0.007	–0.003	–0.001	0

in the first year. This is a natural byproduct of the transitory recession: r is higher on the transition path because aggregate consumption spending rises over time as demand and output recover in the nontradables sector.

The adverse impact on the real interest rate is important, for it implies that the simulation results underestimate the real output losses from floating. Our model assumes constant output in the tradables sector. But if a higher return on treasury bills increases the cost of working capital or depresses investment spending, then tradables production will contract and the demand curve in the nontradables sector will shift further to the left. In a more elaborate model that captured these linkages, the recession would be deeper and more persistent than in Table 5. A pure float is impractical when the foreign exchange market has to absorb large private capital inflows.

VI. A Crawling Peg

In a crawling peg some policy rule controls the path of the nominal exchange rate. A variety of rules are plausible and compatible with stable dynamics. For simplicity, we assume the government lowers the rate of currency depreciation to its new steady state level at time $t = 0$.

All Aid Is Spent

The macroeconomic effects are still small and generally uninteresting when all aid is spent. The choice of exchange rate regime is not, however, unimportant. In a crawling peg the nominal exchange rate is predetermined. Consequently, appreciation of the real exchange rate at $t = 0$ occurs through a large increase in the nominal price of the nontraded good. Purists may argue that this is not inflation but rather a change in a relative price. Be that as it may, the nasty spike in the CPI (P rises 2.9–3.3 percent at $t = 0$) is something most policymakers would prefer to avoid.[17] We return to this point later in Sections VII and VIII.

PDR Aid

PDR aid has potentially strong effects on private capital flows and total currency demand. The qualitative results hinge on the degree of substitutability between domestic and foreign currency. If

$$\sigma > \tau(1 + \rho/\pi\theta_f) + \frac{i\rho(1-\varepsilon)(\eta+\gamma)}{\pi\theta_f \underbrace{[\pi\mu(\eta+\gamma) - \rho s\gamma + \eta(1-\psi)]}_{\text{Positive for PDR aid}}} \frac{J}{E}, \tag{15}$$

currency substitution allows the private agents to enjoy more liquidity services while spending down part of their financial wealth. ($J = m + F$ decreases across

[17] Aid is funneled to the private sector through lump-sum transfers. Since $\gamma_o = 0.50$, approximately half of the extra aid money is spent on nontraded goods. If aid financed some project that involved a larger component of nontradables spending, the initial increase in the price level would be greater. When all aid is spent on nontraded goods, for example, the upward jump in P at $t = 0$ is about twice as large.

steady states.) The paths for expenditure, the real exchange rate, the current account, and the real interest rate are then qualitatively the same as the paths in a pure float. The item missing from the list is the impact effect on the price level. Once again, the big increase in spending at $t = 0$ triggers large jumps in the nominal price of the nontraded good and the CPI. Nor is the effect small: under the weaker condition $\sigma > \tau(1 + \rho/\pi\theta_f)$, the spike in the price level is *larger* than in the case where 100 percent of the aid is spent.

The dynamics are quite different when the condition in equation (15) does not hold: expenditure and the real exchange rate undershoot their steady state levels, the real interest rate rises, and the current account registers surpluses instead of deficits. Moreover, expenditure may *decrease* initially, causing the real exchange rate to depreciate and the price level to jump downward at $t = 0$. The result is odd but it cannot be ruled out by plausible parameter values.

Numerical results and comparisons with the outcome under a pure float

How does switching from a pure float to a crawling peg affect the paths of key macroeconomic variables? We should be able to say a lot about this *without* taking a stand on the condition in equation (15). In a pure float, spot appreciation of the nominal exchange rate at $t = 0$ confers a large wealth gain on the private sector ($m + F \uparrow$ on impact) while also exerting strong downward pressure on the price level. No similar effects operate in a crawling peg. Thus intuition suggests that in comparisons of the two systems a crawling peg buys greater stability of the real exchange rate and smaller current account deficits (or possibly current account surpluses) at the price of higher inflation and higher real interest rates.

For the parameter values that underlie our simulations, the condition in equation (15) does not hold (implying $J \uparrow$) in five of six cases. The choice of exchange rate regime exerts a strong influence therefore on the adjustment process. Compare the numbers in Tables 4 and 6. In Table 4, inflation and the real exchange rate overshoot their steady state levels, the real interest rate decreases, and the current account worsens. All of this turns around in Table 6. The real interest rate rises, the current account improves, and inflation and the real exchange rate undershoot, approaching their steady state levels from above.[18] At higher values of σ and π_o the qualitative properties of the transition paths are frequently the same (apart from the initial jump in the price level) as in a float. We carried out 30 simulations for this part of the parameter space ($\sigma = 3 - 5$, $\pi_o = 0.10 - 0.50$, $s = 0.10 - 0.25$, $m_o = 0.05 - 0.08$, $F_o = 0.08 - 0.16$). The results proved perfectly robust. Under a crawling peg, inflation and the real interest rate always decreased less, the real exchange rate always appreciated less, and the current account deficit was always smaller.

Two other results merit comment. First, the increase in the real interest rate is small in most cases. For $\tau = 0.25$ and $\sigma = 0.75$, the rate jumps initially to 12 percent;

[18]The results are not quite uniform. In the panel for $\tau = 0.25$ and $\sigma = 3$, the real interest rate decreases two-tenths of a percentage point at $t = 0$, and inflation barely overshoots its steady state level.

Table 6. Transition Path in a Crawling Peg

	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
			$\tau = 0.25$ and $\sigma = 0.75$				
π	0.041 (0.025)	0.037 (0.064)	0.035	0.034	0.034	0.033	0.033
r	0.120	0.110	0.106	0.103	0.102	0.101	0.10
RER	0.95	0.94	0.93	0.93	0.93	0.93	0.92
CA	0.007	0.004	0.002	0.001	0.001	0	0
			$\tau = 0.50$ and $\sigma = 0.75$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	0.042 (0.015)	0.038 (0.055)	0.035	0.033	0.032	0.032	0.031
r	0.115	0.108	0.105	0.103	0.102	0.101	0.10
RER	0.97	0.95	0.94	0.94	0.93	0.93	0.92
CA	0.012	0.008	0.005	0.003	0.002	0.001	0
			$\tau = 0.25$ and $\sigma = 2$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	0.029 (0.035)	0.028 (0.063)	0.027	0.027	0.026	0.026	0.026
r	0.106	0.103	0.102	0.101	0.101	0.10	0.10
RER	0.93	0.93	0.93	0.93	0.93	0.93	0.92
CA	0.002	0.001	0.001	0	0	0	0
			$\tau = 0.50$ and $\sigma = 2$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	0.032 (0.022)	0.029 (0.052)	0.027	0.026	0.025	0.025	0.024
r	0.110	0.106	0.103	0.102	0.101	0.101	0.10
RER	0.96	0.95	0.94	0.93	0.93	0.93	0.92
CA	0.009	0.006	0.003	0.002	0.001	0.001	0
			$\tau = 0.25$ and $\sigma = 3$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	0.022 (0.043)	0.022 (0.064)	0.023	0.023	0.023	0.023	0.023
r	0.098	0.099	0.099	0.10	0.10	0.10	0.10
RER	0.92	0.92	0.92	0.92	0.92	0.92	0.92
CA	–0.001	–0.001	0	0	0	0	0
			$\tau = 0.50$ and $\sigma = 3$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	0.027 (0.027)	0.025 (0.052)	0.023	0.022	0.022	0.021	0.021
r	0.107	0.104	0.103	0.102	0.101	0.101	0.10
RER	0.95	0.94	0.93	0.93	0.93	0.93	0.92
CA	0.007	0.004	0.003	0.002	0.001	0.001	0

in every other case, the increase is less than a percentage point. Second, inflationary pressures are confined to the spike in the price level at $t = 0$. Although the spike is large (P jumps 2.5–4.3 percent), the path of the CPI drops below the pre-aid path within 3–7 months and the inflation rate for the first year decreases from 10 percent to 5.2–6.4 percent. (The number in parentheses in the cell for $t = 1$ is the cumulative percentage increase in the price level over the first year—the real world definition of annual inflation.[19])

Sticky Prices

The results for a crawling peg in Table 7 are what policymakers dream about. Inflation decreases smoothly without an initial spike in the price level. The current account records a small surplus and the real exchange rate moves toward its long-run equilibrium value in a gradual, orderly manner. For a couple of years, the economy also enjoys higher output and lower real interest rates. What makes everything work is that the deficit-reduction component of aid effectively finances a perfectly credible exchange-rate-based stabilization (ERBS). The small ERBS component (¼ of the total aid package) ensures that inflation decreases monotonically even though real spending rises 2.2–3.4 percent in the short run.

Does this mean that a crawling peg with fully accommodating monetary policy solves all macroeconomic problems in the case of PDR aid? Probably not. Few macroeconomists have trouble with the notion that prices are sticky downward. But are prices sticky upward as well? For reasons that are hard to justify, we suspect that price adjustment is asymmetric in sub-Saharan Africa and that the flex-price specification is correct for many branches of the nontradables sector (e.g., the informal sector) when nominal price increases are required to clear the market. The pure flex-price model may exaggerate the initial upward jump in the CPI, but the sticky-price model is overly optimistic in assuming the problem away. Doubtless the truth lies somewhere in between.

VII. Policy Implications

The preceding analysis yields some useful guidelines for policy. Our strongest conclusion is that a pure float is the best way to absorb aid that will be entirely spent. Adjustment is quick in both a float and a crawling peg, with 80–90 percent of total appreciation of the real exchange rate being concentrated in the short run. What differs is the type of nominal price adjustment paired with real appreciation. Under a crawling peg, real appreciation takes the form of a sharp increase in the nominal price of the nontraded good and a spike in the CPI. In a float, by contrast, spot appreciation of the nominal exchange rate reconciles higher spending and appreciation of the real exchange rate with a large decrease in the price level. Crucially, nominal appreciation is not so large as to require significant deflation in the nontradables

[19]Due to continuous-time compounding, the increase in the price level over the calendar year is greater than 10 percent when $\dot{P}/P = \pi = 0.10$ (i.e., $e^{0.10} - 1 = 0.105$). The figure reported for inflation in the first year is the constant level of inflation that produces the same increase in the price level at $t = 1$ as in the model.

Table 7. Transition Path in a Crawling Peg When Nontradables Prices Are Sticky

	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
			$\tau = 0.25$ and $\sigma = 0.75$				
π	0.062	0.046	0.039	0.036	0.034	0.034	0.033
r	0.091	0.101	0.103	0.102	0.102	0.101	0.10
RER	1	0.96	0.94	0.94	0.93	0.93	0.92
CA	0.009	0.005	0.003	0.002	0.001	0.001	0
Q_n	0.022	0.008	0.004	0.002	0.001	0	0
			$\tau = 0.25$ and $\sigma = 2$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	0.061	0.040	0.032	0.028	0.027	0.027	0.026
r	0.064	0.088	0.096	0.099	0.10	0.10	0.10
RER	1	0.95	0.94	0.93	0.93	0.93	0.92
CA	0.006	0.003	0.001	0.001	0	0	0
Q_n	0.028	0.010	0.004	0.002	0.001	0	0
			$\tau = 0.50$ and $\sigma = 2$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	0.052	0.036	0.030	0.027	0.026	0.025	0.024
r	0.088	0.10	0.102	0.102	0.102	0.101	0.10
RER	1	0.96	0.94	0.94	0.93	0.93	0.92
CA	0.008	0.006	0.004	0.003	0.002	0.001	0
Q_n	0.023	0.008	0.003	0.001	0.001	0	0
			$\tau = 0.25$ and $\sigma = 3$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	0.062	0.037	0.028	0.025	0.024	0.023	0.023
r	0.047	0.081	0.093	0.098	0.099	0.10	0.10
RER	1	0.95	0.93	0.93	0.93	0.92	0.92
CA	0.003	0.001	0	0	0	0	0
Q_n	0.034	0.012	0.004	0.001	0.001	0	0
			$\tau = 0.50$ and $\sigma = 3$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	0.052	0.033	0.026	0.024	0.022	0.022	0.021
r	0.079	0.096	0.10	0.101	0.101	0.101	0.10
RER	1	0.96	0.94	0.93	0.93	0.93	0.92
CA	0.006	0.005	0.003	0.002	0.001	0.001	0
Q_n	0.027	0.009	0.003	0.001	0.001	0	0

sector: the overall price level decreases 1.6–6.4 percent, but the nominal price of the nontraded good rises or is unchanged in four cases and decreases 1.7–2.9 percent in the other two cases ($\tau = 0.25 - 0.50$ and $\sigma = 3$).[20]

Absorption of PDR aid presents more difficulties. PDR aid uses part of the external windfall to reduce the fiscal deficit and the equilibrium inflation rate. So far so good. But expectations of lower inflation elicit large private capital inflows. This complicates macroeconomic management because staying out of the foreign exchange market is no longer a genuine option: central banks that rely on a pure float passively acquiesce to (i) stupendous appreciation of the nominal exchange rate, (ii) lower employment in both the tradables and nontradables sectors (assuming wages and prices are not exceptionally flexible downward), (iii) overshooting of the real exchange rate, and (iv) large current account deficits. A crawling peg eliminates the threat of a harsh recession and secures greater stability of the real exchange rate but leaves the government with the problem of negotiating an initial big spike in the CPI. Surprisingly, the initial jump in the price level may be higher than when all aid is spent even though inflation decreases more in the long run.

Summing up, in the case of PDR aid, neither a crawling peg nor a pure float produces fully acceptable results. We move on therefore to the analysis of alternative policy strategies. In Section VIII the central bank temporarily sterilizes capital inflows; in Section IX it operates a managed float, intervening in the foreign exchange market to prevent extreme fluctuations in the nominal exchange rate.

VIII. Temporary Sterilization

The price level jumps when aid flows increase and the central bank maintains a crawling peg. Since inflation decreases rapidly after the initial spike in the CPI, temporary sterilization comes to mind as a strategy for smoothing the paths of money growth and the price level. To fix ideas, suppose the government sells bonds as needed to stabilize the price level at $t = 0$ and then redeems the debt in future periods. That is

$$\dot{b} = -\alpha[b(t) - b_o], \tag{16}$$

and hence

$$b(t) = b_o + [b(0) - b_o]e^{-\alpha t}. \tag{17}$$

Initial bond sales are $b(0) - b_o$ and the parameter α determines how fast the debt is paid off. The steady state is unchanged—b eventually returns to b_o.

Tables 8 and 9 assume 80 percent of the newly issued debt is redeemed over 10 years ($\alpha = 0.161$).[21] A quick scan of the results reveals pluses and minuses. On

[20]In the two cases where nontradables demand decreases, output would fall if prices were sticky downward. The reduction in output, however, is very small. In the worst case, where $\tau = 0.50$ and $\sigma = 3$, Q_n falls only 0.5 percent in the first year.

[21]Paying off the debt more quickly results in higher real interest rates.

Table 8. Transition Path in a Crawling Peg with Temporary Sterilization

	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
			$\tau = 0.25$ and $\sigma = 0.75$				
π	0.065	0.050	0.041	0.037	0.034	0.033	0.033
r	0.255	0.152	0.121	0.109	0.104	0.101	0.10
RER	1	0.95	0.93	0.92	0.91	0.91	0.92
CA	0.020	0.008	0.002	–0.001	–0.003	–0.003	0
			$\tau = 0.50$ and $\sigma = 0.75$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	0.054	0.045	0.039	0.035	0.033	0.032	0.031
r	0.145	0.120	0.110	0.106	0.103	0.101	0.10
RER	1	0.96	0.94	0.93	0.92	0.92	0.92
CA	0.020	0.010	0.005	0.002	0	–0.001	0
			$\tau = 0.25$ and $\sigma = 2$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	0.063	0.045	0.035	0.030	0.028	0.026	0.026
r	0.312	0.162	0.123	0.109	0.103	0.10	0.10
RER	1	0.95	0.92	0.91	0.91	0.91	0.92
CA	0.020	0.006	0	–0.003	–0.005	–0.005	0
			$\tau = 0.35$ and $\sigma = 2$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	0.057	0.043	0.034	0.030	0.027	0.026	0.025
r	0.207	0.138	0.117	0.107	0.103	0.101	0.10
RER	1	0.95	0.93	0.92	0.91	0.91	0.92
CA	0.020	0.008	0.001	–0.002	–0.003	–0.004	0
			$\tau = 0.50$ and $\sigma = 2$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	0.050	0.039	0.033	0.029	0.026	0.025	0.024
r	0.154	0.123	0.111	0.105	0.103	0.101	0.10
RER	1	0.96	0.94	0.93	0.92	0.92	0.92
CA	0.020	0.009	0.003	0	–0.002	–0.002	0
			$\tau = 0.25$ and $\sigma = 3$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	0.063	0.043	0.033	0.027	0.024	0.023	0.023
r	0.360	0.169	0.124	0.109	0.102	0.10	0.10
RER	1	0.94	0.92	0.91	0.90	0.90	0.92
CA	0.020	0.005	–0.002	–0.005	–0.006	–0.006	0

Table 8. *(concluded)*

			$\tau = 0.35$ and $\sigma = 3$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	0.057	0.041	0.032	0.027	0.024	0.022	0.022
r	0.226	0.142	0.117	0.107	0.103	0.10	0.10
RER	1	0.95	0.92	0.91	0.91	0.91	0.92
CA	0.020	0.007	0	−0.003	−0.005	−0.005	0
			$\tau = 0.50$ and $\sigma = 3$				
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	0.049	0.037	0.030	0.026	0.023	0.022	0.021
r	0.162	0.125	0.111	0.105	0.103	0.101	0.10
RER	1	0.96	0.93	0.92	0.91	0.91	0.92
CA	0.020	0.009	0.002	−0.001	−0.003	−0.003	0

Table 9. Initial Bond Sales and Path of Capital Flows When Central Bank Engages in Temporary Sterilization

		Path of F ($F_0 = 0.12$)[1]			
τ	$t = 0$	$t = 1$	$t = 2$	Long Run	σ
0.25	0.078 (0.103)	0.094 (0.108)	0.104 (0.110)	0.114	0.75
0.50	0.086 (0.102)	0.099 (0.109)	0.108 (0.113)	0.120	
0.25	0.044 (0.073)	0.058 (0.075)	0.067 (0.076)	0.077	2
0.35	0.047 (0.072)	0.060 (0.074)	0.069 (0.076)	0.078	
0.50	0.052 (0.070)	0.063 (0.074)	0.071 (0.077)	0.081	
0.25	0.024 (0.052)	0.035 (0.052)	0.043 (0.052)	0.051	3
0.35	0.027 (0.050)	0.037 (0.051)	0.044 (0.051)	0.052	
0.50	0.031 (0.047)	0.040 (0.050)	0.046 (0.051)	0.054	

	Value of b after bond sales at $t = 0$ ($b_0 = 0.09$)		
τ	$\sigma = 0.75$	$\sigma = 2$	$\sigma = 3$
0.25	0.130	0.146	0.155
0.35	—	0.140	0.148
0.50	0.119	0.131	0.138
	Offset Coefficient[2]		
τ	$\sigma = 0.75$	$\sigma = 2$	$\sigma = 3$
0.25	0.60	0.52	0.43
0.35	—	0.50	0.40
0.50	0.55	0.44	0.33

[1]The number in parentheses is the value of F when there is no temporary sterilization.

[2]The offset coefficient is calculated as $[F(0)_{ns} - F(0)]/[b(0) - b_0]$, where $F(0)$ and $F(0)_{ns}$ are the postjump values of foreign currency holdings at $t = 0$ with and without sterilization.

the plus side, temporary sterilization does a nice job of smoothing the path of the price level. The inflation rate drops to 4.9–6.5 percent at $t = 0$ and then declines monotonically toward its steady state level. This is accomplished, to repeat, without a prefatory spike in the CPI. Compared to the no-sterilization case, inflation is 1–2 percentage points lower in the first year and slightly higher in subsequent years. Preferences decide which path is superior. That said, we suspect most policymakers would opt for the smooth, spike-free path proffered by temporary sterilization.

The drawbacks of the policy concern the impact on the real interest rate and the size of the bond sales needed to prevent the price level from jumping. In the runs for $\tau = 0.50$ the real interest rate fluctuates between 12 and 16 percent in the first year. This is not too worrisome, but when $\tau = 0.25 - 0.35$ the rate vaults to 21–36 percent and takes two full years to fall back to 12 percent. It is also disturbing that so much debt has to be sold so quickly. The policy rule in equation (17) is partly to blame as it forces all bond sales to occur at $t = 0$. A fair interpretation of the results, however, is that smoothing the path of the price level requires the central bank to increase the internal debt by 4–6 percent of GDP in the span of six months or less. This is probably the outer limit of what is feasible in Africa's thin bond markets. It is easy to understand therefore why most governments have employed a mix of sterilization and foreign exchange sales to counteract the short-run inflationary pressures created by high aid flows.

In passing we should remark on something that is not a problem, or at least not as much of a problem as the literature on sterilization contends. Schadler and others (1993), Calvo, Leiderman, and Reinhart (1994), and others have asserted that sterilization is self-defeating because bond sales push up the real interest rate and thereby attract the capital inflows they are trying to neutralize. In our model, this argument is substantially but not completely correct. Observe in Tables 8 and 9 that high real interest rates are associated with *massive* overshooting of private capital inflows and fairly large offset coefficients (for $\sigma = 0.75 - 2$).[22] Certainly this is not to the liking of the central bank. Sterilization works by reducing liquidity and raising the real interest rate to a level that induces the private agent to hold expenditure constant at $t = 0$. At the margin, the withdrawal of one dollar of domestic currency from circulation reduces liquidity services by i dollars (20 cents worth in Table 6). When the private agent exchanges foreign for domestic currency at the central bank, π dollars of the cut in liquidity services is restored, leaving a net loss of r dollars. This is only 50 percent of the decrease in liquidity services achieved from selling bonds for domestic currency [$r/i = \rho/(\rho + \pi) = 0.50$ for differential changes]. Thus capital inflows make it harder but not impossible for the central bank to control liquidity. Monetary policy *can* be used to smooth the path of the CPI, huge capital inflows notwithstanding. The critical question is: when does it become too costly to do so? Our own view is that the cost is acceptable when $\tau = 0.50$ and the real interest rate temporarily increases 3–5 percentage points more than in the no-sterilization case. But for $\tau = 0.25 - 0.35$ it is a hard call; since high T-bill rates are not of concern *per se,* a lot depends on the structure of financial

[22]Interestingly, numerous empirical estimates find offset coefficients close to those in Table 9. See Agénor and Montiel (1999, p. 204).

markets and the extent to which sterilization affects the cost of credit for private firms.[23]

IX. A Managed Float

. . . the question of the appropriate exchange rate regime for African countries remains open. None of these countries has a 'pure' floating exchange rate, opting instead for the common intermediate case of a 'managed' float . . . (Leape, 1999, pp. 126–27).

The preceding results for PBS aid shed light on why most countries prefer managed floats to either a pure float or a crawling peg. Policy is too passive in a pure float: while inflation decreases strongly, the nominal exchange rate is allowed to appreciate to the point where output contracts in the nontradables sector. A crawling peg errs in the opposite direction, imperiling a different target: when the government commits to a fixed path for the exchange rate it throws away the policy instrument that is most effective in combatting the short-run inflationary pressures created by higher aid spending and accompanying private capital inflows. Nor does more active monetary policy resolve the targets-instruments problem. A crawling peg combined with temporary sterilization *does* deliver continuously lower inflation; but, as we have just seen, this often produces very high real interest rates and may require bond sales on a scale that is not feasible.

A managed float gives policymakers the freedom to find the middle ground between too much and too little intervention. The right amount of intervention depends, of course, on the weights attached to the targets for output, inflation, the real exchange rate, and the real interest rate. Rather than derive a complicated intervention rule by optimizing over a quadratic objective function that incorporates all of these targets, we assume the central bank sells/buys foreign currency whenever the real exchange rate ($1/P_n$) is above/below its long-run equilibrium level:

$$\dot{Z} = \Omega \frac{P_n - P_n^*}{P_n}, \ \Omega > 0. \tag{18}$$

Equation (18) relates the *flow* accumulation of reserves to deviations of the real exchange rate from its target value. In addition, Z may jump at $t = 0$. The initial purchase of reserves and Ω are chosen jointly to ensure that the existing nominal price of the nontraded good clears the market at $t = 0$. The intervention strategy, in other words, is to let the exchange rate appreciate enough to reduce inflation but not so much as to drive the nontradables sector into a recession. Other targets do not influence the intervention rule; it turns out, however, that the rule postulated here also greatly reduces volatility of the real exchange rate and the real interest rate.

[23]High T-bill rates are usually a concern because they threaten fiscal stability. In the case at hand, however, the increase in the fiscal deficit (relative to the no-sterilization path) is temporary and does not prevent inflation from decreasing monotonically. The remark about the structure of financial markets is motivated by the fact that sometimes changes in the T-bill rate do not have a perceptible impact on bank loan rates.

Table 10 shows the outcome when the initial stock of reserves is 5 percent of GNP. At long last, we have something that can be pronounced an unqualified success. In contrast to the polar exchange rate regimes, the managed float reduces inflation immediately without any adverse side effects on output, the current account balance, or the real exchange rate. The one minor blemish in the results is that the real interest rate initially jumps to 12–13 percent in three cases.

The upshot of all this is that the optimal exchange rate regime lies close to the crawling peg end of the policy spectrum. To quantify the meaning of "close," consider the paths of the exchange rate and reserves associated with the policy rule in Table 10. Appreciation of the nominal exchange rate at $t = 0$ is 3–9 percent vs. 24–55 percent in a pure float. Cumulative reserve purchases are 42–96 percent as large as in a crawling peg, with the figure exceeding 70 percent when $\sigma = 2 - 3$. (The figure in parentheses in the row for Z is the stock of reserves in a crawling peg.) Note, however, that the managed float entails greater reserve purchases at $t = 0$ in the runs for $\tau = 0.50$. This makes an odd impression. Shouldn't a managed float involve less, not more, intervention than a crawling peg? Ceteris paribus, the answer is yes. But other things are not equal in Tables 6 and 10. For $\tau = 0.50$, inflation and the rate of currency depreciation χ decrease more in the short run when the government operates a managed float instead of a crawling peg.[24] This leads to larger capital inflows and greater reserve accumulation in the short run even though appreciation of the nominal exchange rate bears some of the burden of adjustment. When the central bank intervenes only at $t = 0$ (i.e., $\Omega = 0$), initial reserve purchases decrease 8–29 percent but are still a bit larger than in a crawling peg.

X. Concluding Remarks

The dynamic response to persistent official capital flows is linked to the degree of budget support they provide and the strength of private portfolio substitution. When these take even ordinary values by the standards of poststabilization African economies, portfolio adjustments dominate the short-run dynamics and produce some distinctly unpleasant trade-offs. A pure float, in particular, performs very poorly. Portfolio pressures produce a nominal appreciation that is an order of magnitude larger than the required real appreciation, and unless the prices of nontraded goods are perfectly flexible, the real exchange rate overshoots and substitution effects produce a potentially deep recession. A crawling peg does better, but allows a short-run spike in inflation; bond sterilization can prevent the inflation spike, but only at the cost of a rapidly rising interest burden. In our preferred "managed float" scenario, the central bank uses unsterilized foreign exchange intervention to target the modest real appreciation needed to absorb the aid inflow. Real interest rates then stay low and macroeconomic adjustment is rapid. Our analysis suggests that African central banks have been correct to intervene substantially in the face of recent increases in aid, and to discount the argument that rapid domestic liquidity expansion necessarily calls for a combination of bond sterilization and cleaner floating.

[24]In a crawling peg, χ is constant and equal to the steady state inflation rate. In Table 10, $\chi = -0.013$ and 0 at $t = 0$ in the runs where $\tau = 0.50$ and $\sigma = 0.75, 2$.

Table 10. Transition Path in a Managed Float[1]

	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
	$\tau = 0.25$ and $\sigma = 0.75$ ($\Omega = 0.15$)						
π	0.023	0.029	0.031	0.032	0.032	0.032	0.033
r	0.118	0.108	0.104	0.102	0.101	0.10	0.10
RER	0.94	0.93	0.93	0.93	0.93	0.93	0.92
CA	0.005	0.003	0.001	0.001	0	0	0
Z	0.069 (0.067)	0.067	0.065	0.065	0.065	0.064	0.064 (0.081)
	$\tau = 0.50$ and $\sigma = 0.75$ ($\Omega = 0.10$)						
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	0.003	0.019	0.025	0.028	0.029	0.030	0.031
r	0.128	0.111	0.105	0.102	0.101	0.101	0.10
RER	0.97	0.95	0.94	0.93	0.93	0.93	0.92
CA	0.012	0.006	0.003	0.002	0.001	0.001	0
Z	0.078 (0.068)	0.074	0.072	0.071	0.071	0.070	0.070 (0.095)
	$\tau = 0.25$ and $\sigma = 2$ ($\Omega = 1$)						
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	0.028	0.027	0.026	0.026	0.026	0.026	0.026
r	0.099	0.099	0.10	0.10	0.10	0.10	0.10
RER	0.92	0.92	0.92	0.92	0.92	0.92	0.92
CA	0	0	0	0	0	0	0
Z	0.090 (0.097)	0.092	0.092	0.092	0.093	0.093	0.093 (0.102)
	$\tau = 0.50$ and $\sigma = 2$ ($\Omega = 0.25$)						
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	0.010	0.018	0.021	0.023	0.023	0.024	0.024
r	0.118	0.107	0.103	0.102	0.101	0.10	0.10
RER	0.96	0.94	0.93	0.93	0.93	0.93	0.92
CA	0.008	0.004	0.002	0.001	0.001	0	0
Z	0.115 (0.10)	0.109	0.105	0.104	0.103	0.102	0.102 (0.120)
	$\tau = 0.25$ and $\sigma = 3$ ($\Omega = 1$)						
	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$	$t = 5$	Long Run
π	0.033	0.028	0.025	0.024	0.023	0.023	0.023
r	0.093	0.096	0.098	0.099	0.10	0.10	0.10
RER	0.91	0.92	0.92	0.92	0.92	0.92	0.92
CA	–0.004	–0.002	–0.001	0	0	0	0
Z	0.093 (0.118)	0.104	0.109	0.112	0.113	0.113	0.113 (0.116)

[1]The row for *Z* shows the path of reserves. *Z* equals 0.05 initially. The number in parentheses is the level of reserves in a crawling peg.

We close with some thoughts about two extensions of the analysis that would test the robustness of our conclusions in a broader policy context.[25] The first concerns aid flows that support public investment. We have equated aid with transfer payments to the "poor" (i.e., the representative private agent). It is also desirable to investigate the repercussions of aid that finances rehabilitation of social and physical infrastructure. This type of aid brings many new effects into play. If productive capacity increases proportionately in the tradables and nontradables sectors, then appreciation of the real exchange rate will be strictly temporary. Furthermore, if private capital and infrastructure are complements, aid may produce large multiplier effects and a nontrivial increase in tax revenue in the long run.[26] The complications that were confined here to PDR aid would then materialize in the case where all aid is spent. Related to this, we conjecture that productive aid—aid that has a strong positive impact on permanent income and the equilibrium private capital stock—will elicit immediate, large increases in private consumption and investment. In the short run, therefore, it might prove very difficult to contain inflationary pressures. This pushes the "optimal" managed float more in the direction of the middle ground between a fixed exchange rate and a pure float. How much more is not clear absent careful analysis. For what it is worth, our prior is that the macroeconomic tradeoffs associated with aid and the right policy intervention *are* sensitive to the type of aid.

The second extension acknowledges that African central banks have to worry about more than just aid shocks when deciding on the appropriate exchange rate regime. We are currently working on a stationary, discrete-time version of our model in which aid shocks compete with other important shocks for policymakers' attention and some portion of aid may in fact represent a response to other shocks (e.g., to the terms of trade). We look for desirable intervention and sterilization rules, given a plausible loss function and given the observed joint distribution of shocks and aid. This approach links the analysis in the current paper with the growing literature on monetary policy rules in the open economy (e.g., Svensson, 2000). The conclusions we have emphasized here—including the merits of managed floating and the limited role for bond sterilization—seem likely to survive if the environment is dominated by autonomous and reasonably persistent changes in aid. What remains to be seen is whether these conclusions constitute a serious challenge, under more general circumstances, to rules that incorporate greater exchange rate flexibility and/or more aggressive bond operations.

[25]For a couple of reasons, we do not consider the assumption that aid is permanent to be especially limiting. First, empirical measures of aid generally show strong persistence in African countries. Even after removing a linear trend, for example, the variance of variables like real aid per capita or the aid-to-GNP ratio tends to be dominated by low-frequency components. (Thus while Bulíř and Hamann (2001) emphasize the volatility of aid, their analysis applies to the short-run "cycle"—that is, the component that remains after using the Hodrick-Prescott filter to remove a slow-moving nonlinear "trend." The trend itself shows very substantial persistence, even when applied to linearly detrended aid series.) Second, intuition suggests that temporary aid inflows will produce results qualitatively similar to but quantitatively weaker than in the case of permanent aid flows. (The present model applies, of course, if the government converts temporary aid into permanent aid by spending only its annuity value.)

[26]Theory suggests that the crowding-in effect on private investment could be quite strong. See Buffie (1995).

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In statistical matter throughout this issue,

dots (. . .) indicate that the data are not available;

a dash (—) indicates that the figure is zero or less than half the final digit shown, or that the item does not exist;

a single dot (.) indicates decimals;

a comma (,) separates thousands and millions;

"billion" means a thousand million; and "trillion" means a thousand billion;

a short dash (–) is used between years or months (for example, 1998–99 or January–June) to indicate a total of the years or months inclusive of the beginning and ending years or months;

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