Pegging and Stabilization Policy in Developing Countries*

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I review the case for pegging the exchange rate by surveying the recent theoretical literature on the choice of exchange rate regimes. This literature suggests that by enhancing the transparency or controllability of monetary policy, pegging may be more effective in lowering inflation expectations than other targets (such as money growth). However, under certain conditions a peg may be vulnerable to shifts in expectations. A peg also may require greater fiscal restraint by limiting the availability of inflation tax revenue; however, given certain economic distortions, policymakers may find it less costly to adopt expansionary fiscal policies under a peg than under a float. Pegging may stimulate growth by enhancing international trade or investment. However, it may reduce welfare by restricting the ability of policymakers to offset shocks. I also examine how pegging is associated with inflation and output in a sample of developing countries using a new exchange rate classification method. I find that a pegged exchange rate is associated with lower inflation and inflation volatility and with faster growth and similar output volatility. However, the theoretical survey suggests that any inferences should be drawn with care.

1. Introduction

The recent financial crises in emerging markets have renewed debate on the relative merits of pegged versus floating exchange rate arrangements and, in particular, have raised doubts about the long-run viability of pegged exchange rate regimes. Nonetheless, pegged regimes maintain their attraction. For example, Calvo and Reinhart (2000) find evidence that many countries actually intervene to smooth fluctuations in the exchange rate even though they claim to be floating. Some countries, such as Malaysia, have preferred to impose capital controls rather than give up exchange rate stability. The desire for exchange rate stability also is reflected in the ongoing interest in dollarization in Latin America and in common exchange rate arrangements in Southeast Asia. Other economies, such as Hong Kong and Argentina, have maintained currency board style arrangements that limit the freedom of monetary authorities to print money; and eleven European nations formed the European Union in which they have given up their national currencies in favor of a common currency in order to promote trade.

Policymakers who peg the exchange rate are typically motivated by two arguments. First, pegging to the currency of another successful monetary authority is believed to "import" that authority's policies and credibility and thereby lower inflation. These benefits of pegging are achieved through lower inflation expectations and through the monetary and fiscal restraint required by a peg. Second, pegging may contribute to faster output growth in the medium and long run by encouraging greater openness to international trade.

Pegging does entail costs, however. The monetary and fiscal restraint imposed by pegging reduces policymakers' ability to respond to shocks; as a result, the economy may experience increased output volatility or reduced welfare. Furthermore, it is not immediately obvious that pegging is a superior way of reducing inflation. In a neoclassical framework with optimizing agents, it can be shown that, given a path of output and fiscal policy, any inflation outcome achieved by an exchange rate peg can be achieved by an equivalent monetary target under a floating regime (Helpman 1981). The case for pegging, therefore, relies on the existence of distortions that will be discussed below.

In this paper, I attempt to shed further light on the implications of pegging for stabilization policy by selectively reviewing some of the recent theoretical literature and by comparing the behavior of certain macroeconomic indicators under both pegging and floating regimes in a sample of developing countries. Recent research addresses issues that could not be addressed by the traditional analysis of pegging and stabilization policy, which relies on a static open-economy IS-LM framework. In particular, recent research clarifies the dynamic incentives policymakers face under alternative monetary regimes, thus helping identify the conditions under which an exchange rate peg may lower inflation by enhancing credibility and the conditions under

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which pegging leads to greater macroeconomic policy restraint. The theoretical literature suggests that the effects of pegging could go either way. Pegging may enhance the transparency or controllability of monetary policy, so it may be more effective in lowering inflation expectations than other targets (such as money growth). However, under certain conditions a peg may be vulnerable to shifts in expectations that are arbitrary or caused by fiscal shocks. A peg may require greater fiscal restraint by limiting the availability of inflation tax revenue, but, given certain economic distortions, policymakers may find it less costly to adopt expansionary fiscal policies under a peg than under a float.

I also survey the implications of pegging for output growth and volatility. The recent empirical growth literature suggests that lower inflation and more openness stimulate growth. Pegging may therefore contribute to growth through these channels. Pegging also may affect the policymakers' ability to respond to shocks or to reduce the volatility of output, the latter being the traditional focus of the analysis of pegging and stabilization policy. Recent advances in the literature, which analyze the implications of pegging using general equilibrium models, permit comparisons of economic welfare under pegging and under alternative monetary regimes given a variety of shocks.

Because the predictions of the theoretical literature on the implications of pegging for macroeconomic performance are ambiguous, I also briefly compare the inflation and output outcomes under pegging to those under floating for a group of developing countries over the period 1975–1999. The existing empirical evidence suggests that pegging is associated with lower inflation than floating and with about the same growth performance (Ghosh, et al. 1995, IMF 1997). However, the classification of exchange rate regimes used in these studies is based on what countries report to the International Monetary Fund (IMF). These reports are thought to be inaccurate, as countries that peg often report they are floating (Edwards and Savastano 1999, Calvo and Reinhart 2000). My analysis classifies countries as pegging or floating based on observed exchange rate volatility rather than on reports to the IMF. I also attempt to control for the possibility that, during certain periods, macroeconomic performance under a floating regime either actually reflects policies adopted under pegging or may not be the result of the exchange rate regime. I confirm that inflation and inflation volatility are higher under floating than under pegging. However, output appears to grow faster under pegging than under floating.

The paper is organized as follows. Section 2 discusses the choice of regime and the implications for inflation and monetary and fiscal policy. Section 3 examines the relationship between pegging and output growth and volatility. Section 4 briefly discusses the exchange rate classification method used in this paper and then compares average performance under pegging and floating of: (i) inflation and output, (ii) indicators of macroeconomic policy, and (iii) indicators of external sector behavior. Section 5 offers a summary and some discussion.

2. Pegging, Credibility, and Macroeconomic Policy

Until the second half of the 1970s, it was generally assumed that the interests of policymakers fully coincided with those of consumers and producers. However, more sophisticated analyses of the incentives of policymakers in a rational expectations setting, based on work by Kydland and Prescott (1977), revealed a fundamental source of conflict. Under certain conditions that are discussed below, policymakers have an incentive to introduce inflation surprises so as to maximize inflation tax revenue (Calvo 1978) or increase output and employment (Barro and Gordon 1983).

2.1. Inflation Bias

To illustrate the policymakers' incentives, consider an economy producing a single good in which policymakers care about (squared) deviations of output and inflation from their respective target levels.[1] Labor market rigidities in this economy imply that the "natural" (zero inflation) level of output and employment are inefficiently low. Inflation is costly because, when anticipated, it reduces holdings of real money balances and the corresponding liquidity services money provides. Inflation also redistributes income, adversely affects the efficiency of resource allocation by introducing price volatility and adding noise to relative price signals, and accentuates tax distortions.

In this economy, nominal wages are set for one period, based on an anticipated rate of inflation. At that wage rate, labor is supplied elastically to meet firms' demand. If inflation is higher than expected, real wages fall and firms' demand for labor rises, as do employment and output. The reverse is true when inflation is lower than expected.

Because output is below its efficient level, the central bank has an incentive first to announce a zero inflation target, but then, after wages are set, to surprise workers by in-

1. More precisely, the policymakers' objective function is:

$L = (y_t - \bar{y})^2 + w\pi_t^2$,

where L is the loss function of policymakers, y_t is real output, $\bar{y}$ is the output targeted by policymakers, π is the rate of inflation, and w is the relative weight policymakers assign to high inflation. The targeted level of output $\bar{y}$ is assumed to be greater than the "natural" level consistent with zero inflation.

creasing inflation above zero, thus lowering real wages and increasing output and employment in the short run. This "inflation bias" creates a credibility problem for the central bank, because rational workers will be aware of the bias. If they are, they will discount the central bank's promise of zero inflation and increase their nominal wage demands accordingly. The result is that, in equilibrium, inflation is higher while output and employment remain inefficiently low.

Economists have explored the credibility problem extensively, as well as various means of mitigating it. In the following, I discuss several papers that analyze the role of pegging as a means to enhance central banks' credibility.

2.2. Regime Choice, Transparency, and Credibility

One strand of the literature focuses on cases where the public is uncertain about whether the central bank is credible—that is, whether the central bank prefers low inflation or high inflation. Specifically, the public can learn about the central bank's preferences only by reviewing its behavior. Some observers have argued that, under these conditions, an exchange rate target is preferable to alternatives like a float with a monetary base target, because an exchange rate target is more "transparent."

Recent theoretical studies motivate the greater transparency of a peg by assuming either that a peg is more easily monitored or more "controllable" than the alternatives, such as a monetary base target. A peg is easier to monitor than monetary data, for example, because the peg is known immediately by market participants, whereas monetary data often are known only with a significant lag and may be subject to reporting errors.[2] A peg is more controllable in the sense that, under certain plausible assumptions, the inflation outcome that results from a peg is predictable. In contrast, the inflation outcome under a monetary base target is less predictable—actual inflation reflects not only planned inflation but also unpredictable shocks (to velocity or to the money multiplier).

Equilibrium inflation depends on the interaction between central bank actions and the public's perceptions of the central bank type, which influences expected inflation.[3] This interaction is modeled in a two-period setting by assuming that the public starts with a set of priors about the central bank's type. These priors are revised in the second period according to the central bank's actions in the first period.

The central bank must trade off the gain in output from increasing inflation today against the possible loss of reputation which precludes an inflation surprise tomorrow. The choice of regime has a bearing on this tradeoff. If a peg is adopted, the public can immediately observe the central bank's actions and tell that planned inflation is zero and may revise its expectations about the central bank's type accordingly. In contrast, under a float, the central bank's actions are harder to evaluate, either because the policy instrument cannot be easily observed or because lack of controllability implies that the central bank's inflation target is obscured by unobservable shocks (e.g., to velocity). Thus, a high-inflation type central bank may use a float to disguise its intentions under certain conditions.

Canavan and Tommasi (CT 1997) explore how the public's ability to monitor the policy instrument affects inflation. To simplify the analysis, they first assume that the transparency of the instrument is given in a two-period setting. Then they examine the effects of the transparency of the signal and uncertainty about the central bank type on first-period inflation. The model reveals that a more transparent central bank signal (an exchange rate target) lowers equilibrium first-period inflation. Greater signal transparency encourages the public to place more weight on the signal, and less on its priors, in deciding whether the central bank is a low-inflation or a high-inflation type. (Higher signal transparency also lowers the dispersion of first-period inflation rates between low-inflation and high-inflation types.)

In addition, CT find that, independent of the signal, *less* (rather than more) public certainty about the central bank type also lowers first-period inflation. The reason is that both types want to build expectations for low inflation in the second period. The low-inflation type central bank wants expectations low because it will be easier to deliver low inflation in the second period. The high-inflation type central bank wants expectations low because the inflation "surprise" in the second period will be that much stronger.

CT also show that a high-inflation central bank would rather target the monetary base and allow the exchange rate to float, as the monetary base is a less transparent instrument. In contrast, a central bank that prefers low inflation also will prefer a more transparent instrument (a peg) to signal its type and differentiate itself more clearly from the high-inflation central bank. The alternative is to implement even lower inflation, which is costly.

Herrendorf (1999) develops a framework to analyze transparency issues that focus on "controllability." Much

2. For example, data on the monetary base published by the IMF at the time of the Mexican peso crisis of December 1994 were about six months old. More timely data on Mexico or other emerging markets are available now on their respective central bank websites.

3. The analysis is extended to an open economy setting by assuming purchasing power parity, so that inflation and an exchange rate depreciation are the same thing. A depreciation (inflation) is costly, but, as in the preceding analysis, it can be beneficial if it is higher than anticipated by the public.

of his analysis is devoted to determining when reputation effects will be sufficiently strong to induce the high-inflation type central bank to adopt zero inflation in the first period. He shows that if the exchange rate is floating, this will occur under three conditions: (i) Control over inflation is more precise; in this case, the public knows that velocity shocks are small, so if inflation is higher than zero, then the central bank is revealed as a high-inflation type. (ii) The central bank cares about the future (so reputation effects arising in the second period are given a higher weight). (iii) The central bank starts out with a reputation for preferring low inflation.

If these conditions are not met, the high-inflation type central bank will plan "high" inflation (higher than zero). The inflationary bias is then larger the less precisely inflation can be controlled, that is, the larger the shocks to money velocity. The reason is that these shocks give the high-inflation type central bank cover to disguise the fact that it is planning high inflation. This lowers the expected reputation cost of any given rate of planned inflation, making higher inflation more attractive. If velocity shocks are sufficiently large, reputation effects lose their force entirely.[4]

Herrendorf also shows when a peg imposes more discipline than a float, i.e., when a high-inflation type central bank chooses zero inflation under a peg but plans positive inflation under a float. This occurs if: (i) the cost of exchange rate pegging is small, that is, imported inflation or real exchange rate volatility is low, (ii) policymakers attach a high value to the future, so reputation effects are assigned more weight, (iii) the central bank starts with a reputation for being "low-inflation type," or (iv) velocity shocks are large.

Assuming these conditions hold, the payoffs to central banks will vary according to the exchange rate regime in place (this is true even for the low-inflation type central bank, which always chooses zero inflation). The reason is that the public expects inflation to be lower under a peg, when both types of central banks choose zero inflation, and higher under a float, when high inflation will be chosen if a high-inflation type central bank is in office. It can be shown that the low-inflation type central bank will choose a peg if the credibility gains outweigh the costs from pegging associated with imported foreign inflation and shocks to the real exchange rate, which lead to suboptimal fluctuations in domestic output. It also can be shown that, under certain conditions, the high-inflation type central bank will choose an exchange rate peg if the low-inflation type central bank would do so; choosing a peg in the first period hides the fact that it is a high-inflation type, thus lowering inflation expectations and maximizing the impact of the surprise when it abandons the peg in the second period.

2.3. Pegging, Credibility, and Crises

Another strand of the literature emphasizes that the success of a pegged regime in curbing inflation expectations may be limited if (i) inflation expectations shift arbitrarily, or (ii) the pegged regime is inconsistent with fiscal policy, possibly as a result of an unanticipated shock.

To illustrate the first case, suppose the central bank minimizes a loss function comprising squared deviations of output and inflation, as in the preceding discussion. As is well known, the inflation bias that tends to arise in this setting can be eliminated by setting the inflation rate to zero, which, in an open economy with purchasing power parity, can be accomplished by credibly pegging the exchange rate to a zero inflation currency forever. One way a country can do this is by surrendering its own currency, as argued by proponents of dollarization. However, the central bank then will be unable to adjust policy to respond to shocks, resulting in greater output volatility. A floating regime in which the central bank picks a rate of devaluation and inflation that minimizes its loss function is still preferable.[5]

The inflation bias may be reduced in a less costly manner if, apart from caring about deviations of output and inflation, the central bank also faces a fixed cost whenever the fixed exchange rate is realigned. This may be the political cost from breaking a commitment to peg or from strained relations with trading partners, particularly if the exchange rate peg reflects an international arrangement (like the Exchange Rate Mechanism of the European Monetary System in the 1980s). It is possible to show in this case that the central bank will adopt a fixed but adjustable exchange rate. It will keep the exchange rate pegged as long as shocks to the economy are small enough to ensure that the cost of maintaining a peg is lower than the cost of adjusting it. However, the policymakers will adjust the exchange rate whenever the shock is sufficiently large.

Lohmann (1992) argued that an institutional design that prompts the policymaker to pre-commit to low inflation

4. The conditions under which a "high-inflation type" policymaker will decide to maintain zero inflation under a peg are similar, although there are differences because the transparency of the peg unambiguously reveals the planned inflation rate of zero.

5. For further discussion of the implications of alternative arrangements see Lohmann (1992) and Obstfeld and Rogoff (1995, Chapter 9). On the other hand, Mendoza (forthcoming) discusses in a general equilibrium model applied to Mexico how the credibility costs of not fixing given credit constraints may be so high as to warrant dollarization. Note that in Herrendorf's (1999) model, the "low-inflation type" central bank always chooses zero inflation, regardless of the size of the shock to the economy or the exchange rate regime chosen.

with an escape clause is optimal, in the sense that it simultaneously minimizes inflation bias and output distortions.[6] However, it is possible to show that, in this framework, arbitrary changes in the inflation expectations of workers may trigger the escape clause. In particular, if for some reason workers fear that the central bank is going to devalue, they will increase their wage demands accordingly, reducing competitiveness and output, and, in effect, forcing the central bank to devalue. As a result, expectations of inflation (or currency devaluation) are self-fulfilling, and there are multiple equilibria consistent with differing ex ante inflation expectations (Obstfeld 1996). Indeed, inflation expectations under the "escape clause" rule may be the same as under a floating regime, in which case the central bank incurs the cost associated with temporarily pegging and devaluing the currency without any reduction in inflation bias.

The vulnerability of monetary targets to shifts in expectations is highlighted by recent experience with efforts to stabilize the exchange rate through tighter monetary policy around episodes of currency crises. Recent empirical studies suggest that tighter monetary policy under crisis conditions either has no effect on the exchange rate (Kamien and Gould 2001) or, if it does have any effect, the effect is very small (Dekle, Hsiao, and Wang 2001).

To illustrate the second case, recall that, as emphasized by "first generation" currency crises models, a zero-inflation pegged regime must be consistent with an exogenously determined fiscal policy. Burnside, Eichenbaum, and Rebelo (BER 1998) develop an intertemporal equilibrium version of such a "first generation" model.[7] The central bank faces standard present value budget constraints, and it finances expenditures through lump sum taxes, seigniorage revenues, and borrowing. (All agents, including the central bank, have access to international capital markets.) As is often assumed in this type of analysis, purchasing power parity holds, so that the rate of inflation equals the rate of devaluation of the currency.

BER first describe a sustainable peg in which the rate of expected and actual inflation is zero (no seigniorage revenues) so that the present discounted value of net future government revenues equals the value of today's net government debt. The present value of the deficit unexpectedly rises because of a rise in future transfer payments (in the context of the recent crises in emerging markets, the deficit could rise to subsidize a failing financial sector). It is possible to show that, under these conditions, the peg will be unsustainable.

BER assume that the central bank will finance the deficit by increasing the stock of money at a given time period, T, and then raise the growth of money supply permanently in a manner that satisfies the intertemporal budget constraint. They also assume that the pegged exchange rate will be abandoned when the net government debt reaches a certain threshold, and they highlight the various conditions that determine when that threshold will be reached. It is apparent in this setting that a pegged regime is associated with lower inflation, while a floating regime will be associated with higher inflation. However, this does not reflect any disciplining effect of the exchange rate on macroeconomic policy. Instead, the association occurs because of a fiscal shock that makes a peg unsustainable.

A model of the East Asian crisis by Corsetti, Pesenti, and Roubini (CPR 1998) has similar implications. However, CPR emphasize that the fiscal shock is a result of central bank guarantees to the financial sector that lead to an accumulation of contingent government liabilities to borrowers whose projects have had poor results. Once government liabilities reach a certain threshold relative to foreign reserves, the guarantee is no longer credible, so borrowers cash in, raising the measured government deficit. The expectation that at least part of this deficit will be monetized causes the peg to collapse.

2.4. Pegging and Fiscal Discipline

So far, I have focused on the relationship between the choice of exchange rate regime and monetary discipline or inflation. However, it is also sometimes claimed that the choice of exchange rate regime has implications for fiscal discipline. The models presented earlier cannot directly address this question, as they either ignore fiscal policy or assume it is not entirely under the control of policymakers.

The link between a peg and fiscal discipline is intuitive: Pegging the exchange rate may reduce the revenue from money creation, so in some circumstances a decision to peg may require a fiscal adjustment to ensure sustainability. Chin and Miller (1998) provide an example of this in an overlapping generations model with optimizing agents who produce two goods—traded and nontraded—and are, respectively, borrowers and lenders. In their model, shocks may affect relative prices and interest rates, consequently

6. See also Flood and Isard (1989).

7. The model is a continuous time, perfect foresight endowment economy populated by an infinitely lived representative agent and a government. The original "first generation" models of Krugman (1979) and Flood and Garber (1984) are not intertemporal optimizing models but instead are motivated by the model of resource depletion of Salant and Henderson (1978). These models emphasize that a fiscal deficit is incompatible with a pegged regime because it will ultimately lead to the exhaustion of foreign reserves. Anticipating this, agents will attack the peg and suddenly deplete reserves at a well-specified point in time in which no capital gains or losses from the abandonment of the peg are possible.

affecting wealth, the distribution of income between lenders and borrowers, and the government budget. In this setting, a peg may not be sustainable in some cases unless the government reduces its spending.

However, recent research reveals that pegging does not always imply a greater degree of fiscal discipline. Tornell and Velasco (2000) develop an intertemporal optimizing model of a small open economy with price flexibility and perfect capital mobility that describes how the choice of exchange rate regime may influence fiscal discipline, i.e., the decision to limit government spending. In this setting, output is given. There is a representative (infinitely lived) agent who maximizes lifetime utility and dislikes inflation because real money balances (as well as consumption) are an argument in his utility function. The government includes a fiscal authority that has a given stream of revenue but that can spend (engage in fiscal transfers) as well as issue bonds. A monetary authority sets a rate of depreciation of the currency (which, assuming purchasing power parity, is equivalent to setting the rate of inflation) in a pegged regime, or sets the rate of growth of the money supply in a floating regime. The fiscal authority derives utility from the utility of the representative agent, which implies that the fiscal authority also dislikes inflation.

Three distortions ensure that the choice of exchange rate regime matters in this model. First, in addition to valuing the utility of the representative agent, the fiscal authority also values spending (fiscal transfers); that is, it likes to spend more than is socially optimal or than what a social planner who cares only about the welfare of the representative agent would spend. Second, the fiscal authority is impatient; it cares more about what happens up to a certain time horizon *(T)* than about what happens subsequently. This assumption may be motivated by the plausible idea that the government is run by politicians with limited tenure who, therefore, value the present more than the general public does. This assumption also yields a key feature of the model, namely, that the decision to spend today is influenced by whether the inflation cost is borne today or tomorrow. Third, the monetary authority has limited independence; it can independently choose a monetary target (if floating) or a rate of depreciation (if pegging) up to time *T*, but after that it must adjust its policy (the revenue from money creation or the inflation tax) to satisfy the government budget constraint. (In what follows, I will call the period up to *T* "today" and the period after *T* "tomorrow"). This condition ensures that the monetary authority cannot simply set the entire path of monetary revenues, thus leaving the fiscal authority some leeway to determine the path of spending as well as to influence money growth and inflation outcomes after *T*.

How does the choice of regime influence the level of spending and the deficit and inflation behavior today or tomorrow? If a pegged regime is in place today (what Tornell and Velasco call a "predetermined exchange rate system") the rate of inflation will be determined by how much the central bank allows the exchange rate to depreciate. Any spending by the fiscal authority that cannot be fully financed by its revenues (including the inflation tax revenue) will have to be financed by borrowing. The intertemporal budget constraint of the government implies that inflation will have to rise in the future in order to service the additional debt. Thus the inflationary cost of financing government spending under a pegged regime is borne tomorrow, not today.

This is in contrast to what happens if the central bank fixes the rate of nominal money growth today, allowing the exchange rate to float. If the fiscal authority runs a fiscal deficit, agents who know the government's intertemporal budget constraint will anticipate higher future inflation. This raises inflation today relative to the inflation that would have occurred under a peg (however, inflation tomorrow will be lower than the inflation that would have followed a pegged regime).

Will the fiscal authority spend more under pegging or under floating? For any given increase in spending, the timing of the inflation cost depends on the regime in place. Under pegging, the fiscal authority bears the inflation cost (arising from the disutility of the representative agent) tomorrow, while under floating the fiscal authority will bear some of the inflation cost immediately. For this reason, an impatient fiscal authority will tend to limit spending more under floating, when the penalty is imposed immediately. Tornell and Velasco's analysis also implies that if there is a sudden decline in fiscal revenues, a fiscal authority will respond with a sharper cutback on expenditures under a floating regime. They provide evidence from Africa indicating that following a reduction in revenues, CFA member countries that fixed their currencies to the French franc tended to adjust expenditures by less than neighboring countries that were floating. CFA is a common currency arrangement that stands for *Communauté Financière Africaine* for its West African members and *Coopération Financière en Afrique Centrale* for its Central African members.[8]

8. A decision to peg does not always reflect a desire to limit inflation and may instead be the outcome of a political process, in which the number gaining from a peg exceeds the number losing from it. Chin and Miller's (1998) two-sector (traded and nontraded goods) model has this feature. In their model, shocks create distribution effects between producers in traded (debtors) and nontraded (creditors) goods via relative price and interest rate changes, influencing the choice of regime. In this case, while the decision to peg may have implications for fiscal discipline, such discipline is not necessarily the underlying motivation for policy.

3. Pegging, Output Growth, and Volatility

While I have focused on how the selection of an exchange rate regime may influence inflation outcomes, policymakers also typically are concerned with how such a choice affects output growth and volatility. Theory has little to say about the direct effects of the choice of exchange rate regime on growth; indeed, output is given in a number of the models discussed earlier. However, the choice of regime may affect output indirectly. If pegging reduces average inflation, it may encourage faster investment and growth by reducing uncertainty as well as the effects of the inflation tax. There is some empirical evidence that inflation is negatively related to growth (Fischer 1993), although recent studies suggest that the relationship may be nonlinear. Ghosh and Phillips (1998) find (in their base specification) that inflation tends to be positively related to growth for inflation rates of about 3 percent or lower but is negatively related to growth at higher rates of inflation.

Pegging also may reduce real exchange rate volatility or limit real exchange rate appreciation, which may encourage greater openness. Greater openness, in turn, may stimulate growth by facilitating technology transfer and exposure to best international practices (Grossman and Helpman 1991). Levine and Renelt (1992) show that openness is one of just two variables that are robust to specification changes in a standard growth regression, while Frankel and Romer (1999) find that openness affects growth even after correcting for endogeneity in the typical measures of openness.[9] However, as noted by Moreno (2000), the evidence that pegging encourages international trade (and therefore openness) is weak, with the exception of common currency areas. Neither is there a consensus on how pegging affects the real exchange rate, which, in turn, may influence openness. In Latin America, pegging generally is thought to be associated with real appreciation in the exchange rate, which may reduce openness and growth. In contrast, in East Asia, pegging is thought to be associated with real exchange rate stability or depreciation, which suggests the opposite.

Apart from influencing growth, the choice of regime may influence the business cycle through its impact on financing behavior and vulnerability to crises. Chang and Velasco (2000) argue that a pegged exchange rate makes an economy more vulnerable to currency collapses resulting from illiquidity. In addition, a pegged regime may amplify boom and bust cycles, in part by facilitating the external financing of risky projects made attractive by implicit government guarantees, as in Corsetti, Pesenti, and Roubini (1998). In their model, implicit government guarantees, backed by foreign reserves, encourage borrowing from foreigners. As long as the guarantees and, consequently, the pegged regime are credible, borrowers experiencing adverse outcomes can cover any shortfalls through additional borrowing. During the pegged period, growth and investment expand past efficient levels, and the current account deficit rises. However, once reserves fall below a certain threshold, the peg is abandoned, the current account deficit experiences a reversal, and growth contracts to efficient levels.[10]

The analysis of the choice of exchange rate regime does not traditionally focus on the effects on output growth discussed above but, rather, on how regime choice affects the volatility of output in response to shocks from various sources. In an open-economy IS-LM setting, it can be shown that a pegged regime minimizes output volatility if there are shocks to money demand ("LM" shocks), while a floating regime minimizes such volatility if there are real shocks ("IS" shocks) or external shocks. If the sources of shocks are uncertain, a mixed response that reflects the relative volatility of the underlying shocks is called for (Boyer 1978). A number of empirical studies suggest that external shocks are relatively important in explaining capital flows or currency crises (see Calvo, Leiderman, and Reinhart 1993, and Moreno and Trehan 2000), suggesting that they also play an important role in business cycle fluctuations. If external shocks are more important than domestic shocks, the volatility of output will tend to be higher under pegged regimes than under floating regimes because the former would be less effective in insulating an economy from external shocks.

Unfortunately, the earlier theoretical literature on the choice of regime and economic shocks is not based on a general equilibrium framework, so it is impossible either to assess whether the conclusions are consistent with optimizing behavior or to perform welfare comparisons of alternative policies. Recent research addresses these concerns, providing new insights on the optimal choice of monetary regime.

Schmitt-Grohe and Uribe (forthcoming) illustrate the costs of permanently pegging the exchange rate using

9. Some recent research does cast doubt on the robustness of the relationship between inflation or openness and growth. Sala-i-Martin (1997) runs nearly two million regressions to compute the distribution of coefficients for various explanatory variables used in growth regressions and finds that inflation and openness are significant only in a small proportion of the cases. However, these regressions do not account for nonlinearities or simultaneity.

10. Output is given in the BER (1998) model, but the choice of regime affects the cyclical behavior of consumption. In their framework, the collapse of a peg may be associated with a contraction in consumption and corresponding reduction in money demand.

Mexican data. They calibrate an equilibrium small open economy model with nontraded, exportable, and importable goods sectors, with sticky prices. The economy faces three external shocks—terms of trade, world interest rate, and import-price inflation—which account for 45 percent of the output error variance of Mexican output and the Mexican real exchange rate at 8-quarter to 16-quarter horizons. Schmitt-Grohe and Uribe compare the welfare costs of a permanent exchange rate peg (which they describe as dollarization) to a number of targets. These are the money growth rate, CPI inflation, nontraded goods inflation, an optimal devaluation rate rule (which responds to shocks to the terms of trade, import prices, and the world interest rate), an ad hoc devaluation rate rule (dampening the response of the rate of devaluation to a global interest rate shock relative to the optimally derived rule in a way that the authors consider more plausible), and the crawling peg in place under the Mexican "*Pacto*" arrangement, in which the government negotiated its macroeconomic policies with the private sector and the labor unions.

Their estimates suggest that agents would rather give up between 0.1 and 0.3 percent of their nonstochastic steady-state consumption than adopt a permanent peg (dollarization). To illustrate the intuition, consider a rise in world interest rates, the most important influence on Mexican output. In response, aggregate demand falls, as does the equilibrium relative price of nontradables to tradables (because nontradables supply is less than perfectly elastic). Since prices are sticky, the nontradables price cannot fall if the exchange rate is pegged, so nontradables output falls instead. The best response would be a devaluation of the domestic currency, which would lower the price of nontradable goods and mimic the adjustment in a flexible-price economy.

Due to the complexity of their setup, Schmitt-Grohe and Uribe rely on simulations to assess the implications of their model. Obstfeld and Rogoff (2000) instead develop a one-period model which allows them to derive analytic solutions and discuss in more detail the implications of the choice of exchange rate regime on welfare, expected output, and the expected terms of trade in a general equilibrium framework. The setting is a world economy consisting of two countries of equal size, each producing an array of differentiated tradable goods indexed over distinct intervals. Workers are monopolistic suppliers of a distinctive variety of labor services to the two sectors in the economy, tradables and nontradables. In this framework, the choice of regime matters because wages (but not prices) are sticky. Workers set their nominal wages before production and consumption, supplying labor elastically at that wage according to what firms demand in response to shocks to the economy. This demand, in turn, can be influenced by monetary policy. However, inflation surprises are ruled out. Obstfeld and Rogoff assume monetary authorities commit to a monetary rule and do not have the leeway to vary the rule each period. For this reason, the credibility issues discussed earlier do not arise.

An advantage of the Obstfeld and Rogoff approach is that it clarifies how economic uncertainty affects decision-making in an optimizing framework. For example, economic uncertainty is shown to influence ex ante wage setting, in turn affecting expected levels of consumption, output, and the terms of trade.[11] To assess the implications of alternative monetary rules, Obstfeld and Rogoff analyze the case in which there is a shock to productivity that calls for an increase in output. If wages and prices are fully flexible, wages will adjust in response to the shock, and output will expand accordingly. If wages are sticky, however, this first best equilibrium is not automatically attained and must be accomplished through policy. It can be shown that if monetary authorities follow a particular procyclical monetary policy (set in response to both domestic and foreign productivity shocks) the optimal flexible price equilibrium can be replicated. The optimal rule expands the money supply in order to increase demand in response to the productivity shock. This monetary arrangement will typically imply floating, rather than fixed, exchange rates unless productivity shocks are perfectly correlated in the two countries.

The research cited in this section suggests that real GDP growth may be higher under pegging than under floating, if pegging stimulates investment spending or openness. However, a finding that growth is faster under pegging may be misleading. In some cases it may reflect the fact that a peg stimulates a boom that culminates in a bust. In this case, collapsing pegs that are classified as floating will typically be associated with slower output growth or contractions even if they reflect policies in place at the time of a peg.

The implications of a peg for output volatility, and the corresponding welfare implications of such volatility, are unclear. For example, pegging imposes higher welfare costs than alternative policy regimes by *increasing* output volatility in the face of external shocks. However, if there are shocks to productivity and wages are sticky, a peg may limit output adjustment by delaying adjustment in real wages and labor supply. Under these conditions, welfare may be enhanced by a procyclical monetary policy under

11. It also can be shown that expected utility rises with expected log expenditure, measured in tradables, and the expected log real exchange rate, but falls with greater volatility in expected spending or in productivity. This sets the stage for assessing alternative monetary regimes based on how they affect these variables.

floating that may be associated with greater output volatility than is possible under a pegged regime. More broadly, the research cited suggests caution in attributing output performance to the choice of regime as well as in making normative statements.

4. Stylized Facts

4.1. Classifying Exchange Rate Regimes

As there is some ambiguity in how a decision to peg may be related to inflation or output, I attempt to describe some of the stylized facts of this relationship. For this purpose, I collected monthly exchange rate data to classify the exchange rate regimes and to identify currency crises (discussed briefly below). However, I use annual frequencies to describe the CPI inflation and real GDP from the International Financial Statistics CD-ROM of the International Monetary Fund.

One popular approach (e.g., Ghosh, et al. 1995) to determining the kind of exchange rate regime uses the regimes reported by the countries themselves to the IMF, which appear in the annual publication *Exchange Rate Arrangements and Restrictions.* However, as noted by Edwards and Savastano (1999), Reinhart (2000), and Calvo and Reinhart (2000), the main disadvantage of this source is that the reporting often appears to be imprecise. Calvo and Reinhart (2000) study the empirical properties of exchange rates and of indicators of efforts to stabilize the exchange rate (foreign reserves, interest rates) and find that many countries that report to the IMF they are floating appear to be pegging. Fluctuations in the exchange rate of many self-proclaimed floaters are just as likely to fall within a narrow band (2.5 percent in either direction for monthly data). Calvo and Reinhart find that self-reported floaters actually experience more foreign reserve volatility, suggesting heavy intervention.

Table 1 illustrates the problems with classifying exchange rate regimes based on country self-reporting. It lists the officially declared exchange rate regime in a small group of East Asian and Latin American economies as well as in Germany and Japan, and it compares the mean monthly percentage change (annualized by multiplying by 1,200) and the standard deviation of the currency against the U.S. dollar. South Korea's "other managed float," for example, exhibits volatility that is similar to Argentina's

TABLE 1
DECLARED EXCHANGE RATE REGIME AND INDICATORS OF EXCHANGE RATE BEHAVIOR AGAINST THE U.S. DOLLAR

Country	Officially Declared Exchange Rate Regime	Annualized Mean Monthly Percentage Change[a]	Standard Deviation against U.S. Dollar	Estimated regime
		East Asia		
Thailand	Peg to composite of currencies[b]	0.1	1.4	U.S. dollar peg
Hong Kong	U.S. dollar peg[c]	–0.2	0.4	U.S. dollar peg
South Korea	Other managed float	2.5	0.9	U.S. dollar peg
		Latin America		
Argentina	U.S. dollar peg	0.8	0.9	U.S. dollar peg
Brazil	Independently floating	376.7	14.3	Float
Mexico	Other managed float[d]	–0.3	1.1	U.S. dollar peg
Panama	U.S. dollar peg (dollarized)	0.0	0.0	U.S. dollar peg
		Major currencies		
Germany	Independently floating	7.3	10.5	
Japan	Independently floating	10.5	9.4	

[a]Mean is annualized by multiplying by 1,200.
[b]Australian dollar, deutsche mark, Indian rupee, Italian lira, South African rand, and Russian ruble.
[c]According to the Hong Kong page of the report; the regime at the back of the report is misreported as "Other managed float."
[d]This is actually a crawling peg, with a daily limit of Mex. $0.40 per U.S. dollar on the depreciation of the maximum selling rate.

Note: Data used in estimates are for the first half of 1993.

U.S. dollar peg. In addition, except for Brazil, the currencies of the self-described floaters among the emerging economies were much less volatile than the deutsche mark or the yen (note that the DM-$ volatility of about 10.5 is broadly representative of that currency's volatility since the 1970s (Moreno 2000)).

In the last column of the table, I draw on ongoing research and use a method to classify the exchange rate regime based on observed monthly exchange rate behavior.[12] The classification method of the exchange rate regime proceeds in four steps.[13] First, for each country, I identify the major currency against which it has the lowest lagging twelve-month volatility. Second, I check whether the lowest volatility, σ_{ij} , of currency *i* against major currency *j* falls below a threshold $\overline{\sigma}$. If so, I tentatively classify the regime in place in country *i* in that month as a peg against currency *j*. Otherwise, I classify the regime as floating. I use an (arbitrary) "intermediate" threshold volatility that is one-third the volatility of the DM-$ in the first half of 1993.[14]

Third, I define a new regime only if it is sufficiently persistent; for the purposes of this study, the minimum period is six months. This requirement addresses the problem arising when the currency with the lowest volatility changes briefly (for example, during the collapse of an exchange rate peg) but then reverts.

Fourth, in order to time regime switches more precisely, I add a percentage change criterion. If a switch in regime to fixed or floating is reported according to the lowest volatility criterion, the absolute percentage changes in the exchange rate from $t-1$ to $t-n$ (n=12, and the check begins at $t-1$) are checked. A change in regime is said to begin in the first month in which the change in exchange rate is less than or equal to the change at *t* or less than 5 percent annualized (whichever threshold is higher will bind). Hong Kong's experience illustrates the usefulness of this criterion: Hong Kong switched from floating to a dollar peg in late 1983, but a simple volatility rule identifies the switch much later, in October 1984. This fourth step ensures that the switch is recorded in 1983. Regime switches (from a peg to floating) also are identified for the Mexican peso in 1994 and for the Thai baht in July 1997.

To sum up, these four steps allow me to classify currencies as either floating or as pegged to one of the five major currencies (U.S. dollar, yen, deutsche mark, French franc, sterling).

4.2. Exchange Rate Regimes, Inflation, and Output

I use this classification scheme to examine the stylized facts of the relationship between exchange rate regimes, inflation, and output, focusing on a sample of 98 developing countries. I exclude developed countries because differences in their institutional characteristics may influence the interpretation of results. For example, inspection of the results for the full sample of countries suggests that wealthier nations tend to float, while poorer economies tend to peg. As wealthier countries also have greater macroeconomic stability that may be attributable to the quality of their institutions, including them complicates the interpretation.

Table 2 reports average percentage changes of inflation, real GDP, and volatility (as measured by standard deviations) in pegged and floating regimes. The Z-test statistics of the significance of the difference of the means of inflation and output growth under pegged and floating regimes also are reported. The results reported in the first two rows suggest that inflation is lower and real GDP growth higher under pegging than under floating regimes. Also, in floating regimes, the inflation volatility is much higher while the output volatility is about the same.[15] These results may be compared to those of Ghosh, et al. (1995), or IMF (1997). They find that while inflation is higher, real GDP growth per capita is about the same across pegged and floating regimes.[16] The results reported here rely on the estimates of the mean of the data series without controlling for other factors.

12. Ghosh, et al., (1995, p. 3) argue that focusing on observed volatility of the exchange rate provides no indication of the degree of commitment to a peg. However, it is unclear from the data or the theoretical discussion that a declared exchange rate regime provides any information on commitment, either.

13. As noted earlier, we use monthly data to classify exchange rate regimes, but the discussion later in this paper will involve annual frequencies. To switch to annual frequency, we classify a country as pegging to the dollar in a given year if it was pegged to the dollar in most of the months. If there is a tie, the classification is based on the regime in place at the beginning of the year.

14. An alternative is to adopt a "strict" threshold volatility similar to the volatility of the Thai baht in the first half of 1993 as reported in Table 1. However, this threshold appears to be too strict to capture the many cases in which countries attempt to peg their currencies.

15. This estimate eliminates one extreme outlier observation for real GDP growth. If the outlier is not eliminated, the volatility under pegging is much higher.

16. Applying similar methods to a more recent sample to test the impact of currency boards, Ghosh, Gulde, and Wolf (1998) find that inflation is lower, and per capita real GDP growth higher, under currency boards than under alternative exchange rate regimes—whether pegged rates or floating. Their study relies on regression analysis, which provides a more systematic comparison than the stylized facts offered in this paper. However, although the authors attempt to control for simultaneity, the results of such regression analysis are still difficult to interpret due to the theoretical issues raised above.

TABLE 2
INFLATION AND REAL GDP GROWTH (1974–1998)

	Peg	Float	Z-test
Inflation (CPI)	16.6	147.6	–3.42***
	(95.4)	(1,099.9)	
Real GDP Growth	4.3	3.2	4.37**
	(5.6)	(5.6)	
Excluding episodes of currency depreciation preceded by a peg and two periods after			
Inflation	14.1	142.5	–2.80**
	(98.8)	(1,141.6)	
Real GDP Growth	4.6	3.6	3.43***
	(5.6)	(5.3)	
Excluding top 1% high-inflation episodes			
Inflation	12.7	36.7	–8.6***
	(25.6)	(76.6)	
Real GDP Growth	4.4	3.3	3.86***
	(5.6)	(5.5)	

***Significant at 1%.
**Significant at 5%.

Notes: Figures reported are mean (standard deviation). Real GDP growth data exclude one extreme outlier observation.

The theoretical literature allows for alternative interpretations of these results. For example, they fit conventional preconceptions of the pros and cons of fixed versus flexible regimes, viz., that inflation is lower under pegging, perhaps stimulating more rapid growth. The table also suggests that the loss of policy flexibility under a pegged regime does not lead to higher output volatility. However, this last result should be interpreted with caution; the observed output volatility under a pegged regime may reflect the impact of factors our comparison does not account for, such as capital controls.

The theory reviewed above also cautions us that regimes are connected over time by the government's intertemporal budget constraint. Thus, inflation may be lower under pegging because of fiscal policies or other shocks that make the peg untenable rather than because of any disciplining effect of a pegged regime. Indeed, as emphasized in Tornell and Velasco (2000), the government can defer inflation to the future under a pegged regime by borrowing; the effect would be higher inflation under floating. Regardless of the interpretation, the results do give an idea of the variation in average inflation and growth across exchange rate regimes.

The remainder of the table re-examines the data by accounting for the possibility of "survivor bias." Specifically, the results may reflect the impact of outliers. Inspection of median inflation rates (not reported) reveals that they are much lower than mean inflation rates. (However, the median under pegging is still lower than under floating, 8.5 percent versus 13.6 percent, respectively). It can be argued that these outliers, which have a particularly strong effect on average inflation under floating, are misleading, in part because they may be associated with survivor bias—for example, high inflation often is associated with floating rates in the aftermath of currency crises, but such episodes need not be attributable to a floating regime.[17]

I account for the possible effects of survivor bias in two ways. First, assuming that the aftermath of a currency crisis is the result of the policies that preceded the crisis, I eliminate observations in the year of a currency crisis and the two years that follow, as long as the crisis is preceded by a peg. The definition of a crisis is broadly consistent with the exchange rate regime classification: A crisis is an event in which the percentage change depreciation at T exceeds the lagging twelve-month mean percentage change plus three standard deviations and is also larger than 25 percent. The criterion of three standard deviations accounts for greater volatility that may occur during periods of high inflation; the criterion of 25 percent rules out changes that may be proportionately large but are quantitatively small (for example, a change of 10 percentage points in the tightly pegged Argentinean exchange rate that involves fractions of the peso).

The results of this adjustment are in rows three and four of Table 2, which show average inflation and GDP performance excluding years in which there is a currency crisis and the two years that follow. Average inflation falls in both pegged and floating exchange rate regimes, but not by much. Inflation under a float continues to be considerably higher than under a peg, and the volatility of inflation rises rather than falls. However, the point estimate of the growth rate rises under floating, bringing it closer to the average under a pegged regime. Output volatility remains comparable across the two regimes.

Next, I eliminate episodes of very high inflation from the sample, presuming that the exchange rate regime is endogenous to such high inflation, and not vice versa. It is hard to think of any fixed exchange rate regime that can survive extreme episodes of high inflation. Even countries with capital controls face strong pressure to devalue when very high inflation reduces competitiveness. As a cutoff, I

17. Edwards (1993) attempts to deal with survivor bias by assessing whether, for a given 10-year period, countries with a fixed regime had lower inflation in the first year. However, this approach leaves open the question of what happened in the succeeding nine years that may have influenced observed inflation rates.

eliminate observations in which inflation is in the upper 1 percent for the full sample. These results are in the final two rows of Table 2 and show that average inflation and its volatility are reduced across all regimes even more sharply, although inflation and inflation volatility remain higher under floating than under pegging. Real GDP growth rates are similar to those observed in the full sample.

To sum up the stylized facts, inflation and the volatility of inflation tend to be higher and real GDP growth lower under floating than under pegging. The volatility in real GDP growth is roughly the same across exchange rate regimes.

5. Summary and Discussion

In this paper I discussed how a decision to peg might influence inflation and output. The theoretical survey reviewed the conditions under which pegging may be associated with different inflation and output outcomes as well as the factors that account for such an association. In particular, I reviewed the conditions under which a peg may or may not lower inflation expectations or encourage macroeconomic discipline. I also described the channels through which a peg might stimulate faster output growth, produce boom and bust cycles, or influence output volatility.

I also reviewed the stylized facts associated with pegged and floating exchange rate regimes, using an exchange rate classification based on the observed volatility of exchange rates. The comparison of mean values suggests that inflation and the volatility of inflation tend to be higher under floating than under pegging. The estimates suggest that episodes of pegging are associated with significantly faster (but no more volatile) real GDP growth than are episodes of floating.

The survey of the recent theoretical literature suggests that caution is needed in interpreting these stylized facts. For example, the lower inflation under pegging may indeed reflect greater macroeconomic discipline, as is often argued. Alternatively, a peg may be unsustainable, having no disciplining effect, but simply postponing inflation to some future date when the peg collapses. A similar ambiguity arises in interpreting more rapid growth under pegging, which may reflect the stimulus associated with reduced uncertainty, or unsustainable booms.

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Appendix

Data Description and Sources

From the International Financial Statistics (IMF) CD-ROM I obtained the following series: The end-of-period exchange rates (line ae), consumer prices (line 64), exports (line 70..d), real GDP (line 99b.r or 99b.p), population (line 99z). Due to lack of data, Brazil's CPI is substituted with wholesale prices (line 63). The end-of-period exchange rates (line ae) are used to calculate monthly percentage changes in the exchange rate.

The data range from 1974 to 1998, collected at an annual frequency except for CPI and end-of-period exchange rates, which were collected at a monthly frequency and then annualized when appropriate. A number of macroeconomic series contained missing values or did not contain values for the entire time span. Estimates then were constructed using the available data for each country from alternative sources, including FAME.

Full country set of 98 developing or emerging market economies: Algeria, Argentina, Bahrain, Bangladesh, Barbados, Belize, Benin, Bhutan, Bolivia, Botswana, Brazil, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Chile, People's Republic of China, Colombia, Democratic Republic of Congo, Republic of Congo, Costa Rica, Côte d'Ivoire, Cyprus, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Ethiopia, Fiji, Gabon, The Gambia, Ghana, Grenada, Guatemala, Guinea-Bissau, Guyana, Haiti, Honduras, Hong Kong, Hungary, India, Indonesia, Islamic Republic of Iran, Jamaica, Jordan, Kenya, Korea, Kuwait, Lao People's Democratic Republic, Lesotho, Luxembourg, Madagascar, Malawi, Malaysia, Mali, Malta, Mauritania, Mauritius, Mexico, Morocco, Mozambique, Myanmar, Nepal, Nicaragua, Niger, Nigeria, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Romania, Rwanda, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Singapore, South Africa, Sri Lanka, Sudan, Swaziland, Syrian Arab Republic, Thailand, Togo, Trinidad and Tobago, Tunisia, Uganda, Uruguay, Vanuatu, Venezuela, Republic of Yemen, Zambia, and Zimbabwe.