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Verifiability and the Vanishing Intermediate Exchange Rate Regime

Jeffrey Frankel, *Harvard University*

Sergio Schmukler, *World Bank*

Luis Servén, *World Bank*

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ABSTRACT

The corners hypothesis holds that intermediate exchange rate regimes are vanishing, or should. Surprisingly for a new conventional wisdom, this hypothesis so far lacks analytic foundations. In part, the generalization is overdone. We nevertheless offer one possible theoretical rationale, a contribution to the list of arguments against intermediate regimes: a lack of verifiability, needed for credibility. Central banks announce intermediate targets such as exchange rates, so that the public can judge from observed data whether they are following the policy announced. Our general point is that simple regimes are more verifiable by market participants than complicated ones. Of the various intermediate regimes (managed float, peg with escape clause, etc.), we focus on basket pegs, with bands. Statistically, it takes a surprisingly long span of data to distinguish such a regime from a floating exchange rate. We apply the econometrics, first, to the example of Chile and, second, by performing Monte Carlo simulations. The amount of data required toverify the declared regime may exceed the length of time during which the regime is maintained. The amount of information necessary increases with the complexity of the regime, including the width of the band and the number of currencies in the basket.

Jeffrey Frankel
KSG, Harvard University
79 JFK St., Cambridge MA 02138
jeffrey_frankel@harvard.edu

Sergio Schmukler
World Bank, 1818 H St.
Washington DC 20433
sschmukler@worldbank.org

Luis Servén
World Bank, 1818 H St.
Washington DC 20433
lserven@worldbank.org

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I. Introduction

When it comes to international monetary economics, it is said that the exam questions stay the same over time, but the correct answers to those questions change. In the debate over the merits of fixed vs. floating, the preponderance of learned opinion has experienced several swings of the pendulum. At the time of Bretton Woods (1944), the architects of the postwar system favored fixed rates, attributing the economic instability of the interwar period in part to flexible exchange rates. During the 1960s, a growing number of economists came to favor floating rates, responding in particular to the widening U.S. balance of payments disequilibrium, a view that events in the early 1970s ratified by force.

In the 1980s, the accumulating experience with high inflation in many parts of the world brought the pendulum back, at least in an intellectual sense. Setting a target for the exchange rate came to be viewed as one way for central banks to put some steel behind attempts at monetary stabilization. New theories of rational expectations and dynamic consistency said that a commitment to such a nominal anchor, if credible, would even allow disinflation without the usual costs of lost output and employment. In the late 1990s we saw in a sense the completion of the half-century's second complete roundtrip of the pendulum, as the conventional wisdom blames exchange rate targets for crises in Mexico (1994), East Asia (1997), Russia (1998) and Brazil (1999). Thus the new language of speculative attacks, multiple equilibria and moral hazard is in many ways simply a new overlay on an old debate.

And yet, a genuinely new element has recently been thrown into the mix. This is the proposition that countries are – or should be – moving to the corner solutions. They are said to be opting either, on the one hand, for full flexibility, or, on the other hand, for rigid institutional commitments to fixed exchanges, in the form of currency boards or full monetary union with the dollar or euro. It is said that the intermediate exchange rate regimes are no longer feasible -- the target zones, crawls, basket pegs, and pegs-adjustable-under-an-implicit-escape-clause -- are going the way of the dinosaur. A corollary of this theory is that the number of independent currencies in the world is declining, perhaps with a rising fraction of the world accounted for by a few large regional blocs built around the dollar, the euro, and perhaps the yen or some other third currency in Asia.

One motivation of this paper is the observation that, as fashionable as this proposition has become, few of its proponents, if any, have offered an analytical rationale for it, let alone a fully worked out theoretical model. The aim is to offer a possible theoretical rationale. We seek to introduce the notion of *verifiability*, and to suggest that a simple peg or a simple float may be more verifiable by market participants than a more complicated intermediate regime. Verifiability can be thought of as a concrete instance of the more general principle of "transparency" that is so often invoked in recent discussions of the new international financial architecture but so seldom made precise.

Consider the exchange rate regime that Chile had for most of the 1980s and 1990s: a band around a central parity that itself is a basket with a rate of crawl. So far as existing theory is concerned, the complexity of this arrangement has no implications for its credibility. But, in truth, when a central bank announces a regime of this type, the

public has no way of verifying quickly, by observing the exchange rate, whether the central bank is doing what it claims to be doing.

A central bank does not earn credibility merely by announcing a monetary regime with a nominal anchor such as the exchange rate, even if its intentions are sincere. The public will judge credibility from data available to it. Indeed, a major motivation for announcing an intermediate target -- whether it is phrased in terms of an exchange rate, money supply, price level or nominal GDP -- is precisely to give the public a basis on which to be able to monitor or verify the central bank's performance. Our key point is that the corner regimes may be easier to monitor than the intermediate regimes. If the announced exchange rate regime is a simple dollar peg, a market participant need only check that the exchange rate today is the same as the exchange rate yesterday, in order to verify that the central bank is indeed following its announced policy. If the announced regime is a pure float, a participant can essentially check every month whether the central bank has intervened in the market by seeing whether its reserve holdings have changed. Furthermore, on a more timely basis, the banking community is likely to have a good idea whether or not the central bank is in the foreign exchange market. (Admittedly, the free-float corner is not as instantly verifiable as the firm-fix corner.) Under the basket band, by contrast, the market participant needs more months of data in order to be able to verify that the central bank is indeed implementing the announced policy. How many months of data he or she needs is the central analytical exercise of this paper.

We are not claiming that verifiability is the complete story behind the purported non-viability of intermediate regimes. And we are certainly not claiming that it is the only criterion, or even the most important criterion, in the larger debate about fixed and

floating exchange rate regimes. Many other factors, whether from the traditional optimum currency area literature or the newer criteria associated with credibility and financial markets, need to be taken into account.[1] The goal is rather to offer an attempt at what, so far as we are aware, may be the first explicit analytical rationale for the corners hypothesis. Or, more modestly, we offer verifiability as another on an existing list of drawbacks to intermediate regimes.

In this paper, we study the verifiability of exchange rate regimes by analyzing the case of Chile and by doing Monte Carlo simulations. Simple pegs, and even basket pegs, are easy to verify. But as we will see from the case of Chile, a band around a peg makes the verification more difficult. Under a narrow band the weights on the central parity can be estimated fairly well, with 50 days of data.[2] Wider bands, however, make impossible the verification of the central parity. More precisely, verification would require many years of data, in excess of the length of the time period that a given exchange rate regime typically lasts. The Monte Carlo exercise shows the role of a number of factors in determining verifiability: the band size, number of currencies in the basket, the rate of crawl, sample period, periodic adjustments of the central parity. The results confirm the intuition that the amount of information necessary to verify the exchange rate regimes increases with the complexity of the regime.

Verifiability is a partial means to the Holy Grail of credibility. In the 1980s, central banks wanted, above all, credibility with those who set wages and prices in the economy. The essence of the nominal anchor argument was that one would get less inflation in wages and prices, for any given level of real economic activity, if the central banks commitment not to inflate was credible with these people. The 1990s was a period

during which high inflation was no longer such a big problem as previously in most places. Now central banks desire, above all, credibility with those who participate in financial markets. It is the credibility of the commitment not to devalue (or default) that is seen as key. In models that assume purchasing power parity, inflation and devaluation or deprecation are the same thing. But we know that purchasing power parity does not in fact hold over the span of a decade. Indeed, it is striking how little inflation was generated by the massive devaluations in East Asia and other emerging markets. In any case, whatever the correlation between alternative measures of the value of a currency, the focus is now on establishing in the financial markets credibility that the local currency will not lose value against the dollar, more than on credibility in the labor and goods markets that the currency will not lose value in terms of wages and prices.

The easiest way to measure imperfect credibility is by looking at nominal interest rates. When speculators perceive a danger of devaluation against the dollar, they demand higher interest rates in compensation. The latter part of this paper looks at interest rates in some emerging markets, and their sensitivity to international conditions, as a way of assessing the credibility of different exchange rate regimes. We will see that, contrary to traditional views regarding monetary independence, local interest rates in emerging markets may be more sensitive to US interest rates under an intermediate regime than under a currency board or currency union. If this finding holds up, it suggests that countries are not gaining much when they give up the advantages of the firm-flex corner.

Interestingly, it is not just that investors demand an extra return for holding assets denominated in local currencies – the currency premium that is the obvious counterpart to devaluation fears. Investors also seem to demand an extra return for holding claims on

emerging-market countries when they are expressed in dollars – the country premium that is compensation for the risk of default. One of the clear lessons of the crises of recent years is that the danger of default has an effect on default risk. It does the international investor little good to have taken care to invest only in dollar-denominated assets, if the bank or corporation that issues those dollar liabilities is unable to service its debt in the event of a devaluation because its earnings are in local currency. In this way, currency risk creates default risk.

The rest of the paper is organized as follows. Section II elaborates on the corners hypothesis, and its dearth of theoretical foundations. Section III introduces the analytical framework used to verify exchange rate regimes. Section IV presents estimations for the case of Chile. Section V performs Monte Carlo exercises to study the verification time under simulated models. Section VI summarizes the results on verifiability. Section VII steps back to review the factors that traditionally are said to determine the choice between fixed and floating exchange rates (the optimum currency area criteria). Section VIII discusses the fixed-rate corner, including currency boards and dollarization; it presents some of the new criteria that suit a country for these institutional commitments, and it presents some results on how local interest rate sensitivity seems to vary across exchange rate regimes. The Appendix describes in detail the recent history of the Chilean exchange rate policy, corresponding to Section IV.

II. The Corners Hypothesis

Surely a proposition that has become such conventional wisdom as the vanishing intermediate regime has a long intellectual pedigree? Apparently not.

II a. Intellectual Origins

What is known about the origins of the hypothesis of the vanishing intermediate regime? An ancient Greek said "There is nothing under the sun." Eventually someone will come up with an early historical antecedent.[3] But, as of yet, the earliest known explicit reference is Eichengreen (1994). The context was not emerging markets, but rather the European Exchange Rate Mechanism. In the ERM crisis of 1992-93, Italy, the United Kingdom, and others had been forced to devalue or drop out altogether, and the bands had been subsequently widened substantially so that France could stay in. This crisis suggested to some that the strategy that had been planned previously -- a gradual transition to European Economic and Monetary Union, where the width of the target zone was narrowed in a few steps -- might not be the best way to proceed after all. Crockett, 1994, made the same point. Obstfeld and Rogoff (1995) concluded, "A careful examination of the genesis of speculative attacks suggests that even broad-band systems in the current EMS style pose difficulties, and that there is little, if any, comfortable middle ground between floating rates and the adoption by countries of a common currency." The lesson that "the best way to cross a chasm is in a single jump" was seemingly borne out subsequently, when the leap from wide bands to EMU proved successful in 1998-99.

After the East Asia crises of 1997-98, the hypothesis of the vanishing intermediate regime was applied to emerging markets. In the effort to "reform the financial architecture" so as to minimize the frequency and severity of crisis in the future, the proposition was rapidly adopted by the financial establishment as the new conventional wisdom.

For example, Summers (1999a):[4]

> "There is no single answer, but in light of recent experience what is perhaps becoming increasingly clear -- and will probably be increasingly reflected in the advice that the international community offers -- is that in a world of freely flowing capital there is shrinking scope for countries to occupy the middle ground of fixed but adjustable pegs. As we go forward from the events of the past eighteen months, I expect that countries will be increasingly wary about committing themselves to fixed exchange rates, whatever the temptations these may offer in the short run, unless they are also prepared to dedicate policy wholeheartedly to their support and establish extra-ordinary domestic safeguards to keep them in place."

Other high-profile examples include Eichengreen (1999, p.104-105), Minton-Beddoes (1999) and Council on Foreign Relations (1999, p.87). The International Monetary Fund has now agreed that countries that get into trouble by following an intermediate regime will in the future not be bailed out, though it qualified the scope of the generalization a bit, for example, by allowing a possible exception for "systemically" important countries.

It is not only the international financial establishment that has decided intermediate regimes are non-viable. The recent Meltzer report, commissioned by the U.S. Congress to recommend fundamental reform of the International Financial Institutions, has adopted the proposition as well: "The Commission recommends that …the IMF should use its policy consultations to recommend either firmly fixed rates (currency board, dollarization) or fluctuating rates" (Meltzer, 2000, p.8).

Apparently the *Economist* (1999, p.15-16) is right that "Most academics now believe that only radical solutions will work: either currencies must float freely, or they must be tightly tied (through a currency board or, even better, currency unions)." But the proposition remains yet to be modeled, let alone proven.

II b. What do countries actually do?

Out of 185 economies, the IMF (September 30, 1999) now classifies 51 as independently floating and 45 as following rigid pegs (currency boards or monetary unions, including the CFA franc zone in Africa). This leaves 89 following intermediate regimes – almost half of the total (of which 30 follow conventional pegs against a single currency).

Most of those listed as floating in fact intervene in the foreign exchange market frequently. As Reinhart (2000) correctly observes, "Countries that say they allow their exchange rate to float mostly do not." Only the United States floats so purely that intervention is relatively rare.

At the other end of the spectrum, most of those classified as pegged have in fact had realignments within the last ten years. Obstfeld and Rogoff (1995) report that only six major economies with open capital markets, in addition to a number of very small economies, had maintained a fixed exchange rate for five years or more, as of 1995. Klein and Marion (1997) report that the mean duration of pegs among Western Hemisphere countries is about 10 months. The implication is that conventional pegs should be called "adjustable pegs," and classified as intermediate regimes.

Only 37 countries have altogether given up an independent currency as legal tender: the euro-11, the 14 members of the CFA Franc Zone[5], Panama, San Marino, and some tiny island states. Of these, only the euro-11 have given up national currencies recently; the others never had independent currencies in the first place. (Ecuador has recently announced an intention to dollarize, but has not yet done so.) True, six economies have adopted currency boards: Hong Kong (1983), Argentina (1991), Estonia (1992), Lithuania (1994), Bulgaria (1997), and Bosnia (1998.)[6] That adds up to almost 20 countries that have chosen ultra-fixed exchange rate arrangements in the past decade. But this does not constitute evidence that the heralded world trend toward a smaller number of currencies has begun. The missing fact is that -- as the result of the breakup of the Soviet Union and of Czechoslovakia and Yugoslavia -- roughly as many independent currencies have been created in the 1990s as have disappeared. One might assert a sort of Markov stasis, in which independent currencies are always being created and disappearing, but the overall pool remains roughly steady. Masson (2000) statistically rejects the hypothesis that "hard fix" and "hard float" are absorbing states, thus concluding empirically that intermediate regimes are not in fact vanishing.

Many countries still choose something in between rigid fixity and free float. The intermediate regimes in the IMF classification scheme break down as follows. In addition to the 30 pegged to a single currency, there are 13 pegged to a composite, 5 crawling pegs, 7 horizontal bands, 7 crawling bands, and 26 managed floats.[7] In short, the facts do not support the claim that countries are rapidly moving toward the corners and vacating the middle. Figure II.1, which plots the evolution of exchange rate regimes since the 1970, confirms this.

This leaves the question whether countries *should* be moving toward the corners, the question that the remainder of this paper considers. Do those countries that still follow intermediate regimes have good reasons for their choices? Close to the center of the economists' creed is that interior solutions are more likely to be optimal -- for the interesting questions -- than corner solutions.

But it is true that for the middle-income emerging market countries, all of which have been exposed to substantial financial volatility in the period in recent years, the casualties among intermediate regimes have been high. Mexico, Thailand, Korea, Indonesia and Brazil had not in fact been following explicit tight dollar pegs when they were hit by speculative crises and were forced to move in the direction of floating. Each had a sort of basket or band that they were forced to abandon.[8] At the same time, Hong Kong in Asia and Argentina in Latin America, the two countries with currency boards, were the two that got through the period successfully, judged by the (very particular) criterion of avoiding being forced into increased exchange rate flexibility. As a statement of observed trends, at least, the set of emerging market countries in the late 1990s does seem to bear out the claimed movement toward the corners.

The countries that have abandoned band arrangements in recent years include the Czech Republic (May 27, 1997), Indonesia (Aug. 10, 1997), Russia (Aug. 27, 1998), Brazil (Jan. 15, 1999), Ecuador (Mar 4, 1999), Chile (Sept 3, 1999) and Colombia (Sept. 26, 1999).[9] While most of these policy changes took place under great pressure, Chile was not facing tremendous speculative pressure when it made its recent switch, and Indonesia abandoned the bands before the full crisis hit. (This move won praise at the time. Even though the country was soon thereafter hit with the worst of the Asian crises,

commentators today tend to include Indonesia on the list of data points that is supposed to demonstrate the superiority of the floating option over the band option.[10])

It seems intuitively right that these countries, facing finicky international investors and rapidly disappearing foreign exchange reserves, had little alternative but to abandon their pegs and baskets and bands and crawls and move to a float, unless they were prepared to go to the opposite corner. But what this proposition is need of a rationale.

II c. Lack of theoretical foundations for the corners hypothesis

What is the analytical rationale for the hypothesis of the disappearing intermediate regime (or the "missing middle")? Surprisingly, none currently exists, to our knowledge.

At first glance, it appears to be a corollary to the principle of the Impossible Trinity.[11] That principle says that a country must give up one of three goals: exchange rate stability, monetary independence, and financial market integration. It cannot have all three simultaneously. If one adds the observation that financial markets are steadily becoming more and more integrated internationally, that forces the choice down to giving up on exchange rate stability or giving up on monetary independence.

This is not the same thing, however, as saying one cannot give up on *both*, that one cannot have half-stability and half-independence in monetary policy. Economists tend to believe in interior solutions for most problems. In the closed-economy context, Rogoff (1985) derived the optimal intermediate-degree of commitment to a nominal

target for monetary policy, balancing the advantages of pre-commitment against the advantages of discretionary response to shocks.

There is nothing in existing theory, for example, that prevents a country from pursuing an exchange rate target zone of moderate width. The elegant line of target-zone theory begun by Krugman (1991), in which speculation helped stabilize the currency, always assumed perfect capital mobility. Similarly, there is nothing that prevents the government from pursuing a managed float in which half of every fluctuation in demand for its currency is accommodated by intervention and half is allowed to be reflected in the exchange rate. (To model this, one need only introduce a "leaning against the wind" central bank reaction function into a standard monetary model of exchange rate determination.) And there is nothing that prevents a country from pursuing a peg with an escape clause contingent on exogenous shocks or, more practically, a peg that is abandoned whenever there is a shock large enough to use up half its reserves.

Another justification that has been offered is that when a government establishes any sort of exchange rate target, as did the East Asian countries, its banks and firms foolishly underestimate the possibility of a future break in the currency value.[12] As a result, they incur large unhedged dollar liabilities abroad. When a devaluation occurs, their domestic-currency revenues are inadequate for servicing their debts, and so they go bankrupt, with devastating consequences for the economy. "It follows that in a world of high capital mobility there are only two feasible approaches to exchange rate policy. One is not just to peg the exchange rate, but to lock it in – the Argentine strategy….The vast majority of countries will … have to follow the other alternative of allowing their

currencies to fluctuate. If the exchange rate moves regularly, banks and firms will have an incentive to hedge their foreign exposures…" (Eichengreen, 1999, p.105).

There is little doubt that the focus on unhedged foreign-currency debt describes accurately why the 1997-98 devaluations were economically devastating to East Asia. But the argument, as stated, has some weaknesses. First, it appears to depend on irrationality on the part of banks and firms. Second, it appears to imply that a country would be better off by gratuitously introducing extra noise into the exchange rate, to deter borrowers from incurring unhedged dollar liabilities. This seems unlikely to be right. Third is the point emphasized by Ricardo Hausmann: foreigners are unwilling to take open positions in the currencies of emerging-market countries.[13] Thus the admonition to avoid borrowing in dollars is to some extent an admonition to avoid borrowing at all. (An admonition to hedge the dollar exposure is not helpful; someone has to take the other side of the futures contract, and this will be difficult in the aggregate if foreigners are unwilling to take the open position.) It may well be that this is the right road to go down, that exchange rate volatility is a way to put some sand in the wheels of the excessive capital movements, and that a lower volume of total debt is a good outcome. But if this is the argument, the proponents should be explicit about it. In any case, it seems doubtful that this argument could be captured by conventional models. Recall that Tobin's original motivation for proposing to put sand in the wheels of international capital movement was to *reduce* exchange rate volatility!

A third possible justification is that governments that adopt an exchange rate target, and sometime later experience a major reversal of capital inflows, tend to wait too late before abandoning the target. As of 1998, we thought we had learned that the one

thing an emerging-market government can do to minimize the eventual pain from a currency crisis is to try to devalue early enough (or else raise interest rates early enough, as would happen automatically under a currency board – anything to adjust, rather than try to finance an ongoing deficit). Mexico, Thailand and Korea made the mistake of waiting too long, until reserves ran very low, so that by the time of the devaluation there was no good way out, no combination of interest rates and exchange rate that would simultaneously satisfy the financing constraint externally and prevent recession domestically. But exiting from an exchange rate target can be difficult politically. The lesson is drawn that, to avoid this difficulty, governments should either adopt a rigid institutional fixed-rate commitment (as have Hong Kong and Argentina), or, if not prepared to do that, abandon the peg early.[14]

On this basis, when Brazil in the autumn of 1998 delayed the seemingly inevitable jettisoning of the exchange rate target that remained from its *real* plan, many thought this would be a repeat of the earlier mistakes. Instead, when the devaluation finally came in January 1999, Brazil's trade balance improved sharply, the lack of confidence subsided, and output and employment subsequently performed far better than in neighboring Argentina. Thus it is more difficult to generalize from recent experience than widely believed. Furthermore, if we are to use government reluctance to exit a target arrangement as the basis of a model of the unviability of intermediate regimes, it seems that we would again require some sort of irrationality (or political constraints[15]) on the part of policy-makers.

Thus, each of the three arguments offered -- the impossible trinity, the dangers of unhedged dollar liabilities, and the political difficulty of exiting -- contains some

important truth. But none seems able to stand as a theoretical rationale for the superiority of the corner solutions over the intermediate regimes. Is the corners hypothesis, then, just a misplaced manifestation of the temptation to believe that the grass is always greener somewhere else?

III. Verifiability

The idea behind verifiability is that the government's announcement of an exchange rate regime is more likely to be credible if market participants can check for themselves from observable data that the announced regime is in fact in operation. This process of verification can be modeled along the lines of the process of statistical inference familiar to econometricians. We are not suggesting that market participants will necessarily run OLS regressions literally, but rather that they must do something similar implicitly.

In this paper we will concentrate on the case of the basket peg with a band, and perhaps with a crawl. One could pursue analogous exercises with other intermediate regimes -- a managed float or a peg with an escape clause -- to show that they are similarly difficult to verify. We intend the basket-peg exercise to be illustrative of the more general difficulty in verifying intermediate regimes.

If a country follows a precise basket peg, with no band, the problem of statistical inference is of limited interest. In that case, the announcement of a basket of N major currencies can be verified with N+1 observations. But in practice there is almost always some range of variation in the observed exchange rate data, even if it is only within a

narrow bid-ask spread quoted by the banking system, or within the +/- 1 percent range that constituted a fixed exchange rate under the rules of the Bretton Woods system. Then the problem of statistical inference is not trivial, especially if nervous speculators need to be reassured in a matter of days rather than months. For bands of substantial width, the statistical inference can in fact be difficult, as we shall see. This is all the more true if one allows for the ever-present possibility of shifts in the parameters -- basket weights, band width, rate of crawl, or level of parity -- or changes in the regime altogether, especially if some of these shifts are not announced.

We will begin with an analysis of the actual basket band followed by Chile during most of the 1990s, and then move on to Monte Carlo results. If the currency in question is in truth following a basket band, the question of interest is how many data are necessary, i.e., how much time must elapse, in order to verify that the data support the hypothesis. In general, we will consider an anchored exchange rate regime to have been verified if it passes three tests: (1) we can find statistically significant basket parameters, i.e., can reject the hypothesis that the currency is behaving like any "random" currency, (2) we fail to reject the hypothesis that the exchange rate is following a basket peg, (3) we have reason to believe that the second test has power to reject the null hypothesis, in that it succeeds in rejecting when applied to a times series of equal length for which the null hypothesis is false. In cases where the weights are publicly announced, then we may also apply related test criteria: (4) we fail to reject that the exhibited weights are the same as those announced, and (5) we do reject that the exhibited weights are equal to other possible arbitrary values, such as the weights on the SDR.or 1/3,1/3,1/3 on the three big currencies. We want to see how the ability to confirm the announced nominal regime

statistically is affected by the width of the band, by the presence of more than one foreign currency in the basket, by the presence of a non-zero rate of crawl, by the government's decision whether to announce these parameters, and by the frequency of changes in the parameters. Clearly these complications slow down the attempt to verify the regime; the question is how important is this effect.

Throughout, we will focus on 95% significance levels. If the time sample needed for a currency to pass these tests at 95% significance levels is long (relative, for example, to the average length of time that these regimes tend to last), then we pronounce the regime not verifiable. If it is not verifiable, we suspect that the country cannot reap the credibility gains that an anchored exchange rate regime theoretically offers – credibility in the eyes of workers and producers who set wages and prices, and in the eyes of speculators who have the ability to attack the central bank's reserves and bring about a crisis. Verifiability contributes to viability.

The goal of our paper is to study how long it takes for financial markets to learn from observable data the rules guiding the intervention behavior of monetary authorities in the foreign exchange markets. To perform both the analytical and empirical analysis, we need a basic framework and testing procedure. This section introduces the analytical framework used in the subsequent sections to verify exchange rate systems.

III.a Basic Framework

We assume that the exchange rate for a given small country is given by a geometrical average of N foreign currencies, with a possible rate of crawl d and an error term. The log exchange rate is:

$$\log s_t = c + \log(1+d)\times t + \sum_i^N w_i \times \log s_{i,t} + \log \varepsilon_t \ . \qquad (1)$$

The dependent variable is the log of s_t, the spot exchange rate of the domestic currency with its value measured in terms of a numeraire that we will explain momentarily. On the righthand side, $s_{i,t}$ are the spot exchange rates of major "strong currency countries" with the values measured vis-à-vis the same numeraire . As major currencies, we use the U.S. dollar, the Japanese yen, and the Deutsche mark. The parameter d is the rate of crawl, which for now is assumed to be fixed during a given sample period. (One alternative would be to use past domestic or future inflation rates relative to international inflation rates, where the authorities are believed to be following an indexation policy.) The coefficients w_i are the weights given to the currencies included in the basket.

This general case captures many possible regimes, including simple pegs, basket pegs, crawling pegs, crawling baskets, target zones, certain forms of managed floating, and free floating. In the case of a precise basket peg, the error term vanishes, and an OLS regression can be expected to have an R^2 near 1. A dollar peg is of course the special case where the weight on the dollar is one and on other currencies zero. For most currencies, the error term will be important. In the case of a pure float, the error term may constitute the entire variance of the exchange rate, and the other parameters may be equal to zero. We use daily data in our empirical research, both for estimation and Monte Carlo simulations.

The question of what to use as the numeraire to measure the values of the domestic and foreign currencies is a surprisingly subtle one. In the case of precise basket pegs (or dollar pegs), the choice of numeraire makes no difference, so long as the same

one is used for both dependent and independent variables alike; the correct weights should emerge, with a perfect statistical fit, regardless of the numeraire. This reason is that if equation (1) holds in terms of numeraire x, then it also holds after multiplying through by exchange rate y/x. But in the general case, the choice of numeraire will make a difference. Past studies have used a variety of different numeraires; they include the consumer basket of domestic goods (Frankel, 1993, which emphasized Asian currencies), the SDR (Frankel and Wei, 1995, which emphasized policies of European currencies), the Swiss franc (Frankel and Wei, 1994 and Ohno, 1999) and the dollar (Benassy-Quere, 1999).

Upon further reflection, these measures are not quite right. We wish to consider regimes where the central bank monitors a central parity, but routinely allows appreciations or depreciations relative to that parity in response to such factors as inflation, unemployment, trade deficits or surpluses, various market pressures and so on. These factors are only partially accommodated under an intermediate regime such as a band or managed float, but they have a role nonetheless. We have not yet chosen to model explicitly these factors; they are comprised by the error term. We are assigning them a log normal distribution. The authorities are presumed to be trading off the long-term credibility benefits of sticking relatively close to their central nominal parity against the monetary-independence benefits of responding to short-term developments. But in framing this tradeoff, there is no reason for them to think of the departure above or below the central parity in terms of dollars or a basket of goods, and still less reason to think in terms of Swiss francs. The most useful way to phrase these appreciations and

depreciations is, rather, in terms of an effective exchange rate, that is, a weighted average of trading partners' currencies.

Our central results are based on measuring values of currencies in terms of a weighted basket of the five major currency countries. (The number of currencies in the numeraire basket, representing partners that matter for the domestic country, must be greater than the number of candidate currencies in the target basket that we test for. The result, otherwise, will be perfect multicollinearity.) One possible set of weights is the bilateral trade shares of the smaller country in question. This has a drawback: it leaves out the role of all the other bilateral trade partners, as well as third-country markets and competitors. But most of those are linked to some combination of the major currencies. Here we adopt the simple approach of using the five countries' weights in gross world production. In this way it is hoped that, for example, the large weight of the US will roughly reflect the importance of dollar-linked countries in the trade of Chile or Indonesia beyond the share of the US in bilateral trade of those two countries. (A second advantage of using GDP weights is that one need not obtain the full set of bilateral trade data and recompute a new set of weights for each country. But using bilateral trade weights is a possible extension for future research.) To repeat, our choice of numeraire is the output-weighted basket of the five major currencies.

Pegs: Simple pegs, basket pegs, crawling pegs, crawling baskets

In the first case, the value of the currency follows the exchange rates of the currencies to which it is pegged, plus the crawling rule, and a stochastic error. The error is the error allowed by the government when setting the exchange rate, but it is

hypothesized to be very small in these regimes. The error term is: $\log \varepsilon_t$ *iid* $N(0,\sigma^2)$. In the case of simple pegs, $N=1$. Under basket pegs, $N>1$. Crawling pegs imply $d>0$. Under crawling baskets, $N>1$ and $d>0$.

Target zones

Beyond the special case of pegs is the broader case of bands or target zones. There is a central parity that could be a single peg or a basket peg. In addition, there is a band around the central parity. The government intervenes to keep the exchange rate inside the band.

In a target zone, the observed spot exchange rate s_t^* behaves as follows:

$$s_t^* = \begin{cases} -b & \text{if } s_t < -b \\ b & \text{if } s_t > b \\ \nu_t & \text{otherwise} \end{cases}$$

where s_t is defined by equation (1) above and b is the upper bound of the band. We will assume that inside the band, the exchange follows $\log \nu_t = \rho * \log \nu_{t-1} + \log u_t$, such that $\log u_t \sim N(0,\sigma^2)$. If the floating exchange rate is a random walk, $\rho=1$. If not $\rho<1$.

We will concentrate on the random walk case, since most exchange rate time series cannot reject the unit root hypothesis. In reality, the distribution is likely to be somewhat more complicated than this. Even under two simplifying assumptions made by Krugman (1991), in his famous article that generated a sub-field of research on target zones -- that the band is 100% credible and that the authorities intervene only at the boundaries -- the distribution is not normal, but rather follows a particular S-shape.[16] But extensive empirical investigation of the European Exchange Rate Mechanism in the 1980s and early 1990s established that the spot rate does not in fact obey the predicted

distribution. One reason is clearly that speculators did not have 100% faith that the target zones would prevail. This imperfect credibility was in the event justified by realignments in the early 1980s, and especially by the ERM crises of 1992-93. It is also very relevant for the present exercise, which is entirely based on a starting point that assumes imperfect credibility. (Another explanation for why the ERM data did not fit the Krugman distribution was the prevalance of intra-marginal intervention.) One extension for further research would be to use statistical distributions implied by more sophisticated versions of the target zone theory. Another would be to take the observed statistical distribution from historical episodes such as the ERM currencies in the 1980s or 1990s. But to start with we assume the log normal distribution indicated.

Managed floating and free floating

There are many possible patterns of exchange rate intervention. Our basic framework allows us only to test the cases when d or w_i are different from 0. In other words, the government is using some form of nominal anchor or crawling peg rule to guide its operations. All other forms of intervention are not nested in our specification. Therefore, we would not be able to reject them. Pure floating takes place when d=0 and w_i=0.

III.b Testing Strategies

We apply a number of tests. Some are set up with a null hypothesis that should be rejected if the country in question is in fact following an exchange rate target, and some were the null hypothesis should not be rejected.

Hypothesis testing

Test 1 (T1): The first case tests whether the government uses some sort of exchange rate target as a nominal anchor and whether the rate of crawl is zero. We assume that market participants do not know what the government is doing or they do not believe the announced exchange rate regime. The null hypothesis is that the exchange rate follows a random walk with no drift. Therefore, we think of market participants as testing if all the weights on the major currencies are jointly equal to zero. In other terms,

$$H0: w_1 = 0 \ldots \text{and} \ldots w_N = 0 \text{ and } d=0$$

$$HA: w_1 \neq 0 \ldots \text{or} \ldots w_N \neq 0 \text{ or } d \neq 0.$$

Test 2 (T2): The second case is a slight modification of the base case. In this case, market participants only test whether the weights are equal to zero. The null and alternative hypotheses are:

$$H0: w_1 = 0 \ldots \text{and} \ldots w_N = 0$$

$$HA: w_1 \neq 0 \ldots \text{or} \ldots w_N \neq 0.$$

Test 3 (T3): We complement T2 with another test. To show that T2 has size we replace the dependent (LHS) variable by white noise. In this case, we expect to fail to reject the null hypothesis specified in T2.

$$H0: w'_1 = 0 \ldots \text{and} \ldots w'_N = 0$$

$$HA: w'_1 \neq 0 \ldots \text{or} \ldots w'_N \neq 0,$$

where w'_i are the weights.

Test 4 (T4): In the third case, market participants test whether the observed weights are equal to the announced weights. Conditional on the announcement being true, we expect that this null will not be rejected. The null and alternative hypotheses are as follows,

H0: w_i= announced weights

HA: $w_i \neq$ announced weights.

Test 5 (T5): T4 might raise a problem. T4 might fail to reject the null simply because we work with a short time sample. Market participants know instinctively that a failure to reject the regime is an impressive finding only when that test would be capable of rejecting the regime in the case where it was false. In other words, we want the test to have power. To show that T4 has power, we complement the above test with another experiment in which the same test is capable of rejecting the null hypothesis. To do this, we replace the LHS variable with white noise. The hypotheses tested are:

H0: w'_i= announced weight on currency i

HA: $w'_i \neq$ announced weights on currency i.

Estimation procedures

A variety of estimation/testing procedures are potentially applicable. Results using OLS in first differences are reported in Frankel, Fajnzylber, Schmukler, and Servén (2000). Here, we assume that financial markets estimate error-correction models (ECMs). In fact, we also use ECMs to estimate simple and basket pegs with bands. These models

simultaneously estimate the long-term and short-term relationship of the domestic exchange rates. The long-term relationship links the level of the domestic exchange rate with the level of the strong currency exchange rates. The domestic exchange rate adjusts in the short-term to deviations from the long-term relationship. The ECM is estimated by the following equation, which yields estimates of w_i under tests 1-5:

$$\Delta \log s_t = c + g\left(\log s_{t-1} - \log(1+d)\times t - \sum_i^N w_i \times \log s_{i,t-1} \right) + \sum_{h=1}^{L} \boldsymbol{b}_h \Delta \log s_{t-h} + \sum_i^N \sum_{h=1}^{L} \boldsymbol{b}_{i,h} \times \Delta \log s_{i,t-h} + \log \boldsymbol{e}'_t \quad . \quad (2)$$

IV. The Case of Chile

To provide a background and motivate our Monte Carlo results below, we first focus on the particular case of the Chilean peso. We select the case of Chile because during most of the 1990s it provided a relatively transparent example of a basket peg with a band. The parameters configuring the basket peg and the band width were publicly announced. Thus, if we conclude that the Chilean exchange rate regime was not verifiable, such a conclusion is likely to apply even more strongly to other countries in Latin America or Asia, where governments often have not announced explicit regimes or the parameters in them, or in some cases have not for long abided by the regime they announced.

IV.a Data Description

A number of successive exchange rate regimes have been in place in Chile since the early 1980s. In 1982, Chile had a crawling peg vis-à-vis the U.S. dollar, with daily devaluations following the difference between domestic and external inflation. The peg to the dollar continued until 1992, with bands of varying width around the central parity and with realignments of the central parity. In 1992, the government decided to adopt a target zone around a basket peg. The weights in the central parity changed over time and there were realignments, but the central parity was always tied to the U.S. dollar (US$), the Deutsche mark (DM), and the Japanese yen (JY). In September 1999, the central bank decided to float the peso. A full chronology of the exchange rate system in Chile is displayed in Table A.1 in the appendix. Figure IV.1 illustrates the band arrangements.

We analyze the case of Chile by looking at seven sub-periods, selected on the basis of a minimum duration (specifically, those comprising at least 249 daily observations, amounting to approximately one year). The first three sub-periods involve a peg to the U.S. dollar with a band. The last four involve a basket peg with a band. For each of the seven sub-periods, Figure IV.1 lists the announced weights in the central parity, and the band around the central parity. The figure summarizes the main aspects of the evolution of the exchange rate regimes in Chile. The figure shows that the trend of the peso has been to depreciate over time, with significant appreciations and depreciations on several occasions.

The "dolar acuerdo" or central parity

On July 3, 1992, the Chilean central bank established a basket of 3 foreign currencies, the US$, the DM, and the Japanese Yen with weights of 50%, 30% and 20%, respectively. The so-called "dolar acuerdo" (or central parity given by the basket rule) is computed as a function of two bilateral exchange rates. This rule establishes that the peso/US$ exchange rate is a function of the peso/DM and the peso/JY exchange rates.

The Chilean exchange rate vis-à-vis the US$ is calculated using the formula:

$$X_t = C_t/C_0 * X_0 * 1/(w_1 + w_2 D_0/D_t + w_3 J_0/J_t).$$

As this is not a linear function of the parameters, a more convenient representation is:

$$(X_0/X_t) = w_1 (C_0/C_t) + w_2 (D_0/D_t)(C_0/C_t) + w_3 (J_0/J_t)(C_0/C_t) \quad (3)$$

where,

C_t	:	Value of Basket at time t (in $)
C_0	:	Value of Basket at the beginning of the period (in $)
X_t	:	Exchange rate of Chilean $ vis-à-vis the US$ at time t
X_0	:	Exchange rate of Chilean $ vis-à-vis the US$ at time 0
w_1, w_2, w_3	:	weights in the basket
D_t	:	Exchange rate of Chilean $ vis-à-vis the DM at time t
D_0	:	Exchange rate of Chilean $ vis-à-vis the DM at time 0
J_t	:	Exchange rate of Chilean $ vis-à-vis the JY at time t
J_0	:	Exchange rate of Chilean $ vis-à-vis the JY at time 0.

The Chilean authorities used to report daily the "dolar acuerdo" or central parity. This central parity is determined ex-ante by the announced weights of the peg. The central bank just computes the central parity according to the spot exchange rate of the strong currencies. The actual Chilean peso could not be outside a predetermined distance of the central parity if the band was not to be violated. As already noted (see Table IV.1), the central parity is a simple peg during the first three periods we analyze and a basket peg during the last four periods.

As a benchmark, we apply the same tests mentioned above to the central parity. This helps us determine the effect of the width of the band on our verifiability assessment, since the tests on the central parity amount to testing the identifiability of a zero-width band. In addition, the case of Chile also helps us determine the effect of one versus more currencies in the basket, as the central parity in the first three periods contains only one currency (the US$), while the last three periods involve three currencies.

The construction of the numeraire

All exchange rates are measured relative to a numeraire. As explained above, the numeraire is based on a weighted-basket of major currencies. The weights are based on the 1991 GDP shares of 5 countries: U.S., France, Germany, Japan, and U.K. The shares are 39.2%, 9.2%, 14.3%, 31%, and 6.4% respectively. Specifically, we use the GDP at market prices (constant 1995 US$) obtained from the World Bank World Development Indicators.

The above equation is rewritten and expressed in terms of the numeraire. The equation we estimate is the following:

$$s_t = c + w_{US\$} \times s_{US\$,t} + w_{DM} \times s_{DM,t} + w_{JY} \times s_{JY,t} + \boldsymbol{n}_t \qquad (4)$$

The exchange rates are defined as follows:

s: Spot exchange rate between the Chilean peso and the numeraire (US$/N)

$s_{US\$}$: Spot exchange rate between the U.S. dollar and the numeraire (US$/N)

s_{DM}: Spot exchange rate between the Deutsche mark and the numeraire (DM/N)

s_{JY}: Spot exchange rate between the Japanese yen and the numeraire (JY/N).

The exchange rates, both of the major currencies and the Chilean peso, are calculated as the number of units of the currency necessary to purchase a geometrically weighted basket of strong currencies. Table IV.1 reports the summary statistics of the currencies under consideration.

IV.b Results

All estimations and tests are performed using each of three series as dependent variable: the actual peso exchange rate, a randomly-generated series, and the daily announced central parity. The estimations are reported on each of the seven exchange rates regimes. We focus on two types of results: point estimates of the weights conforming the central-parity basket; and Wald tests of the hypotheses that the estimated coefficients equal those announced by the authorities or, alternatively, equal zero.

We first review the point estimates of each model's parameters at sample sizes of 50 and 100 observations. These estimates tell us how well can market participants estimate the weight of the central parity when the regimes are 50 and 100 days old. The results are displayed in Table IV.2, which presents both the point estimates of the US Dollar weight and their reported standard errors. (To save space, we do not report the point estimates of the other currencies' weights.) When using the central parity as dependent variable, the estimates of the US Dollar weight converge to the announced values fairly quickly, especially in the single-peg sub-periods 1-3. However, in the multiple-peg sub-periods 4-7, some of the level-based and, especially, the first-differenced estimates still remain far from the announced values after 100 observations.

Next, when using the randomly-generated series as dependent variable, we find that the coefficient estimates are almost invariably small relative to their reported standard errors. The error-correction estimates are fairly close to zero in most cases. Perhaps more importantly, when using the actual exchange rate as dependent variable, a contrast emerges between sub-periods 1-3 and 4-7. In the former sub-periods, the error–correction estimates approach the announced value rather quickly – by observation 50, they are not more than 5% apart from it.

In contrast, for periods 4-7 the estimates do not appear close to the announced values. Indeed, some point estimates are negative and large, and precision is in general much poorer according to the reported standard errors. The only exception is sub-period 4 using 100 observations; the estimate becomes closer to the announced value. Thus, the conclusion is that in sub-periods 4-7 none of these simple estimators comes close to the

true basket weights, even after a reasonably large number of observations, except in one case.

We next turn to formal hypothesis tests on the parameter estimates. Specifically, we test the null hypotheses that (a) the estimates of the weights on the various currencies are jointly different from zero (Test 2 above) and (b) the estimates equal the announced weights. We report the tests only for the estimates obtained using as dependent variable the actual exchange rate and the randomly generated series. (Comparable tests using instead the central parity yielded trivial results – rejection of the zero-weights and non-rejection of the announced weights in every sub-period and for every sample size.)

Figure IV.2 reports marginal significance levels for the null of zero weights, corresponding to the error-correction estimates. The graph plots the p-values against sample size for each of the seven sub-periods under consideration. It is apparent that the null can be rejected even at small sample sizes in the case of the actual exchange rate – with the exception of a couple of brief intervals and cannot be rejected in the case of the randomly-generated series – again excepting a brief stretch in sub-period 2.

Next, Figure IV.3 reports marginal significance levels for the null that the estimates equal the announced weights for each regime. Thus the goal is now to fail to reject the null hypothesis. The figure reveals a stark contrast between sub-periods 1-4 and 5-7. The error-correction estimates from the actual exchange rate series reject the null in sub-periods 5-7 (except for some brief intervals), and fail to reject in sub-periods 1-4. This latter result is achieved after a considerable stretch of consecutive rejections, especially in sub-periods 3 and 4 (and to a more limited extent in period 2 too). For the

randomly-generated series, the error-correction estimates clearly reject the announced weights for every sample size and sub-period.

On the whole, these results strongly suggest that the widening of the band, as well as the adoption of multiple instead of simple pegs – the two features that characterize the evolution of Chile's exchange regime between sub-periods 1 and 7 -- both appear to make more difficult the verification of the announced regime using simple econometric estimates.

By way of summary of our results, we present in Table IV.3 a rough and somewhat subjective estimate of "verification time" – that is, the sample size required to reject *irreversibly* the (false) null hypothesis that the currency weights are zero, or to *irreversibly* stop rejecting the (true) null that the currency weights equal their announced values. By "irreversibly" here we mean that the test outcome is not reversed at larger sample sizes. If at no sample size is this irreversible outcome obtained, we enter an "N" (short for "Never") in the corresponding column in the table. The table presents this information for each sub-period. Finally, we also note in the table their overall precision, defined as high if the confidence region extends no farther than 25 percent above/below the parameter's true value, and as low otherwise.

The table shows that the null of zero weights can be rejected from the start only in sub-periods 2 and 3. In sub-period 6, it cannot be rejected even with the full sample. Likewise, it takes some time to stop rejecting the announced weights – from a moderate sample size of 40 in sub-period 1, to over 200 observations in sub-periods 3-4. In the last three sub-periods, the estimates never converge to the announced values. Precision of the estimates is quite good in the first three sub-periods, and quite poor in the last four.

V. Monte Carlo Simulations

We turn now to the Monte Carlo simulations, which offer a more general testing ground for verifiability of intermediate regimes. For our experiments, we generate 1,000 samples according to the simple model described by equation (1), using for the baskets actual data on the exchange rates of the major currencies (valued in terms of the GDP-weighted numeraire). We use daily data between February 1986 and September 1999. The parameters of the data-generating process are c (level of exchange rate), d (yearly rate of crawl), $w_1 ... w_3$ (weights on US$, DM, and JY), σ (standard deviation of the error term), and t_0 (initial observation). In the Monte Carlo simulation, the log error term is generated as *i.i.d* normal with mean zero. Based on this basic framework, we study the effect of different model specifications on the amount of time to reject our proposed null hypotheses.

V.a Role of Band Size

Clearly, it should be harder to verify a basket regime with a wide band than one with a narrow band, and harder to verify a basket regime with a loosely managed float (i.e., a small tendency to intervene when the exchange rate drifts from the parity) than another with a tightly managed float (a strong tendency to intervene). To verify the role of band size in determining the amount of information needed to reject the proposed null hypotheses, we generate sets of 1,000 samples, according to equation (1). Each set has a different standard deviation of the underlying disturbance (σ), representing different band sizes.

For each sample, we calculate the number of observations necessary to obtain 10 rejections of the null hypothesis that both the weights and the rate of crawl are zero (Test 1), and the null hypothesis that the weights are zero (Test 2). We label these sample sizes VT1 and VT2, respectively, where VT stands for "verification time".

For this exercise, we generate the samples using a level parameter equal to 1, a rate of crawl of 1% per year, and equal weights for all major currencies, and starting from observation 1 (2/24/1986). We let the standard deviation σ vary from 1 percent to 10 percent. In this regard, recall that 2% was the width of Chile's band from mid-1985 to 1987, and 10% was the width of the band during the period 1992-97. For purposes of comparison, 2¼ percent was the width of the ERM target zone followed by many European countries up until 1992 (and still followed today by Denmark), 6 percent is the width of the ERM target zone followed by Italy and the United Kingdom up to 1992, and 15 percent is the width of the ERM zone for France and others from 1992 until the beginning of EMU in January 1999.

The results appear in Figure V.1. The graphs plot the quantiles of VT1 and VT2 against the standard error (σ) used to generate the samples. Each line corresponds to one quantile, and depicts the number of observations needed to achieve rejection of the null hypothesis (at the 5 percent level) in x% of the 1,000 samples – where x is the quantile in question.

As expected, the graphs show that, for both tests, the number of observations needed to reject the null of zero weights and rate of crawl in any given percentage of the samples rises steadily with σ. This is reflected by the fact that the lines corresponding to the various quantiles have positive slopes. In other words, wider bands make it more

difficult for investors to reject specific hypotheses concerning the weights of the central parity – they need more time to get an accurate assessment of the parameter values. And the additional time needed is not negligible. For test 2, for example, the number of observations needed to reject the null in 50% of the samples ranges from under 100 days for an (old-) EMU-sized band (2% width) to over 500 for a Chilean-sized one (10% width).

V.b Role of Number of Currencies in Basket

Intuitively, the larger the number of unknown parameters that need to be estimated, the harder it should be to verify that the data match the announced policy regime. This applies not only to the number of currencies in the basket, but also to the presence of a non-zero rate of crawl.

To verify this assertion, we next examine the impact of different basket sizes on the amount of information needed to reject the nulls underlying tests 1 and 2. For this purpose, different numbers of currencies were included in the Data Generating Process (DGP). We construct a simple peg (the U.S. dollar), a two-currency basket (the U.S. dollar and the Deutsche mark), and a three-currency basket (the dollar, the Deutsche mark, and the Japanese yen). In each basket the currencies are equally weighted. The other assumptions are like in the previous exercise.

The results are portrayed in Figure V.2. To avoid cluttering the pictures, only the medians of VT1 and VT2 (defined as before) are presented. They are plotted against alternative values of the standard deviation of the random disturbance assumed in the simulation.

As expected, increasing the number of currencies in the basket shifts the quantile lines upward, reflecting the fact that for any given value of the standard deviation more observations become necessary to reject the null hypotheses. As before, the increase in information requirements is sometimes substantial. For example, with a band width of 10 percent (as observed in Chile in recent times), moving from a single to a 3-currency basket raises the 50-percent quantile of Test 2 by over 200 observations – implying that an extra year of data becomes necessary to reject the null hypothesis.

V.c Role of Rate of Crawl

What about the rate of crawl? Intuitively, its value should have little consequence for Test 2, which is concerned only with the basket weights. However, for Test 1 it can make a big difference – rates of crawl further away from zero must help reject the null hypothesis more quickly, since the latter involves a zero rate of crawl.

This is verified in Figure IV.3, which shows the effects of different rates of crawl on the verification time, as reflected by the 50-percent quantile of VT1 and VT2. For a given value of σ, we generate different samples assuming increasing rates of crawl. As expected, VT1 (measured by the left scale) declines steadily as the rate of crawl rises away from zero, while VT2 (measured by the right scale) shows only modest variation.

V.d Role of Period

The power of these tests depends on the precision of the parameter estimates, itself given by the noise-to-signal ratio -- or the relative size of the variances of the dependent and independent variables. When the variance of the dependent variable is

large relative to the variance of the independent variable, the estimates are imprecise and it is difficult to reject a given null hypothesis. Since these relative variances are not constant over time, the verifiability of a given model may depend on the specific time period over which it is observed.

This can be assessed using data from different time periods to carry out the tests T1 and T2. Since our experiments use actual data on the hard currencies, any differences in VT1 and VT2 across replications using hard-currency data from different time periods should be attributed to changes over time in the variance-covariance matrix of the hard currencies.

The results of such an experiment are reported in Figure V.4, which shows the median values of VT1 and VT2 obtained when the simulations use hard-currency data from different periods in 1986-96, and assuming a three-currency basket with equal weights.

To facilitate the interpretation of the results, we also show in the figure a measure of the variance of the hard currencies – specifically, the inverse of the average of their standard deviations. As the graph shows, variability of the hard-currency exchange rates was particularly high in the first and fourth periods considered. This results in a clear reduction in VT1 and VT2 in such periods, relative to the rest.

VI. Summary of Conclusions Regarding Verifiability

The new conventional wisdom is that intermediate exchange rate regimes, such as baskets, crawls, and bands, are no longer viable. According to this proposition, countries

are being pushed to the "corners," the extremes of either free floating or firm fixing. We have argued that a theoretical rationale for this proposition is currently lacking; none of the candidates offered -- the impossible trinity, the dangers of unhedged foreign liabilities, or government reluctance to abandon ship in time – is quite up to the job. We offered such a rationale, by introducing the notion of *verifiability.* By verifiability we mean the ability of a market participant to infer statistically from observed data that the exchange rate regime announced by the authority is in fact in operation. Verifiability is an instance of transparency, a means to credibility. Our point is that a simple regime such as a clear dollar peg or free float may be more verifiable by market participants than a complicated intermediate regime.

We began the analysis with the case of Chile, which has followed various combinations of basket pegs, crawls, and bands, over the last two decades. From 1982 to 1992, when the band was relatively narrow and the peg was simply to the dollar, 50 observations is generally a big enough sample to achieve some sort of statistical verification. But from 1992 to 1999, when the band was relatively wide and the peg was to a basket of currencies, verification was not possible. On the whole, the results suggest that the widening of the band, as well as the adoption of multiple instead of simple pegs -- the two features that characterize the evolution of Chile's exchange regime over this period -- both make more difficult the verification of the announced regime by means of simple econometric estimates.

We continued the analysis by means of Monte Carlo tests. We began with the effect of the width of the band on verifiability. As expected, when the range of variability is small, the number of observations needed to reject that the weights and the

rate of crawl are zero is relatively small. For larger variances, the number of observations needed to reject the null hypothesis increase. The number of observations needed to differentiate the crawling basket from a random currency in at least half of the samples is under 100 days when the band width is 2%, as it was for Chile from 1985 to 1987, but is over 500 days when the band width is 10 percent, as it was for Chile from 1992 to 1998. In other words, wider bands make it more difficult for investors to verify the regime.

Second, we looked at the role of the number of currencies in the basket. Moving from a single-currency parity to a 3-currency basket increases the amount of data needed to distinguish the basket from a random currency by an extra year's worth of observations (assuming a 10 percent band, and again using the criterion of finding statistically significant weights at least half the time).

If we are right that it is hard for a central bank to establish credibility for its proclaimed monetary regime without verifiability, then our results confirm that complicated combinations of baskets, crawls, and bands, are less likely to satisfy skeptical investors than are simpler regimes. We thus offer a possible and much-needed rationale for the hypothesis of the vanishing intermediate exchange rate regime. If it is not verifiable, it may not be viable.

VII. The Traditional Criteria for Choosing Between Fixed and Flexible Rates

We will turn from considerations relevant for producing credibility to empirical evidence relevant for measuring credibility. But before we look at the empirical evidence on interest rate sensitivity in section VIII, we note a proposition that is fundamental to the

traditional framework for thinking about exchange rate regimes: It is usually presumed that the ability to set interest rates in line with local macroeconomic conditions is a major advantage of intermediate regimes, relative to rigid pegs. If this presumed advantage in fact does not exist for emerging-market countries, then the traditional advantages of a firm peg would seem to dominate. This section of the paper reviews the traditional advantages of flexible vs. fixed exchange rates, as background for the interest rate tests.

This is not the place to enter into an extended discussion of the advantages of fixed and floating exchange rates. The main traditional points from the textbooks can be recalled succinctly. The two big advantages of fixing the exchange rate, for any country, are: (1) to reduce transactions costs and exchange rate risk which can discourage trade and investment, and (2) to provide a credible nominal anchor for monetary policy. The big advantage of a floating exchange rate, on the other hand, is the ability to pursue an independent monetary policy: only by decoupling its currency from those of large partners can it decouple its interest rate from those of large partners.[17]

VIIa. The Advantages of Fixed Exchange Rates

Twenty or thirty years ago, the argument most often made against floating currencies was that higher exchange rate variability would create uncertainty; this risk would in turn discourage international trade and investment. Fixing the exchange rate in terms of a large neighbor would eliminate exchange rate risk, and so encourage international trade and investment. Going one step farther, and actually adopting the neighbor's currency as one's own, would eliminate transactions costs as well, and thus promote trade and investment still more.

Most academic economists have tended to downplay this argument. One reason is that exchange rate risk can be hedged, through the use of the forward exchange market and other instruments. Another reason is that there have been quite a few empirical studies of the effect of exchange rate volatility on trade, and some on investment; most of them find small adverse effects, if they find any at all.[18]

Nevertheless, this argument still carries weight. It looms large in the minds of European policymakers and businesspeople. Furthermore, there is new evidence on the proposition that trade and investment are substantially boosted by full monetary union, in which circumstance even the possibility of a future change in the exchange rate is eliminated, along with all transactions costs. Some recent tests of economic geography suggest that Canadian provinces are far more closely linked to each other then they are to nearby states of the U.S., whether the links are measured by prices or quantities of trade. High on the list of reasons why integration seems to be so much higher between provinces within a federation such as Canada than between countries is the fact that the provinces share a common currency.[19]

Of the advantages of fixed exchange rates, academic economists tend to focus most on the nominal anchor for monetary policy. The argument is that there can be an inflationary bias when monetary policy is set with full discretion. A central bank that wants to fight inflation can commit more credibly by fixing the exchange rate, or even giving up its currency altogether. Workers, firm managers, and others who set wages and prices then perceive that inflation will be low in the future, because the currency peg will prevent the central bank from expanding even if it wanted to (without soon jeopardizing the viability of the exchange rate peg). When workers and firm managers have low

expectations of inflation, they set their wages and prices accordingly. The result is that the country is able to attain a lower level of inflation, for any given level of output. The nominal anchor argument of course presupposes that one is pegging to a hard currency, one that exhibits strong monetary discipline. After the breakup of the Soviet Union, most of the 15 newly independent states wisely reached the judgment that the Russian rouble did not offer a good nominal anchor. The strength of the argument for basing monetary policy on an exchange rate target will also depend on what alternative nominal anchors might be available (money supply, nominal income, or price level).

The advantages of a flexible exchange rate can all be grouped under one major property: it allows the country to pursue independent monetary policy. The argument in favor of monetary independence, instead of constraining monetary policy by the fixed exchange rate, is the classic argument for discretion, instead of rules. When the economy is hit by a disturbance, such as a shift in worldwide demand away from the goods it produces, the government would like to be able to respond, so that the country does not go into recession. Under fixed exchange rates, monetary policy is always diverted, at least to some extent, to dealing with the balance of payments. Under the combination of fixed exchange rates *and complete integration of financial markets*, which characterizes EMU, monetary policy becomes completely powerless. Under these conditions, the domestic interest rate is tied to the foreign interest rate. An expansion in the money supply has no effect: the new money flows out of the country, via a balance of payments deficit, just as quickly as it is created. In the face of an adverse disturbance, the country must simply live with the effects. After the fall in demand, for example, the recession may last until wages and prices are bid down, or until some other automatic mechanism

of adjustment takes hold. By freeing up the currency, on the other hand, the country can respond to a recession by means of monetary expansion and depreciation of the currency. This stimulates demand for domestic products and returns the economy to desired levels of employment and output more rapidly than would the case under the automatic mechanisms of adjustment on which a fixed-rate country must rely.

The argument for stabilizing the exchange rate is sometimes buttressed by reference to an increasingly evident disadvantage of free floating: a tendency toward volatility that does not always derive from macroeconomic fundamentals, including occasional speculative bubbles (possibly rational, possibly not) and crashes. However the argument for flexibility is correspondingly sometimes buttressed by reference to an increasingly evident disadvantage of pegging: a tendency toward borrowers' effectively-unhedged exposure in foreign currency (possibly rational, possibly not), ending badly in speculative attacks and multiple equilibrium. Overvaluation and excessive volatility are possible in either regime.

Which factors are likely to dominate, the advantages of fixed exchange rates or the advantages of floating? There is no one right answer for all countries. The answer must depend, in large part, on characteristics of the country in question. If the country is subject to many external disturbances, for example, such as fluctuations in foreigners' eagerness to buy domestic goods and domestic assets (perhaps arising from business cycle fluctuations among the country's neighbors), then it is more likely to want to float its currency. In this way it can insulate itself from the foreign disturbances, to some degree. On the other hand, if the country is subject to many internal disturbances, then it is more likely to want to peg its currency.

VII.b Definition of Optimum Currency Area

Many of the country characteristics that are most important to the fixed-vs.-floating question are closely related to the size and openness of the country. This observation brings us to the theory of the Optimum Currency Area.[20]

Countries that are highly integrated with each other, with respect to trade and other economic relationships, are more likely to constitute an optimum currency area. An optimum currency area is a region for which it is optimal to have its own currency and its own monetary policy. This definition, though in common use, may be too broad to be of optimum usefulness. It can be given some more content by asserting the generalization that smaller units tend to be more open and integrated with their neighbors than larger units.[21] Then an OCA can be defined as *a region that is neither so small and open that it would be better off pegging its currency to a neighbor, nor so large that it would be better off splitting into subregions with different currencies*. Even to the extent that corner solutions are appropriate for given countries, the optimal geographic coverage for a common currency is likely to be intermediate in size: larger than a city and smaller than the entire planet.

VII.c The Traditional OCA Criteria

Why does the OCA criterion depend on integration? The advantages of fixed exchange rates increase with the degree of economic integration, while the advantages of flexible exchange rates diminish. This is clearest when integration is defined in terms of trade, but is also true for other sorts of integration.

- *Openness*. Recall the two big advantages of fixing the exchange rate that we identified above: (1) to reduce transactions costs and exchange rate risk that can discourage trade and investment, and (2) to provide a credible nominal anchor for monetary policy. If traded goods constitute a large proportion of the economy, then exchange rate uncertainty is a more serious issue for the country in the aggregate.[22] Such an economy may be too small and too open to have an independently floating currency.
- *Labor mobility* -- The OCA criteria offered in the original Mundell article was labor mobility, here defined as the ease of labor movement between the country in question and its neighbors. If the economy is highly integrated with its neighbors by this criterion, then workers may be able to respond to a local recession by moving across the border to get jobs, so there is less need for a local monetary expansion or devaluation.
- *Fiscal cushions* -- The existence of a federal fiscal system to transfer funds to regions that suffer adverse shocks offers another way to help mitigate macroeconomic fluctuations in the absence of an independent currency.
- *Symmetry* -- To the extent that shocks to the two economies are correlated monetary independence is not needed in any case: the two can share a monetary expansion in tandem.
- *Political willingness* to accept neighbors' policies -- To the extent that domestic residents have economic priorities, especially on fighting inflation versus

unemployment, that are similar to those of their neighbors, there will be less need for a differentiated response to common shocks.

VIII. Currency Boards and Dollarization: Do They Make Interest Rates More Sensitive, or Less?

A popular hypothesis is that countries are abandoning their independent currencies in favor of the firmest institutional constraints possible: either a currency board, or outright monetary union with one of the major-currency countries.

VIIIa. Currency Boards

A currency board is a monetary institution that only issues currency that is fully backed by foreign assets. Its principal attributes include the following:

- an exchange rate that is fixed not just by policy, but by law
- a reserve requirement stipulating that each dollar's worth of domestic currency is backed by a dollar's worth of foreign reserves
- a self-correcting balance of payments mechanism, in which a payments deficit automatically contracts the money supply, resulting in a contraction of spending.

The introduction of currency board-like arrangements in Hong Kong (1983), Argentina (1991), Estonia (1992), Lithuania (1994), Bulgaria (1997), Bosnia (1998) and two smaller countries, constitutes a resurgence in their use worldwide. A currency board can help to create a credible policy environment by removing from the monetary

authorities the option of printing money to finance government deficits. Argentina, for example, has benefited from such credibility. Argentina was prompted to adopt a currency board (which it calls the convertibility plan) because of a dramatic hyperinflation in the 1980s and the absence of a credible monetary authority. Since 1991, Argentina has become a model of price stability and has achieved laudable growth rates, aside from setbacks such as the Mexican peso "Tequila"-induced recession in 1995, from which Argentina soon rebounded strongly. By most accounts, the currency board has worked for Argentina.

And yet Argentina does not fit well the traditional optimum currency area criteria. It is not particularly small or open, or subject to high labor mobility or close correlation with the US economy. Although the traditional optimum currency area criteria are still relevant, we have become aware of a new set of criteria that is also relevant, particularly to the decision to adopt an institutional commitment to a fixed rate. The new characteristics have to do with credibility and the need to satisfy international financial markets. The additional criteria[23] are:

- a strong (even desperate) need to import monetary stability, due to either a history of hyperinflation, an absence of credible public institutions, or unusually large exposure to nervous international investors

- a desire for further close integration with a particular neighbor or trading partner (which has the added advantage of enhancing the political credibility of the commitment)

- an economy in which the foreign currency is already widely used[24]

- access to an adequate level of reserves,
- rule of law, and
- a strong, well-supervised and regulated financial system, and

Currency board supporters have recently pushed for their wider use—in particular, for Indonesia, Russia, and Ukraine. Proclaiming a currency board does not automatically guarantee the credibility of the fixed rate peg. Little credibility is gained from putting an exchange rate peg into the law, in a country where laws are not heeded or are changed at will. A currency board is unlikely to be successful without the solid fundamentals of adequate reserves, fiscal discipline, and a strong and well-supervised financial system, in addition to the rule of law.[25]

VIIIb. The Alternative of Dollarization

Currency boards, which not long ago appeared a radical straightjacket, are now in some quarters deemed an insufficiently firm commitment. In January 1999, at the request of Argentina's President, the central bank submitted a report spelling out possible ways to complete the dollarization of that country, that is, to replace the peso fully with the dollar as the legal currency. This plan may well never come to fruition. The timing of the initiative -- immediately after the downfall of the real in neighboring Brazil and in advance of a presidential election in Argentina -- suggests possible short-term objectives: impressing contagion-prone speculators and stability-craving voters. Nevertheless, many

Latin Americans are suddenly taking the dollarization alternative seriously, and at least two countries, El Salvador and Ecuador, may actually go ahead.

The reasons why most countries would not want to adopt the currency of the United States or any other foreign power as its own are clear. It is a total surrender of monetary independence. Also it adds the insult of surrendering a symbol of national political sovereignty, which is demonstrably important to most people. It is striking that, notwithstanding that in theory the boundaries of political units and optimal currency areas need not coincide, in practice they almost always do. In Israel in 1983, adverse popular reaction to the idea of dollarization was severe, and the finance minister who had proposed it resigned.

Yet, consider a country that already has demonstrated sufficient political support for monetary discipline to go as far as a currency board (and where the foreign currency already plays a large role in the economy). Is there anything further to be lost by going the rest of the way and giving up its currency altogether, beyond the symbolic loss of sovereignty?

The conventional interpretation would be that such a country still retains a degree of monetary independence that, though small, is not zero, and which it would be giving up if it were to dollarize fully. Argentina for example could always change the convertibility law if it wanted to, or short of that could switch its peg from the dollar to the euro, if US monetary policy disappointed.[26]

The unfortunate truth is that most developing countries have been unable to make good use of whatever monetary independence they possess. Perhaps the additional loss of discretionary monetary policy for Argentina would be not just small, but zero. Perhaps

an emerging-market country under a fixed exchange rate or currency board is in a worse position, as regards having to accept an interest rate that may not be appropriate to its current domestic cyclical conditions, than under dollarization. Under the current regime, when the Federal Reserve Board raises U.S. interest rates, emerging-market interest rates often rise *more than* one-for-one.

The sensitivity of local interest rates to US interest rates can easily be tested. Some simple regression tests in Frankel (1999) indicate that local interest rates move one-for-one with US interest rates in firm-fix economies such as Hong Kong, but can move much more than that in Latin American countries that maintain only loose links to the dollar.[27] Frankel, Schmukler, and Servén (2000) report results for more countries and longer time periods.

IX. Conclusion

We have offered a theoretical rationale for the hypothesis that intermediate exchange regimes, such as basket pegs with bands, are less likely to inspire credibility than simple firm fixes. This theoretical rationale is the notion of verifiability. While we have only demonstrated the verifiability issue for the case of basket pegs with bands, we believe that the same point applies to other intermediate regimes such as managed floating or pegs with escape clauses. We have also offered some empirical evidence that intermediate regimes do in fact inspire less credibility than institutional arrangements such as dollarization. This empirical evidence is the sensitivity of local interest rates to US interest rates, which is even greater for Latin American countries with flexible exchange rates than for dollarized or currency board countries. If lack of credibility

prevents emerging-market countries from taking advantage of a modicum of monetary independence under intermediate regimes, then they might as well reap the advantages of the fixed-rate corner.

Both the theoretical rationale and the empirical evidence that we have offered are far from complete or without shortcomings. But our view is that the hypothesis of the vanishing intermediate regime is sufficiently new, undeveloped, and as yet lacking in theoretical and empirical support, that even our humble contribution may be useful.

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Figure II.1: Evolution of Exchange Rate Regime Categories 1970-1999

The figure shows the distribution of exchange rate regimes over time, according to the IMF classification. We group all the different subcategories into four large categories of exchange rate regimes: pegged, limited flexibility, managed floating, and independently floating.

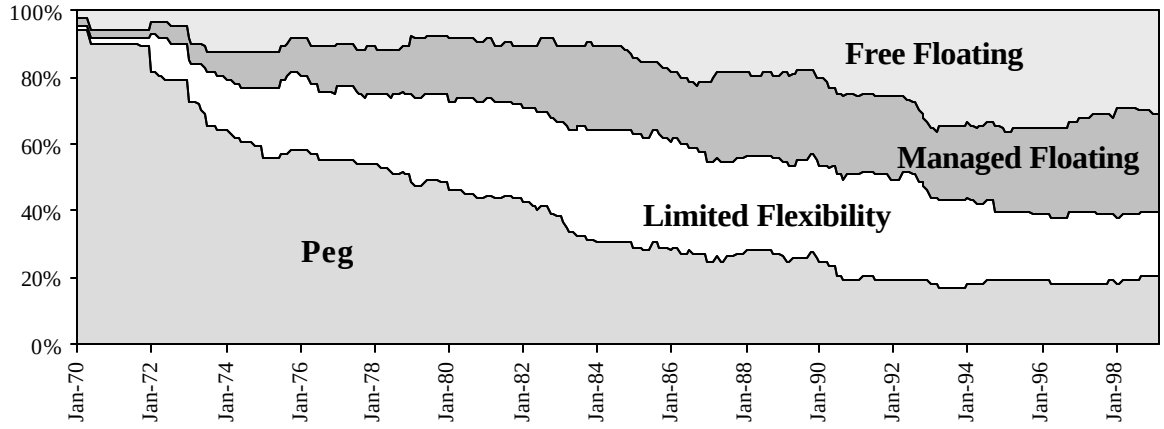


Figure IV.1:
Chilean Exchange Rate Arrangements

The figure plots the Chilean peso exchange rate, relative to the weighted basket specified in the text. The central parity involves the weights detailed in the graph, plus the differential between the domestic and international inflation rates. US$, DM, and JY stand for US dollar, Deutsche mark, and Japanese yen, respectively. Periods 1-7 are the ones used for estimation purposes.

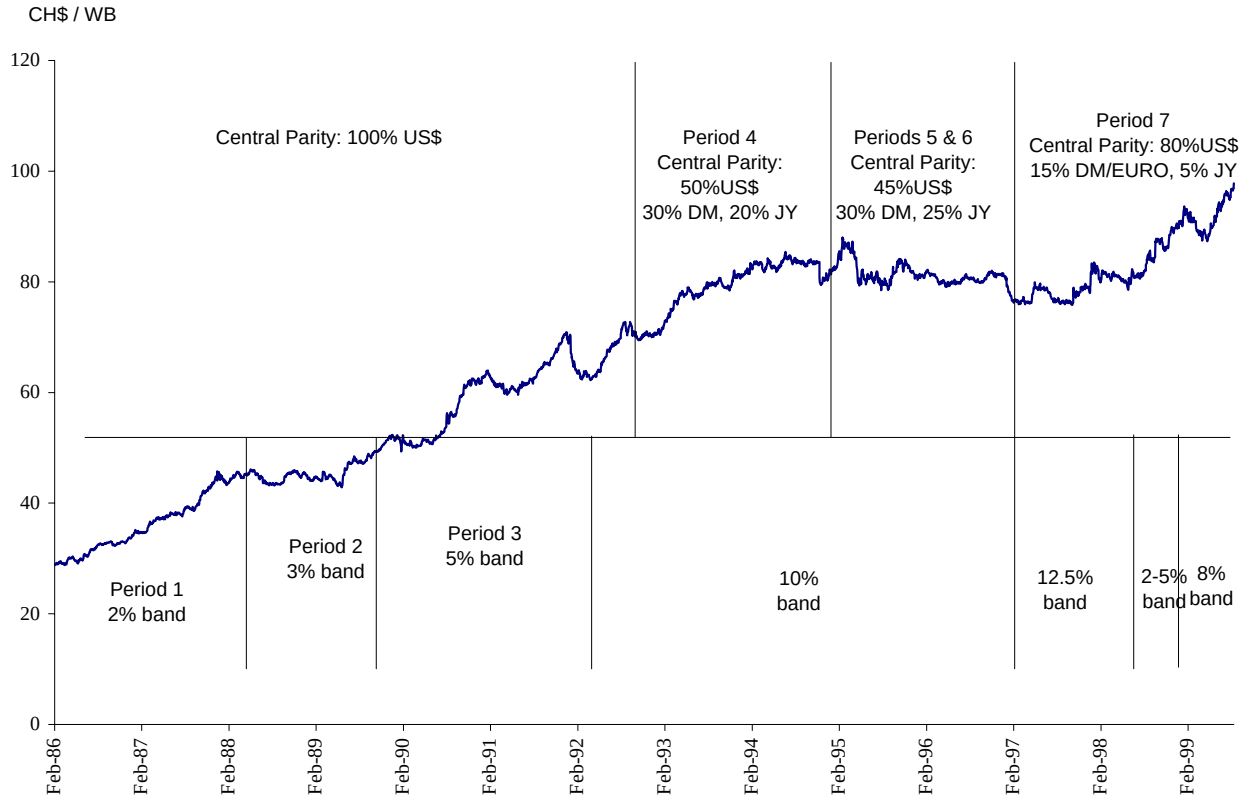


Table IV.1: Strong Currencies
February 1986 – August 1999
Daily data, log differences

Summary Statistics of Strong Currencies

	Chilean peso	U.S. dollar	Deutsche mark	Japanese yen
Mean	0.036%	0.006%	0.000%	-0.009%
Std. Dev.	0.488%	0.362%	0.462%	0.434%
Min.	-4.585%	-2.069%	-2.526%	-4.863%
Max.	3.784%	2.822%	3.415%	2.602%

Correlation Matrix

	CH$	US$	DM	JY
CH$	1			
US$	0.72	1		
DM	-0.32	-0.42	1	
JY	-0.58	-0.81	-0.15	1

Chilean peso (CH$), U.S. dollar (US$), Deutsche mark (DM), Japanese yen (JY), British pound (BP) All exchange rates are relative to the weighted basket. Weights for DM, JY, BP, US$: 15.7%, 34.1%, 7.0%, 43.2%

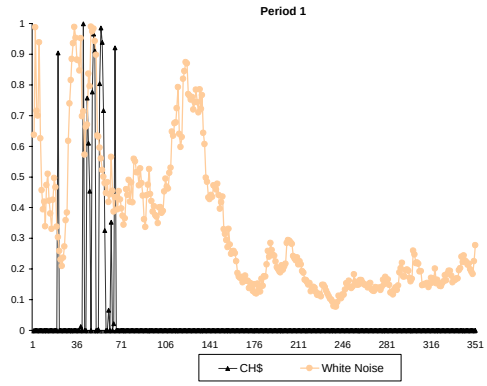
Table IV.2 Chilean Exchange Rate Regime—Point Estimates of US$ Weight Error-Correction Model

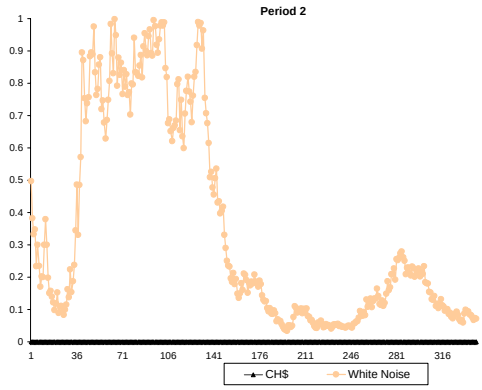
Period	Announced Weight	50 Observations			100 Observations		
		Chilean Peso (CH$)	White Noise	Central Parity	Chilean Peso (CH$)	White Noise	Central Parity
1	1	0.93	-0.03	1.00	1.00	0.00	1.00
		(0.23)	(0.02)	(0.00)	(0.01)	(0.01)	(0.00)
2	1	1.01	-0.04	1.00	1.01	0.01	1.00
		(0.00)	(0.15)	(0.00)	(0.00)	(0.08)	(0.00)
3	1	0.95	0.08	1.00	0.95	0.01	1.00
		(0.00)	(0.06)	(0.00)	(0.00)	(0.03)	(0.00)
4	0.50	1.80	-0.04	0.49	0.68	-0.04	0.48
		(0.21)	(0.02)	(0.01)	(0.54)	(0.02)	(0.01)
5	0.45	5.15	-0.13	0.45	3.57	0.01	0.44
		(2.67)	(0.09)	(0.03)	(7.56)	(0.01)	(0.00)
6	0.45	-3.06	-0.11	0.46	-1.61	-0.21	0.46
		(1.20)	(0.49)	(0.01)	(0.58)	(0.28)	(0.01)
7	0.80	4.80	-0.07	0.81	3.07	-0.02	0.81
		(3.66)	(0.05)	(0.00)	(0.85)	(0.04)	(0.00)

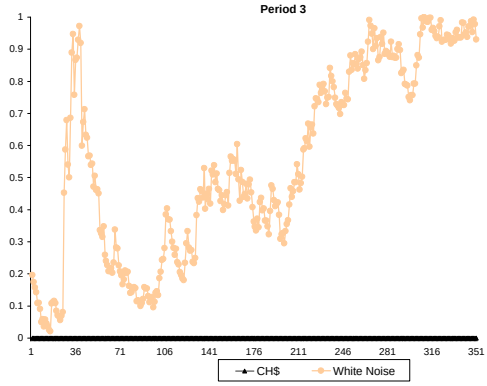
Standard Errors are in parenthesis. ECM estimates are obtained using maximum likelihood, with 1 lag structure.

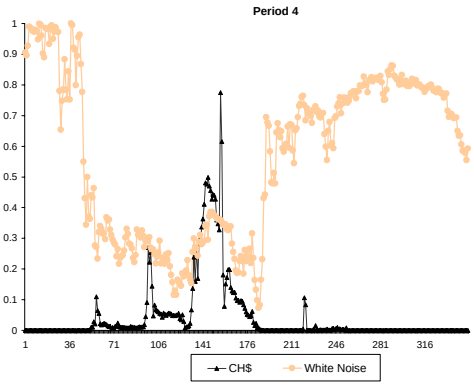
Figure IV.2: Chilean Exchange Rate Regime
P-Value—Test 2 & 3 (H0: Weights=0)

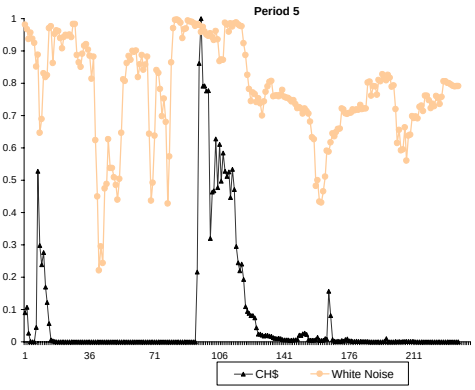
Simple Peg As Central Parity **Error-Correction Model** **Basket Peg As Central Parity**

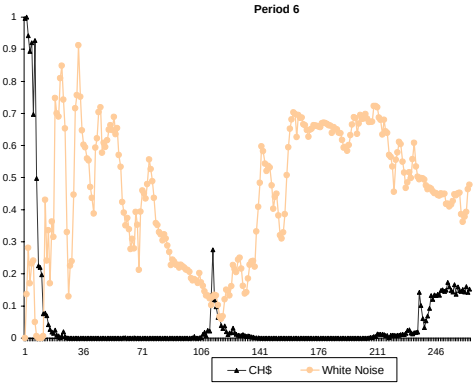


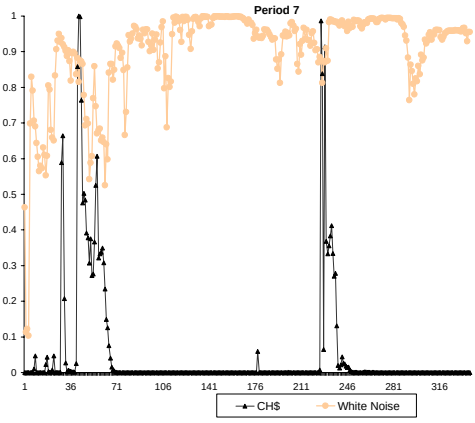








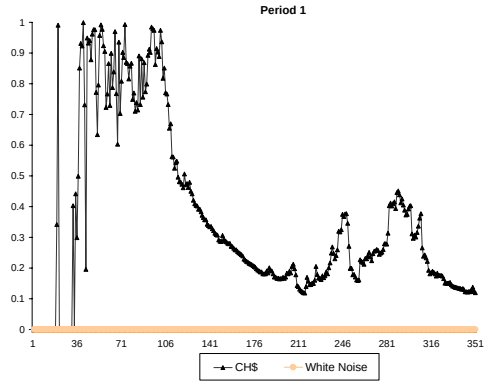


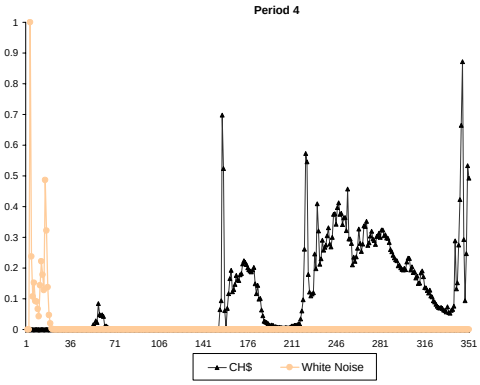


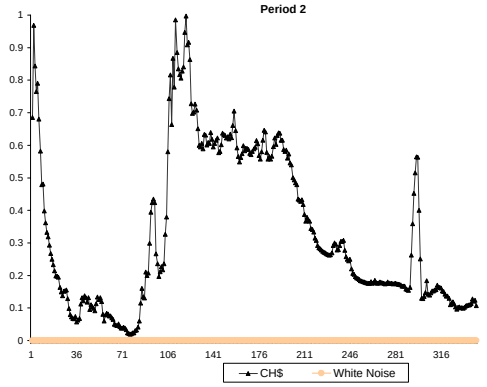
The results for the central parity as a dependent variable are not reported, since they always fail to reject the null hypothesis of weight = 0. The error-correction model is estimated with 1 lag-structure.

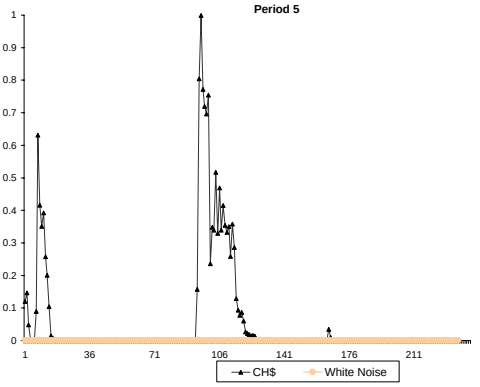
Figure IV.3: Chilean Exchange Rate Regime
Wald Statistic—Test 4 & 5 (H0: Weights= Announcement)

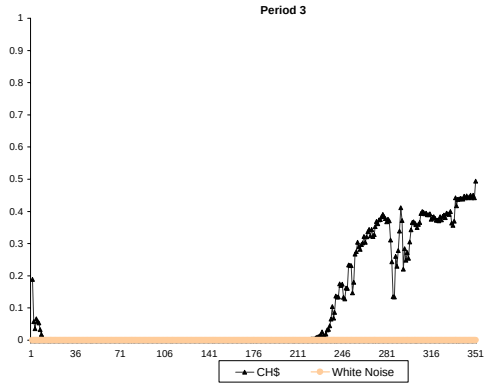
Simple Peg As Central Parity **Error-Correction Model** **Basket Peg As Central Parity**

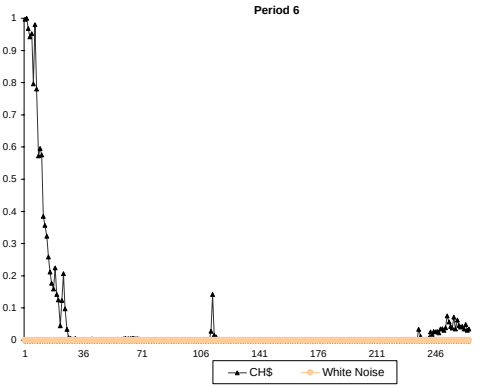


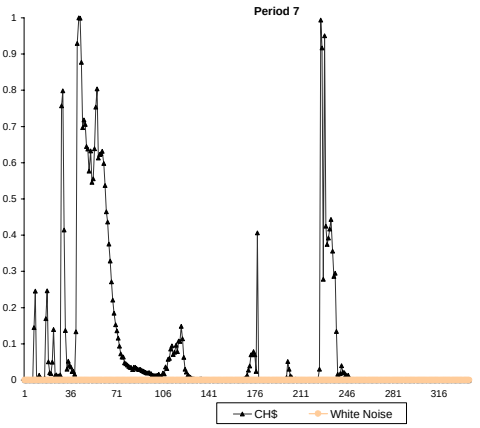












The results for the central parity as a dependent variable are not reported since they always reject the null hypothesis of weight = announcement. The error-correction model is estimated with 1 lag-structure.

Table IV.3: Chilean Exchange Rate Regime
"Verification" Time
Number of Observations Necessary to Reject the Null Hypothesis

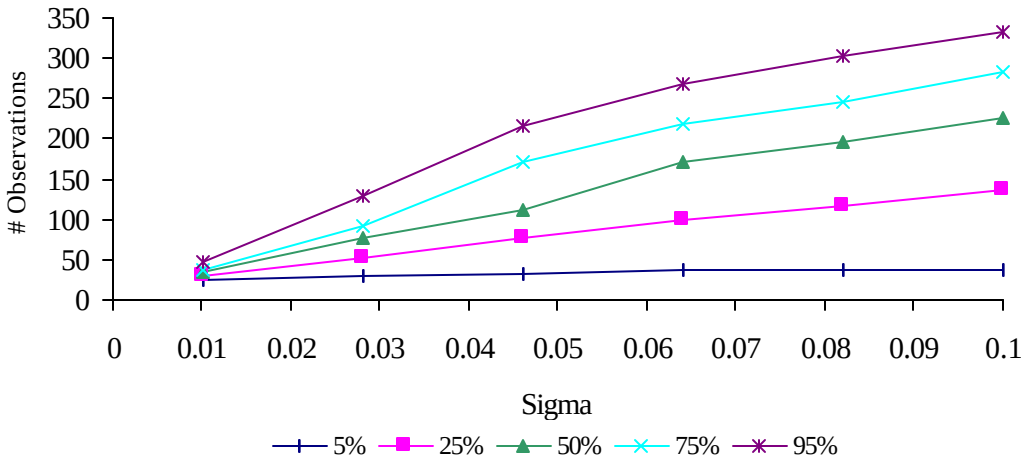
Error-Correction Model

Period	Dependent Variable: Spot Exchange Rate		
	Null Hypothesis:		
	Weights =0	Weights= Announcement	Precision
1	70	40	H
2	1	80	H
3	1	220	H
4	180	220	L
5	130	N	L
6	N	N	L
7	240	N	L

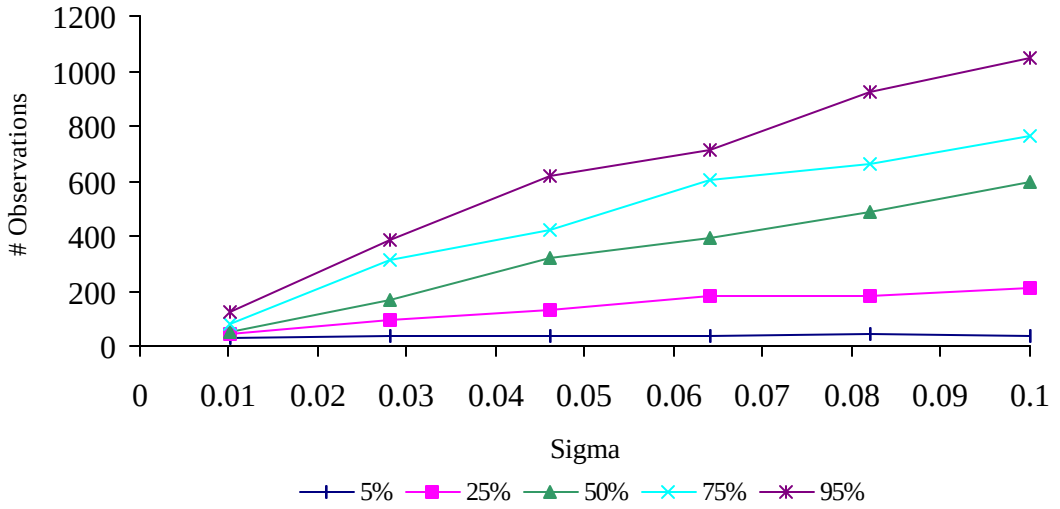
"Precision" means how precise the estimates are when "H" means high precision. "L" means low precision. "N" means never. For further explanations, see text.

Figure V.1: Monte Carlo Simulations—Role of Band Size

Quantiles of Test 1 (Weights=Rate of Crawl=0)

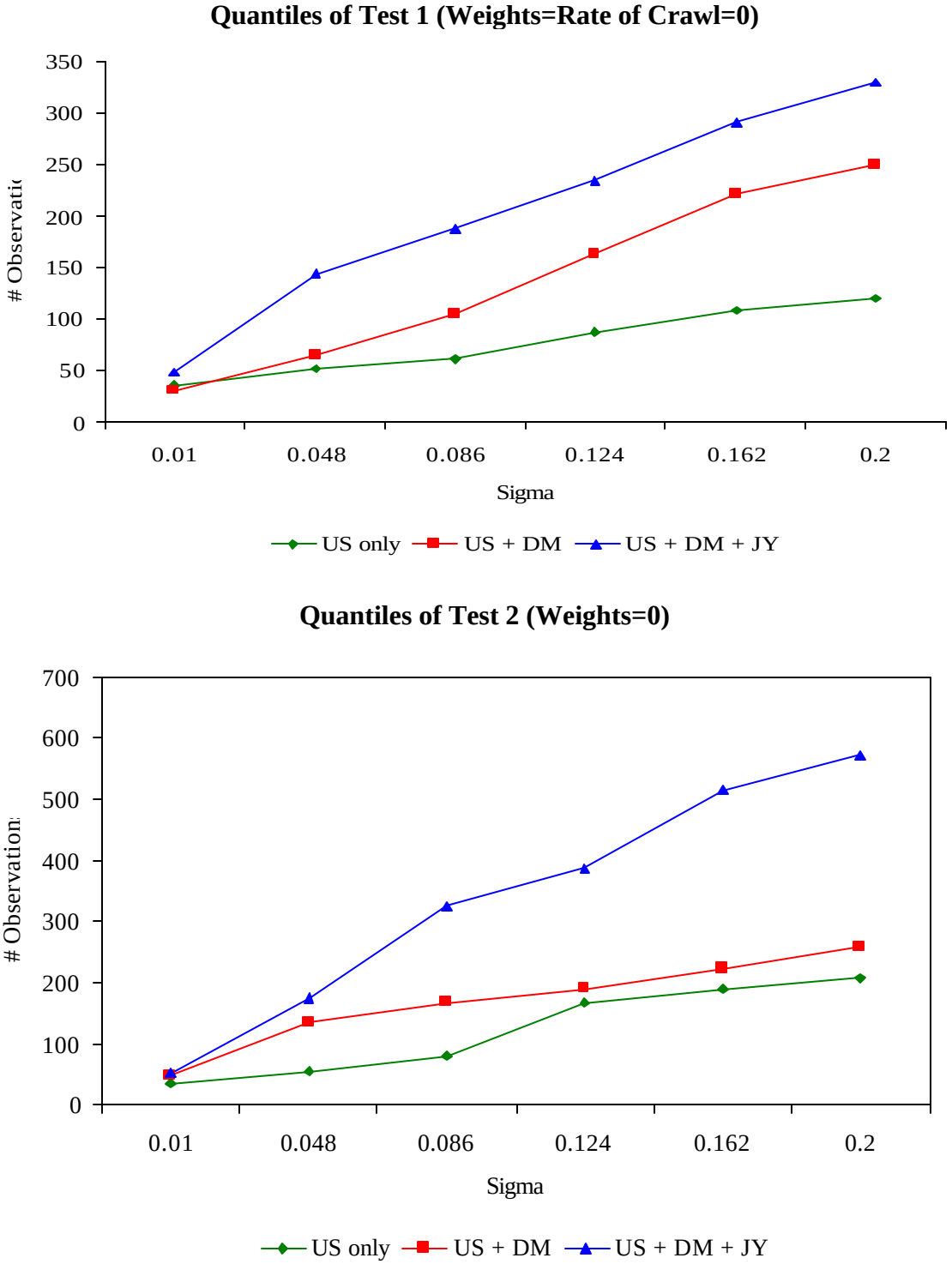


Quantiles of Test 2 (Weights=0)



Parameters of estimations: 500 samples; weights on dependent variables 1/3 for US$, DM, and JY; initial observation February 24, 1986; constant=1; rate of crawl=0.10; sigma={0.01; 0.028; 0.046; 0.064; 0.082; 0.1}. Quantile values are calculated for the first 10 rejections.

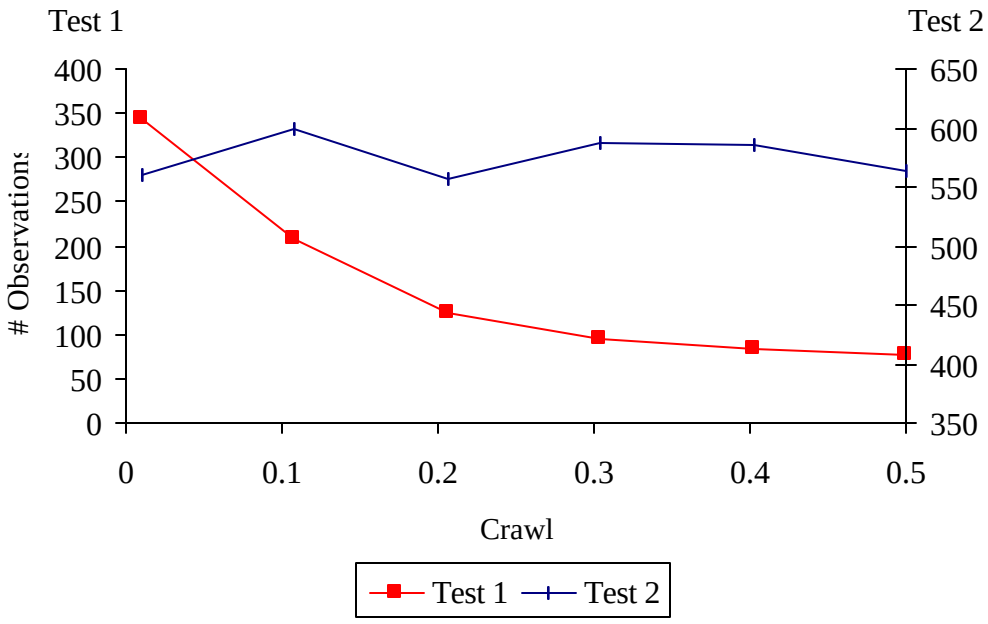
Figure V.2: Monte Carlo Simulations—Role of Number of Currencies in Basket



Parameters of estimations: 500 samples; initial observation February 24, 1986; constant=1; rate of crawl=0.10; sigma={0.01; 0.048; 0.086; 0.124; 0.162; 0.2}; weights on dependent variables are 1, 1/2, and 1/3, for 1, 2, and 3 currencies in the basket respectively. Quantile values are calculated for the first 10 rejections.

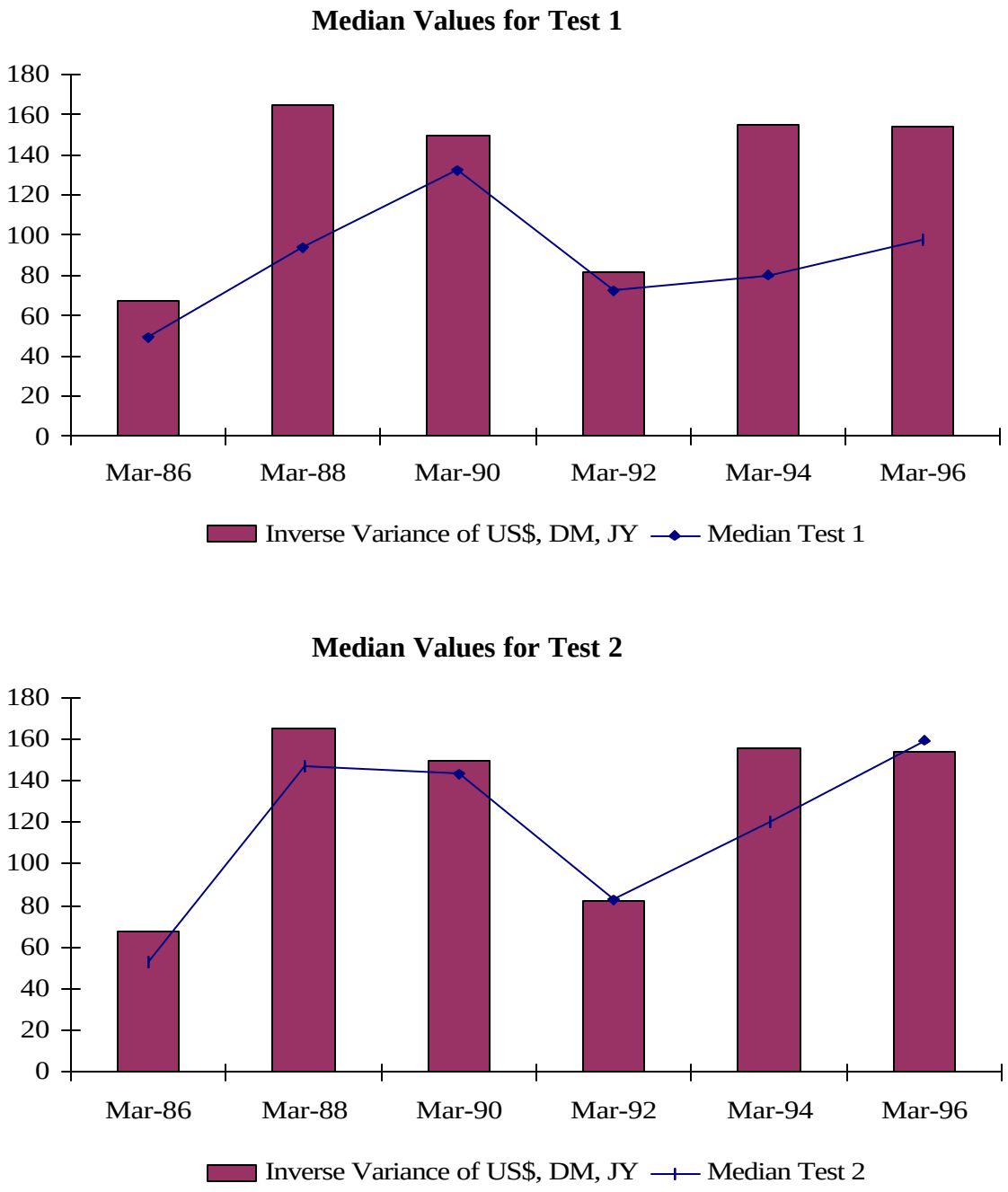
Figure V.3: Monte Carlo Simulations—Role of Rate of Crawl

Median Valules for Tests 1 & 2



Test1: Weights=Rate of Crawl=0 Test 2: Weights=0
Parameters of estimations: 500 samples; initial observation February 24, 1986; constant=1; rate of crawl= {0.01; 0.108; 0.206; 0.304; 0.402; 0.5}; sigma=0.1; weights on dependent variables are equal to 1/3 for each currency in the basket. Median values are calculated for the first 10 rejections.

Figure V.4: Monte Carlo Simulations—Role of Period and Variability of Regressors



Parameters of estimations: 500 samples; weights on dependent variables 1/3 for US$, DM, and JY; constant=1; rate of crawl=0.10; sigma=0.005. Median values are calculated for the first 10 rejections. "Inverse Variance" is the inverse of the average standard error of the three currencies, for the first 50 observations of each respective period.

Appendix

Table A.1: Exchange Rate Policy in Chile

Date	Policy
September, 1982	• Daily devaluations in line with domestic inflation in the preceding month minus an estimate of external inflation
August 1, 1984	• a band of +/- 0.5%
June, 1985	• widening to 2%
January 5, 1988	• widening to 3 %
June 6, 1989	• widening to 5% • accelerate the rate of real depreciation, which was achieved by reducing the estimate of international inflation • adjustment of central parity: previous month inflation minus estimated international inflation
April 3, 1991	• 2% revaluation of central parity
January 23, 1992	• band widened to 10% (from +/-5%) • discrete 5% revaluation of central parity
March, 1992	• managed floating is authorized
July, 1992	• central parity: 50% U.S. dollar, 30% Deutsche mark, 20% Japanese yen
November, 1994	• central parity: 45% U.S. dollar, 30% Deutsche mark, 25% Japanese yen
November 30, 1994	• 9.66% revaluation of central parity
December, 1995	• 2% revaluation • 2% annual revaluation
January 21, 1997	• 4% revaluation of central parity • new band: +/- 12.5% • new weight: 80% U.S. dollar, 15% Deutsche mark, 5% Japanese yen
June 25, 1998	• 2% annual revaluation • new asymmetric band: +2%, -3,5%

September 16, 1998	• new band: +/- 3.5% • between September 17 and December 31, 1998 the band will be widened progressively until it accumulates and additional 1.5% in each extreme , such that by the end of the year the band would be +/- 5% • new estimates of annual international inflation from 2.4% to 0% for the rest of the year • the relevant internal inflation rate is the inflation target and not past inflation
December 23, 1998	• new band: +/-8% • no change in other parameters (central parity adjusts only with internal inflation and the band continue widening daily by 0,013575%)
January 1, 1999	• Deutsche mark is replaced by the euro, with the same weight
September 2, 1999	• free floating with managed intervention only in exceptional cases • release of new information regarding interventions in the foreign exchange markets

* * * * *

Endnotes

[1] Two recent reviews are Larrain and Velasco (1999) and Frankel (1999).

[2] Even 50 days may be too long, however, in the midst of a full-fledged speculative attack, which is the circumstance in which intermediate regimes have been abandoned in recent years. In the midst of a currency crisis, the central bank needs to regain the confidence of market participants in a matter of days, not a matter of months.

[3] Perhaps the best precursor is Friedman (1953, p.164): "In short, the system of occasional changes in temporarily rigid exchange rates seems to me the worst of two worlds: it provides neither the stability of expectations that a genuinely rigid and stable exchange rate could provide in a world of unrestricted trade…nor the continuous sensitivity of a flexible exchange rate."

[4] Other high-profile examples include Eichengreen (1999, p.104-105), Minton-Beddoes (1999) and Council on Foreign Relations (1999, p.87).

[5] Even the francophone countries of Africa finally devalued against the French franc in 1994 (though they have retained their currency union among themselves).

[6] Two smaller countries, Brunei and Djibouti, and some even smaller Caribbean islands, have had currency boards since independence. Montenegro is now said to be adopting a currency board too, or even declaring marks legal tender

[7] The data pertain to September 30, 1999. The source is International Financial Statistics, February 2000. These totals reflect that Colombia and Chile abandoned their crawling bands in mid-1999, while the early stages of this research was underway. Also Angola dropped its crawling peg and Croatia its horizontal band. All moved toward increased flexibility.

[8] Even in the case of Thailand, where the baht had been *de facto* linked closely to the dollar in the last two years before the crisis of July 1997, the official policy was still a basket peg.

[9] Goldman Sachs.

[10] The conventional wisdom now is that it is far worse to be forced to abandon an exchange rate target late into a speculative episode than early. Indonesia is one counterexample, a country that abandoned early, and suffered a severe crisis anyway. (Perhaps political instability made this inevitable.) Brazil is another counterexample, in the opposite way: it clung to its target long after speculative outflows began to surge in August 1998, and yet when it finally devalued in January 1999, adverse effects on the economy were very mild compared, for example, to its neighbor Argentina.

[11] Summers (1999b, p. 326) is explicit: "…the core principle of monetary economics is a trilemma: that capital mobility, an independent monetary policy, and the maintenance of a fixed exchange rate objective are mutually incompatible. I suspect this means that as capital market integration increases, countries will be forced increasingly to more pure floating or more purely fixed exchange rate regimes."

[12] The version of this argument in Eichengreen (1999, p.104) overstates the extent to which the East Asians had "a stated commitment to the peg," as most commentators have done as well. In fact few of the East Asian countries had explicit dollar pegs.

[13] He calls this the "original sin." The term is not meant to imply that the fault lies in policy failings of the local government.

[14] Taiwan, for example, devalued promptly, and suffered less than the others.

[15] Governments may have an incentive to postpone devaluations until after elections. See Ernesto Stein and Jorge Streb (1998, 1999).

[16] When the spot rate draws close to one edge, speculators are aware that there is a limit on how far it can continue to move in that direction. The expected value will show a regression back toward the central parity. As speculators respond to that expectation, they will push the spot rate away from the margin, even without any intervention.

[17] To be sure, other factors enter as well. Two other advantages of an independent currency are that the government retains seignorage, and floating allows smooth adjustment to real shocks even in the presence of price frictions. Most of the important factors, however, can be lumped into the major arguments presented in the text.

[18] Surveys of the literature, which consists primarily time-series tests, are included in Edison and Melvin (1990) and Goldstein (1995). A more recent cross-section approach that finds statistically significant effects of bilateral exchange rate variability on bilateral trade in the 1960s and 1970s is Frankel and Wei (1995) or Frankel (1997, 137-139). The negative effect disappears, however, after 1980.

[19] McCallum (1995) for a quantity-based measure of trade integration, and Engel and Rogers (1996) for a price-based measure. The most direct test yet of the effect of a common currency on bilateral trade is Rose (2000). Frankel and Rose (2000) find that the effect is to raise openness, and thereby, in the long run, real income.

[20] A survey is Tavlas (1992). The issues are also reviewed by Bayoumi and Eichengreen (1994).

[21] Gravity estimates suggest that for every one percent increase in the size of a country's economy, its ratio of trade to GDP falls by about .3 percent. (Frankel, 1997.)

[22] This is the rationale for the openess criterion originally suggested by McKinnon (1963).

[23] Similar lists are also offered by Williamson (1995) and Larrain and Velasco (1999).

[24] In a country that is already partially dollarized, devaluation is of little use. If many wages and prices are already tied to the dollar, they will simply rise by the same amount as the exchange rate. If liabilities are already denominated in dollars – and, in the case of international liabilities, foreign creditors generally insist on this -- then devaluation may bankrupt domestic borrowers. Such initial conditions are discussed as criteria for dollarization by Calvo (1999) and Hausmann, Gavin, Pages-Serra, and Stein (1999).

[25] For a balanced evaluation, see Williamson (1995). Ghosh, Gulde, and Wolf (1997) look at the statistical record, and find that currency board countries have lower inflation rates than other categories.

[26] Furthermore Argentina actually has a "quasi" currency board, which can in effect sterilize a certain proportion of reserve outflows.

[27] Similar results regarding the behavior of interest rates in fixed vs. flexible regimes are found by Hausmann et al (1999). The finding that interest rates in emerging markets react more than one-for-one to U.S. short-term interest rates is not new. More results and references are given in Frankel and Okongwu (1996). Tests of monetary stability under various exchange rate regimes are found in Ghosh, Gulde, Ostry, and Wolf (1997).