Exchange Rate Bands and Monetary Policy: The Case of Mexico

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Abstract: In addition to the well-known policy recommendations of tight fiscal and monetary policies to curb inflation in traditional stabilization programs, the disinflation attempt in Mexico relied on the exchange rate as a nominal anchor. The exchange rate regimen evolved from a publicly announced rate of devaluation of the peso to a fully-fledged exchange rate band. The gradual widening of the band and its asymmetric feature combined a considerable degree of certainty with a greater degree of flexibility. The paper analyses the role played by exchange rate policy in Mexico's stabilization effort and its monetary policy implications. Special emphasis is given to intra-marginal interventions by the Central Bank.

Resumen: Aunado a la implantación de políticas fiscales y monetarias restrictivas para frenar la inflación, el programa de estabilización en México se basó en forma importante en la utilización del tipo de cambio como ancla nominal. El régimen cambiario pasó del anuncio público de la tasa de devaluación del peso a una banda cambiaria. El ensanchamiento paulatino de la banda y su forma asimétrica combinaron mayor certidumbre con mayor flexibilidad. El artículo analiza el papel de la política cambiaria en el programa de estabilización de México y sus implicaciones sobre la política monetaria. Se le da un énfasis especial a las intervenciones intramarginales del Banco Central.

In recent years, the Mexican economy has undergone a comprehensive adjustment process, with a decisive strategy for stabilization and structural change. The adjustment process started at the beginning of the 1980s and was intensified in late 1987 with the introduction of an explicit stabilization program, "The Pact for Economic Solidarity" (*Pacto*) whose aim has been the drastic reduction of infla-

tion, while at the same time fostering conditions for sustained economic growth.

In addition to the well-known policy recommendations of tight fiscal and monetary policies to curb inflation in traditional stabilization programs, the disinflation attempt in Mexico relied heavily on the exchange rate as a nominal anchor. The exchange rate regime evolved from a publicly announced rate of devaluation of the peso to a fully-fledged exchange rate band. The gradual widening of the band and its asymmetric feature combined a considerable degree of certainty with a greater degree of flexibility.

This paper intends to analyze the role played by the exchange rate policy in Mexico's stabilization effort, the evolution of the exchange rate regime, its credibility and its monetary policy implications. In our analysis, special emphasis is given to the sustainability of the exchange rate regime and to intra-marginal interventions by the Central Bank.

The paper consists of six more sections. The next section reviews the Mexican stabilization attempt and emphasizes its main achievements. Section two describes the evolution of the exchange rate regime in Mexico and its monetary policy implications. Section three provides the theoretical foundations of exchange rate target zones and section four empirically tests the predictions of the basic model of exchange rate target zones for the case of Mexico. Section five presents "event studies" as a way to infer sustainability of the exchange rate regime. The final section presents concluding remarks.

1. The Stabilization Attempt in Mexico

In late 1987 a new stabilization plan was introduced: "The Pact for Economic Solidarity" (Pacto). Its main objective was the drastic reduction of inflation through a renewed effort involving the cooperation of workers, farmers, entrepreneurs and government.

The stabilization program included the typical orthodox policy measures: a tight fiscal policy, which entailed spending cuts, realignment of public goods' prices to reflect costs, a broad-based tax reform and the privatization of a significant number of state-owned enterprises. Moreover, a restrictive monetary policy was designed to avoid inflationary pressures. A fixed, and later quasi-fixed exchange rate regime was also adopted, in order to use the exchange rate as a "nominal anchor" in the disinflation program.

Chart 1. Annual Inflation Rate (CPI)
(percentage change compared to same month of the previous year)
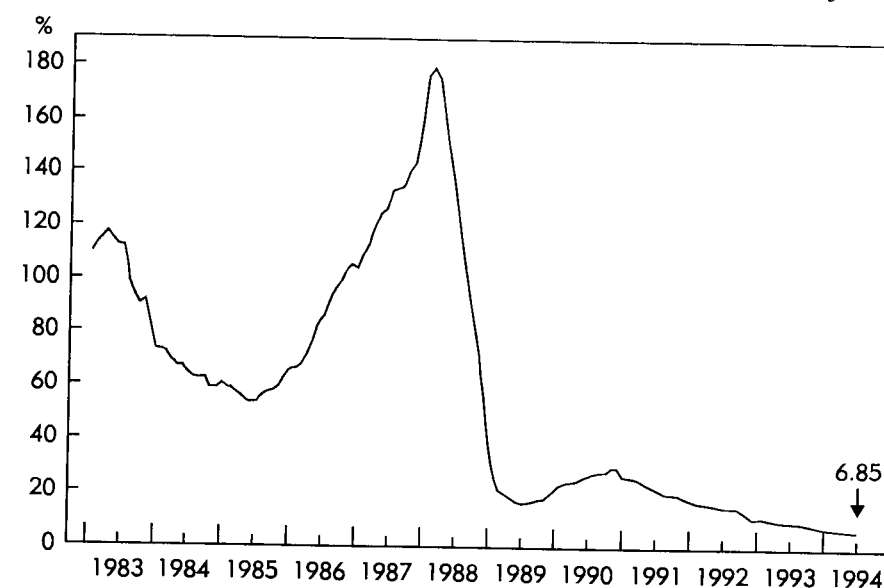
To brake the "inertial" elements of inflation, heterodox policy measures were also adopted. In this respect, an agreement (Pacto) between workers, farmers, entrepreneurs and government was reached. The government committed itself to making fiscal and monetary policies consistent with the exchange rate regime; the business sector agreed to moderate their price increases and labor unions accepted smaller wage hikes. These commitments were intended to support a downward adjustment in price expectations and brake the inflationary process's dynamics. In addition, in most sectors deregulation was deepened to promote economic efficiency, and trade and financial liberalization were accelerated to enhance competition and reduce production costs.

As a result of the stabilization program, the yearly inflation rate has fallen from almost 180% in February 1988, to 6.85% in June 1994, the lowest in the last 21 years (see chart 1). The fiscal deficit has been slashed from 16.1% of GDP in 1987 to a surplus of 0.7% in 1993, and consolidated total public debt, as a percentage of GDP, has fallen from 74.4% in 1987 to 22% in 1993. Moreover, financial savings have increased from 28.9% of GDP in 1987 to 51.5% and economic activity, although sluggish in the recent past, has been recovering on a sustainable basis.

While the Mexican peso has inevitably appreciated against the U.S. dollar in real terms in recent years, the performance of manufactured exports suggests that the exchange rate continues to be consistent with the maintenance of competitiveness. This is owing in part to the structural policies' favorable effects on efficiency. As a matter of fact, during the last three years Mexican non-oil manufacturing exports grew at a faster rate than those of the Asian Tigers: Hong Kong, Singapore, South Korea and Taiwan.

Economic figures suggest that Mexico's stabilization effort has been successful. Moreover, prudent macroeconomic management in Mexico has been complemented with comprehensive structural and institutional reforms. An important deregulation of the economy has taken place and decisive action has been taken in order to increase efficiency and productivity.

2. Mexico's Exchange Rate Regime and Monetary Policy

In addition to the well-known policy recommendations of tight fiscal and monetary policies to curb inflation in traditional stabilization programs, the disinflation attempt in Mexico has relied heavily on the exchange rate as a nominal anchor. In a span of more than seven years, Mexico's exchange rate policy evolved from a publicly announced rate of devaluation of the peso to a fully-fledged exchange rate band (see chart 2). During the initial stages of the stabilization program, the peso was fixed to the dollar (after a 22% devaluation of the controlled exchange rate creating a virtually unified rate). Then, as of January 1989, the controlled exchange rate was subject to a pre-announced daily depreciation, or "crawling peg", with the peso devaluing against the U.S. dollar by 16.8% during the year. The rate of devaluation was then gradually reduced, until it reached an annual rate of 5% during most of 1991. In November 1991, capital controls were completely eliminated and the dual exchange regime, which had been introduced during the crisis of 1982, was abandoned.

At this stage, the authorities decided to introduce a band within which the unified exchange rate could float. The maximum exchange rate at which the banks could sell dollars to the public continued to be subject to a crawling peg, while the minimum exchange rate at which they could buy dollars from the public remained fixed.

In the November 1991 renewal of the Pacto, the government an-

Chart 2. Exchange Rate and Exchange Rate Regime
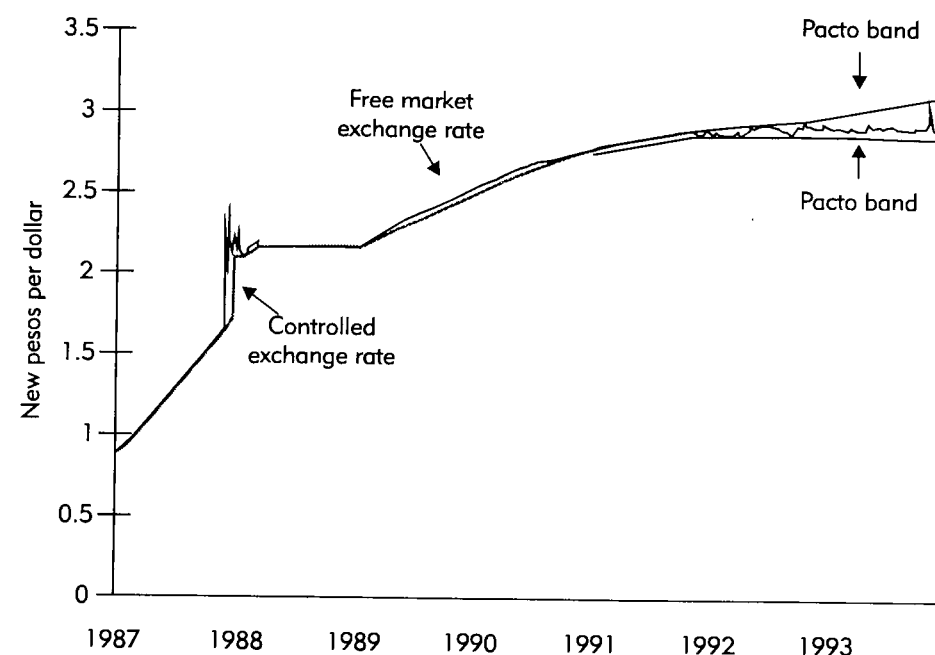
nounced that the maximum spread between the selling and the buying exchange rates quoted by commercial banks would increase gradually from 35 to 60 pesos. To attain this objective, the maximum exchange rate at which banks could sell dollars would crawl at the rate of 20 cents per day, while the minimum exchange rate at which banks could buy dollars would remain unaltered from its November 11, 1991 level, until March 15, 1992. Once the referred differential of 60 pesos was achieved on March 15, both exchange rate quotations would crawl at the rate of 20 cents per day. That is, Mexico intended to establish a "diagonal" exchange rate band. However, on March 13, 1992, as a result of the favorable experience with the widening of the band, the authorities decided to continue with the prevailing exchange rate policy. That is, the ceiling of the Pacto band continued with its ascendant path at the rate of 20 cents per day, and the floor of the band remained fixed at the level of 3,051.20 pesos per dollar.

In the October 1992 renewal of the Pacto, the rate of the crawl of the ceiling of the band was increased from 20 cents to 40 cents per day. In the most recent renegotiation of the Pacto (October 1993), it was

Chart 3. Mexican Exchange Rate Policy under the PECE
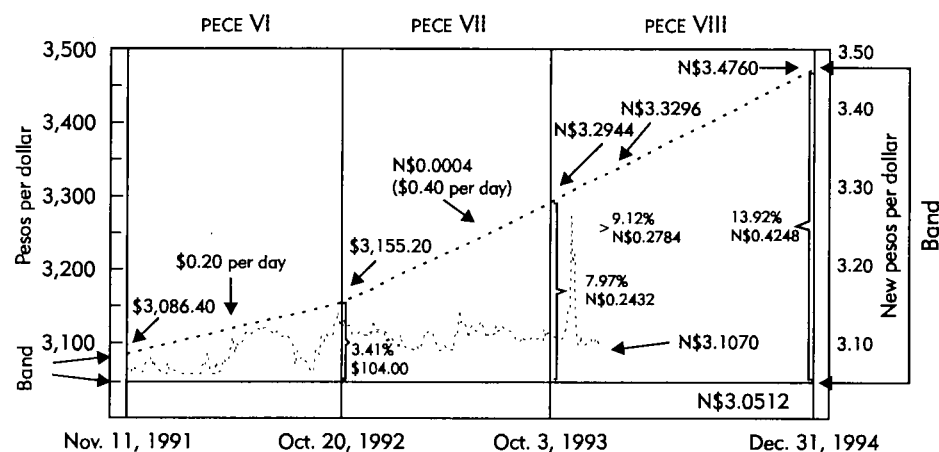
Note: It should be noted that as of January 1, 1993, a new monetary unit —the new peso— was introduced. One new peso is equivalent to one thousand "old" pesos (N$1/$1,000).

PECE is the Pact for Stability, Competitiveness and Employment agreed upon by the Federal Government, workers' unions and farmers' organizations, and the business sector.

Last observation, December 31, 1993.

agreed that the crawling peg of the band's ceiling would remain at 40 cents per day, an implied annual rate of depreciation of 4.4% (see chart 3).

As observed in other recent heterodox stabilization programs, the first phase of these programs typically relies on a fixed exchange rate as a way to break inflationary inertia and thus produce rapid disinflation. Once it becomes clear that fiscal and monetary fundamentals are in place, and that major disinflation is being achieved, countries have tended to increase flexibility in nominal exchange rates. Mexico, like Chile and Israel, adopted an exchange rate band a few years after the implementation of its exchange rate-based disinflation program. In doing so, these countries have attained greater autonomy of domestic monetary policy without giving up the role of the exchange rate as a nominal anchor, since the bands portray the authorities' commitment to intervene to support it.

The gradual widening of the band, since November 1991, and its asymmetric feature has allowed to attain a proper balance between two objectives: to stabilize inflationary expectations, and to achieve greater flexibility in managing balance of payments fluctuations. Despite the commitment imposed by the exchange rate band, the Central

Bank intervened within the band, and thus had an effect on economic agents' expectations as well as monetary implications. The use of the exchange rate as a nominal anchor implies that the government is committed to adjusting all its policies so as to guarantee the stability of the exchange rate, so that domestic inflation converges with international inflation.

When a country experiences substantial capital inflows, monetary authorities are often faced with a well-defined problem: How should a central bank determine the optimal degree of sterilization? Moreover, if capital inflows are sudden and large, it may be difficult for monetary authorities to control inflation. It is well known that when a country such as Mexico is under a fixed or a sliding-peg exchange rate regime and perfect capital mobility exists, the money supply is endogenous and the central bank has no means of affecting the size of the monetary base except for its composition between central bank credit and international reserves. Under these circumstances, determining the amount of capital inflows that should be sterilized is of paramount concern.

If the monetary authority does not sterilize capital inflows, the excess supply of money would imply a reduction in domestic interest rates, an increase in expenditures, higher prices, real exchange rate appreciation and current account deficits. However, maintaining a policy of complete sterilization is not recommendable, nor perhaps possible. In the first place, the cost of accumulating these reserves may become enormous because the rate of return on international reserves tends to be smaller than the return on the government securities that the central bank has to sell. Second, the imported capital could not then be used to expand the country's productive base, since it would be re-exported by the central bank. And third, the policy is not neutral. It benefits those firms that have access to external credit, to the detriment of firms that depend on domestic credit.

After considering the consequences of these two extreme policies, Banco de México has taken an intermediate path: partial sterilization. This policy has allowed the Central Bank to advance in the fight against inflation, while also permitting the use of foreign capital to expand Mexico's productive base.

Taking advantage of interest rate deregulation and of the financial system's development, Banco de México now fully implements monetary policy through open market operations, which is a particularly effective instrument because of its wide scope, immediate impact

and flexibility. The Central Bank determines its daily intervention in the money market so that it does not modify the monetary base, in principle, except to satisfy changes in the expected demand for monetary base, which in turn depends on the targeted rate of inflation, on the anticipated evolution of real GDP, and on the seasonal fluctuations of the demand for cash balances.

In following the referred policy rule, Banco de México precludes the creation of excess liquidity in the money market, a necessary condition to avoid unwanted pressures on the exchange rate. In this way, monetary policy reinforces exchange rate policy in the pursuit of price stability.

The establishment and gradual widening of the band has a number of advantages. Economic agents perceive a considerable degree of certainty, especially in the long-run, while, at the same time, the monetary authorities enjoy greater flexibility than they would with a fixed exchange rate, an appropriate mix for an economy that continues to suffer from inertial inflation but is increasingly open, especially in the financial sector. The wider band has allowed some of the massive capital inflows that Mexico has experienced in recent years to be accommodated through movements in the exchange rate and not necessarily through variations in international reserves. This has allowed the Central Bank to conduct a relatively stable monetary policy, which reinforces the efforts to fight inflation.

The increasing width of the band has also proven helpful in absorbing the uncertainty in domestic financial markets that characterized the ratification of NAFTA by the U.S. Congress in November 1993 (see chart 3).

As mentioned before, sterilization of capital inflows might turn out to be an expensive alternative to achieve monetary control. As a result, central banks have considered different mechanisms to attain monetary control in the short-term. An example of this is the Mexican exchange rate band. After following a preannounced rate of devaluation since the implementation of the stabilization program in late 1987, in November 1991, the exchange rate was placed in the context of a band. The width of the band increases on a daily basis, thus allowing larger exchange rate fluctuations so as to make short-term and temporary investments quite risky. That is, the potential daily depreciation of the peso within the band could easily exceed the return on a very short-term investment. Thus, the exchange rate band has been very helpful in keeping "hot money" out of Mexico.

3. Theoretical Considerations

Krugman's (1991) influential paper on exchange rate target zones demonstrated that the existence of limits on exchange rate movements has important effects on the dynamics of exchange rates. That is, assuming that the authorities defend the exchange rate by infinitesimal interventions at the specified limits, Krugman showed that the relation between the exchange rate and fundamentals presents an "S" shape, with tangency at the band's limits.

Several implications follow from Krugman's model of credible exchange rate bands:

1) In exchange rate target zones, the distribution of the exchange rate is bimodal and "U" shaped, with the lowest density at the central parity and an increasing density towards the boundaries. That is, the exchange rate spends most of the time near the edges of the band.

2) For exchange rate regimes with credible bands, the expected rate of depreciation is highest when the exchange rate reaches the lower bound of the band and it declines monotonically as the exchange rate gets closer to the band's upper limit.

3) Given that interest rate differentials (domestic minus foreign) provide an estimate of devaluation expectations (uncovered interest parity), interest rate differentials should be highest when the exchange rate is at the band's lower limit and decline as the exchange rate approaches the weak edge of the band.

4) The target zone model of exchange rates suggests that the average rate of change of the exchange rate should be smaller when the exchange rate is close to the bounds of the band than when it is close to its central parity. This happens because when the exchange rate is close to the edges of the band, it becomes insensitive to changes in the fundamentals. Thus, the exchange rate should be more volatile in the middle of the band than when it is close to its edges.

Krugman's target zone model relies heavily on two crucial assumptions: *a)* the exchange rate band is perfectly credible by economic agents and; *b)* the target zone is defended only with infinitesimal interventions by the central bank at the edges of the band. However, these two assumptions have been overwhelmingly rejected by empirical evidence of imperfect credibility of target zones and the existence of frequent intra-marginal central bank interventions.

Given the frequent realignments that have actually occurred across exchange rate bands in different countries, the perfect credibility assumption seems not to hold at all times. Moreover, the large interest rate differentials that have been observed before some of the realignments suggest that many realignments have in fact been anticipated by economic agents.[1]

The other crucial assumption of Krugman's model, that central banks engage only in marginal interventions, has also been rejected by the data. In fact, intra-marginal interventions seem to be the rule rather than the exception.[2]

Hence, the referred predictions of Krugman's model have been in clear conflict with the data.[3] As a result of this, the basic target zone model has been extended by removing the perfect credibility and the only marginal intervention assumptions, thus allowing realignment expectations and frequent intra-marginal interventions by the central bank. The results of these models are more in line with empirical observations and have contributed to our understanding of how exchange rate target zones work.

The next section analyzes the behavior of the exchange rate in the Mexican economy and confronts the predictions of Krugman's basic model. Special emphasis is given to the two crucial assumptions of the basic target zone model: perfect credibility in the band and only marginal interventions by monetary authorities. The Mexican case presents an interesting study because, in addition to the well-known and publicly announced parameters of the Pacto band, the Central Bank also intervened in the foreign exchange market in accordance with the parameters set by an "intervention" band. The parameters of the "intervention" band have been established by the Central Bank on a daily basis. Even though there has never been a commitment of Banco de México to defend its own intra-marginal band, market participants, through the observed behavior of the Central Bank's intervention policy, inferred the sustainability of the inner band and, thus, the Central Bank intentions to defend it.

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[1] See for example Svensson (1991a) and Flood, Rose and Mathieson (1991).

[2] See for example Giavazzi and Giovannini (1989) and Dominguez and Kenen (1991).

[3] The empirical implications of Krugman's basic model have been tested extensively on data from the European Monetary System, other industrialized economies and more recently on some developing economies.

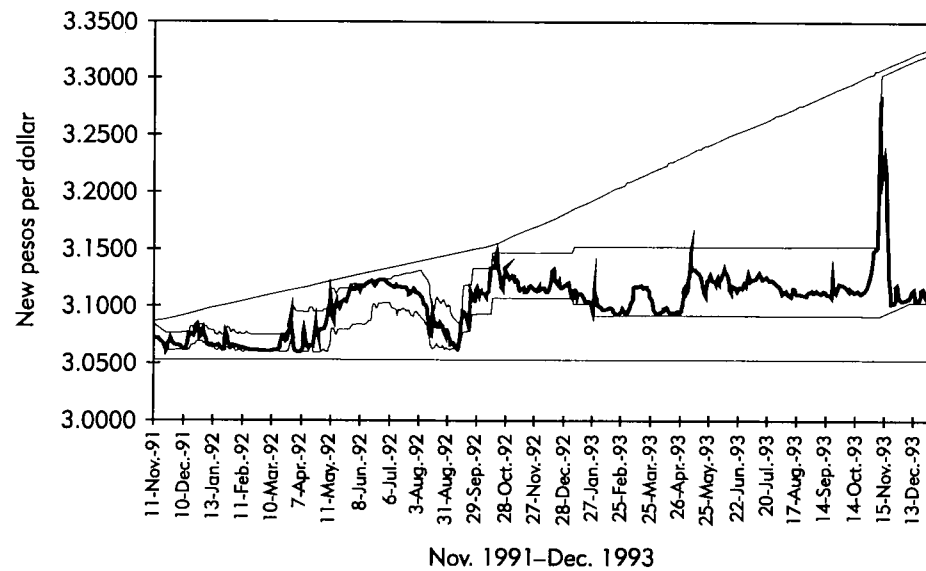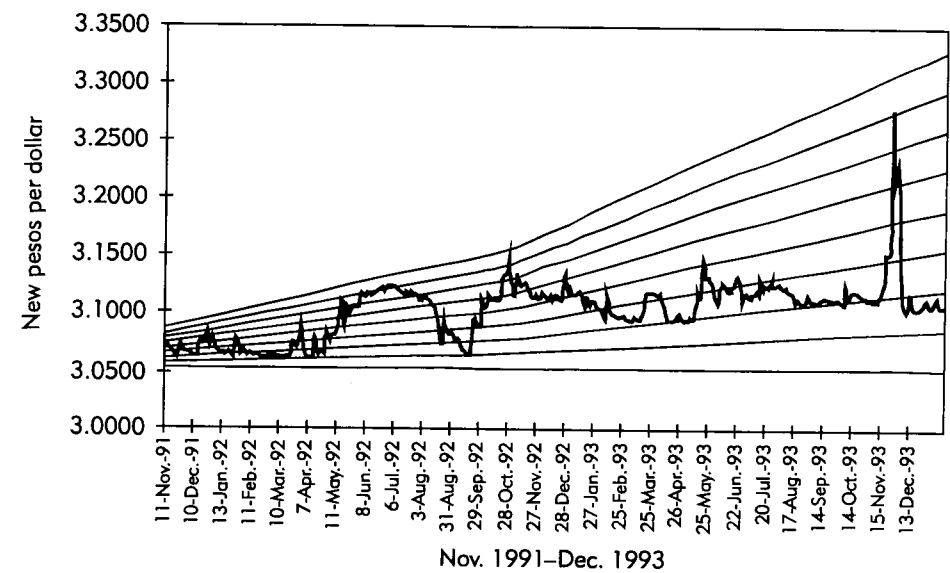## 4. Empirical Test of the Basic Model of Exchange Rate Target Zones

The period analyzed goes from November 11, 1991 (when the exchange rate was placed in the context of a band) to the end of December 1993. Chart 4 shows the behavior of the exchange rate both within the Pacto band and the Central Bank's "intervention" band. As is shown, the Pacto band presents an asymmetric shape, with the ceiling of the band increasing at a constant preannounced rate, while the lower edge of the band has remained unaltered.

From November 11, 1991 to October 13, 1992, the "intervention" band followed the behavior of the market exchange rate. That is, the inner band moved upward when the peso depreciated, and downwards when the peso appreciated. The behavior of the "intervention" band reflects the Central Bank's concern with regard to exchange rate volatility. That is, monetary authorities allowed market forces to determine exchange rate levels, but set the "intervention" band (on a daily basis) so that it would limit the potential daily volatility of the peso. During the first quarter of 1992, the exchange rate spent an important period of time on the lower edge of the "intervention" band. Having reached the upper edge of the band in June, the peso appreciated in July and August and consequently, the inner band was shifted downwards. For the period that goes from mid September to mid October 1992, the peso depreciated, and the inner band was shifted upwards. As a reflection of the observed appreciation of the peso that took place since mid October, the strong edge of the "intervention" band was slightly lowered on January 7, and on January 27, 1993 (see chart 4).

From October 14, 1992 to November 9, 1993, the "intervention" band took a horizontal configuration. The intervention levels of Banco de México continued to be announced on a daily basis, but they were not modified for an extended period of time (10 months).

As opposed to the previous intervention policy in the foreign exchange market by the Central Bank, the resolution to maintain a stable horizontal "intervention" band caused Banco de México to intervene more actively in the foreign exchange market, and this was translated into an important accumulation of international reserves and a consequent decline in interest rates during the first four months of 1993.

On November 9, 1993, the upper edge of the inner band was increased as a result of the amounting pressure on the exchange rate because of the uncertainty regarding the NAFTA vote in the U.S. Con-

Chart 4. Exchange Rate and Exchange Rate Bands

Nov. 1991–Dec. 1993

gress. In consequence, the interbank exchange rate suffered a substantial depreciation and almost immediately returned to the lower end of the "intervention" band.

In chart 5 the Pacto band is divided into eight equal segments. Given that the Pacto band widens on a daily basis, the segments of the band increase accordingly. Thus their width, along the period under analysis, is not constant. The "intervention" band is also segmented into eight equal pieces (see chart 6). Chart 7 shows the distribution of the exchange rate in the different segments of the Pacto band, and in charts 8 and 9 the same exercise is done for the "intervention" band. The analysis of the Pacto band goes from November 11, 1991 to the end of December 1993, while the analysis of the "intervention" band is divided into two periods of time, reflecting the shift in the intervention policy of the Central Bank in the foreign exchange market from a "moving" (November 11, 1991 to October 13, 1992) to a horizontal (October 14, 1992 to November 8, 1993) band.

As can be seen in chart 7, in contrast to Krugman's predictions, the exchange rate spent too much time in the middle segments of the Pacto band and too little time in the lowest and upper segments. In fact, the exchange rate spent more time in segments number 2 and 3 (100 and 192 observations respectively). Interval 1 contains only 2

Chart 5. Exchange Rate Distribution within the Pacto Band

Nov. 1991–Dec. 1993

observations, while the highest segment of the band, interval 8, has 14 observations.

When the same exercise is done with Banco de México's "intervention" band (as was mentioned before, there was no commitment by the Central Bank to defend the band beyond the date that was set), some interesting results are obtained.

For the first period of time under analysis, when the "intervention" band followed the behavior of the exchange rate, the interbank exchange rate is scattered through all the segments of the band, with an important concentration of observations in the two extreme intervals (see chart 8). However, for the second period of time, when the "intervention" band is horizontal, observations are concentrated in the middle to low segments of the band (82% of the observations are concentrated in the first four intervals, see chart 9). Thus, it can be inferred that the extended period of time for which the horizontal inner band remained unaltered built up expectations regarding its sustainability. The concentration of observations in the lower parts of the band, and the observed decline in interest rates during the first four months of 1993, could suggest that the lower limit of the "intervention" band was not credible, and that speculators may have been expecting an appreciation of the Mexican peso towards the strong edge of the Pacto band.

Chart 6. Exchange Rate Distribution within the Intervention Band

Nov. 1991–Dec. 1993
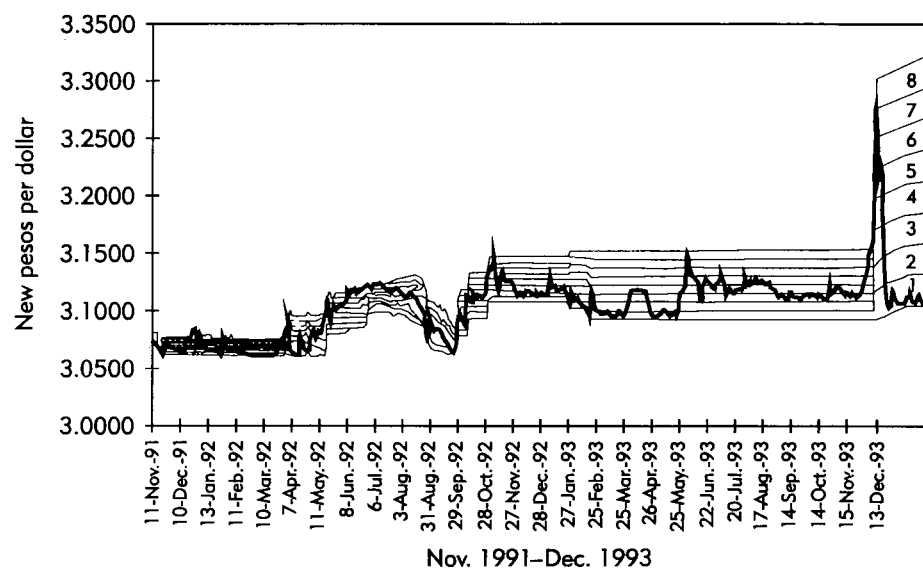
When the bands are divided into four segments (see charts 10, 11 and 12) the first two segments of the Pacto band include 372 observations (70% of the total). That is, there still remains an important concentration of observations in the middle to low segments of the band. For the "intervention" band, there is again a concentration of observations in the low segments of the band for the second period of time under analysis, while for the period when the band is adjusted to the behavior of the market exchange rate, observations are scattered through all the portions of the band.

An explanation for the observed behavior of the exchange rate within the different segments of the Pacto band becomes evident by looking at the position of the "intervention" band inside the Pacto band. Chart 13 displays both the Pacto band and the "intervention" band divided into eight equal segments. As shown, for some periods of time the "intervention" band of Banco de México has prevented the exchange rate from falling, and thus reaching the lowest segment of the Pacto band (there are only 2 observations in segment 1). The same is true for the upper intervals of the Pacto band. That is, the existence of the "intervention" band imposed constraints on the behavior of the market exchange rate within the Pacto band. This simple exercise shows how intra-marginal intervention by monetary authorities pre-

Chart 7. Frequency of Observations by Segment within the Pacto Band

Segments
Nov. 1991-Dec. 1993
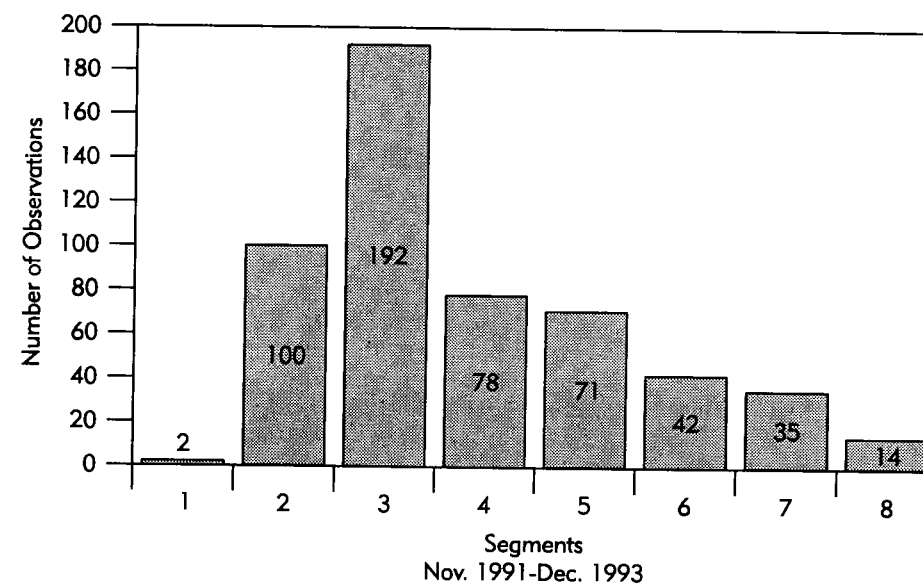
vent Krugman's target zone model empirical implications from holding and thus explains the hump-shaped distributions of exchange rates within the bands, with most of the observations in the middle

Table 1. Pacto Band
Nov. 1991-Dec. 1993

Segments	Number of Observations	Average Variation	Standard Deviation	Number of Observations	Average Variation	Standard Deviation
1	2	(0.3244)	0.1871	102	(0.0357)	0.9063
2	100	(0.0313)	1.2032	270	(0.0239)	1.3486
3	192	(0.0087)	1.4886	113	(0.0184)	0.9573
4	78	(0.0272)	1.0968	49	0.0580	0.6536
5	71	0.0224	1.0556	—	—	—
6	42	0.0420	0.8393	—	—	—
7	35	0.0087	0.7720	—	—	—
8	14	0.1922	0.5009	—	—	—

Chart 8. Frequency of Observations by Segment within the Intervention Band

Segments
Nov. 11, 1991-Oct. 13, 1992
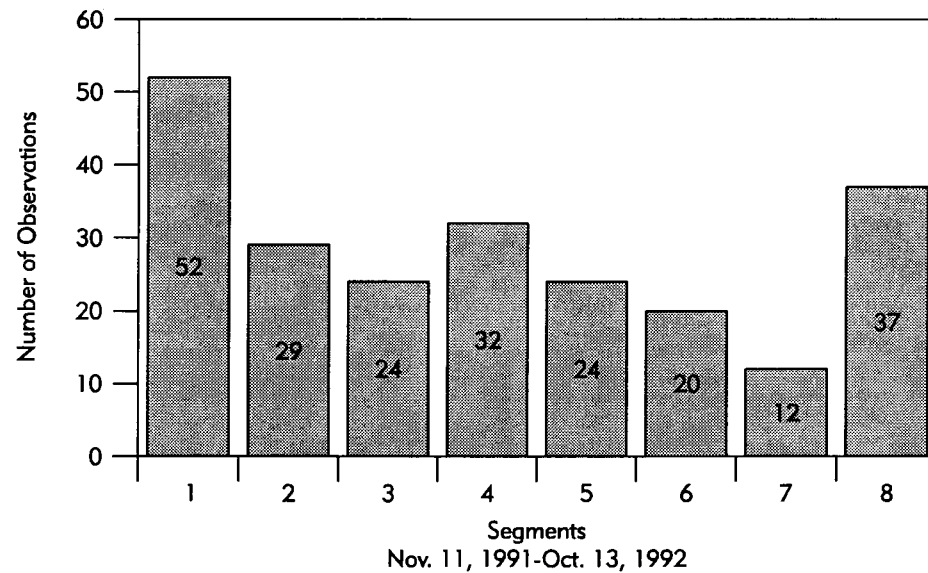
of the exchange rate band, in contrast to the U-shaped distribution predicted by the model, where most of the observations would occur near the edges of the band. That is, the exchange rate is being held in the middle of the band by intra-marginal interventions of the Central Bank.

By looking at the frequency distributions of the exchange rate for the two intervention policy regimes that Banco de México has followed, it is clear that once the intervention policy of the Central Bank is anticipated, economic agents will judge its sustainability and act consequently.

Table 1 displays both the average variation and the standard deviation of the exchange rate in the different segments of the Pacto band.[4] When the Pacto band is divided into eight segments, the standard deviation tends to be higher in intervals 2 and 3, while it is highest in interval 2 when the band is divided into four equal segments. The average variation of the exchange rate is relatively high in the lower segment of the Pacto band (0.3244) and relatively low in segments 3

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[4] The average variation of the exchange rate is defined as the current exchange rate minus next period's exchange rate, as a proportion of the current exchange rate.

Chart 9. Frequency of Observations by Segment within the Intervention Band

Segments
Oct. 14, 1992-Nov. 8, 1993
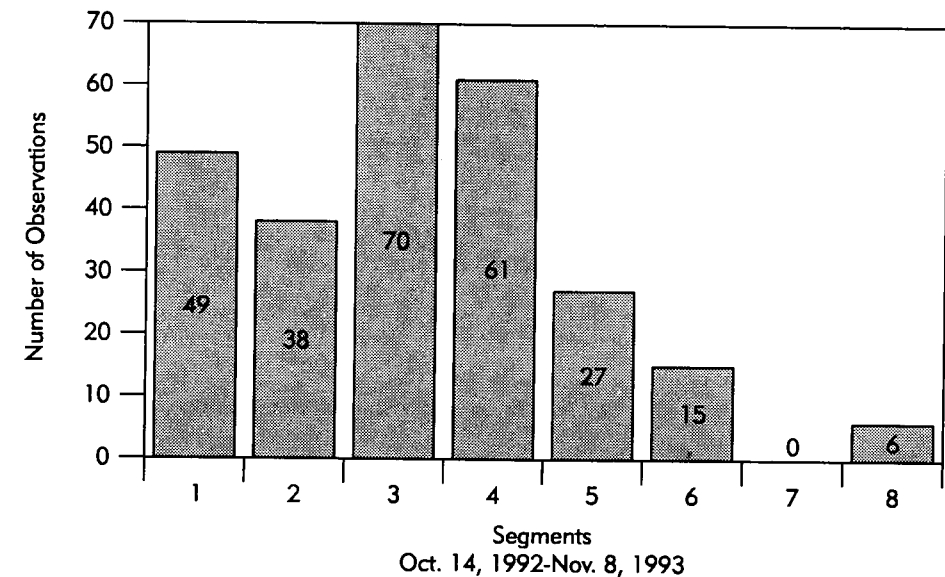
and 7 (0.0087), when the band is divided into eight segments. Thus, it is difficult to infer that the exchange rate is more volatile in the middle of the band than close to its edges. Nevertheless, the sign of the average variation of the exchange rate is consistent with the theory. In the upper slices of the Pacto band, the average variation of the exchange rate is positive, while it is negative in the lower segments of the band (this is also true when the band is divided into four segments). That is, on average the exchange rate appreciated when it was located in the weak segments of the Pacto band, and tended to depreciate when it was situated in the strong parts of the band. Tables 2 and 3 show the standard deviation and the average variation for the different segments of the "intervention" band for the two periods of time under analysis. Again, one cannot infer that the exchange rate is more volatile in the middle of the band than close to its edges.

As mentioned before, expectations of future exchange rate movements affect interest rates. Consequently, one can extract information about the public's expectations of future exchange rates from data on short-term interest rates. Given that under uncovered interest rate parity, interest rate differentials provide an estimate of devaluation expectations, a careful analysis of these differentials in the context of

Chart 10. Frequency of Observations by Segment within the Pacto Band
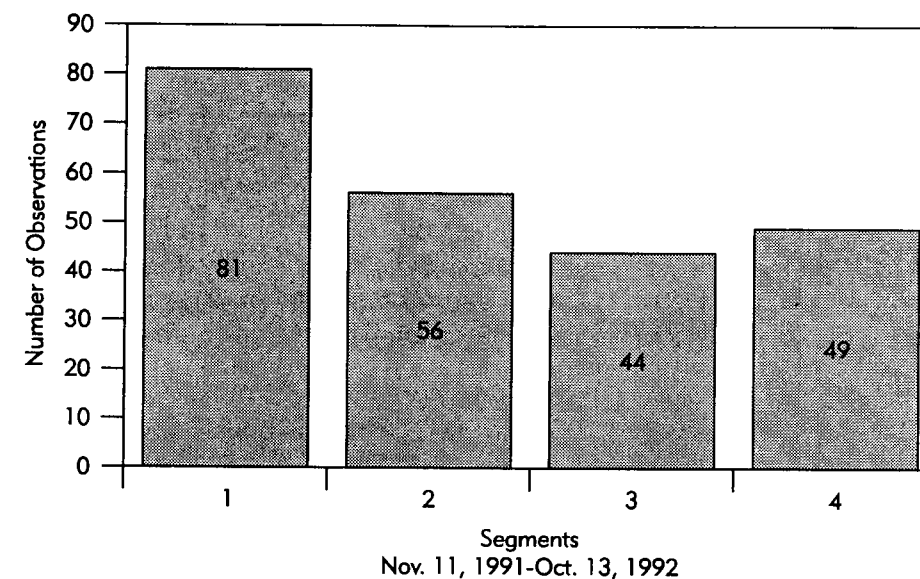

Segments
Nov. 1991-Dec. 1993
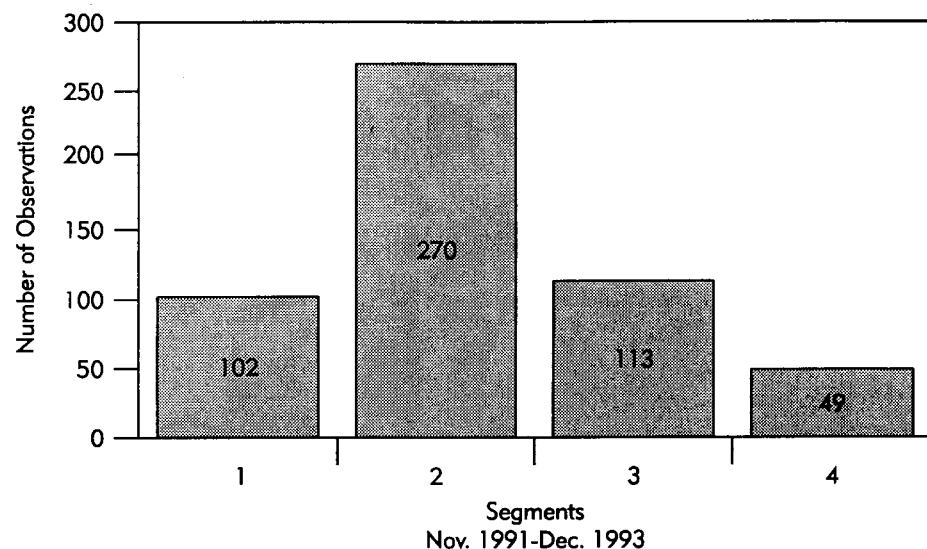
an exchange rate band should help us infer credibility in the exchange rate regime. If an exchange rate band is credible, interest rate differentials should be high when the exchange rate is located in the lower

Table 2. Intervention Band
Nov. 11, 1991-Oct. 13, 1992

Segments	Number of Observations	Average Variation	Standard Deviation	Number of Observations	Average Variation	Standard Deviation
1	52	(0.0295)	1.2814	81	(0.0225)	1.1674
2	29	(0.0102)	1.0183	56	0.0005	1.0096
3	24	0.0026	0.9410	44	(0.0110)	0.9111
4	32	(0.0011)	1.0711	49	0.0073	0.9586
5	24	(0.0167)	0.9471	—	—	—
6	20	(0.0041)	0.8728	—	—	—
7	12	(0.0052)	0.6920	—	—	—
8	37	0.0114	1.1412	—	—	—

Chart 11. Frequency of Observations by Segment within the Intervention Band
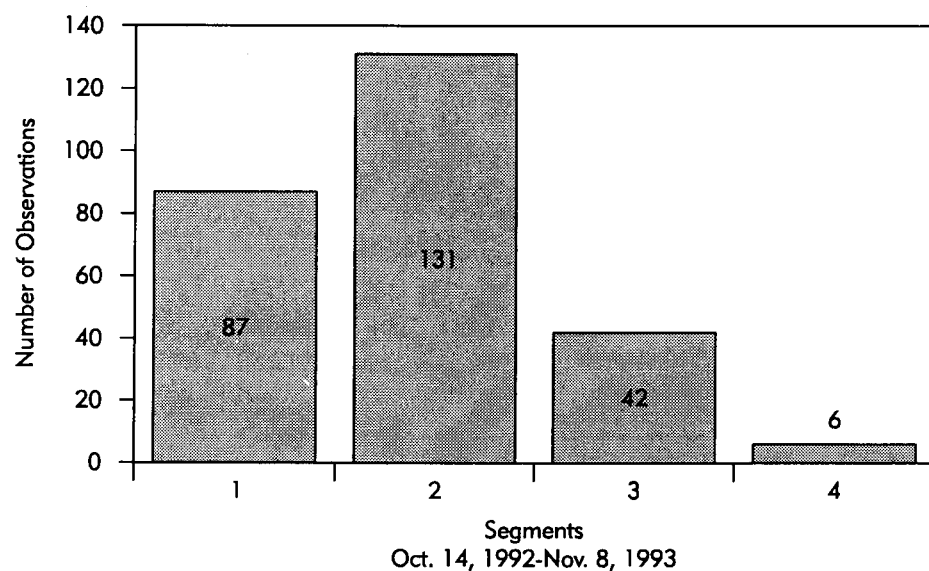

Segments
Nov. 11, 1991-Oct. 13, 1992

end of the band, and low when the exchange rate is close to the upper bound of the band.

Chart 14 plots the location of the exchange rate within the band

Table 3. Intervention Band
Oct. 14, 1992-Nov. 8, 1993

Segments	Number of Observations	Average Variation	Standard Deviation	Number of Observations	Average Variation	Standard Deviation
1	49	(0.0326)	1.2008	87	(0.0193)	1.1479
2	38	(0.0021)	1.0888	131	(0.0060)	1.3424
3	70	(0.0175)	1.3708	42	0.0202	0.8435
4	61	0.0071	1.3114	6	(0.5127)	0.3326
5	27	0.0486	0.9439	—	—	—
6	15	(0.0309)	0.7226	—	—	—
7	0	0.0000	0.0000	—	—	—
8	6	(0.5127)	0.4677	—	—	—

Chart 12. Frequency of Observations by Segment within the Intervention Band

Segments
Oct. 14, 1992-Nov. 8, 1993

Chart 13. Exchange Rate Distribution within the Bands

Nov. 1991–Dec. 1993

expressed as its distance from the lower end of the band as a share of the total width of the band and interest rate differentials for three months. Thus, if the band was credible, the higher the location of the exchange rate inside the band, the lower the interest rate differential. As shown in chart 14, the negative relationship suggested by the theory has only appeared occasionally.

Another way of inferring credibility in the band is displayed in chart 15. This chart presents the difference between domestic and foreign interest rates for a 90 day investment period and the maximum possible exchange rate depreciation within the band during the next 90 days. According to this methodology, a lack of credibility in the band prevailed during the end of 1991 and most of 1992. For the period that goes from January 7, 1993 to December 1993, with the exception of November 8, 1993 (a period that reflects the uncertainty with regard to the ratification of NAFTA by the U.S. Congress), interest rate differentials were smaller than the maximum possible exchange rate depreciation, thus reflecting an increased improvement in the credibility of the band. However, not all interest rate differentials reflect exclusively devaluation expectations, and thus, credibility matters. There are other types of risks that can be reflected in interest rate differentials

(country and political risks); in addition, the existence of a "peso problem" can also have some effect on those differentials. Moreover, one should also take into consideration that the Central Bank implemented a restrictive monetary policy during the end of 1991 and most of 1992, thus causing interest rates to increase.

The fact that a restrictive monetary policy was also responsible for the large interest rate differentials that were observed during some periods, calls for an alternative interpretation of interest rate movements in the setting of exchange rate target zones for developing economies. As opposed to some industrialized economies where monetary policy has followed a predetermined and anticipated rule, and where interest rates are more likely to reflect devaluation expectations, monetary policy in Mexico has played an important role in the stabilization program, and in the abatement of inflation. Hence, for the Mexican case, as well as for other developing countries that have used monetary policy as a means to stabilize their economies, interest rate differentials could reflect a very restrictive monetary policy, as well as credibility issues.

An alternative way of inferring credibility in the band is to use Svensson's simple test (1991a). This exercise consists of testing whether forward exchange rates fall inside the exchange rate band. If

Chart 14. Three Month Interest Rate Differential and Exchange Rate Position within the Pacto Band

△ Exchange Rate Position ■ Interest Rate Differential
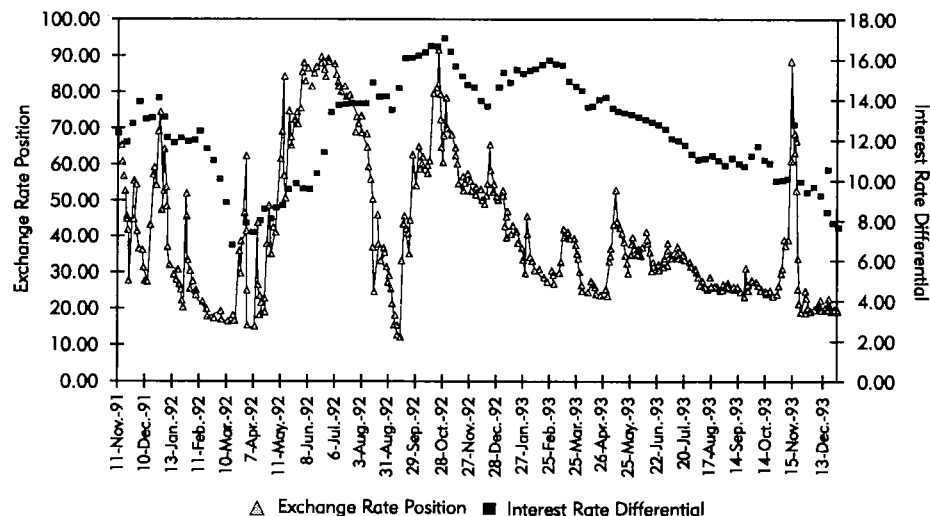
forward exchange rates fall outside the exchange rate band for some maturity, under the maintained assumption of international capital

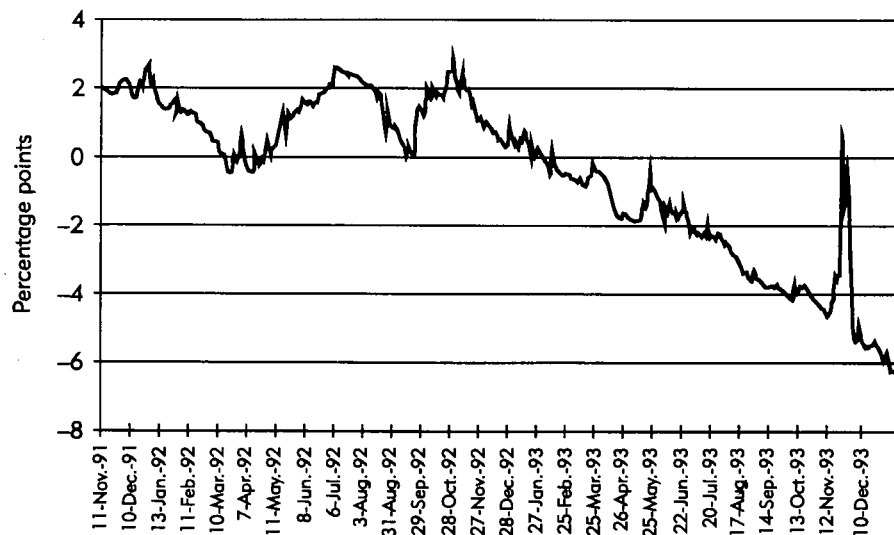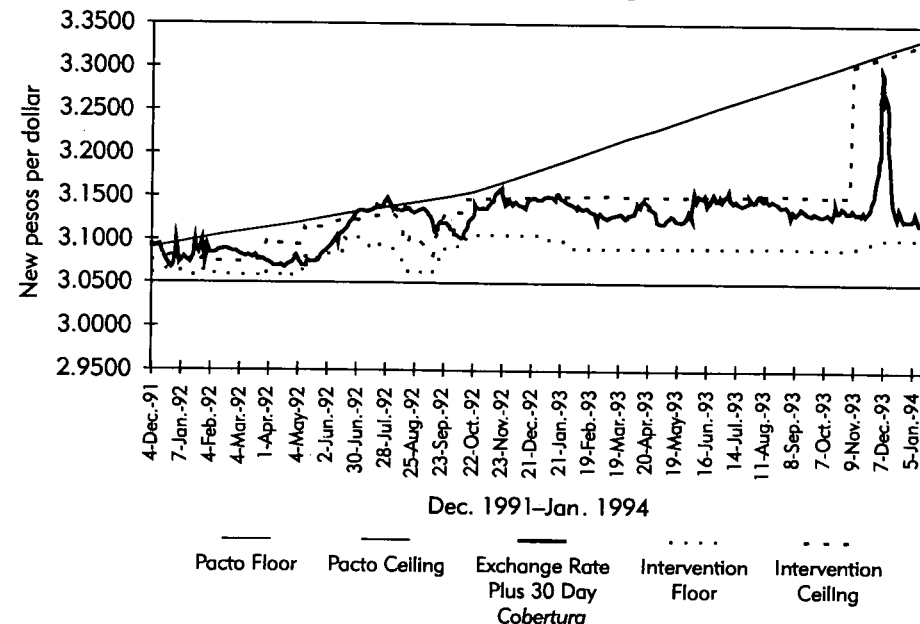**Chart 15.** Three Month Interest Rate Differential Minus Maximun Devaluation

Chart 16. Thirty Day *Cobertura* and Exchange Rate Bands

Dec. 1991–Jan. 1994

Pacto Floor Pacto Ceiling Exchange Rate Plus 30 Day Cobertura Intervention Floor Intervention Ceiling

mobility the exchange rate target zone cannot be perfectly credible; if it were perfectly credible, unexploited profit opportunities would exist on the forward foreign exchange market.

In order to approximate the forward exchange rate for the Mexican peso the following relationship was used:

$$s_t + c_{tp}(1 + i_{tp}),$$

where s_t is the current exchange rate, c_{tp} is the current price of a *cobertura* (foreign exchange hedging price) for p days and i_{tp} is the current Cetes rate of return with a maturity of p days.[5] The exercise was done for *coberturas* hedging 30 days into the future. Chart 16 displays future exchange rates constructed according to the above methodology and their behavior inside the bands. As can be seen from the chart, the Pacto band is credible for most of the period under analysis, excepting very few periods in 1992.

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[5] The price of the *cobertura* is adjusted by the interest rate in order to consider the opportunity cost of buying the hedging instrument.

5. Event Studies

As was mentioned before, in December 1987, the Mexican government undertook a broad-based stabilization program. The stabilization program included, among other measures, an incomes policy (wage, price and exchange rate freezing) for a period of time specified by the government. During its more than seven years of existence, the stabilization program has been renewed several times, and each renewal has been preceded by the announcement of the government of the continuation, or slight modification, of the stabilization program for another specified period of time.

Several studies that have analyzed the sustainability of exchange rate bands stress the fact that economic agents are uncertain as to when realignments will occur and how large they will be. As a result, market participants tend to form expectations of realignments given the available information, generally putting preassure on the market during the period that precedes the realignment. For example, realignments in the European Monetary System have been preceded by a sizable increase in domestic interest rates. That is, one should expect interest rates to increase prior to realignments and to decrease after realignments.

In the case of Mexico, not only can the sustainability of the band be threatened, but there is also an additional element that adds uncertainty to the prevalence of the current band or of the current exchange rate regime: specifically, the fact that the government has to announce, at some point (before the expiration of the previous Pacto), the continuation or alteration of the exchange rate regime. That is, market participants anticipate announcements with regard to the exchange rate regime, meaning one should observe an increase in interest rates in the period that precedes the renewal of the Pacto, and a decline in interest rates after the announcement. In order to capture this effect, the implementation of "event" studies should prove helpful.

Event studies have extensively been used to analyze the impact of firm-specific events such as announcements of stock splits, earnings reports and acquisition activity on the prices of the affected firms' securities.[6] A major concern in these event studies has been to assess the extent to which security price performance around the time of the

event has been "abnormal". A security's price performance can only be considered abnormal relative to a particular benchmark; thus, these event studies have specified different models that generate "normal" returns such as the Mean Adjusted Returns Model, the Market Adjusted Returns Model or some versions of the Capital Asset Pricing Model. For each of these "normal" returns generating models, the ex post abnormal return of a given security has been defined as the difference between its return and the expected return suggested by the model. In the implementation of event studies the focus has been placed on the returns of a given security around the time of the event, and on the analysis of whether or not the return on the security in the event period is abnormal.

Event studies have also been used in an effort to capture the effects of Mexico's moratorium on foreign debt payments of August 1982, and of the consequent deteriorating quality of bank assets composed of loans to other highly indebted Latin American countries such as Brazil and Argentina, on the pricing of bank stocks.[7]

Given my presumption that economic agents anticipate renewals of the stabilization program (and hence information with regard to the exchange rate regime) and that interest rates reflect these concerns, an event study which analyzes movements of interest rates around the time of the event (the announcement of the renewal of the stabilization plan) should help us infer the credibility of the exchange rate regime.

Since its implementation in December of 1987, the stabilization program has been renewed 13 times, and each renewal has been preceded by the announcement of the government of the continuation of the stabilization attempt for another specified period of time. Table 4 presents two columns. The first column displays both the announcement date of the initial stabilization program and of each of its renewals, while the second column shows the termination date of each phase of the stabilization attempt. As can be seen from the table, the stabilization program was implemented on December 15, 1987, and its expiration date was February 29, 1988. That is, for this period of time, a complete freezing of wages, prices and of the exchange rate took place. An interesting feature of the table is that the first three renewals were announced very few days before the expiration date of

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[6] See for example Brown and Warner (1980), and Schipper and Thompson (1983).

[7] See for example Bruner and Simms (1987), and Cornell and Shapiro (1986).

Table 4. Phases of the Mexican Stabilization Program

Announcement Date	Expiration Date
December 15, 1987	February 29, 1988
February 28, 1988	March 31, 1988
March 27, 1988	May 31, 1988
May 28, 1988	August 31, 1988
August 14, 1988	November 30, 1988
October 16, 1988	December 31, 1988
December 12, 1988	July 31, 1989
June 18, 1989	March 31, 1990
December 3, 1989	July 31, 1990
May 27, 1990	January 31, 1991
November 11, 1990	December 31, 1991
November 10, 1991	January 31, 1993
October 20, 1992	December 31, 1993
October 3, 1993	December 31, 1994

the previous announcement (the first renewal of the stabilization attempt was implemented only one day before the expiration date of the initial program), while the subsequent renewals were announced several days before the expiration date of the previous program. The obvious rationalization for the government to announce the continuation of the program for another period of time several days before the expiration of the previous announcement, was to eliminate the increasing uncertainty that prevailed in the economy regarding the future course of the stabilization attempt and, in particular, of the exchange rate.

The fact that the Mexican stabilization program has followed an incomes policy for a specified period of time gives us a unique opportunity to verify the hypothesis that prior to each renewal of the stabilization program there has been an important increase in domestic interest rates reflecting the prevailing strain in financial markets. If this were the case, we should observe a statistically significant reduction in interest rates immediately after the announcement of each

renewal of the program. This of course occurs because immediately after the announcement individuals will not anticipate a devaluation of the currency, if the economic package is consistent.

In order to test for abnormal performance in interest rate movements when an announcement occurs, the following t-statistic was constructed:

$$t = (i_t^a - i_{t-1}^a)/\sigma_{(i_t - i_{t-1})}.$$

where i_t^a is the 28 day Cetes rate of return of the primary auction that takes place immediately after the event (the announcement of the continuation of the stabilization attempt), i_{t-1}^a is the rate of return which precedes the event period, and $\sigma_{(i_t - i_{t-1})}$ is the standard deviation of the interest rate differentials.[8] For the estimation procedure, two different standard deviations of the interest rate differentials were used. In the first specification, the standard deviation of the interest rate differentials for the period (−40, −10) was computed. That is, the standard deviation was computed for 30 observations which go from 40 periods (weeks) before each event period (period 0) to 10 periods before the event. In the second specification of the standard deviation, the interest rate differentials were computed for the period going from the first observation of January 1986 to 10 periods before the implementation of the stabilization program (December 15, 1987), that is, it includes 92 observations.[9] The results of the two tests are presented in table 5. The first column of the table shows the announcement dates of the initial stabilization program (December 15, 1987) and of each of its subsequent renewals.

As can be seen from the table, the results of the two specifications of the standard deviation of the interest rate differentials are very similar. The results are self explanatory.

As one would expect, the implementation of a stabilization program in an economy that has been experiencing high inflation rates, and where other economic programs had failed in the past, would be taken with caution and perhaps disbelief by the economic agents, cre-

[8] Similar t-statistics are used by Jaffe (1974) and Mandelker (1974).
[9] The reason for excluding the 10 observations previous to the event is that if high levels of abnormal performance are present, then including observations from around the time of the event gives more weight to apparent outliers, tending to increase the variance of the rates of return differentials and thus, lowering the power of the test. For more on this subject see for example Brown and Warner (1980).

Table 5. $t = (i_t^a - i_{t-1}^a)/\sigma_{(i_t - i_{t-1})}$

Announcement Date	t-statistic (– 40, –10)	t-statistic (January 1986, –10)
December 15, 1987	6.732	3.503
February 28, 1988	–14.283	–24.245
March 27, 1988	–2.342	–9.823
May 28, 1988	–0.377	–2.438
August 14, 1988	0.052	0.355
October 16, 1988	0.234	1.590
December 12, 1988	0.019	0.123
June 18, 1989	0.730	0.502
December 3, 1989	0.277	0.486
May 27, 1990	–1.365	–2.462
November 11, 1990	–2.128	–2.276
November 10, 1991	–1.603	–0.779
October 20, 1992	–0.271	–0.154
October 3, 1993	–1.228	–0.301

ating uncertainty regarding the future evolution of the exchange rate. This was the case in the Mexican economy, where after the implementation of the stabilization program interest rates presented a statistically significant upward movement (first row of table 5). As we should expect, the first two renewals of the program were reflected in a significant decline in interest rates. This can be explained by the fact that during the early stages of the stabilization program, people expected the stabilization attempt to fail, thus, the increase in devaluation expectations was reflected in higher interest rates; which only after the announcement of the continuation of the program diminished their levels.

Most of the other Pacto renewals do not present a significant interest rate differential. This may be the result of the fact that people started to believe in the success of the program, and also because the government renewed the program before economic agents started to realize the proximity of the expiration date of the previous an-

nouncement. Thus, by announcing the continuation of the stabilization program with sufficient time before the expiration date of the previous stage of the program, interest rates were thus prevented from increasing, since market participants had not yet increased their devaluation expectations, because the expiration date of the current phase of the program was still far away.

The announcements of the renewals of the stabilization program of May 27, 1990 and of November 11, 1990 caused a statistically significant decline in interest rates, even though the renewals were announced well in advance of their expiration dates. A clear explanation of the observed decline in interest rates on those dates, is that besides the announcement of the continuation of the dominant features of the program, the government also announced a reduction in the previously specified rate of devaluation of the Mexican peso. On May 27, 1990 the government announced the reduction in the rate of devaluation from one peso daily to 80 cents daily, and on November 11, 1990 from 80 cents to 40 cents daily, thus causing devaluation expectations to decrease.

The fact that most of the differences between interest rates are negative and statistically different from zero, suggests that interest rates that followed an announcement were significantly lower than the rates observed before the event. This suggests that there was a significant change in market expectations after the announcement of the renewals of the stabilization program.

Concluding Remarks

The Mexican economy has gone through a true economic revolution during the last decade, going from a strategy of inward-looking policies and ample government intervention, to a more market-oriented economy characterized by trade and financial liberalization, with a greater role for competition, productivity and efficiency. Sound macroeconomic management has been fortified with structural and institutional reforms that have set the pace for long-term sustainable growth. Institutional reforms, such as granting independence to Banco de México, will ensure the transparency of monetary policy-making, helping to avoid short-term political pressures and allowing monetary authorities to credibly precommit themselves to a given course of action.

The results of the Mexican stabilization program have been re-

markable. Nevertheless, Mexico must persevere in its efforts to set the pace to ensure adequate conditions for rapid and sustainable economic growth.

Exchange rate policy in Mexico evolved considerably in recent years, as it sought to strike an appropriate balance between strengthening the external sector and providing an anti-inflationary nominal anchor. In addition to the well-known policy recommendations of tight fiscal and monetary policies to curb inflation in traditional stabilization programs, the disinflation attempt in Mexico relied heavily on the exchange rate as a nominal anchor. The exchange rate mechanism evolved from a publicly announced rate of devaluation of the peso to a fully-fledged exchange rate band. The gradual widening of the band and its asymmetric feature combined a considerable degree of certainty with a greater degree of flexibility.

Empirical evidence presented in the paper indicates that for the case of Mexico, the fact that the government has followed the policy of announcing, at some point in time, the continuation or alteration of the exchange rate regime, has generated short-term uncertainty in domestic financial markets. Nevertheless, this kind of policy has proven to be extremely helpful in providing confidence to economic agents and has reinforced the stabilization effort.

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