

**ESSAYS ON EXCHANGE RATE TARGET ZONES AND
STABILIZATION POLICIES**

by

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ABSTRACT

This dissertation studies two separate issues in the field of international economics: the determination of exchange rates and interest rates under a target zone regime and the political economy of stabilization attempts.

Chapter two develops a target zone model for the exchange rate where the expected realignment is an increasing function of the distance of the exchange rate from the central parity, as a percentage of the width of the band. In this framework, the interest rate differential increases with the deviation of the exchange rate from the central parity when the exchange rate is close to the central parity, and it decreases when the exchange rate is close to the edges of the band. Another interesting implication is that when the band is widened, for some parameter values, the exchange rate will move closer to the edges of the new band. This is due to the fact that the decrease in the expected realignment caused by the increase in the width of the target zone is more than offset by the decline in the probability of future stabilizing interventions at the edges of the band. Finally, I look at the evidence from the EMS and Chile and find partial support for the implications of the model.

In Chapter three I develop a model of exchange rate determination where the only cause of fluctuations in exchange rates is the expectation of a realignment. In this model I look at the optimal target zone as the one that minimizes a linear combination of the asymptotic variance of the deviations of the exchange rate from the central parity and the interest rate differential. The main conclusions from this exercise is that the optimal target zone will be increasing with the instantaneous variance of the expected realignment

and decreasing with the limits within which the expected realignment fluctuates. The reduction in the asymptotic variance of the interest rate differential due to the optimal currency band is in the order of 10% to 50%. I then studied the Mexican and Israeli experience with a target zone. The main results from the empirical study is that the target zone regime helped reduce the interest rate variability by absorbing part of the shocks to the expected realignment with movements of the exchange rate inside the band. I also show that the variability of the expected realignment did not go down during the period that the target zone was in place. So I conclude that the target zone is a useful exchange rate regime to reduce the variance of the interest rate differential but it does not help in reducing the volatility of the expected realignment.

In Chapter four the political economy of stabilization attempts is studied. Most stabilization attempts by weak governments in the 1980's followed a two stage approach. In the first stage some partial and temporary measures were taken to achieve a very drastic fall in the inflation rate. In the second stage, which sometimes never materialized, the fiscal reform is done. We develop a model where under certain conditions the first stage (or the temporary policies) is necessary for the fiscal reform to take place. Allowing for political uncertainty introduces the possibility that after the first stage is in place the government is not able to achieve the fiscal reform. The probability of failure of the program is positively related to the degree of political uncertainty and to the short run cost that the economy suffers during the first stage.

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CHAPTER 1
INTRODUCTION

This dissertation studies two separate issues in the field of international economics: the determination of exchange rates and interest rates under a target zone regime (Chapters 2 and 3) and the political economy of stabilization attempts (Chapter 4).

During the 1980's a majority of European countries adopted currency bands as their exchange rate regime, by the end of the decade countries which had recently stabilized after suffering bouts of high inflations, such as Chile, Israel and Mexico, switched from fixed exchange rates to target zones.

The first part of this thesis deals with a central issue on the behaviour of the exchange rate and interest rates within a target zone. In particular, Chapters 2 and 3 examine how the public's expectation of a central parity realignment affect the behaviour of the exchange rate and interest rates. In Chapter 2 the expectations of a realignment are modeled in a highly intuitive and general way in order to study how this changes the major conclusions of the more traditional models. Chapter 3 looks at the experiences of Israel and Mexico and studies the motives behind the decision of adopting a currency band instead of a fixed exchange rate. I develop a stylized model to determine the optimal width of the band when the major determinant of the exchange rate inside the band is the expected realignment. The following paragraphs give a brief description of these chapters.

Chapter 2 develops a target zone model for the exchange rate where the expected realignment is an increasing function of the distance of the exchange rate from the central parity, as a percentage of the width of the band. In this framework, some new results emerge regarding the behaviour of the interest rate differential. When the exchange rate is close to the central parity, the interest rate differential will be increasing with the deviation of the exchange rate from the central parity; however, when the exchange rate is close to the boundaries of the band the interest rate will be decreasing with the position of the exchange rate inside the band. These changes in the relation between the interest rate differential and the exchange rate inside the band arise because of the interaction of two opposite forces: the increase in the expected realignment and the increase in the expected appreciation inside the band that take place when the exchange rate moves away from the central parity. Another interesting implication is that when the band is widened, for some parameter values the exchange rate will away from the central parity. This effect is due to the fact that the decrease in the expected realignment which is caused by the increase in the width of the target zone is more than offset by the decrease in the probability of future stabilizing interventions at the edges of the band. The last section of the chapter provides evidence in favor of the implications of

the model with data from the European Monetary System and Chile.

Chapter 3 studies the optimal width of the target zone in a model where the position of the exchange rate inside the band is driven by changes in the expected realignment. In this framework I derive the asymptotic variance of the interest rate differential and the deviations of the exchange rate from the central parity. I assume that the monetary authority chooses the width of the band to minimize some linear combination of these two asymptotic variances. The optimal width of the target zone turns out to be highly sensitive to two things, the instantaneous variance of the expected realignment and the range of fluctuation of this expectation. The optimal width for sensible assumptions on the model's parameters, turns out to be between +/- 4% and +/- 10%. This achieves a reduction of the interest rate asymptotic variance in the 10% to 50% range. I look at the experiences of Israel and Mexico to see if they support the claim that the target zone is a useful instrument to reduce the volatility of the nominal interest rate. The results clearly point to a significant reduction in the conditional variance of the interest rate differential due to having a target zone in place instead of a fixed exchange rate. I also, show that for the case of Mexico the target zone in these countries was not helpful in reducing the volatility of the expected

realignment; which indicates that the volatility of short run capital movements did not decrease with the currency band.

This chapter in conjunction with the previous ones comprises the first part of this thesis. The principal theme in this part is how the possibility of realignments in a target zone affect the behaviour of the exchange rate and the interest rates. The second part of the dissertation (Chapter 4) deals with the political economy of stabilization attempts.

Chapter 4 was motivated by the fact that most of the stabilization attempts that were carried out during the 1980's achieved a drastic fall in the inflation rate. This was accomplished with widespread use of nominal anchors, i.e. exchange rate freezes and/or price controls. The most important part needed for a successful program, the fiscal reform, was almost always postponed. This poses two important questions. One, is the first stage, i.e. the use of nominal anchors without a sound fiscal reform, a necessary condition for the accomplishment of the fiscal reform?. Second, if this is so, what are the factors that determine if the fiscal reform is carried out and how long does it take to accomplish it?

In this chapter, I develop a model that tries to explain this kind of behaviour on the part of governments who try to stabilize.

In the model, I assume that given the individuals uncertainty regarding their benefits from lowering the

inflation rate (the total benefits of the program are not uncertain, only its distribution is), it is not politically feasible to carry out a fiscal reform. The government has an alternative policy, which is to fix the exchange rate and finance the deficit through debt issues or with international reserves. This strategy will achieve a temporary stabilization. It is clear that this situation is not sustainable in the long run, but if during this period the individual uncertainty gets resolved, at the end of the period there will be a majority that supports the fiscal reform. In the model I derive certain conditions that make the first stage (or the temporary policies) necessary for the fiscal reform to take place. Allowing for political uncertainty introduces the possibility that after the first stage is in place, the government is not able to carry out the fiscal reform. The probability of failure of the program is positively related to the degree of political uncertainty and to the short run cost that the economy suffers during the first stage.

Two central issues are at the center of this work. First, the understanding of the effects that alternative exchange rate regimes have on the economy is one of the fundamental goals of international finance. The adoption of exchange rate target zones by a large group of countries posed new questions to this long lasting debate. The first two essays of this dissertation contribute to our understanding of this

alternative exchange rate regime. Second, the last chapter analyzes how the political support for a fiscal reform evolves, when a stabilization plan has been announced. This chapter contributes to the literature that analyzes the behaviour of governments in a framework where politics imposes an additional constraint on economic policy.

CHAPTER 2

EXCHANGE RATE REALIGNMENTS AND TARGET ZONE

WIDTH: THEORY AND EVIDENCE

INTRODUCTION:

During the last decade several countries have adopted target zones as their exchange rate regime. This has inspired many theoretical models which describe the behaviour of the exchange rate inside the target zone. Most of the literature on this topic has emphasized the stabilizing effects of target zones on the exchange rate. However, the first models did not work well empirically with data from the European Monetary System (EMS)^{1/}. These target zone models were extended by adding a probability of a realignment, meaning that the current currency band is not perfectly credible. Previous models have included a constant probability of realignment, a stochastic one (Svensson and Bertola (1991)), and yet others have assumed that the probability is zero inside the band and positive at the edges (Bertola and Caballero (1992)).

In this chapter I develop a target zone model where the probability of a realignment is an increasing and continuous function of the distance of the exchange rate from the central parity as a percentage of the width of the band. This assumption is a better representation of people's expectations of a realignment than assuming that realignments only take place when the exchange rate touches the edges of the band, or

^{1/} The correlation between the interest rate differential and the position of the exchange rate inside the band implied by the models was not reflected in the data.

that realignments occur with a constant probability. Several important results emerge from this model. First, the instantaneous interest rate differential behaves differently in this model. Previously it was always increasing (Bertola and Caballero (1992)) or decreasing in the exchange rate (Krugman (1991)), depending on the model; now it is first increasing and at some point it begins to decrease. This is because when the exchange rate is close to the central parity, the expected movements of the exchange rate inside the target zone are not important and the interest differential is driven more by the expectations of a realignment. When the exchange rate gets closer to the edges of the band, the expected change of the exchange rate inside the band is larger and the chapter shows that this effect is stronger than the increase in the expected realignment.

This result has implications for the term structure of interest rates. For short maturities, the interest rate differential will be either first increasing in the exchange rate and eventually it will decrease, or it will always be decreasing. For long maturities the interest rate differential will be independent of the exchange rate's position inside the target zone.

Second, given the assumptions of the model, changes in the width of the band have important effects on the probability of a realignment, whereas in previous models this was not so. By analyzing the effects of changes in the width of the currency

band on the exchange rate, I find that if the probability of a realignment is not an increasing function of the deviation of the exchange rate from the central parity, increasing the width of the band leads to a devaluation in the upper part of the band and an appreciation in the bottom. This result no longer holds when the probability of a realignment is increasing in the distance between the exchange rate and the central parity. However, I show that when the exchange rate is close to the edges of the band, increasing the width marginally will always generate a devaluation at the top of the band and an appreciation at the bottom. Again, the model shows that the two effects driving this result are how changes in the width of the band change the expectations of a realignment on the one hand and how it affects the exchange rate for a constant probability of a realignment on the other. These two effects will pull the exchange rate in opposite directions and depending on the relative strength of these effects we will have an appreciation or a devaluation of the exchange rate when we increase the width of the target zone.

Third, for some parameter values the exchange rate will fluctuate in a range that is larger than the fundamentals fluctuation range. This means that the stabilizing effect of the target zone disappears. Also, I prove in the chapter that this is more likely to occur when the band is wider.

Finally, I test some of the implications of the model using data from Chile, Belgium, Italy, Ireland, Denmark,

France and The Netherlands. The empirical evidence strongly supports the implications of the model for the effects of changes in the width of the band. Regarding the behaviour of the interest rate differential at different maturities, I find that the two-day and one month interest rate differential (with respect to the DM) behaves in the following way for almost all the sample. It increases with the distance between the exchange rate and the central parity for levels of the exchange rate that are close to the central parity, and decreases for levels of the exchange rate that are close to the edges of the band. These results are in line with the implications of the model.

The rest of the chapter is outlined below. The next section presents the model. Section III analyzes the behaviour of the interest rate differential, and Section IV the effects of increasing the width of the band. The empirical evidence is presented in Section V. Section VI summarizes the major conclusions and results.

SECTION II:

Following Krugman (1991) I consider a log-linear monetary model of the exchange rate $\underline{2/}$ where f denotes the logarithm

$\underline{2/}$ A typical simple flexible-price monetary model is based on a money demand equation ($m-p=\theta y-\alpha\pi+\xi$), assuming purchasing power parity we get equation one where $f=m-\theta y-\xi$.

of the fundamentals, driven by a Wiener process with instantaneous variance σ , and is the sum of the money supply and a money velocity shock. In this set-up, the exchange rate will be determined by:

$$s = f + \alpha \frac{Eds}{dt} \quad (1)$$

Where s is the logarithm of the exchange rate, α is the semielasticity of the demand for money with respect to inflation, and Eds/dt is the expected depreciation of the exchange rate. I also assume that the government intervenes so as to maintain f within certain bounds ($F1$ and $F2$). The central parity (c) is equal to:

$$c = (F1+F2)/2$$

At each instant there is a probability of a realignment $\frac{p}{w}$, a shift in the central parity, equal to:

$$\frac{p}{w} |f-c| dt \quad (2)$$

Where w is the width of the target zone and p is how the probability of a realignment changes when the fundamentals move. The size of a realignment is:

$$\begin{aligned} &v \text{ if } f > c \\ &-v \text{ if } f < c \end{aligned}$$

While no realignment occurs with probability:

3/ Intra-marginal stochastic interventions of size $-(f-c)$ and constant probability could be easily introduced in the model.

$$1 - \frac{D}{W} |f - c| dt \quad (3)$$

This process for the realignment establishes that when the exchange rate is on the upper (lower) half of the band there is an expected positive (negative) realignment with the probability of this happening increasing with the distance of the exchange rate from the central parity. Empirical evidence that supports this assumption is presented in Giovannini and Chen (1992). I assume that the pressures to realign when the exchange rate is at the edges of the band are independent of the width of the band. This is the reason for normalizing the probability of a realignment by the width of the band. This process is extremely intuitive and can easily be derived from a political economy model of target zones such as in Cukierman, Kiguel and Leiderman (1993). Appendix 2.A shows that if we assume that the size of the realignments is positive and independent of whether the exchange rate is on the upper or lower part of the band and make the probability of a realignment occurring increasing in the fundamentals, all the properties derived in this section will hold.

It will be convenient to write:

$$s = \tilde{s} + c \quad f = \tilde{f} + c \quad (4)$$

Where the \sim over a variable indicates its log deviation with respect to the central parity. When a realignment takes place, the upper and lower boundaries of the exchange

fluctuation band are redefined and both the central parity and the fundamentals undergo a discrete change 4/5/. In what follows it will be convenient to assume that the exchange rate position within the band is unchanged by a realignment 6/. Given equation (4), the expected change in the exchange rate is:

$$\frac{Eds}{dt} = \frac{Ed\bar{s}}{dt} + \frac{Edc}{dt} \quad (5)$$

and from equation (2) the expected change in the central parity is:

$$\frac{Edc}{dt} = \frac{vp}{w} (f-c) \quad (6)$$

Substituting equation (6) in equation (5) we get:

$$\frac{Eds}{dt} = \frac{Ed\bar{s}}{dt} + \frac{vp}{w} (f-c) \quad (7)$$

So equation (1) can be rewritten as :

$$s = f + \alpha \left[\frac{Ed\bar{s}}{dt} + \frac{vp}{w} (f-c) \right] \quad (8)$$

Next, using equation (4), we obtain an expression for the exchange rate inside the band:

4/ I can also assume that after the realignment the exchange rate is set equal to the central parity and the results of the paper will still hold.

5/ The model can also be interpreted as one with a constant probability of a realignment and a size of realignment that is increasing in the fundamentals.

6/ The model can also be interpreted as one where the exchange rate after a realignment is set equal to the central parity but the realignment size is such that the devaluation is constant.

$$s - c = \bar{s} = \tilde{f} \left(1 + \frac{\alpha v p}{w}\right) + \alpha \frac{E d \bar{s}}{d t} \quad (9)$$

This equation has the same form as the original target zone model in Krugman (1991), except that instead of having \tilde{f} as the fundamentals, now I have $\tilde{f}(1 + \alpha v p/w)$. Applying Ito's Lemma in equation (9) the solution for the exchange rate within the band will be the following:

$$\bar{s} = \tilde{f} \left(1 + \frac{\alpha v p}{w}\right) + A(e^{\lambda(f-c)} - e^{-\lambda(f-c)}) \quad (10)$$

Where:

$$\lambda = \sqrt{\frac{2}{\alpha \sigma^2}} \quad (11)$$

To solve for A we use the smooth pasting condition. This condition states that the derivative of the exchange rate schedule with respect to the fundamentals should be zero at the edges of the band ($\tilde{f}=w$).

$$\frac{\partial \bar{s}}{\partial \tilde{f}} = \left(1 + \frac{\alpha v p}{w}\right) + A \lambda (e^{\lambda(w)} + e^{-\lambda(w)}) = 0 \quad (12)$$

Solving for A we get :

$$A = \frac{-(1 + \frac{\alpha v p}{w})}{\lambda (e^{\lambda w} + e^{-\lambda w})} \quad (13)$$

Next, we get an expression for the exchange rate inside the band by substituting (13) into (10):

$$\bar{s} = \left(1 + \frac{\alpha v p}{w}\right) \left[\bar{f} - \frac{(e^{\lambda} - e^{-\lambda})}{\lambda(e^{\lambda w} + e^{-\lambda w})}\right] \quad (14)$$

It is easy to see that although the smooth pasting condition imposes concavity on the exchange rate schedule, it is possible to have the exchange rate above the level that would prevail if it were allowed to float ($s=f$). If this holds for the whole range of the fundamentals where there is no intervention, then the introduction of a target zone will have a destabilizing effect on the exchange rate, that is, the honeymoon effect highlighted by Krugman (1991) disappears ^{2/}.

Next I present a necessary and sufficient condition on the parameters of the model for this result to hold.

If:

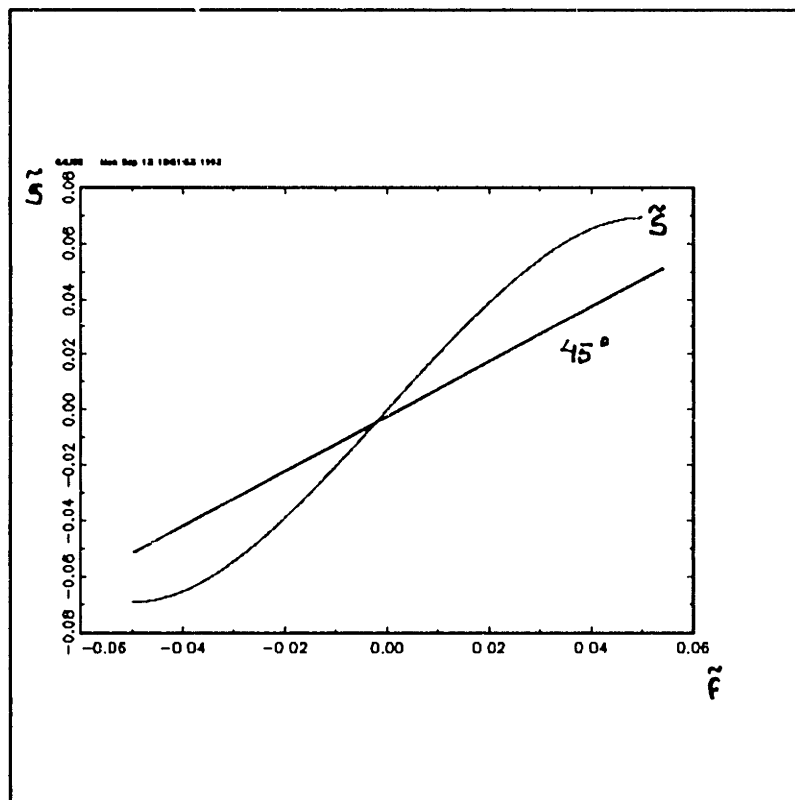
$$\alpha v p > \frac{w(e^{\lambda w} - e^{-\lambda w})}{w\lambda(e^{\lambda w} + e^{-\lambda w}) - (e^{\lambda w} - e^{-\lambda w})} \quad (15)$$

then the exchange rate band will be larger than the fundamentals' fluctuation band. In this case the exchange rate will be a concave function of the fundamentals, but it will always be above the 45 degree line. (See Section I of Appendix 2.B). Given this, the introduction of a target zone in a country that is not highly committed to sustain it, could mean

^{2/} This result also is present in other models where there is a realignment probability, such as Bertola and Caballero (1992), the only difference is that in their model the exchange rate is a convex function of fundamentals.

bringing more instability for the exchange rate. This contrasts with the usual case where the exchange rate schedule is always below the diagonal. In Figure 1, I plot the exchange rate as a function of the fundamentals and we see that it is concave but it is always above the 45 degree line. This shows that it is possible to have mean reversion but no stabilizing effect of a target zone.

Figure 1: Exchange Rate and Fundamentals



It is also straightforward to show (see Section II of Appendix 2.B) that the right hand side of equation (15) is decreasing in the width of the band. This means that wider

bands are less likely to have a stabilizing effect on the exchange rate (in Krugman's sense).

The next section studies the behaviour of the interest rate differential for instantaneous and long term interest rates.

SECTION III

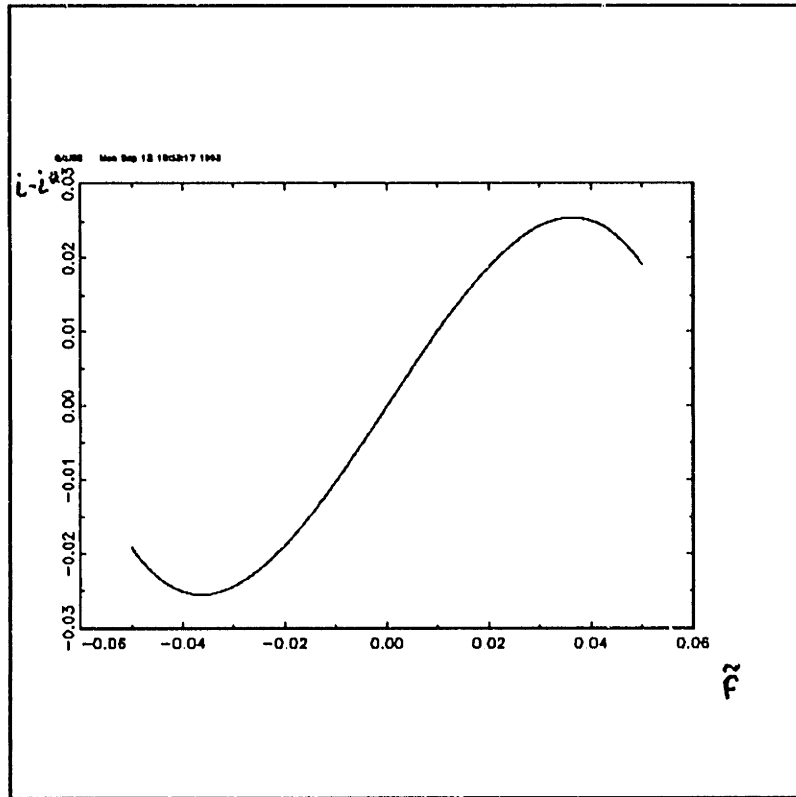
III.1 Instantaneous Interest Rate Differentials.

Assuming uncovered interest rate parity, the instantaneous interest rate differential is equal to the expected rate of depreciation. This is obtained from equation (1).

$$i - i^* = \frac{E ds}{dt} = \frac{(s-f)}{\alpha} \quad (16)$$

To get an idea of how the interest rate differential depends on the fundamentals, equation (16) shows that it will be proportional to the difference between the exchange rate and the fundamentals (s-f). By looking at Figure 1 we can see how this difference depends on the level of the fundamentals. In Figure 2 we show the interest rate differential as a function of the fundamentals for the same parameter values used in Figure 1.

Figure 2: Interest Rate Differential and Fundamentals



Substituting the solution for the exchange rate, equation (14), in (16) we get

$$i - i^* = \frac{1}{\alpha} \left[\frac{\alpha v p}{w} \tilde{f} - \left(1 + \frac{\alpha v p}{w}\right) \left(\frac{1}{\lambda}\right) \left(\frac{e^{\lambda \tilde{f}} - e^{-\lambda \tilde{f}}}{e^{\lambda w} + e^{-\lambda w}}\right) \right] \quad (17)$$

In order to characterize the behaviour of the interest rate differential when fundamentals change, I calculate the partial derivative of the interest rate differential with respect to \tilde{f} .

$$\frac{\partial (i - i^*)}{\partial \tilde{f}} = \frac{1}{\alpha} \left[\frac{\alpha v p}{w} - \left(1 + \frac{\alpha v p}{w}\right) \left(\frac{e^{\lambda \tilde{f}} + e^{-\lambda \tilde{f}}}{e^{\lambda w} + e^{-\lambda w}}\right) \right] \quad (18)$$

This expression is decreasing in \tilde{f} , and it is negative when $\tilde{f}=w$. To examine the behaviour of $i-i^*$ we need one more condition.

If:

$$\frac{\alpha v p}{w} > \frac{2}{e^{\lambda w} + e^{-\lambda w} - 2} \quad (19)$$

the instantaneous interest rate differential will be first increasing in \tilde{f} and at some point it will start to decrease 8/. (For a proof see section III of Appendix 2.B). This result differs from the previous literature, where this differential is either always decreasing (Krugman (1991)), or always increasing (Bertola and Caballero (1992)). If this condition does not hold, the interest rate differential will be always decreasing. This might help explain the lack of empirical evidence supporting the hypothesis of a negative correlation between the instantaneous interest rate differential and the exchange rate inside the band. (See Flood, Mathieson and Rose (1991)).

This result is easy to understand because when the fundamentals increase there are two effects working in opposite directions. The first effect is that the interest rate differential increases as the probability of a

8/ This result is not specific to the functional form assumed for the probability of a realignment. Most functions where the probability of a realignment is increasing in the position of the exchange rate inside the band will do.

realignment increases. This can be seen in the first term of the right hand side (RHS) of equation (18). The last term in equation (18) shows the opposite effect; that is a decrease in the interest rate differential due to the usual mean reversion argument that we find in the standard target zone model. The first effect is constant along the band, given my assumption of the process governing the probability of a realignment. The second effect, mean reversion, is increasing in the fundamentals. In addition, given that the behaviour of the exchange rate inside the band is affected by the probability of a realignment the mean reversion effect is stronger than in the usual target zone model. The change in the extra mean reversion (due only to the increase in the probability of a realignment) when the fundamentals increase is equal to the first effect, the increase in the probability of a realignment, when the exchange rate hits the edges of the target zone, at which point we are left only with the usual mean reversion effect. This is why at low levels of the fundamentals the first effect dominates if condition (19) holds, but eventually mean reversion starts dominating since equation (18), evaluated at the edges of the band, is always negative.

III.2 Interest Rate Differentials for Long Term Maturities.

I follow Svensson (1991) to derive the interest rate differential for different maturities in a target zone. Until now it was not necessary to specify what happens after a realignment takes place, because only the expected depreciation enters into the determination of the exchange rate and the instantaneous interest rate differential. But, to determine the interest rate differential for positive maturities we need to specify this. I will assume that after a realignment the parameters p and v remain constant. Let $i^*(\tau, t)$ denote the foreign nominal interest rate on the foreign currency bond purchased at τ with time to maturity t . And let $i(f, \tau, t)$ be the domestic nominal interest rate when fundamentals are equal to f . Then from uncovered interest rate parity we have:

$$i(f, \tau, t) - i^*(\tau, t) = \frac{E(s(f(\tau+t) | f(\tau)=f)) - s(f)}{t} \quad (20)$$

Given that the right hand side is a Markov process (it only depends on t and f , and not on τ), I can rewrite equation (20) as:

$$i(f, \tau, t) - i^*(\tau, t) = \delta(f, t) = \frac{E(s(f(t) | f(0)=f)) - s(f)}{t} \quad (21)$$

In the present model the exchange rate is the sum of two components, the exchange rate inside the band and the central

parity. The expression for the expected change in the exchange rate is:

$$E(s(f(t)) | f(0)=f) - s(f) = E(\tilde{s}(\tilde{f}(t)) | \tilde{f}(0)=\tilde{f}) - \tilde{s}(\tilde{f}) + D(\tilde{f}, t) \quad (22)$$

The expected change in the exchange rate is the sum of the expected change in the exchange rate inside the band plus the expected change in the central parity ($D(\tilde{f}, t)$). Now I have to study the behaviour of these two components. For the expected change in the exchange rate inside the band from today to time t , we only need to make the assertion that it is bounded by the width of the band. For expositional purposes I will use $h(\tilde{f}, t)$ for the expected change of the exchange rate inside the band between today and time t , given the initial value of the fundamentals (\tilde{f}).

The expected realignment up to time t will be given by:

$$D(\tilde{f}, t) = E\left[\int_0^t \frac{p(\tau)v(\tau)}{w} \tilde{f} d\tau | \tilde{f}_0 = \tilde{f}\right] \quad (23)$$

Under the assumption made earlier that p and v remain constant after a realignment, the expression for the expected realignment then becomes:

$$D(\tilde{f}, t) = \frac{pv}{w} \int_0^t [E(\tilde{f}(\tau)) | \tilde{f}(0) = \tilde{f}] d\tau \quad (24)$$

Given that \tilde{f} is a Wiener process with reflecting barriers, the expectation as time increases gets closer to the unconditional mean, that in this case is equal to zero. Now we have the

final expression for the interest rate differential for maturity t .

$$\delta(\bar{f}, t) = \frac{h(\bar{f}, t)}{t} + \frac{pv}{wt} \int_0^t E(\tilde{f}(\tau) | \bar{f}(0) = \bar{f}) d\tau \quad \text{for } t > 0 \quad (25)$$

The numerator of the first term of equation (25) is bounded, so for long maturities that term becomes irrelevant. The same thing happens with the second term, as t increases the second term goes to zero. This is because as τ increases the expectation of $\tilde{f}(\tau)$ goes to zero given that it is asymptotically uniformly distributed with mean zero. This makes the interest rate differential for long maturities independent of the fundamentals 9/.

We expect to find that countries with almost negligible expected realignments have an interest rate differential that is decreasing in the exchange rate for all maturities and this correlation decreases and approaches zero as the maturity increases. For countries where the probability of a realignment is significant, we expect the interest rate differential to be independent of the exchange rate for long maturities, and for short maturities we expect it to be either always decreasing or first increasing and then decreasing.

9/ I have assumed that the position inside the band is unchanged by a realignment. But this result still holds if we replace that assumption by the weaker one that the position inside the band after the realignment is positively correlated to the position before the realignment.

Having examined the behaviour of the interest rate differential, I turn next to the effect of increasing the width of the band on the exchange rate.

SECTION IV

IV.1 Changes in the Width of the Band

This part of the chapter examines the effects of increasing the width of the band on the exchange rate. I study the possibility that by reducing the probability of a realignment, an increase in the width might move the exchange rate closer to the central parity. This does not happen in the usual target zone model. I use equation (14) to find the marginal effect of changes in the width of the band on the exchange rate.

$$\frac{\partial \bar{s}}{\partial w} = -\frac{\alpha v p}{w^2} \left(\bar{f} - \frac{1}{\lambda} \left(\frac{e^{\lambda} - e^{-\lambda}}{e^{\lambda w} + e^{-\lambda w}} \right) \right) + \left(1 + \frac{\alpha v p}{w} \right) \frac{(e^{\lambda} - e^{-\lambda})(e^{\lambda w} - e^{-\lambda w})}{(e^{\lambda w} + e^{-\lambda w})^2} \quad (26)$$

This equation highlights the two effects that are at work when the width of the band increases. The first term on the right hand side shows that for any value of the fundamentals inside the old band, the rate of the expected realignment has gone down; this brings about an expected appreciation in the upper part of the band, and a depreciation in the bottom part of it. The second term illustrates the fact that when the band

is increased, the option value terms are less valuable so the exchange rate is more closely related to the fundamentals. This triggers a devaluation if we are in the upper part of the band and an appreciation if we are in the bottom.

Equation (26) has the following implications. When there is no probability of a realignment ($vp=0$), the first term disappears and an increase in the width generates a depreciation if the exchange rate is in the upper half of the target zone and an appreciation if the exchange rate is in the bottom part. The magnitude of this effect increases with the level of the exchange rate. This is obvious because when $vp=0$ equation (26) is always positive if the exchange rate is at the upper half of the target zone and the opposite happens if it is at the bottom half.

When vp is different from zero then changes in the width of the band will have the same effect as in the previous case for values of the fundamentals that are close to the edges of the band. To show this, I evaluate equation (26) at $\tilde{f}=w$. At that value of f , equation (26) is always strictly positive. (See Appendix 2.B, section IV).

The effects of increasing the width of the band on the exchange rate when vp is different from zero is formally shown in section 5 of Appendix 2.B. The main implications of this exercise are:

a) If vp is not too large then increasing the width of the band will generate a depreciation if the exchange rate is in

the upper part of the band and an appreciation if it is in the bottom half.

b) If v_p is large enough then there will exist an interval from the central parity to some exchange rate inside the band where if the exchange rate lies in that interval, increasing the band will move the exchange rate closer to the central parity. If the exchange rate is outside this interval then the opposite happens.

IV.2 Interpretation

Next, I present an intuitive explanation of how increasing the width of the band affects the exchange rate. The previous literature suggested that the exchange rate in a target zone can be interpreted as a compound asset whose price is determined by the present value of the fundamentals plus the option to sell the asset at the lower bound and the obligation to sell on demand at the upper bound. When the width of the band changes unexpectedly, the present value of the fundamentals changes by the change in the expected realignment coefficient ($\alpha v_p/w$). The change in the value of the two options changes as well, both due to a change in ($\alpha v_p/w$) and also because now the probability of exercising the option, given the value of the fundamentals, has gone down. When $v_p=0$ the change in the exchange rate is due exclusively to the change in the value of these two options. Making the band wider, decreases the value of the option to sell at the lower

bound and increases the value of the obligation to sell at the upper part. Depending on whether the exchange rate is in the upper or lower half of the band, the impact of either option is more important to the current price of foreign currency. When the exchange rate is close to the central parity these two effects offset each other. Another important implication is that at the extremes of the target zone, a marginal increase in the width of the band will move the exchange rate to the new bounds. This implication is not as clear in this model because for simplicity, the band was defined on the fundamentals and not on the exchange rate. This occurs due to the smooth pasting condition which causes the exchange rate function to flatten at the edges of the target zone. If the probability of a realignment is increasing in the position of the exchange rate inside the band ($v_p > 0$), this will work to partially offset the previous effect, because when the width increases the probability of a realignment goes down and this causes the exchange rate to appreciate (depreciate) if we are in the upper (lower) half of the band.

SECTION V:

In this section I test some of the implications of the model using data from Chile, Belgium, Italy, Ireland, Denmark, France and The Netherlands. First, I study the relationship between the interest rate differential and the exchange rate.

Second, I test the prediction of the model regarding an increase in the width of the target zone.

V.1 The Interest Rate Differential and The Exchange Rate

In this section, I estimate the relation between the interest rate differential, for different maturities, and the exchange rate within the band. First, I summarize the results for the instantaneous interest rate differential derived in Section III and Appendix B. The relation between the short term interest rate differential and the position of the exchange rate inside the band should be negative for countries and periods where there is no expected realignment. When the expected realignments are positive and sufficiently increasing in the exchange rate we should find a positive correlation when the exchange rate is close to the central parity and negative when the exchange rate is close to the edges of the band. To test for this I ran the following regression for the two day and one month interest rate differential (with respect to the DM) of Denmark, Belgium, France, Ireland, Italy and The Netherlands.

$$i - i^* = k + \beta_0 \bar{s} + \beta_{00} \bar{s}^3 \quad (27)$$

I include the distance of the logarithm of the exchange rate to the logarithm of the central parity raised to the third power, to take into account the non-linearities present in the short term interest rate differential. In particular,

this should capture the fact that the position of the exchange rate inside the band affects the interest rate differential in a different way when the exchange rate is close to the central parity than when it is near the edges. The semielasticity of the interest rate differential with respect to the exchange rate inside the band will be equal to:

$$\frac{\partial i - i^*}{\partial \bar{s}} = \beta_0 + 3\beta_{00}(\bar{s})^2 \quad (28)$$

This expression will only depend on the distance of the exchange rate from the central parity and not on whether the exchange rate is on the upper or lower half of the band, that is what both models predict.

For the short term interest rate differential, I expect to find that when the expected realignment is insignificant both coefficients (β_0 and β_{00}) should be negative (or at least one and the other not significant). When realignments are highly probable we should see $\beta_0 > 0$ and $\beta_{00} < 0$.

I used daily data 10/ from March 1979 to May 1990. The interest rates used were the two-day and one month euro-rates. I split the sample into subperiods between each of the realignments of each currency with respect to the DM. Given that the exchange rates and interest rate differentials are both endogenous variables in my model I use instrumental variables estimation to correct for the simultaneity problem.

10/ I am grateful to Andrew Rose and Donald Mathieson for providing me with their data-set.

I used the lagged values of the exchange rate deviations from the central parity and its cube as instruments. The results presented used 4 lags of each of these instruments. To correct for the autocorrelation present in the error term, these were adjusted by the Newey-West procedure.

Even though theory predicts that the variables use in these regressions are all stationary, if the mean reversion effect that the target zone imposes on the exchange rate were absent then the exchange rate deviation from the central parity would be an integrated process with reflecting boundaries. Because of this I performed unit root test on all the variables. I rejected the null hypothesis of a unit root for the exchange rate deviations from central parity for every country except Italy at the 1% significance level, in the italian case I was able to reject at 5% significance level. I rejected the null hypothesis of a unit root in the interest rate differential for every country at the 1% significance level.

Table 1 shows the results the of these regressions for the one month interest rate differential. The same regressions were performed with the two-day interest rate and the results were the same. In the cases of Denmark, France, Italy and Ireland both regressions provide evidence that in a majority of the sub-samples the correlation between the interest rate differential and the exchange rate inside the band is the one predicted by the model. That is $\beta_0 > 0$ and $\beta_{00} < 0$. Also, when I

calculate the semielasticity of the interest rate differential with respect to the exchange rate inside the band at the central parity and at the boundaries we observe that it goes from being positive (at the central parity) to being negative at the boundaries. Table 2 presents the elasticity at the central parity and at the edges of the band.

There is also evidence of a positive expected realignment when the exchange rate is equal to the central parity, that is $k > 0$ in all the regressions. In addition, the results justify my assumption of parameter instability across sub-samples.

For the case of Belgium, only half of the sub-samples behave as predicted by the model (the first three). Finally the results for The Netherlands don't show the pattern suggested by the theory. We think the two most important reasons why in some countries during some periods I don't find the expected results are the following. First, the behavior of the expected realignment might be a discontinuous function of the fundamentals (such as in Bertola-Caballero (1992)). Second, in some periods the monetary authorities changed the money supply inside the target zone; a careful analysis of the central bank's policy function might help in explaining these results.

TABLE 1: ONE-MONTH INTEREST RATE DIFFERENTIAL

Country	k	β_0	β_{00}
BELGIUM			
30/03/79-16/09/79	0.0074 (0.45)	2.7978 (1.09)	-2230.7 (-0.53)
29/09/79-27/09/81	0.0400 (11.7)	4.6285 (4.62)	-6206.6 (-5.68)
17/10/81-14/02/82	0.0423 (29.0)	0.3390 (1.36)	-1902.0 (-1.69)
06/03/82-06/06/82	0.0382 (33.1)	-0.7776 (-2.7)	3274.2 (5.04)
26/06/82-13/03/83	0.0552 (38.1)	-0.2441 (-1.7)	2217.8 (3.32)
02/04/83-30/03/86	0.0469 (26.9)	-0.4433 (-1.5)	1726.3 (3.18)
19/04/86-04/01/87	0.0324 (13.9)	-0.4727 (-1.5)	125.81 (0.14)
24/01/87-16/05/90	0.0327 (10.5)	-0.5139 (-1.1)	-939.51 (-0.9)
DENMARK			
17/10/81-06/06/82	0.0682 (12.6)	4.3826 (4.84)	-6703.5 (-3.4)
26/06/82-13/03/83	0.1019 (10.4)	2.4111 (1.29)	735.97 (0.18)
02/04/83-30/03/86	0.0480 (51.6)	0.6488 (2.87)	-3456.9 (-4.3)
19/04/86-04/01/87	0.0371 (51.6)	0.8662 (5.66)	-505.30 (-1.3)
24/01/87-16/05/90	0.0507 (33.1)	-0.5845 (-2.1)	-1609.1 (-1.9)
FRANCE			
30/03/79-16/09/79	0.0371 (40.6)	2.9430 (10.5)	-17012.6 (-4.4)
29/09/79-27/09/81	0.0603 (9.08)	3.7938 (4.08)	-3786.5 (-2.1)
17/10/81-06/06/82	0.0945 (13.7)	5.8814 (6.17)	-7850.1 (-2.5)
26/06/82-13/03/83	0.1879 (5.21)	24.284 (2.10)	-44310.5 (-1.8)
02/04/83-30/03/86	0.0642 (33.7)	1.9534 (4.22)	-6268.6 (-5.8)
19/04/86-04/01/87	0.0295 (25.9)	0.5393 (3.85)	-1125.5 (-3.7)
24/01/87-16/05/90	0.0358 (36.9)	-0.7751 (-4.3)	1475.9 (1.94)

TABLE 1 (cont)

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ITALY

30/03/79-16/09/79	0.1435	4.4827	-1956.9
	(4.48)	(1.91)	(-1.2)
29/09/79-15/03/81	0.0918	1.3809	-1914.8
	(21.0)	(2.84)	(-3.7)
04/04/81-27/09/81	0.1325	-0.3199	7761.5
	(6.29)	(-0.1)	(0.87)
17/10/81-06/06/82	0.1279	3.9483	-4397.9
	(19.5)	(4.48)	(-3.1)
26/06/82-13/03/83	0.1783	3.5770	-1145.3
	(25.3)	(7.39)	(-3.4)
02/04/83-14/07/85	0.0896	-0.5608	58.256
	(60.8)	(-7.5)	(2.05)
03/08/85-30/03/86	0.1186	5.0515	-7543.1
	(42.8)	(11.7)	(-6.2)
19/04/86-04/01/87	0.0340	-2.5661	2174.2
	(2.74)	(-1.9)	(1.14)
24/01/87-31/12/89	0.0596	0.0944	-36.813
	(31.3)	(0.72)	(-0.3)
20/01/90-16/05/90	0.0458	-0.2052	1819.8
	(17.9)	(-0.6)	(2.37)

IRELAND

17/10/81-06/06/82	0.0879	1.9151	-1589.7
	(29.5)	(4.06)	(-0.9)
26/06/82-13/03/83	0.0886	1.8559	-5231.3
	(34.2)	(3.04)	(-2.7)
02/04/83-30/03/86	0.0753	0.4405	-1449.3
	(32.9)	(1.43)	(-1.5)
19/04/86-27/07/86	0.0511	0.4606	-8144.5
	(38.2)	(1.18)	(-3.1)
16/08/86-04/01/87	0.0544	0.5244	10514.1
	(32.4)	(0.82)	(3.43)
24/01/87-16/05/90	0.0400	1.2661	-5840.6
	(15.1)	(1.79)	(-1.9)

NETHERLANDS

30/03/79-16/09/79	0.0182	-0.1478	2847.9
	(30.4)	(-1.2)	(5.06)
29/09/79-13/03/83	0.0051	-0.0689	770.95
	(2.44)	(-0.2)	(1.04)
02/04/83-16/05/90	0.0075	-0.1823	15020.6
	(21.3)	(-0.8)	(2.64)

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t-statistic in parenthesis

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TABLE 2: SEMI-ELASTICITY OF THE INTEREST RATE DIFFERENTIAL

Country	Central Parity	Edges
BELGIUM		
30/03/79-16/09/79	2.7	-0.58
29/09/79-27/09/81	4.6	-4.79
17/10/81-14/02/82	0.3	-2.55
06/03/82-06/06/82	-0.8	4.19
26/06/82-13/03/83	-0.2	3.12
02/04/83-30/03/86	-0.4	2.17
19/04/86-04/01/87	-0.5	-0.28
24/01/87-16/05/90	-0.5	-1.94
DENMARK		
17/10/81-06/06/82	4.4	-5.79
26/06/82-13/03/83	2.4	3.52
02/04/83-30/03/86	0.6	-4.60
19/04/86-04/01/87	0.8	0.09
24/01/87-16/05/90	-0.6	-3.03
FRANCE		
30/03/79-16/09/79	2.9	-22.89
29/09/79-27/09/81	3.8	-1.95
17/10/81-06/06/82	5.8	-6.04
26/06/82-13/03/83	24.3	-43.02
02/04/83-30/03/86	1.9	-7.56
19/04/86-04/01/87	0.5	-1.16
24/01/87-16/05/90	-0.7	1.46

TABLE 2 (cont)

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ITALY

30/03/79-16/09/79	4.5	-16.64
29/09/79-15/03/81	1.4	-19.29
04/04/81-27/09/81	-0.3	83.49
17/10/81-06/06/82	3.9	-43.53
26/06/82-13/03/83	3.6	-8.78
02/04/83-14/07/85	-0.6	0.06
03/08/85-30/03/86	5.0	-76.41
19/04/86-04/01/87	-2.6	20.91
24/01/87-31/12/89	0.1	-0.30
20/01/90-16/05/90	-0.2	2.55

IRELAND

17/10/81-06/06/82	1.9	-0.49
26/06/82-13/03/83	1.8	-6.08
02/04/83-30/03/86	0.5	-1.76
19/04/86-27/07/86	0.5	-11.90
16/08/86-04/01/87	0.5	16.49
24/01/87-16/05/90	1.3	-7.60

NETHERLANDS

30/03/79-16/09/79	-0.1	4.17
29/09/79-13/03/83	-0.1	1.10
02/04/83-16/05/90	-0.2	22.62

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Overall the results give some support to the model developed in the chapter. For the short term interest rate differential there is evidence of a positive relation with the exchange rate at levels that are close to the central parity and a negative one at levels that are close to the edges of the band. This happens in periods where the possibility of a realignment was present and the realignment that took place was large.

V.2 Changes in the Width

From Section II, equation (14), we know that the exchange rate inside the band behaves according to:

$$\tilde{s} = \left(1 + \frac{\alpha v p}{w}\right) \tilde{f} - \left(1 + \frac{\alpha v p}{w}\right) \left(\frac{1}{\lambda}\right) \left(\frac{e^{\lambda \tilde{f}} - e^{-\lambda \tilde{f}}}{e^{\lambda w} + e^{-\lambda w}}\right) \quad (29)$$

If the exchange rate were only determined by the first term in the RHS, the expected change in s would be always zero; so it would behave as a random walk. The second term is what forces the exchange rate to exhibit mean reversion. We can easily see that when the width of the target zone increases, this term will be less important so the exchange rate will exhibit less mean reversion (the opposite will happen in the Bertola-Caballero model).

I test this implication of the model for Chile and Italy, because these are the countries in the sample that have changed the width of their target zones. Chile's exchange rate

has been on a target zone regime since 1985. The width of the band was $\pm 2\%$ around the central parity during the initial phase, it increased to $\pm 3\%$ in 1988 and it was further widened to $\pm 5\%$ in June of 1989. On January 1992, the band was increased to $\pm 10\%$. This last adjustment also included a revaluation of the central parity of 5% ^{11/}. The Italian lira had a fluctuation band of $\pm 6\%$ from the introduction of the EMS until January 1990, at which time they reduced it to 2.25%.

The objective is to see if the observed changes in the width of these countries' target zones had the expected effect, that mean reversion decreases with increases in the width of the band. To do this, I estimate the expected depreciation inside the band for each country under each regime as an AR(1) process. Although theory tells us that the exchange rate inside the target zone is a non-linear function of the fundamentals, previous research has shown that to estimate the expected exchange rate inside a target zone as an AR(1) is the best specification (See Bertola and Svensson (1992)).

^{11/} Chile adjusts its central parity according to a purchasing power parity rule. It is simple to show that the model's implications are replicated in a model where the fundamentals have a deterministic trend and the central parity is adjusted through time with the same deterministic trend.

Given the behaviour of Chile's economy^{1/} and the increased independence that the Central Bank obtained during 1990, I assumed that the process driving fundamentals changed in this year. I will test for a change in the slope parameter when the band was increased in the 1985-1990 period and in the 1990-1992 period.

The data are weekly observations of the log difference of the exchange rate with respect to the central parity from the Central Bank of Chile. The same test was performed for Italy using daily data from BIS that covers the period from May 1979 to June 1990. Italy had a +/-6% target zone since the EMS started to December 1989 when the band was narrowed to +/- 2.25%. The results of these structural change tests for both Chile and Italy are presented in Table 3.

I ran the following regression:

$$\tilde{s}_t = k + \gamma \tilde{s}_{t-1} + \epsilon_t \quad (30)$$

where s is the logarithm of the deviation of the exchange rate from the central parity and k and γ are the parameters to be estimated, the standard errors are adjusted by the Newey-West procedure to correct for autocorrelation and heteroskedasticity.

^{1/} Chile has been experiencing large capital inflows since 1990 and the Central Bank has been trying to sterilize them. This intervention will affect the autorregressive coefficient and justifies the assumption that there is a break in the process driving the fundamentals.

The results give support to the fact that an increase in the width of the band generates a decline in the mean reversion of the exchange rate, supporting the model developed in Section II.

TABLE 3: Target Zone Width and Mean Reversion.

	k	γ	struct Δ	R ²	DW
CHILE					
a) 85.11-88.08	.0011 (1.4)	.896 (19)		.80	1.84
b) 88.09-90.05	.0006 (.63)	.956 (34)	1.1 ^a	.89	1.91
c) 90.06-91.12	-.020 (-4)	.566 (5.7)		.68	1.27
d) 92.01-92.07	-.005 (-1.14)	.94 (15)	3.0 ^b	.88	1.73
ITALY					
a) 79.03-89.12	0.000 (0.0)	.99 (271)		.98	1.90
b) 90.01-90.06	0.003 (1.5)	.82 (6.3)	-1.4	.85	2.10

t-statistics in parenthesis
 struct is a t-test for the change in γ
 a=significant at 30%
 b=significant at 1%
 c=significant at 15%

For the case of Chile the slope coefficient goes up each time that the band was increased as predicted by the model. The first time that the band was widened this change is not statistically significant but in the second width change, it is significant at a 1% significance level. In the Italian case mean reversion increases when the band was narrowed this change is statistically significant at the 15% significance level. The result is robust to changes in the pre 1990 sample, I performed the same test using the last period without a realignment prior to the narrowing of the band and the results are exactly the same. This results indicate that when a target zone is made wider the exchange rate will exhibit less mean reversion.

VI. CONCLUSIONS:

This chapter introduced into the standard target zone model of exchange rates a probability of a realignment that is an increasing function of the distance of the exchange rate from the central parity, as a percentage of the width of the band. This has important implications regarding the interest rate differentials for different maturities, and for the effect on the exchange rate of changes in the width of the band.

For instantaneous and short term maturities the relation between the interest rate differential and the exchange rate

inside the band is first increasing and eventually it becomes decreasing. On the other hand, depending on the parameters, it might always be decreasing. For the long term interest rate differential there should be no correlation.

Increasing the width of the band has two effects on the exchange rate. First, it diminishes the stabilizing properties of the target zone. Second, it decreases the probability of a realignment. The first effect generates a devaluation of the exchange rate if the exchange rate is in the upper part of the band and an appreciation if it is in the bottom part. The second effect works in the opposite direction. When the exchange rate is close to the edges of the band the first effect dominates. When the exchange rate is close to the central parity the first effect dominates if the probability of a realignment is small, and the second effect dominates if the opposite happens.

Finally, some of the implications of the model were tested with data from Chile, Italy, France, The Netherlands, Belgium, Denmark and Ireland. To some extent the experience of these countries provided empirical support for the model.

APPENDIX 2.A:

Here I show that if the process driving realignments is one sided the properties developed in the text still hold. Now I assume that the size of the realignment is v and it is independent of which side of the band the exchange rate is in. The probability of a realignment will be equal to:

$$prob = \frac{k}{w} + \frac{p\bar{f}}{w} \quad k > p \quad (31)$$

with this assumption and working through the model as I did in the text, the expression for the exchange rate inside the band will be:

$$\bar{s} = \frac{\alpha kv}{w} + \left(1 + \frac{\alpha vp}{w}\right) \bar{f} + \alpha \frac{d\bar{s}}{dt} \quad (32)$$

This expression is equal to the one in the text plus the first term in the right hand side ($\alpha vk/w$), so the solution will be:

$$\bar{s} = \frac{\alpha vk}{w} + \left(1 + \frac{\alpha vp}{w}\right) \bar{f} + A(\exp(\lambda \bar{f}) - \exp(-\lambda \bar{f})) \quad (33)$$

Now it is straightforward to see that everything will be equal to the model in the text augmented by the constant $\alpha vk/w$.

APPENDIX 2.B:

I) I prove that if condition (15) holds then the maximum deviation of the exchange rate from the central parity is greater than the width of the band. Given that equation (10) is increasing in \tilde{f} , I need only to evaluate it at $\tilde{f}=w$.

$$\bar{s}(w) = \left(1 + \frac{\alpha v p}{w}\right) \left(w - \frac{(e^{\lambda w} - e^{-\lambda w})}{\lambda(e^{\lambda w} - e^{-\lambda w})}\right) > w \quad (34)$$

This implies:

$$\alpha v p > \frac{(e^{\lambda w} - e^{-\lambda w})}{w\lambda(e^{\lambda w} + e^{-\lambda w}) - (e^{\lambda w} - e^{-\lambda w})} \quad \blacksquare \quad (35)$$

II) Here I show that the right hand side of equation (15) in the text is decreasing in the width of the fundamental's band. This implies that wider bands are less likely to exhibit the honeymoon effect.

The derivative of the right hand side of equation (15) is equal to:

$$\frac{-1 + w^2 \lambda^2 \left(\frac{4}{(e^{\lambda w} - e^{-\lambda w})^2}\right)}{\left((w\lambda) \left(\frac{e^{\lambda w} + e^{-\lambda w}}{e^{\lambda w} - e^{-\lambda w}}\right) - 1\right)^2} \quad (36)$$

I need to show that the numerator is negative. The condition for this to hold is:

$$e^{2\lambda w} + e^{-2\lambda w} - 4w^2 \lambda^2 > 2 \quad (37)$$

The left hand side of this expression is always greater or equal than 2 so the condition is satisfied.

III) Next, I show that if condition (19) is met then the claim that follows in the text is true. Equation (18) indicates that the derivative of the interest rate differential with respect to the fundamentals achieves its maximum at zero and it is negative when $\tilde{f}=w$. Here I look for conditions that make this derivative positive when $\tilde{f}=0$.

$$\frac{\partial (i-i^*)}{\partial \tilde{f}} = \frac{1}{\alpha} \left[\frac{\alpha v p}{w} - \left(1 + \frac{\alpha v p}{w}\right) \left(\frac{2}{e^{\lambda w} + e^{-\lambda w}}\right) \right] > 0 \quad (38)$$

This implies:

$$\frac{\alpha v p}{w} > \frac{2}{e^{\lambda w} + e^{-\lambda w} - 2} \quad \blacksquare \quad (39)$$

IV) In this step I show that when the band increases then there will be a devaluation if the exchange rate is close to the upper limit and an appreciation if it is close to the lower limit regardless of the value of the parameters. To do this we just evaluate equation (26) at $\tilde{f}=w$ and show that it is positive.

$$\frac{\partial \tilde{s}}{\partial w} = \frac{-\alpha v p}{w^2} \left(w - \frac{1}{\lambda} \left(\frac{e^{\lambda w} - e^{-\lambda w}}{e^{\lambda w} + e^{-\lambda w}} \right) \right) + \left(1 + \frac{\alpha v p}{w} \right) \left(\frac{e^{\lambda w} - e^{-\lambda w}}{e^{\lambda w} + e^{-\lambda w}} \right)^2 > 0 \quad (40)$$

This can be rewritten as

$$\frac{\alpha v p}{w} \left[\left(\frac{e^{\lambda w} - e^{-\lambda w}}{e^{\lambda w} + e^{-\lambda w}} \right)^2 - \left(1 - \left(\frac{e^{\lambda w} - e^{-\lambda w}}{\lambda w (e^{\lambda w} + e^{-\lambda w})} \right) \right) \right] + \left(\frac{e^{\lambda w} - e^{-\lambda w}}{e^{\lambda w} + e^{-\lambda w}} \right)^2 \quad (41)$$

Which is equal to

$$\frac{\alpha v p}{w} \frac{(-4\lambda w + e^{2\lambda w} - e^{-2\lambda w})}{\lambda w (e^{\lambda w} + e^{-\lambda w})^2} + \left(\frac{e^{\lambda w} - e^{-\lambda w}}{e^{\lambda w} + e^{-\lambda w}} \right)^2 > 0 \quad \text{for } w > 0 \quad \blacksquare \quad (42)$$

V) Equation (26) gives the effect on the exchange rate of increasing the band, we showed in section IV that it is always positive for exchange rates that are close to the edges of the band and it is zero when the exchange rate is close to the central parity. Here, I look for the conditions under which this result is reversed for exchange rates that are close to the central parity. I calculate the derivative of equation (28) with respect to the fundamentals.

$$\frac{\partial \left(\frac{\partial \bar{s}}{\partial w} \right)}{\partial \tilde{f}} = \frac{-\alpha v p}{w^2} \left(1 - \left(\frac{e^{\tilde{y}} + e^{-\tilde{y}}}{e^{\lambda w} + e^{-\lambda w}} \right) \right) + \left(1 + \frac{\alpha v p}{w} \right) \lambda \left(\frac{(e^{\tilde{y}} + e^{-\tilde{y}}) (e^{\lambda w} - e^{-\lambda w})}{(e^{\lambda w} + e^{-\lambda w})^2} \right) \quad (43)$$

This expression is increasing in the fundamentals. If we want to have a range where increasing the width generates an appreciation if the exchange rate is above the central parity, but close to it; this expression should be negative at $\tilde{f}=0$. Therefore we need the following condition

$$\frac{\alpha v p}{w} > \frac{2w\lambda (e^{\lambda w} - e^{-\lambda w})}{(e^{\lambda w} + e^{-\lambda w} - 2) (e^{\lambda w} + e^{-\lambda w}) - 2\lambda w (e^{\lambda w} - e^{-\lambda w})} \quad (44)$$

If this condition holds there will be a range between the central parity and exchange rate inside the band where equation (28) is negative.

CHAPTER 3

REALIGNMENT EXPECTATIONS AND THE OPTIMAL

TARGET ZONE

I. INTRODUCTION.

After having stabilized their inflation rates from three digit levels to a moderate range of 10%-30%, Israel and Mexico adopted a target zone as their exchange rate regime but they still use the exchange rate as the nominal anchor of the economy. This decision came after experiencing fixed or crawling exchange rates for a period of time.

Given the lack of credibility on the exchange rate announcements, the wide swings in expectations of a realignment and the high degree of capital mobility these countries experience, a fixed exchange rate made the domestic interest rates extremely volatile. Due to this experience with fixed exchange rates these countries decided to switch to a target zone on the grounds that this regime would enable the country to keep the benefits of the exchange rate as a nominal anchor, and at the same time provide a degree of flexibility to cope with highly variable capital movements 1/. An exchange rate band allows for some degree of adjustment of the nominal exchange rate in response to shocks without breaking the long run policy commitments. In contrast to a fixed exchange rate, the variability of the domestic interest rate will be reduced because the exchange rate fluctuations inside

1/ Similar arguments have been made by Helpman and Leiderman (1991) and Svensson (1993).

the band will also help to absorb the shocks that have a speculative nature.

After adopting the target zone, Israel changed the width of its band a few times and Mexico continuously increases its target zone. This brings us to the question of what determines the optimal width of the target zone, and how effective is the optimal target zone in reducing the volatility in the interest rates.

This chapter develops the simplest model of a target zone with stochastic realignments, and in this framework looks for the optimal width of the target zone. This will be the one that minimizes some linear combination of the asymptotic variance of the deviations of the exchange rate from the central parity and the interest rate. Finally the relation between the optimal width of the target zone and the volatility of the expected realignment is studied. The optimal width turns out to be increasing in the variance of the expected realignment and the semi-elasticity of money demand and decreasing with the limits within which the expected realignment fluctuates. For sensible values of the model's parameters the optimal width is around $\pm 4\%$ and $\pm 10\%$. The target zone achieves a 10% to 50% reduction in the asymptotic variance of the interest rate differential.

The second part of the chapter looks at the Mexican and Israeli experience with a target zone. I show evidence that supports the claim that the currency band is a good instrument

to the reduce the volatility of the interest rate differential. I do this in two ways. First I compare the conditional variance of the interest rate differential before and after the target zone was in place and second I construct a measure of the expected realignment by subtracting the expected depreciation inside the band from the interest rate differential (As in Svensson (1992)), then I compare the variance of the expected realignment and the variance of the interest rate differential. The results from both of these exercises show that the target zone was effective in reducing the interest rate variability, the results also show that the volatility of the expected realignment did not decrease with the introduction of the band.

The chapter is structured as follows. Section II develops a simple model of the exchange rate in a target zone. Section III looks at the variances of the exchange rate and the interest rate differential. Section IV determines the optimal width of the band as a function of the model's parameters. Section V reviews the Mexican and Israeli experience and Section VI concludes.

II. THE MODEL

The exchange rate will be determined in the simplest log linear monetary model of the exchange rate. The exchange rate at any point in time will be equal to:

$$x(t) = f(t) + \alpha \frac{Edx}{dt} \quad (1)$$

where f denotes a measure of fundamentals^{2/} and x is the exchange rate, all variables are measured in logarithms. We assume that when a change in the central parity (realignment) takes place the fundamentals also jump by the size of the realignment and the exchange rate inside the band stays in the same place^{3/}. Given this assumption the expected depreciation will be the sum of the expected depreciation inside the band plus the expected realignment.

$$\frac{Edx}{dt} = \frac{E\bar{dx}}{dt} + g(t) \quad (2)$$

where a bar over a variable denotes deviations from the central parity and g is the expected rate of realignment (that is the product of the probability of a realignment and the size of it). Using eq (2) we can rewrite eq (1) as:

^{2/} If we think in terms of a monetary model f will be the sum of the nominal money stock and a velocity shock. Start with a money demand as follows $m-p=v+y-\alpha\pi$, assume purchasing power parity and we get equation (1).

^{3/} The model will not change if I alternatively assume that a realignment implies a jump of fixed size in the exchange rate independently of the position in the band, and this level of the exchange rate will be the new central parity. So the central parity is adjusted by different amounts depending on the position of the exchange rate inside the band. So at the time of a realignment the money supply will be adjusted to achieve this realignment, and set the exchange rate equal to the central parity.

$$x(t) = f(t) + \alpha g(t) + \alpha \frac{Ed\bar{x}}{dt} \quad (3)$$

Subtracting the mean of the fundamentals from both sides of equation (3) we finally get:

$$\bar{x}(t) = \bar{f}(t) + \alpha g(t) + \alpha \frac{Ed\bar{x}}{dt} \quad (4)$$

Where a bar over a variable denotes deviations from central parities. For purposes of analytical tractability we will assume that f is the sum of a velocity shock that will be assumed constant ^{4/} and the money supply that will be a function of g , to capture the effect of intramarginal interventions. We assume that the monetary rule is a linear function of the expected realignment. Then the only exogenous variable that will determine the behaviour of the exchange rate inside the target zone will be the expected realignment. This is not totally accurate, but the majority of the movements of the exchange rate inside the band seem to be driven by the expectations of a devaluation, the same is true for intramarginal interventions. It is also true that the majority of the interventions are inside the band as opposed to marginal interventions on the boundaries of the band. The devaluation expectation will be modeled as a Weiner process

^{4/} In a previous version of the paper I developed a model where the velocity shock was stochastic and the expected realignment was unbounded. When the variance of the velocity shock was smaller than the variance of the expected realignment the results from both models are similar.

with reflecting barriers. This means that the rate of expected realignment will fluctuate around two values which it never goes over. Formally:

$$dg = \sigma_g dW_g \quad (5)$$

With reflecting states g_0 and $-g_0$, where W_g is a Weiner process with instantaneous variance σ_g^2 . Given that this process is bounded, for each policy choice by the monetary authority there will be a corresponding target zone. For the highest possible value of g (g_0) there is a value of the exchange rate that is the highest value the exchange rate can get, so this determines the width of the target zone. I assume that the monetary policy followed by the central bank is linear in the state variable (g). I define a new state variable h as:

$$h(t) = \bar{f}(t) + (\alpha - a)g(t) \quad \text{so} \quad dh(t) = (\alpha - a)\sigma_g dW_g \quad (6)$$

Here the government is offsetting shocks to the expected realignment by decreasing the money supply by the amount ag . With this and applying Ito's Lemma to equation (4) we get a second order differential equation for the exchange rate inside the band.

$$\bar{x}(t) = h + \frac{\alpha(\alpha - a)^2 \sigma_g^2}{2} \bar{x}_{hh}(t) \quad (7)$$

The solution for the exchange rate will be given by the following equation:

$$\bar{x}(t) = h(t) + A(\alpha - a) (\exp(\lambda g) - \exp(-\lambda g)) \quad (8)$$

Where:

$$A = \frac{-1}{\lambda (\exp(\lambda g_0) + \exp(-\lambda g_0))} \quad (9)$$

and

$$\lambda = \sqrt{\left(\frac{2}{\alpha \sigma_s^2} \right)} \quad (10)$$

We can write the expression for the exchange rate inside the band as:

$$\bar{x}(t) = (\alpha - a) \left[g(t) - \frac{\exp(\lambda g) - \exp(-\lambda g)}{\exp(\lambda g_0) + \exp(-\lambda g_0)} \right] \quad (11)$$

Increasing (a) will make the target zone narrower and when $a = \alpha$ the central bank will offset completely the shocks to the expected realignment, then there will be a fixed exchange rate.

Next we derive the interest differential. Under the assumption of perfect capital mobility and risk neutrality it will be equal to:

$$i(t) - i^*(t) = \delta(t) = \frac{Edx}{dt} = \frac{\bar{x}(t) - \bar{f}(t)}{\alpha} = \quad (12)$$

$$= g(t) + \frac{A}{\alpha} (\alpha - a) (\exp(\lambda g(t)) - \exp(-\lambda g(t)))$$

That is the interest rate differential is the sum of the expected realignment plus the expected change in the exchange rate inside the band (the second term on the right hand side). These two terms will be negatively correlated because when the expectations of a realignment go up this devalues the exchange rate inside the band creating an expected appreciation inside the band. This second effect is increasing with the expected realignment because we are closer to the upper part of the band. This effect will also be stronger the higher the instantaneous variance of the expected realignment. The framework used in this chapter has the nice property that by adjusting the parameter a (that is directly related to the width of the band) the government chooses the magnitude of the expected devaluation inside the band.

We see that the response of the interest rate differential to a change in the expected realignment will be smaller than one (the value that has when there is a fixed exchange rate). The value of this response will be:

$$\begin{aligned} \frac{d\delta(t)}{dg(t)} &= 1 + (\alpha - a) \lambda A (\exp(\lambda g(t)) + \exp(-\lambda g(t))) = \\ &= 1 - \frac{(\alpha - a)}{\alpha} \frac{\exp(\lambda g(t)) + \exp(-\lambda g(t))}{\exp(\lambda g_0) + \exp(-\lambda g_0)} \end{aligned} \quad (13)$$

Given that the interest rate differential is less sensitive to the expectations of a realignment when a band is in place this effect will help reduce the variance of the interest rate differential. This effect is stronger the smaller is the parameter a , that is a wider band makes the interest rate differential less responsive to changes in the expected realignment.

Given that the interest differential is also a brownian motion its instantaneous variance will be equal to :

$$\sigma_{\delta}^2 = \frac{d\delta}{dg} * \sigma_g^2 \quad (14)$$

and it is also increasing with the parameter (a) . By increasing the width of the band the instantaneous variance of the interest rate differential will decrease.

The width of the band will be given by the exchange rate that prevails when the expected realignment is at its boundaries $(g_0$ and $-g_0$) taking into account the intramarginal interventions. We see that the higher is (a) the narrower the band will be because the monetary authority will be offsetting all of the shocks to the expected realignment. Next for each (a) we want to derive the asymptotic distribution of the deviations of the exchange rate from the central parity and the interest rate differential.

III. ASYMPTOTIC VARIANCES OF THE EXCHANGE RATE AND INTEREST RATES.

We have assumed that the expected depreciation behaves like a Weiner process with reflecting barriers, so its asymptotic distribution will be uniform on $(g_0, -g_0)$ (see Harrison (1985)).

The interest rate differential and the exchange rate inside the band are linear and exponential functions of the fundamentals, so their asymptotic distribution will be given by:

$$\begin{aligned} \text{Var}(\bar{x}) = & (\alpha - a)^2 \text{Var}(g) + A^2 (\alpha - a)^2 \text{Var}(\exp(\lambda g) - \exp(-\lambda g)) + \\ & + 2A(\alpha - a)^2 \text{Cov}(g, \exp(\lambda g) - \exp(-\lambda g)) \end{aligned} \quad (15)$$

and the asymptotic distribution of the interest rate differential is:

$$\begin{aligned} \text{Var}(\delta) = & \text{Var}(g) + \left(\frac{A}{\alpha}\right)^2 (\alpha - a)^2 \text{Var}(\exp(\lambda g) - \exp(-\lambda g)) + \\ & + \frac{2A}{\alpha} (\alpha - a) \text{Cov}(g, \exp(\lambda g) - \exp(-\lambda g)) \end{aligned} \quad (16)$$

Where $\text{Var}(z)$ is the asymptotic variance of variable z . In the appendix 3.A we show the derivation of these variances, here we just show the results:

$$\begin{aligned}
\text{EVar}(\bar{x}) = & (\alpha - a)^2 \frac{g_0^2}{3} + \frac{A^2}{2g_0\lambda} (\alpha - a)^2 (\exp(2\lambda g_0) - \exp(-2\lambda g_0) - 4\lambda g_0) + \\
& + 2A(\alpha - a)^2 \left(\frac{1}{\lambda} (\exp(\lambda g_0) + \exp(-\lambda g_0)) - \frac{1}{(\lambda)^2 g_0} (\exp(-\lambda g_0) - \exp(\lambda g_0)) \right)
\end{aligned}
\tag{17}$$

and the asymptotic variance of the interest rate differential will be equal to:

$$\begin{aligned}
\text{EVar}(\delta) = & \frac{1}{3} g_0^2 + \left(\frac{A}{\alpha} \right)^2 \frac{(\alpha - a)^2}{2\lambda g_0} (\exp(2\lambda g_0) - \exp(-2\lambda g_0) - 4\lambda g_0) + \\
& + \left(\frac{2A}{\alpha} \right) (\alpha - a) \left(\frac{1}{\lambda} (\exp(\lambda g_0) + \exp(-\lambda g_0)) + \frac{1}{(\lambda)^2 g_0} (\exp(-\lambda g_0) - \exp(\lambda g_0)) \right)
\end{aligned}
\tag{18}$$

The simulations will show that the exchange rate deviations asymptotic variance will be increasing with the width (smaller a) of the band and the interest rate differential asymptotic variance will be decreasing with the width of the band. The effect that minimizes the interest rate variability is due to the mean reversion that is present in the exchange rate inside the band, this effect is stronger the closer we are to the edges of the band. Next we show simulations of the interest rate differential and the exchange rate deviation asymptotic variances. To perform the simulations we assumed that the semi-elasticity of the money demand was 1 ($\alpha=1$), the bounds where the expectation of a realignment fluctuate is +/- 50% ($g_0=.5$) and the variance of this expectation will be equal to .07 ($\sigma^2=.07$ per year). These seemed plausible values for these countries experiences.

TABLE 1: WIDTH OF THE BAND AND ASYMPTOTIC VARIANCES OF EXCHANGE RATE DEVIATIONS AND INTEREST RATE

WIDTH	@VARER	@VARIR
0.15	0.01100	0.061
0.14	0.00900	0.062
0.12	0.00700	0.065
0.11	0.00500	0.067
0.09	0.00400	0.069
0.07	0.00300	0.071
0.06	0.00200	0.075
0.04	0.00100	0.077
0.03	0.00050	0.079
0.01	0.00045	0.081

Given that the marginal decrease in the interest rate asymptotic variance is almost constant and the marginal increase in the exchange rate deviation asymptotic variance is increasing with width of the band at an increasing rate, so at the beginning the increase in it when we start increasing the target zone is negligible. This makes us look for the optimal width of the target zone as the one that minimizes some linear combination of the asymptotic variability of the exchange rate and the interest rate.

IV. THE OPTIMAL TARGET ZONE.

If the government knows that it is not going to realign the central parities, the ex-post real interest will be highly

volatile. In this case the nominal interest variance will affect the variance of economic activity as well as the level of investment, according to theories of irreversible investment. Also this high variance in the real interest rate has potential to generate financial distress. The same arguments can be made for the behavior of the exchange rate. Because of this we assume that the governments objective will be to minimize some linear combination of the asymptotic variances of the exchange rate and the interest rate differential \bar{g} . Given that for the target zone width that we observe in Israel and Mexico the choice of width will not affect the realignment process (which is determined by fundamentals such as the inflation differential with its trading partners) I assume that by changing the width of the band the variance of the exchange rate deviations from the long run trend (defined by the process driving g) can change but not the trend itself. The central bank will choose the width of the band that minimizes the following expression.

$$\text{Min } L = \omega \text{Var}(\bar{X}) + (1 - \omega) \text{Var}(\delta) \quad (19)$$

Where ω is the weight in the welfare function that the government assigns to the exchange rate deviation asymptotic

\bar{g} / Even when common sense suggest that the importance that the monetary authority assigns to the asymptotic variance of the nominal exchange rate is higher than the one assign to the interest rate differential asymptotic variance we do not think this weights are $\{1,0\}$. So the optimal width is never 0.

variance. Substituting the asymptotic variance of the interest rate differential and the exchange rate, derived in the previous section, in equation (19) and solving for the optimal (a) will give us the optimal monetary policy and width of the band as a function of the model's parameters. This is worked out in appendix 3.B. Here I present charts of how the optimal width depends on the underlying parameters of the model. We show that the most important determinant of the optimal width of the target zone will be the instantaneous variance of the expected devaluation in relation to the range of variation of the expected realignment (g_0). The semi-elasticity of money demand will also matter but we don't think that there is much variation across countries in this parameter and I show that its influence is almost negligible. First when the instantaneous variance of the expected realignment is negligible we see that the optimal width of the band goes to zero, this is because the mean reversion in the target zone will be negligible, and the same will happen to the stabilizing effect of the target zone on the interest rate.

The optimal width of the band is an increasing function of the instantaneous variance of the expected realignment. When this variance is larger the expected change in the exchange rate inside the band is greater for any bandwidth, so the marginal effect of increasing the band width will be greater, this gives us a wider target zone.

Next I show how the optimal width of the band depends on the instantaneous variance of the expected realignment, the semi-elasticity of money demand and the limits of the expected realignment.

Figure 2 shows the optimal width as a function of the instantaneous variance of the expected realignment and the range where this expectation fluctuate (g_0). For the other parameters we assumed a semielasticity of money demand $\alpha=1$, and the weight that the government puts on the exchange rate deviation variance, $\omega=0.8$. The percentage reduction in the interest rate asymptotic variance compared with the one observed under fixed exchange rates is shown in parenthesis. We see that the optimal width is a non-linear and increasing function of the σ_g^2 , for all the range of parameters explored. For countries where this variance is around .05 and .11 the optimal target zone will be around +/-3% and +/-6%. This target zone will achieve a reduction of the interest rate asymptotic variance that is around 5% to 60%. What is important to determine the optimal width is the relation between the instantaneous variance and the bounds of fluctuation of the expected realignment. When this ratio is higher the target zone will be wider and a greater reduction in interest variability will be accomplished. Because the higher this ratio is the larger mean reversion inside the band is and we achieve a higher reduction in the interest rate

differential asymptotic variance for a given size of the band.

TABLE 2: OPTIMAL WIDTH AND RANGE OF FLUCTUATION OF FUNDAMENTALS

σ_{g2} g_0	0.05	0.07	0.09	0.11	0.13	0.15
0.30	0.040 (24%)	0.050 (37%)	0.060 (50%)	0.060 (60%)	0.060 (70%)	0.062 (77%)
0.50	0.027 (3%)	0.036 (7%)	0.046 (10%)	0.054 (15%)	0.062 (20%)	0.069 (25%)
0.70	0.020 (1%)	0.027 (3%)	0.035 (3%)	0.042 (5%)	0.049 (6%)	0.055 (8%)
0.90	0.016 (1%)	0.022 (2%)	0.028 (2%)	0.034 (2%)	0.039 (3%)	0.045 (3%)

In Figure 3 we show the optimal target zone as a function of α . We see that it is almost insensitive to changes in this parameter (the other parameters are $g_0=0.5$ and $\omega=0.8$). For a given monetary policy rule a higher α will give us a wider target zone. On the other hand a higher α increases the exchange rate volatility by more than it reduces the interest rate one so the authority will adjust its monetary policy more when g increases (a will go up). This second effect will work to reduce the width of the band. What I find is that for plausible parameter values these two effects will offset each other and the optimal target zone will be almost unresponsive to changes in α . The number in parenthesis is the percentage

reduction in the asymptotic variance of the interest rate compared to that observed under a fixed exchange rate.

TABLE 3: OPTIMAL WIDTH AND THE SEMIELASTICITY OF MONEY DEMAND

α	σ_g^2	.05	0.07	0.09	0.11	0.13	0.15
0.8		0.027 (3%)	0.037 (6%)	0.046 (10%)	0.054 (15%)	0.062 (20%)	0.069 (25%)
1.0		0.027 (3%)	0.036 (7%)	0.046 (10%)	0.054 (15%)	0.062 (20%)	0.069 (25%)
1.2		0.026 (3%)	0.036 (7%)	0.045 (10%)	0.054 (15%)	0.062 (19%)	0.069 (25%)
1.4		0.026 (3%)	0.036 (6%)	0.045 (10%)	0.054 (14%)	0.061 (20%)	0.061 (24%)

Finally Figure 4 shows the optimal width of the target zone when the weight that the government assigns to the exchange rate and interest variance changes. I get the obvious result that for a given σ_g^2 the width of the band is increasing in the weight the government assigns to the asymptotic variance of the interest rate. Increasing this weight from .1 to .6 increases the optimal width of the band 10 times. It seems plausible to assume that governments place a higher weight on the exchange rate deviation asymptotic variance than on the interest rate differential asymptotic variance.

Summarizing, the most important determinant of the target zone width is the instantaneous variance of the expected realignment in relation to the range of variation that the

expected realignment has. Increasing the instantaneous variance while keeping the range of variation fixed increases the optimal width of the band. Increasing the range but leaving the instantaneous variance constant decreases the optimal target zone. It is interesting to notice that if the concern for exchange rate variance by the monetary authority is higher than .6, the other parameters can be changed around as much as we like and we will always end up with a target zone that is between 3% and 10%, when it is a useful instrument.

TABLE 4: OPTIMAL WIDTH AND PREFERENCE TOWARDS EXCHANGE RATE VARIANCE

ω	σ_g^2	0.05	0.07	0.09	0.11	0.13	0.15
0.40		0.150 (17%)	0.190 (31%)	0.210 (42%)	0.230 (53%)	0.250 (63%)	0.250 (65%)
0.60		0.070 (9%)	0.090 (16%)	0.110 (23%)	0.130 (32%)	0.140 (40%)	0.150 (49%)
0.80		0.027 (3%)	0.036 (7%)	0.046 (10%)	0.054 (15%)	0.062 (20%)	0.069 (25%)
0.90		0.012 (2%)	0.016 (3%)	0.021 (5%)	0.025 (8%)	0.029 (10%)	0.033 (13%)

Next we turn to the Mexican and Israeli experiences to look for evidence of a reduction in the variance of the interest differential caused by the adoption of a target zone

at the end of 1991 in Mexico and at the beginning of 1989 in Israel.

V. MEXICO AND ISRAEL'S EXPERIENCES WITH A TARGET ZONE.

V.1 An Overview of the Mexican and Israeli Experiences.

By the end of 1987 inflation in Mexico reached 150% per year. At this time the authorities implemented a comprehensive stabilization plan. The important fiscal adjustment was supported by price controls and a fixed exchange rate. After a year with a fixed exchange rate the authorities decided to start a crawling peg for the exchange rate. The main reason was to reduce the rate of appreciation of the real exchange rate. After changing the rate of crawl a few times the government finally adopted a target zone in November of 1991. The floor of the band was fixed and the ceiling was devalued by .02 cents per day (equivalent to 2.4% per year). In October of 1992 the pace of crawl of the ceiling of the band was raised to .04 cents per day (equivalent to 4.5% per year). By the end of 1993 the width of the band was 9.4%.

The experience in Israel is similar. Following the stabilization plan of 1985 the New Israeli Shekel was fixed with respect to the U.S. dollar. This regime persisted with a few devaluations and a change from pegging the currency with respect to the dollar towards a basket of currencies. On January of 1989 the government adopted a target zone with a

fixed central parity and a 3% band around it. The width was increased to 5% in March of 1990. After five realignments the authorities decided to start a daily devaluation of the central parity at a rate of 9% per year. During this second period there were two minor realignments and also a reduction in the rate of crawl of the central parity.

Figures 1 and 2 show the evolution of the exchange rate and the target zone for the Mexican and Israeli case respectively.

Figure 1

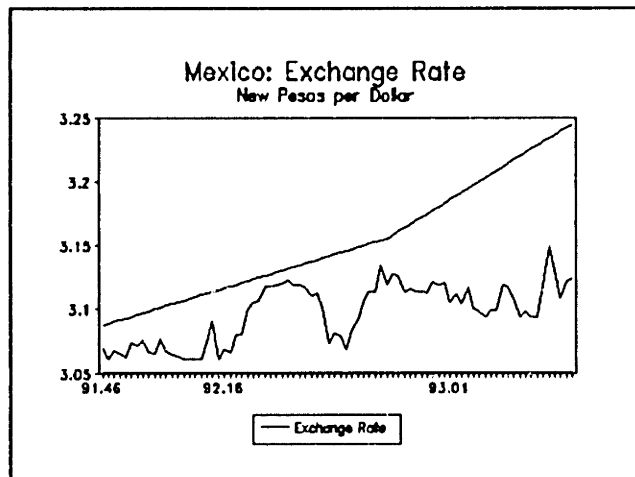
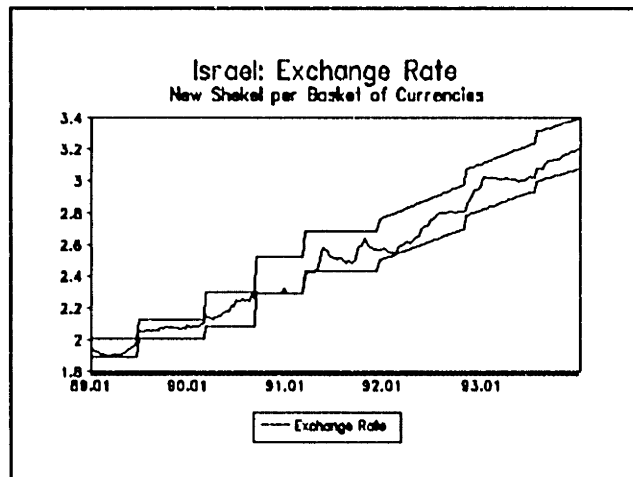


Figure 2



In what follows I will study the behavior of the interest rate differential and I will show that the target zone was a helpful device to reduce the interest rate variance.

V.2 Target zones and interest rate variability.

We first look at the process driving the interest rate differential in Mexico from 1990 to 1993. We want to see if the conditional variance (the variance of the prediction error) decreased with the introduction of the target zone. Even though the interest rate differential (adjusted by the announced devaluation) in a target zone is a complicated non-linear process, empirical evidence and a more realistic modeling of the intramarginal intervention suggests that an autoregressive structure is a suitable representation. We included a trend to account for the continuous increase in

confidence in the program that we observed during the period. We ran this regression with weekly observations of monthly interest rates and then estimate the variance of the errors. We did this for the periods 1990.01 to 1991.47 and 1991.48 to 1993.25, the first period covers a crawling peg period and the second one covers the time where the target zone has been in place. After doing this we ran a test to see if the decrease in the variance is statistically significant. We ran the interest rate as a function of itself lagged five times, a constant and a trend.

The results from this exercise are presented in Table 5 (I omit the coefficient on the trend) and point to a significant reduction in the conditional variability of the interest rate. The conditional variance goes down from $2.9e-08$ to $1.1e-08$ when the target zone is introduced. If we take the first 30 weeks of 1990 of the sample because in this period there is a big reduction in the interest rate differential that it is unrelated to the exchange rate regime (the foreign debt agreement), we still have a change in the conditional variance of the interest rate that is statistically significant. It is also interesting to notice that all the parameters in the regression are quite stable.

Table 5: Interest Rate Differential: Mexico

$$(i-i^*)_t = c + \beta_0(i-i^*)_{t-1} + \beta_1(i-i^*)_{t-2} + \beta_2(i-i^*)_{t-3} + \beta_3(i-i^*)_{t-4} + \beta_4(i-i^*)_{t-5}$$

Period:	c	β_0	β_1	β_2	β_3	β_4	SSR
1990.01	5.8	1.05	-.07	0.27	-.39	0.12	2.72e-06
1991.45	(1.2)	(10)	(-.6)	(2.0)	(-2.9)	(1.3)	
1991.46	0.0	1.10	-.17	0.37	-.47	.12	9.20e-07
1993.25	(1.5)	(9.7)	(-1.1)	(2.5)	(-3.0)	(1.1)	

F(SSR1/SSR2)=2.64

This exercise can be criticized on the grounds that since the two periods are different we might be capturing other effects that reduce the variability of the interest rate differential, besides the introduction of the target zone. Also there was no data available for Israel for the weekly interest rate for the period prior to 1989.

V.3 Target zones and Expected Realignment.

To see if the introduction of the target zone reduced the volatility of the interest rate differential we want to recover the expected realignment from the interest rate differential. If the exchange rate were fixed the interest rate differential would be equal to the expected realignment.

By comparing the variance of the interest rate differential and the expected realignment we will be able to see if the band help to decrease the volatility of the interest rate differential.

Remember that in a target zone the interest rate differential adjusted by the announced devaluation of the central parity is equal to the sum of the expected realignment plus the expected change of the exchange rate inside the target zone^{7/}.

$$\delta_r = g + \frac{E d\tilde{s}}{dt} \quad (20)$$

From here we can solve for the expected realignment:

$$g = \delta_r - \frac{E d\tilde{s}}{dt} \quad (21)$$

Now we need to estimate the expected change of the exchange rate inside the target zone, again following the literature ^{8/} we regress the observed monthly change in the logarithmic deviation of the exchange rate from the central parity ($er_{(t+4)} - er_t$) on a constant and on the logarithmic

^{7/} Although in the model developed in the paper we did not include a deterministic rate of devaluation of the central parity, this will not change any of the results. All the results in the paper will only shift by a constant.

^{8/} See Svensson and Bertola (1992) and Caramazza (1993).

deviation of the exchange rate from the central parity^{9/} (er_t). For the Israeli case I also included dummies for the different periods between realignments to account for changes in the credibility across regimes. The results for these regressions are shown next.

TABLE 6: Expected Change in the Exchange Rate Inside the Band

$$er_{(t+4)} - er_t = c + \beta_0 er_t$$

	c	β_0
Mexico	-0.00095	-0.4718
1991.46-1993.26	(-1.483)	(-4.635)
Israel	-0.01074	-0.6965
1989.01-1993.52	(-3.207)	(-12.334)

Source: Central Bank of Israel and Mexico

The coefficients for the dummy variables for each different band for the case of Israel are not reported^{9/} (They are significant for almost all the regimes). We see that in both countries the degree of mean reversion inside the band is very significant.

^{9/} The estimation of the expected change of the exchange rate inside the band is done under the assumption that no realignment takes place. Because of this for the case of Israel we drop the observations from the months before and after each realignment.

^{9/} Several specifications were tried and the results presented here were not changed.

With this estimates we can form the expected change of the exchange rate inside the band and subtracting this from the monthly interest differential adjusted by the announced devaluation of the central parity gives us a measure of the expected realignment (See equation 21). This helps us evaluate the conjecture that the band was not credible 10/.

In Figures 3 and 4 we plot the estimated expected realignment and the interest rate differential (For Mexico and Israel respectively). We see that throughout the period the expected realignment was fairly high and extremely volatile in both countries, more so in Mexico. We see that the expected realignment was more volatile than the interest rate, and that the movements of the exchange rate inside the target zone were really helpful in isolating the domestic short term interest rates from shocks to the expected realignment. This is a little surprising given the small size of the target zone, but when we look at the expected rate of change of the exchange rate inside the target zone for the following month, we realize that this is very high. Given that this expected change of the exchange rate has a negative correlation with the expected realignment the smoothing effect on interest rates is considerable.

10/ The estimation procedure does not incorporate the possibility that the expected future deviations of the exchange rate from the central parity cannot be greater than the width of the band. A logistic transformation that took this into account was tried and the results were similar to those reported here.

Figure 3

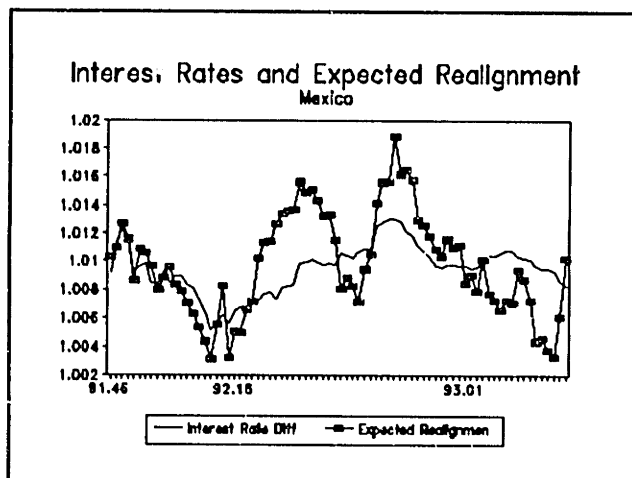
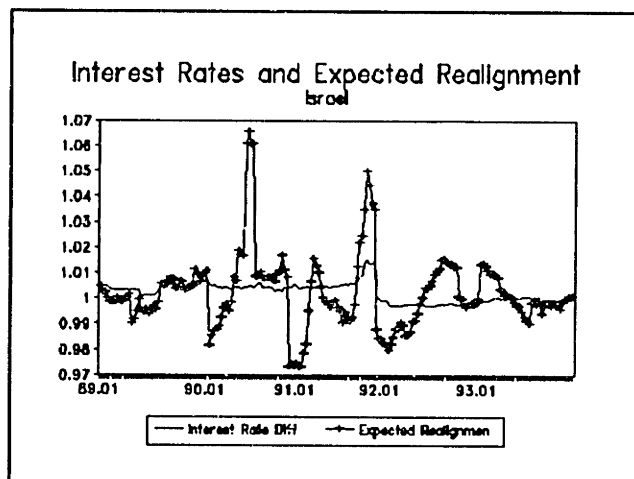


Figure 4



To confirm that the conditional variance of the expected realignment is higher than the interest rate differential variance we estimate the process driving the interest rate differential and the expected realignment as an autoregressive process for both countries (The results are shown in Tables 7

and 8)11/. When we do this we see that the estimated conditional variance of the interest rate differential for Mexico (Israel) is $2.8e-07$ ($1.9e-06$) and the variance of the expected realignment is $2.6e-06$ ($6.5e-05$). When we do an F-test we see that the differences are statistically significant (the value of the F-statistic for Mexico (Israel) is 9 (34)). This is additional evidence in favor of a target zone over a fixed exchange rate regime , because if a fixed exchange rate regime were in place the interest rate differential would be equal to the expected realignment. For larger maturities this effect will be reduced because the expected rate of change of the exchange rate in the band is limited by the size of the band. Then as the maturity of the interest rate differential increases the negative correlation between the expected realignment and the expected change of the exchange rate inside the band decreases.

Finally, if we compare the estimated conditional variance of the expected realignment for the Mexican case (during the target zone period) with the variance of the interest rate differential under the fixed exchange rate regime. We see that the variance of the expected realignment is higher. This supports the theory in disregarding the target zones as a useful device to reduce the volatility of the expected devaluation. We conclude that there is supporting evidence to

11/ Given that the lag-length differ in the estimated processes there are empty cells in tables 7 and 8.

the claim that the introduction of the target zone did not help to reduce the volatility of short run expected realignment.

Table 7: Expected Realignment

$$g_t = c + \beta_0 g_{t-1} + \beta_1 g_{t-2} + \beta_2 g_{t-3} + \beta_3 g_{t-4}$$

	c	β_0	β_1	β_2	β_3	SSR
Mexico						
1991.48	0.1143	0.88	---	---	---	0.000212
1993.25	(2.12)	(16.6)				
Israel						
1989.01	0.2289	0.94	-0.007	.007	-0.175	0.010108
1993.52	(5.48)	(13.2)	(-0.07)	(0.07)	(-2.43)	

Table 8: Interest Rate Differential

$$(i - i^*)_t = c + \beta_0 (i - i^*)_{t-1} + \beta_1 (i - i^*)_{t-2} + \beta_2 (i - i^*)_{t-3} + \beta_3 (i - i^*)_{t-4}$$

Period:	c	β_0	β_1	β_2	β_3	SSR
Mexico						
1991.46	0.08	1.09	-0.25	0.32	-0.24	2.25e-05
1993.25	(2.2)	(9.7)	(-1.5)	(2.0)	(-2.4)	
Israel						
1989.01	0.05	0.94	---	---	---	0.00029
1993.52	(2.4)	(39.7)				

Source: Bank of Israel and Banco de Mexico

VI. CONCLUSION.

This chapter developed a model of exchange rate determination where the only cause of fluctuations in exchange rates is the expectation of a realignment (discrete nominal devaluation). We assume that this expectations changes randomly but it is bounded between two values. Under this framework any rule for the money supply will determine a target zone for the exchange rate. I looked within the class of linear functions of the expected realignment for the one that minimizes some linear combination of the asymptotic variance of the exchange rate and the interest rate differential. The main conclusions from this exercise is that the optimal target zone will be increasing with the instantaneous variance of the expected realignment, decreasing with the limits within which the expected realignment fluctuates and not highly sensitive to changes in the semi-elasticity of money demand. The reduction in the interest rate differential due to the optimal currency band is in the order of 10% to 50%.

We then studied the Mexican and Israeli experience with a target zone the main results from the empirical study is that the target zone regime help to reduce the interest rate variability by absorbing part of the shocks to the expected realignment with movements of the exchange rate inside the band. We also showed that the variability of the

expected realignment did not go down during the period that the exchange rate was in place. So we conclude that the target zone is a useful exchange rate regime to reduce the variance of the interest rate differential but it does not help in reducing the volatility of the expectations of a realignment.

APPENDIX 3.A

Here I present the asymptotic variances of the functions that are needed to calculate the asymptotic variances of the exchange rate and the interest rate differential. The @var of the expected realignment g is uniform on $[g_0, -g_0]$.

$$\text{@Var}(g) = \frac{1}{g_0} \int_0^{g_0} g^2 dg = \frac{g_0^2}{3} \quad (22)$$

$$\text{@Var}(\exp(\lambda g) - \exp(-\lambda g)) = \frac{1}{g_0} \int_0^{g_0} (\exp(\lambda g) - \exp(-\lambda g))^2 dg = (23)$$

$$= \frac{1}{2g_0\lambda} [\exp(2\lambda g_0) - \exp(-2\lambda g_0) - 4\lambda g_0]$$

$$\text{@Cov}(g, \exp(\lambda g) - \exp(-\lambda g)) = \frac{1}{g_0} \int_0^{g_0} [g * \exp(\lambda g) - g * \exp(-\lambda g)] dg =$$

$$= \frac{1}{g_0} \left[\frac{g_0}{\lambda} (\exp(\lambda g_0) + \exp(-\lambda g_0)) + \frac{1}{\lambda^2} (\exp(-\lambda g_0) - \exp(\lambda g_0)) \right] \quad (24)$$

APPENDIX 3.B

Here I will derive the optimal width of the band as a function of the model parameters. In the text we assumed that the Central Bank minimizes:

$$L = \omega \text{EVar}(\bar{x}) + (1-\omega) \text{EVar}(\delta) \quad (25)$$

The first order condition will be:

$$\omega \frac{\partial \text{EVar}(\bar{x})}{\partial a} + (1-\omega) \frac{\partial \text{EVar}(\delta)}{\partial a} = 0 \quad (26)$$

Next I will define:

$$B = \text{ECov}(g, \exp(\lambda g) - \exp(-\lambda g)) \quad (27)$$

$$C = \text{EVar}(\exp(\lambda g) - \exp(-\lambda g))$$

Now we can write the partial derivatives in the first order condition as:

$$\frac{\partial \text{EVar}(\bar{x})}{\partial a} = -2(\alpha - a) \left[\frac{g_0^2}{3} + A^2 C + 2AB \right] \quad (28)$$

and

$$\frac{\partial \text{EVar}(\delta)}{\partial a} = -(\alpha - a) \left[\frac{2A^2}{\alpha^2} C \right] - \frac{2AB}{\alpha} \quad (29)$$

From the first order condition we can solve for the optimal a :

$$a = \alpha + \frac{\frac{2(1-\omega)AB}{\alpha}}{\frac{2\omega g_0^2}{3} + 2A^2C\left(\frac{\alpha^2\omega + (1-\omega)}{\alpha^2}\right) + 4\omega AB} \quad (30)$$

Plugging this value of a in equation 11 in the text and evaluating it at $g=g_0$, I obtain the optimal width of the band.

CHAPTER 4

BUILDING CONSENSUS FOR STABILIZATIONS

I INTRODUCTION:

The literature on stabilization policies puts forth two reasons for why a stabilization might fail (Dornbusch (1991)). First, the "wrong policies" are undertaken (for example, price controls) and second, after the program is implemented the realization of certain variables relevant to the success of the program turn out to be unfavorable. No arguments have been made as to why a rational government might want to implement the wrong policies, so these episodes are usually explained by government ignorance.

The stabilization attempts that were made by weak governments in the 1980's often followed a two stage approach. In the first stage, a nominal anchor is established (a fixed exchange rate and/or some price controls) and some partial and temporary measures are adopted. Sometimes, during this first stage the government achieves a balanced budget. However, this is accomplished through temporary measures (i.e. using the proceeds from privatizations or postponing expenditures) and there is no consensus on how to distribute the burden of stabilization. In the second stage, which may take several years or in fact never occur, the rest of the fiscal adjustment is carried out. Generally, this implies a broad fiscal reform that includes an increase in tax revenues and a drop in current expenditures. This creates a situation where all the programs will look similar at the beginning; some of

them will turn out to be successful (the ones that are able to complete the second stage) and others will fail. The stabilization attempts in Argentina and Brazil during 1985 1/, and the 1990 Argentine plan provide good examples of this kind of stabilization. The first two experiences succeeded in bringing inflation down in the short run by fixing the exchange rate and using price controls, however, the correction in the budget deficit was not sufficient at the time (see Dornbusch and Fischer (1987), Kiguel and Liviatan (1992) and Cardoso (1991)). Both plans ended in disaster. The Argentinean 1990 plan started by fixing the exchange rate; this was the key measure at the early stages of the plan. The plan was even named after this measure. Later on, some fiscal adjustment began to be implemented. Even today, the government still relies on privatization revenues to finance some of its expenditures, but the progress on the fiscal side is undeniable.

Why do governments initiate stabilization plans that are incomplete with the expectation of being able to accomplish the rest of the fiscal correction after the program is underway?. There have been different answers to this question, the usual reason given is the lack of political support, or that the government does not know the size of the adjustment

1/ For a detailed description of these plans see Bruno, Di Tella, Dornbusch and Fischer (1988).

that is needed or that governments always overestimate the Tanzi effect. (See De Gregorio (1991)).

This issue deserves further study. The chapter develops a model where under some conditions, the first stage policies (i.e. the "wrong or temporary policies") are a necessary condition for the implementation of the second stage (i.e. the fiscal reform). In essence, these "wrong policies" can generate enough public support for the harder to implement fiscal adjustment. Given this two-stage approach, the model provides an explanation for why a rational government would follow these policies. We also study what conditions are needed to implement the fiscal reform after the first stage has already been put in place. In this framework, the two reasons used to explain the failure of a stabilization mentioned in the opening paragraph turn out to be the same because, whether the fiscal reform is carried out or not depends on the realization of some exogenous variables that become known to the policy maker after the implementation of the first stage.

The model highlights the conditions that drive some countries to attempt these two-stage stabilization programs. It also provides an explanation to another strange phenomena that is observed in some high inflation countries; that is the willingness of the authorities to further increase the inflation rate with the purpose of increasing its international reserves that will be used later in a

stabilization attempt 2/. Finally, the effect of uncertainty on the decision of the government to abandon these plans is studied.

In the model a stabilization is defined as a shift to a less distortionary means of taxation 3/, for example, a move from the inflation tax to other kinds of taxes. This change in the form of taxation will entail a redistribution of the burden of taxation across individuals. In addition, there is an aggregate benefit from the reduction in the distortions. The magnitude of this benefit will be known in the aggregate, but each individual will have uncertainty about how large their personal benefit will be. A stabilization will take place if a majority of people want to support it. This framework, taken from Fernandez and Rodrik (1992), has the characteristic that there might be parameter values where a stabilization will benefit a majority but it will still not be implemented because people vote according to the expected benefits and not their actual benefits. The implication is that governments might find it impossible to start a fiscal reform right away.

If the government fixes the exchange rate, the tax and the distortions disappear and everyone will be in favor of this policy. The government can sustain this situation as long as

2/ For example Mexico in 1987.

3/ The same approach is taken in Alesina and Drazen (1992).

its international reserves permit it. However, if by generating this temporary stability some people learn what their situation will be under a stable environment, this temporary stabilization can achieve the necessary consensus to implement the fiscal reforms. An important result is that a simple form of learning by individuals provides a very plausible explanation for the evolution of the support that the program receives. The model predicts a big increase in the support for the program right after the exchange rate is fixed then increases gradually, and eventually reaches the level that is needed to introduce the fiscal reform. This pattern was documented for the Brazilian experience by Pechman, Grandi and Marins (1989) and by Dornbusch and De Pablo (1988) for Argentina. The model has the characteristic that if a government takes this two stage approach, it will wait until it has a large enough level of international reserves to implement it.

Finally, if the government is uncertain regarding how much time it needs to generate the consensus for a reform, we might see programs that follow a two stage approach and eventually fail. These programs are reasonable even though they will look totally incomprehensible ex-post. The introduction of uncertainty also provides a motive for the government to abandon the program when it suffers a series of negative shocks, only to try again at a later date. The decision to abandon the program is studied, and this decision will be

sensitive to the degree of uncertainty regarding the time needed to generate the support to implement the fiscal reform. Increasing the degree of political uncertainty will lower the probability of success of the program. Another variable that has a positive effect on the probability of failure of the program, is the short run cost of the stabilization attempt. Countries that have stronger unions and less developed financial markets might suffer more during the period were the final stabilization is uncertain, this induces governments to quit these programs earlier. Finally the cost that the government incurs when it abandons the plan has a positive correlation with the probability of success of the program.

II. THE MODEL

II.1 Political support for a fiscal reform.

The static model is a variation of the argument made by Fernandez and Rodrik (1992). Until $t=0$, the government budget is balanced; at $t=0$ a shock hits the economy reducing the available tax revenues and the government starts using distortionary taxation (i.e. the inflation tax). The government has to levy a real amount, d , through the inflation tax to balance the deficit. We assume that there is a continuum of tax payers on $[0,1]$ and they each pay the same amount τ . In addition, each individual, i , suffers a utility loss due to distortionary taxes equal to:

$$K(i) = \theta_i \quad (1)$$

The flow utility of an individual will be linear in consumption and this cost.

$$U(i) = C_i - K_i \quad (2)$$

Individuals maximize utility subject to their budget constraint.

$$\text{Max } \int_0^{\infty} e^{-\pi t} U(i) dt \quad (3)$$

$$\text{s.t. } \int_0^{\infty} e^{-\pi t} C_t = \int_0^{\infty} e^{-\pi t} (Y_t - \tau_t)$$

Since flow utility is linear in consumption and we set the interest rate equal to the discount rate, we choose the path of consumption where individuals consume all their disposable income in each period.

$$C_t(i) = Y_t(i) - \tau_t(i) \quad (4)$$

A stabilization implies a switch to less distortionary taxation, and the burden of taxation will be divided unequally among the two groups that comprise the total population. Group 2 represents a fraction μ of total population, and group 1 a fraction $(1-\mu)$. Each individual, i , will be paying $\tau\alpha$ if he is in group 2, and $\tau(1-\alpha\mu)/(1-\mu)$ with $\alpha < 1$ if he is in group

1. Also, we assume that a stabilization lowers the deadweight loss for each individual. The deadweight loss after the fiscal reform takes place will be:

$$K_i^s = \theta_i^s \quad (5)$$

The change in each individual's instantaneous utility (that is proportional to lifetime utility by a factor $1/r$) will be the following depending on which group he is a member of:

For group 1 (losers)

$$\Delta U^1 = \frac{\tau [\mu (\alpha - 1)]}{1 - \mu} + \theta_i - \theta_i^s \quad (6)$$

For group 2 (winners)

$$\Delta U^2 = \tau (1 - \alpha) + \theta_i - \theta_i^s \quad (7)$$

Where the change in the distortion for each individual will be uncertain (there will not be uncertainty at the aggregate level). I assume that this change will be distributed according to some density function $f(\Delta\theta)$ 4/, the expectation of $\Delta\theta$ will be positive and is equal to the average benefit of stabilizing.

At time $t=0$, group 2 will always favor a reform because they will be paying less taxes and in addition the expected reduction in the distortion is positive. Given that there is

4/ The distribution of $\Delta\theta$ is the same for all the individuals.

individual uncertainty regarding the magnitude of the drop on θ_i from θ_i to θ_i^s before the reform, group 1 will favor the reform only if $E_i \Delta U^1 > 0$. We assume that this is not the case.

$$E(\Delta U^1) = \frac{\tau [\mu (\alpha - 1)]}{1 - \mu} + E(\theta_i - \theta_i^s) < 0 \quad (8)$$

We will assume that if people knew their θ_i^s there would be a majority of people favoring the reform. We develop the conditions for this to hold next. There exist values for $(\theta_i - \theta_i^s)$ such that:

$$\frac{\tau [\mu (1 - \alpha)]}{1 - \mu} = (\theta_i - \theta_i^s)_{\min} = \Delta \theta_{\min} \quad (9)$$

$$\tau (\alpha - 1) = (\theta_i - \theta_i^s)_{\max} = \Delta \theta_{\max} \quad (10)$$

if $\Delta \theta_i > \Delta \theta^{\min}$, then an individual of the group that loses (group 1) is in favor of the reform, and if $\Delta \theta_i > \Delta \theta_{\max}$ an individual of the group that is favored by the reform will support it. The fraction of people that would favor the reform if they knew their true costs is $1 - F(\Delta \theta_{\min})$ in group 1 and $1 - F(\Delta \theta_{\max})$ in group 2, where F is the cumulative density function associated with the pdf, f , introduced earlier. So, if:

$$(1 - \mu) F(\Delta \theta_{\max}) + \mu F(\Delta \theta_{\min}) < \frac{1}{2} \quad (11)$$

then the stabilization would be implemented as long as there were no individual uncertainty. This implies that there might be parameter configurations where the majority and the

average individual would benefit if a reform took place, but due to individual uncertainty the reform is not implemented. If we assume that $\Delta\theta$ is distributed normally with a positive mean, then when equation (11) holds it will set a minimum level for the variance of $\Delta\theta$, such that if the variance of $\Delta\theta$ is greater than this level the stabilization will take place in the absence of individual uncertainty.

The next section considers an alternative faced by a government, to temporarily suspend distortionary taxation by fixing the exchange rate and finance the deficit using international reserves. By creating an environment that resembles a permanent stabilization people will learn their true cost from living in an inflationary environment and this might generate an increase in the support the program receives.

II.2 An Exchange Rate Freeze.

First, we include some monetary considerations into the model. We assume Purchasing Power Parity^{5/} and a simple demand for money.

^{5/} This assumption is not realistic but simplifies the analysis and captures the point that it is still valid with some degree of wage inertia, that there is a sudden drop in the inflation rate when the exchange rate is fixed.

$$M - s = \bar{m} - \delta\pi \quad (12)$$

Where M is the log of the nominal quantity of money, s the log of nominal exchange rate and π is the inflation rate. Given that prior to the reform the government will be financing its deficit by printing money, the inflation rate will be determined by:

$$\pi = h(\bar{m}, \tau) \quad h_m < 0, \quad h_\tau > 0 \quad (13)$$

The function h will give us the inflation rate as a function of τ and m . If the government fixes the exchange rate the inflation rate will immediately drop to zero, due to purchasing power parity, and we know that everybody will support the fixed exchange rate given that the inflation tax and the distortion that it causes will disappear 6/. The government will only be able to maintain this situation as long as its international reserves are positive. This will be determined by the usual speculative attack argument that when reserves run out the exchange rate will start floating, and at this time the exchange rate cannot jump. Next, we derive the timing of the attack.

During the fixed rate period inflation will be zero so real money demand will be constant at m . The government will

6/ The public will also be willing to accept a partial increase in taxes, given that the inflation tax disappeared. We do not follow that route here to preserve the model as simple as possible, but the results do not depend on this difference.

be financing its deficit by money creation so reserves will be declining at a rate equal to the budget deficit. At the time of the depletion of reserves the inflation rate jumps from zero to the level it had before the exchange rate was fixed. When the exchange rate collapses (t^*) the following must be true:

$$D_0 + \tau t^* = \bar{m} + \bar{s} - \delta \pi \quad (14)$$

Where D_0 is the level of domestic currency at the time when the exchange rate was fixed and s the level at which the exchange rate was set. Solving for t^* we get:

$$t^* = \frac{\bar{m} + \bar{s} - \delta \pi - D_0}{\tau} = \frac{\bar{m} + \bar{s} - \delta \pi - M_0 + R_0}{\tau} \quad (15)$$

This determines the maximum amount of time that the government has to generate a majority to support the program. The model predicts on the monetary side, that when the fixed rate is announced we will see a drop in nominal interest rates and an increase in international reserves. From then on a continuous depletion of reserves begins.

II.3 Learning and political support for the program

Now we assume that when the government fixes the exchange rate people start learning what their true cost of living in an inflationary environment is (their $\Delta \theta_i$). We assume that when the exchange rate is fixed prices stop rising and people

start observing what their situation will be. We assume that people observe their situation at each point in time with an error, the variance of the average error of observation will decline as time goes by. Given this they will form the expectation of the change in θ with the average observed after the exchange rate has been fixed and their knowledge of the distribution for the change in θ . The average observed for the change in θ when the exchange rate is fixed for T periods will be:

$$\Delta\theta_i^o(T) = \Delta\theta_i + \frac{\epsilon_T}{T} \quad (16)$$

Where:

$$\epsilon_T \sim N(0, \sigma^2 T) \quad (17)$$

This means that the errors of observation at each point in time are independent and the variance of the instantaneous error of observation is σ^2 . The agents will observe their true change in cost plus a term that represents the error of this observation. We are assuming that the information gets more precise as time goes by. The parameter σ will depend on how fast the economy adjust to the new zero inflation equilibrium, so we think that this parameter will be smaller when stabilizing hyperinflations than when programs are enacted to fight inflations in the 100%-200% range. This is due to the fact that relative price misalignment is higher in high inflation countries than in counties that suffered a

hyperinflation 2/. Because of this when there is a price freeze in the latter case the economy is closer to the true relative price structure than in the former case. This might explain why Bolivia achieved a permanent fiscal reform a few months after the exchange rate was stabilized in 1985 and why it was so difficult for countries fighting lower inflations. Given that we have assumed that $\Delta\theta_i$ is distributed normally with mean $\Delta\theta$ and variance σ_θ^2 across the population, then the expectation that minimizes the mean squared error at time T , for individual i of his change in utility will be given by:

$$E(\Delta\theta_i(T)) = (1-\delta(T))\Delta\theta + \delta(T)\Delta\theta_i \quad (18)$$

Where:

$$\delta(T) = \frac{\sigma_\theta^2}{\sigma_\theta^2 + \frac{\sigma^2}{T}} = \frac{\sigma_\theta^2 T}{\sigma_\theta^2 T + \sigma^2} \quad (19)$$

This expectation will be a weighted average of the two sources of information, the mean of the distribution where the change in θ is taken from, and the observed change in θ . We start using the new information (the observed $\Delta\theta$) gradually as it becomes more precise, so our expectation starts changing quite fast at the beginning, when the new information is being incorporated. After a few periods we almost reach a situation where everybody knows how their utility has changed with

2/ For empirical evidence that supports this claim see Tomassi (1992) and references in that paper.

certainty. When the observations of the change in θ after the exchange rate is fixed are very noisy, it takes longer for them to be incorporated into the optimal projection.

Next, we want to see how the support for the fiscal reform evolves once the government fixes the exchange rate and this learning process starts. We know that once the exchange rate is fixed an individual will support the fiscal reform if the following conditions hold:

$$\text{For group 1 } E\Delta\theta_i > \frac{\tau\mu(1-\alpha)}{1-\mu} \quad (20)$$

$$\text{For group 2 } E\Delta\theta_i > \tau(\alpha-1) \quad (21)$$

Substituting equation (18) in (20) and (21) these conditions imply that the observed average change in their cost due to high inflation, θ , during the time that the exchange rate is fixed, needed for an individual to support the fiscal reform should be:

$$\text{For Group 1 } \Delta\theta_i^o > \frac{1}{\delta(T)} \left[\frac{\tau\mu(1-\alpha)}{1-\mu} - (1-\delta(T))\Delta\theta \right] = \Delta\theta^1 \quad (22)$$

$$\text{For Group 2 } \Delta\theta_i^o > \frac{1}{\delta(T)} \left[\tau(\alpha-1) - (1-\delta(T))\Delta\theta \right] = \Delta\theta^2 \quad (23)$$

Finally we know that for each group of people with the same $\Delta\theta_i$, they will observe different signals. The observed change in θ at time T is distributed normally with mean $\Delta\theta_i$ and variance σ^2/T . Once the government fixes the exchange rate the fraction

of people that support the fiscal reform at time T will be given by:

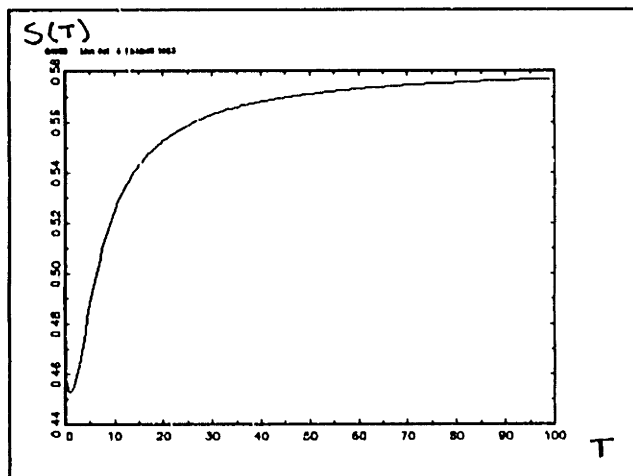
$$S(T) = \mu \int_{-\infty}^{\infty} f(\Delta\theta_i) \left[\int_{\Delta\theta^0}^{\infty} g(\Delta\theta^0) d\Delta\theta^0 \right] d\Delta\theta_i + (1-\mu) \int_{-\infty}^{\infty} f(\Delta\theta_i) \left[\int_{\Delta\theta^0}^{\infty} g(\Delta\theta^0) d\Delta\theta^0 \right] d\Delta\theta_i \quad (24)$$

Where $S(T)$ is the proportion of the population that supports the fiscal reform, $f(\Delta\theta)$ is the normal density function with mean $\Delta\theta$ and variance σ^2_{θ} , and $g(\Delta\theta)$ is the normal density function with mean $\Delta\theta_i$ and variance σ^2/T . The first term on the right hand side will be the support coming from the people that benefitted from the reform and will be decreasing in time because $\Delta\theta^2$ is increasing in time. The second term on the right hand side is the support from the sector of the population that ends up paying higher taxes, this is increasing in time and will outweigh the first effect as we show in the simulations. Whenever $S(T)$ is greater than one half there will be a majority that supports the program. So we will call T^* the time where this happens ($S(T^*)=1/2$), we know that when $t^*>T^*$ a program that starts by fixing the exchange rate will be successful, because before the speculative attack takes place the fiscal reform is done.

Figure 1 and 2 present simulations of equation (24) under two different assumptions for the value of σ^2 . I assume that the fraction of the population whose burden of taxation decrease when the fiscal reform is done is 40% ($\mu=.4$), the variance of the distribution of the change in the welfare

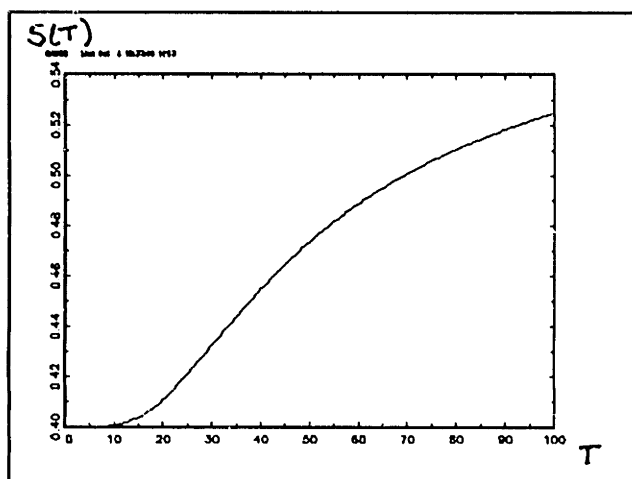
costs of taxation is $\sigma_{\theta}^2=.09$ and the variance of the error of observation is $\sigma^2=\{.3,.9\}$ in Figure 1 and 2. Before the program starts there is 40% of the population that supports a fiscal reform because everybody in group 1 supports it and no one in group two does. We show how the proportion of the population that supports the reform changes after the government fixes the exchange rate. For the case where the observations are very precise (Figure 1) we see that immediately after the exchange rate is fixed there is a jump in the support for the fiscal reform, this jump will be higher for the case where the error of observation has less variance. This is because as information is more precise it gets incorporated faster. After this there is a brief period where this support comes down when the people that thought that they would get benefits from the stabilization start realizing that this is not going to be the case, but this is only the case of a very small fraction of the population. After this the support for the program gradually starts to increase again and eventually goes over 50%, this happens sooner when the variance of the noise is smaller, if we reduce this variance even further we get that the fiscal reform will be done almost immediately after the government fixes the exchange rate. This will explain why countries that stabilized hyperinflations like Bolivia were able to achieve a fiscal reform quite fast as opposed to the actual argentinean case (which has taken over two years).

Figure 1: Political Support after the Exchange Rate is fixed
(Low Variance of the Observational Error)



When the observations of $\Delta\theta_i$ are less precise (Figure 2) we see that there might be a period where information accumulates but it does not change the fraction of the population that supports the fiscal reform. After this period the support starts increasing rapidly and eventually it slows down.

Figure 2: Political Support After the exchange rate is fixed
(High Variance of the Observational Errors)



Until now the model explains why we observe these two-stage programs, why their implementation is delayed until the "right circumstances"^{8/} are in place, and it also explains the determinants of the time spent between the fixing of the exchange rate and the time the fiscal reform takes place. Next, we summarize the most important implications of the model.

a) Countries where the distribution of the tax burden is significantly changed when a stabilization takes place and where the benefits from stabilizing are distributed in a highly unequal way will follow a two-stage stabilization

^{8/} It is clear that to start this kind of program the government needs an important amount of foreign exchange reserves. For an alternative reason for delayed stabilizations see Alesina and Drazen (1992).

program. Countries where this does not hold will do it all at once.

b) If a country follows a two stage program, then the stabilization will be delayed until the level of reserves guarantees a successful program.

c) Once the first stage has started the fiscal reform will be delayed longer whenever i) A smaller fraction of the group that pays higher taxes will benefit from the reform, ii) the less precise the information on the benefits of the reform, is during the first stage of the program (a larger σ) and iii) the smaller the fraction of the population that sees its tax burden reduced.

II.4 Creating the right circumstances for the program.

Next we use the model to explain another situation that has been observed in some stabilization attempts. We have seen some countries that have a high inflation rate pursue inflationary policies to accumulate reserves that will later be used in a stabilization program 9/. At first sight, this seems totally ridiculous but in light of the previous model, it seems that it might be a good idea given that a program, can only be started when there is some crucial level of

9/ The Mexican program of December 1987 is a good example. Although the program did accomplished a substantial fiscal reduction we still use the argument of the paper on the grounds that the sustainability of the program was uncertain.

reserves. In this case, it might be beneficial to accumulate these reserves at the cost of higher present inflation to start a successful stabilization in the future.

In the previous section we had that t^* was the time that the government has before a speculative attack happens, and T^* was the time needed to generate the consensus for a fiscal reform. Whenever $t^* > T^*$ a program that started by fixing the exchange rate today will be successful. When this is not the case the government has the alternative of increasing the inflation rate, if it is on the good side of the inflation tax Laffer Curve, and generate a surplus that will be used to accumulate international reserves, at the following rate :

$$\frac{dR}{dt} = \Lambda(\Delta\pi) \quad \text{where } \Lambda' > 0, \Lambda'' < 0 \quad (25)$$

Where Λ is a function that gives us the increase in revenues due to an increase in the inflation rate. The government will have to maintain this increase in the inflation rate for a period of time to generate the reserves that it needs, i.e the one that makes the time the government has before a speculative attack equal to the time needed to generate support for the program ($T^*=t^*$). So we substitute T^* in place of t^* in equation (15) and solve for R^* , the level of reserves needed to generate the support for the reform.

$$R^* = \tau T^* - \bar{m} - \bar{s} + \delta\pi + M_0 \quad (26)$$

This implies that the increase in the inflation rate will be maintained for a period of length t^* , where:

$$t^* = \frac{R^* - R_0}{\Lambda(\Delta\pi)} \quad (27)$$

If the government follows this strategy it will increase the average distortion in the economy during this period. The first stage will then last T^* , after which we will have a permanent reduction in the distortion. The value for the government of following this policy will be:

$$V = \int_0^{t^*} e^{-\mu t} \Delta\theta(\Delta\pi) dt + \int_{t^*}^{\infty} \Delta\theta_1 e^{-\mu t} dt \quad (28)$$

Where $\Delta\theta(\Delta\pi)$ is the increase in the distortion coming from increasing the rate of inflation and $\Delta\theta_1$ is the decrease in the distortion when the fiscal reform is done (it is also the decrease in the distortion when the fixed exchange rate is introduced). Equation (20) can be simplified to:

$$V = \frac{\Delta\theta(\Delta\pi)}{\mu} [1 - e^{-\mu t^*}] + \frac{e^{-\mu(t^*)}}{\mu} \Delta\theta_1 \quad (29)$$

The government will maximize the value of this policy by choosing the increase in the inflation rate according to:

$$\text{Max } V \quad \text{s.t. } \Delta\pi > 0 \quad (30)$$

The first order condition for this problem will be:

$$\frac{dV}{d\Delta\pi} = \frac{d\Delta\theta}{d\Delta\pi} \frac{1-e^{-\mu^*}}{\mu} + \frac{R^* - R_0}{(g(\Delta\pi))^2} g'(\Delta\pi) e^{-\mu^*} (\Delta\theta_1 - \Delta\theta(\Delta\pi)) \leq 0 \quad (31)$$

$$\Delta\pi \geq 0$$

If the first order condition is negative when evaluated at zero the government will chose not to increase the inflation rate, However, when the FOC is positive when evaluated at zero, the government will chose to increase the inflation rate up to the point where eq (23) holds as an equality. So, when the marginal cost of increasing the inflation rate is small and the marginal revenue from the inflation tax is still high the government will chose to increase the inflation rate and accumulate international reserves that will later be used in a successful stabilization program. Being on the good side of the inflation tax Laffer Curve is a necessary condition but not a sufficient one for this to occur. The next section introduces political uncertainty as one of the reasons why a program that starts by fixing the exchange rate might fail.

III UNCERTAINTY AND STABILIZATION:

Until now, we have been assuming that the time where the speculative attack takes place and the time needed to generate

a consensus are known to the policy maker. In reality both of these variables are stochastic, the first due to changes in international reserves that are not related to increases in domestic credit, and the second because of uncertainty in the political process (i.e. the government does not know with certainty the percentage of people needed to implement the policy).

To simplify the analysis we will assume that the government will be uncertain regarding the time needed to generate the support for the fiscal reform, the expectation at the beginning of the program will be the one derived in the previous section (T^*). This is a sensible assumption given the uncertainty that is inherently present in the political process. On the other hand, for simplicity we assume that the government only starts the program when it has the financial support that will provide the government with the foreign exchange needed to maintain the exchange rate fixed at a certain cost. This is equivalent to ruling out the fall of the exchange rate due to a speculative attack. In addition to this we assume that when the exchange rate is floating the government has an instantaneous probability ω of getting the financial support to start the program. We will define a new variable J that is equal to the time needed to generate the support for the program if a stabilization program is under way, or in the case where it is not under way, this variable indicate the value that it would take if we were to start a

program right now. This variable will follow the following process:

$$dJ = -idt + \gamma idz \quad (32)$$

As we already stated the value that J takes at the start of the program is T^* . Where z is a Wiener process, $i=1$ or 0 depending on whether we have started the first stage or not. When the government fixes the exchange rate, J decreases at rate -1 , additionally we have a shock, with instantaneous variance γ , that comes either from deviations in the process of learning described in the previous section or comes from changes to the percentage of the population needed to achieve the fiscal reform, this could be due to coalitions that are formed after people learn their $\Delta\theta$. On the other hand we assume that if the government has not started a program then the instantaneous probability of getting the financial support for the program is ω . So we will have two kinds of uncertainty, one coming from the political process which can only be resolved if a program is currently in place and the other one coming from the uncertainty of the financial support for the program. We assume that when the government starts the first stage of the program it will incur a cost per unit of time that will consist of two parts, the first will be proportional to the time needed to generate the support and the second will be constant, this represents the cost of financing the program and the costs that the economy suffers

due to the uncertainty of the program. Finally, we assume that when the government quits a program the expectation of the time needed to generate the support for the program will go back to the original one, i.e. all the learning that took place during this program and the shocks that occur will have no effect on future programs^{10/}.

The value for the government of being in the first stage of the program with a certain value of J will be called V(J) and will be equal to the expected benefits from the program^{11/}. It will evolve according to:

$$rV(J) = -c - kJ - V'(J) + \frac{\gamma^2}{2} V''(J) \quad (33)$$

The left hand side is the loss due to discounting when we are in the program during an interval dt, this should be equal to the last two terms on the right hand side that represent the benefits of being in the program that are equal to the expected change in the value function coming from the expected change in J. The first two terms on the right hand side are the flow cost of being in the program; the first is a constant component and the second is increasing in J. This represents

^{10/} This assumption is done only to simplify the model and avoid having an extra state variable. Allowing some of the support gained to stay will increase the probability of failure of the initial programs and increase the probability of success of additional programs. The results of the paper are not dependent on this assumption.

^{11/} This function will be equal to:

$$V(J) = E \left[\int_0^J (-c - kt) dt + e^{-rJ} \Delta \theta \right]$$

the fact that when the time needed to generate the support for the fiscal reform is longer, the probability of achieving it goes down and this imposes a higher cost on the stabilization due to high long term interest rates and the cost of foreign funds to maintain the exchange rate.

When the government has not implemented stage one yet, the value function ($W(J)$) will satisfy:

$$rW(\bar{J}) = \omega(V(\bar{J}) - W(\bar{J})) \quad (34)$$

When the exchange rate is not fixed the time needed to generate the support for the fiscal reform is fixed at $J=T^*$, so the right hand side of eq (34) is the loss due to discounting and the right hand side is the expected gain from the possibility of getting financial support for the program and start at stage 1. We can rewrite eq (34) as:

$$W(\bar{J}) = \frac{\omega}{\mu + \omega} V(\bar{J}) \quad (35)$$

Next, we will study the decision to abandon a program assuming that when the government decides to quit the attempt it will incur a fix cost of abandoning the program (R) this cost represents the political cost of abandoning the program and decreasing the government's credibility. Because the government faces a fixed cost of quitting the program the optimal policy for deciding when to quit if the program has not succeeded will be to choose a value of J (call it J^*) such

that if J ever goes above J^* it quits the program. The conditions that determine J^* are:

$$V'(J^*) = 0 \quad V(J^*) = W(\bar{J}) - R \quad (36)$$

The first condition is the smooth pasting condition that equates the marginal value of staying in the program to the marginal benefit of abandoning it, that is zero (because the value of not being in stage one is independent of the value of J at which we quit stage one). The second condition is a value matching condition and comes from the continuity of the value function of the government at the value of J where it decides to quit the program. At the time of the switch the utility will be the same if it stays in or if it goes out. When it quits it changes the utility of being in stage one for the utility of being outside a program and for this it pays a fixed cost of R .

The solution to the differential equation (33) will be:

$$V(J) = \frac{k}{r^2} - \frac{c}{r} - \frac{k}{r}J + Ae^{\lambda_1 J} + Be^{\lambda_2 J} \quad (37)$$

Where:

$$\lambda_1, \lambda_2 = \frac{1 \pm \sqrt{1 + 2r\gamma^2}}{\gamma^2} \quad (38)$$

Given this we can write the value matching condition and the smooth pasting conditions as:

$$V'(J^*) = -\frac{k}{r} + \lambda_1 A e^{\lambda_1 J} + \lambda_2 B e^{\lambda_2 J} = 0 \quad (39)$$

$$V(J^*) = \frac{\omega}{\mu + \omega} V(\bar{J}) - R \quad (40)$$

The last boundary condition will be given by the knowledge that when $J=0$ the value for the government will be the value of a successful stabilization and is given by $\Delta\theta$. This gives us:

$$V(0) = \Delta\theta \Rightarrow \frac{k}{r^2} - \frac{c}{r} + A + B = \Delta\theta \quad (41)$$

Equations (39), (40) and (41) are a system of nonlinear equations that will determine the values of A, B and J^* . We see by simulating this system that J^* is increasing in R (the cost of quitting) and γ (which measures uncertainty) and it will be decreasing in c and K , which measure the cost of being in the first stage of the program. This cost will have an important effect on the probability of success of the program.

Now, given that the government fixes the exchange rate, and starts the first stage of the program, the probability of failure of this program will be given by:

$$Prob(J > J^* | J_0 = \bar{J}) \quad (42)$$

This is the first passage of a brownian motion with two absorbing states (J^* and 0), this probability is given in Cox and Miller (1965) and is equal to:

$$P(\text{Failure}) = \frac{\exp\left(\frac{2\bar{J}}{\gamma^2}\right) - 1}{\exp\left(\frac{2J^*}{\gamma^2}\right) - 1} \quad (43)$$

Given that the simulations show that J^* is increasing in R we know using equation (44) that the probability of failure is decreasing in the cost that the government faces of quitting the program (R). This explains to some extent the success of the present stabilization plan in Argentina. Because one of the most important measures of this plan was to make a constitutional amendment that requires a 2/3 majority in congress to devalue the exchange rate, thus increasing the political costs of realigning the currency. Next, we present the value that the probability of failure takes for different degrees of political uncertainty (γ), costs of the first stage of the program, c , and the political cost of abandoning the program (R). For the simulations we assumed that the expected time needed to generate the support for the reform when the government fixes the exchange rate is equal to 10 months (T^* from Section 2). The probability of obtaining the foreign exchange needed to start the program ($\omega=.9$) will be .6 per month. The benefit from the stabilization will be equal to 500% of GDP. The real interest rate is 5%.

Table 11₂/ presents the probability of failure of the program when the first stage starts for different values of

12/ For this table we assume $c=.02$

political uncertainty (γ^2 , the variance of J) and different values that the government faces if it quits the program (R). The results are robust to changes in the range that we looked for both parameters. We observe that both of these variables are important determinants of the probability of success of the program. As we said before the decision to increase R in the current stabilization plan in Argentina is one of the measures that increased the probability of the plan significantly.

TABLE 1: Probability of Failure as a Function of Political Uncertainty and Cost of Quitting the Program

γ^2 R	2.0	3.0	4.0	5.0	6.5
.03	13.5%	21.0%	27.0%	32.0%	36.2%
.08	9.5%	16.0%	22.0%	26.2%	31.5%
.13	6.5%	12.2%	18.0%	22.0%	27.5%
.18	4.7%	9.5%	14.8%	19.0%	24.0%
.23	3.2%	7.0%	12.0%	16.0%	21.0%

In Table 213/ we show the probability of failure of the program as a function of political uncertainty and the costs that the economy suffers during the first stage of the program due to the uncertainty that the economy is going through. This cost will depend negatively on the degree of indexation of the

13/ We assume that R=.13

financial and labour markets. We see that the higher this cost is the more tempted the government will be to abandon the program, so the probability of failure increases.

TABLE 2: Probability of Failure as a Function of Political Uncertainty and the Cost during the First Stage of the Program

γ^2 c	2.0	3.0	4.0	5.0	6.5
.01	6.0%	11.0%	17.0%	21.0%	26.2%
.02	6.5%	12.2%	18.0%	22.0%	27.5%
.03	7.2%	13.2%	19.0%	23.0%	28.5%
.04	8.0%	14.2%	20.0%	24.3%	29.5%
.05	8.7%	15.0%	21.0%	25.8%	30.6%

IV CONCLUSIONS:

We developed a model where individual uncertainty prevented a fiscal reform from being carried out. In this situation we showed that a temporary stabilization may achieve the consensus to implement a long lasting fiscal reform that carries with it a permanent stabilization.

Given that to implement this program the government needs international reserves it will wait until it has a sufficient level of them to start the program. In addition we showed that if the government is on the good side of the inflation tax

Laffer Curve (and other conditions hold) then it will increase the rate of inflation to accumulate the international reserves needed for the stabilization program.

Finally, we introduced political uncertainty into the model and studied the decision of the government to quit the program. The basic conclusions from this are that increasing the degree of political uncertainty and the cost of the temporary phase of the stabilization will increase the likelihood of failure. The chapter shows that the probability of failure is increasing in the expected time needed to implement the fiscal reform and decreasing in the political cost of abandoning the stabilization attempt.

REFERENCES:

Alesina, A and Drazen, A. (1991) "Why are Stabilizations Delayed?" *American Economic Review*. Vol 81 num 5, Pg 1170-1188.

Banco de Mexico (1993) "The Mexican Economy".

Bertola, G, and R. Caballero, "Target Zones and Realignment" *American Economic Review* LXXXII (1992), 520-535.

Bertola, G, and L. Svensson, "Stochastic Devaluation Risk and the Empirical Fit of Target Zones Model," NBER Working Paper #3576 (1991).

Bruno, M et al. eds (1988) "Inflation and Stabilization: The Experiences of Argentina, Brasil, Bolivia and Mexico" MIT Press

Calvo, G. (1986) "Temporary Stabilization: Predetermined Exchange Rates" *Journal of Political Economy*. Vol 96 num 6, Pg 1319-1329.

Caramazza, F. (1993) "French-German Interest Rates Differentials and Time Varying Realignment Risk". *IMF Staff Papers*. Vol 40 No 3, Pg 567-583.

Cardoso, E. (1991) "From Inertia to Megainflation: Brazil in the 1980's" in M. Bruno et al. (eds) *Lessons from Economic Stabilizations and its Aftermath*.

- Cox, D.R and H.D.Miller, (1965) "The Theory of Stochastic Processes". London: Chapman and Hall.
- Chen, Z and A. Giovannini, "The Determinants of Realignment Expectations under the EMS: Some Empirical Regularities," NBER, Working Paper #4291 (1992).
- Cukierman, A; M. Kiguel and L.Leiderman, "Balancing Credibility and Flexibility in the Choice of Exchange Rate Bands," World Bank, Mimeo (1993).
- De Gregorio, Jose. (1991) "Comment on What have Populist Learned from Hyperinflation" in Dornbusch and Edwards (eds)"The Macroeconomics of Populism in Latin America".
- Dornbusch,R. (1991) "Credibility and Stabilizations". *Quarterly Journal of Economics*. Vol 56 Num 3, Pg 837-850
- Dornbusch,R and Edwards,S (1991) ""The Macroeconomics of Populism in Latin America" The University of Chicago Press.
- Dornbusch,R and Fischer,S. (1986) "Stopping Hyperinflations Past and Present". *Weltwirtschaftliches Archives*. Band 122 Heft 1, Pg 1-47.

Fernandez,R and Rodrik,D. (1992) "Resistance to Reform: Status Quo Bias in the Presence of Individual Specific Uncertainty". *American Economic Review*. Vol 81 Num 5, Pg 1146-1155.

Flood, R; D. Mathieson and A. Rose, "An Empirical Exploration of Exchange Rate Target Zones," IMF Working Paper # 91/15, (1991).

Grandi,R., Marins,A and Pechman, C. (1989) "Credibilidade e Inflacao: Uma Analise Empirica para o Caso Brasileiro." *Revista Brasileira de Economia*. Vol 43 Num 4, Pg 575-585.

Guidotti,P and Vegh, C. (1992) "Loosing Credibility: The Stabilization Blues". Mimeo IMF.

Helpman, E and L, Leiderman, "Israel's Exchange Rate Band," Mimeo, (1991).

Kiguel, M and N. Liviatan (1992) "When Do Heterodox Stabilization Programs Work? Lessons from Experience" *The World Bank Research Observer*. Vol 7 Num 1, Pg 36-56.

Krugman, P, "Target Zones and Exchange Rate Dynamics," *Quarterly Journal of Economics* LVI (1991), 669-682.

Pyndyck,R (1992) "Investment of Irreversible Cost" NBER Working Paper #4175.

Sachs,J (1986) "The Bolivian Hyperinflation and Stabilization" NBER Working Paper #2073.

Svensson, L, "The Term Structure of Interest Rate Differentials in a Target Zone: Theory and Swedish Data," *Journal of Monetary Economics* XXVIII (1991), 87-116.

Svensson, L, "Target Zones and Interest Rate Variability," *Journal of International Economics* XXXI (1991), 27-53.

Svensson, L, "Assessing Target Zone Credibility: Mean Reversion and Devaluation Expectations in the ERM 1979-1992". *European Economic Review* (forthcoming).

Tomassi (1992) "Inflation and Relative Prices: Evidence from Argentina" Mimeo UCLA.