

Blomberg, S. Brock; Frieden, Jeffrey; Stein, Ernesto

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WORKING PAPER

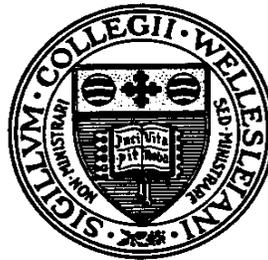
**SUSTAINING FIXED RATES: THE POLITICAL ECONOMY OF
CURRENCY PEGS IN LATIN AMERICA**

By

S. Brock Blomberg, Jeffrey Frieden. And Ernesto Stein

Wellesley College Working Paper 2001-06

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**Department of Economics
Wellesley College
Wellesley, Massachusetts 02481-8203**

Sustaining Fixed Rates: The Political Economy of Currency Pegs in Latin America¹

S. Brock Blomberg
Department of Economics
Wellesley College

Jeffrey Frieden
Department of Government
Harvard University

Ernesto Stein
Research Department
Inter-American Development Bank

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Address Correspondence to: S. Brock Blomberg, Department of Economics, Wellesley College,
Wellesley MA 02482, sblomberg@wellesley.edu

Abstract

This paper studies Latin American exchange rate regimes since 1960. We model government exchange rate regime choice, constrained by politics. The model implies that the larger the tradable sectors exposed to international competition, the less likely is the maintenance of a fixed exchange rate regime. It also implies that the probability of the maintenance of a fixed exchange rate increases as an election approaches. We evaluate these implications with hazard models to analyze the duration dependence of Latin American exchange rate arrangements from 1960 to 1994. We find substantial empirical evidence to support the model. Results are robust to the inclusion of a variety of other economic and political variables, to different time and country samples, and to different definitions of regime arrangement. Controlling for economic factors, a one percentage point increase in the size of the manufacturing sector is associated with a reduction of six months in the longevity of a country's currency peg. An impending election increases the conditional likelihood of staying on a peg by about 8 percent, while the aftershock of an election conversely increases the conditional probability of going off a peg by 4 percent.

1 Introduction

The events of the 1980s and 1990s brought home with a vengeance the centrality, and variability, of Latin American governments' capacity to sustain their exchange rate commitments, especially to a fixed rate. While controversy continues to rage about whether fixing is in itself a desirable goal, there are few systematic analyses of the *determinants* of government decisions to peg their currencies, or of analogous decisions to end such pegs. The paucity of serious analysis of the causes of national exchange rate policy is in itself a real impediment to consideration of the desirability of various policies: if optimal policies cannot be sustained politically, it is important to know exactly why this is so and what politically feasible alternatives present themselves.

There is a substantial normative literature on exchange rate choice, dominated by variants of the optimal currency area approach, but its conclusions are generally ambiguous – there are few unequivocal welfare criteria upon which to base a choice of a peg, a floating rate, or some other policy.² The positive literature – that is, studies attempting to *explain* government exchange rate policies – is much sparser. Analysts have established that exchange rate movements themselves cannot adequately be explained by macroeconomic fundamentals, but there is little agreement as to what additional factors must be considered (Frankel and Rose 1995). There has been some study of these issues in the context of European monetary integration and exchange rate policy in other industrialized regions, and some detailed empirical analyses of particular

² Tavlas 1994 is a good survey; Frankel and Rose 1998 argue for a somewhat less ambiguous view.

experiences.³ Very few of these explicitly consider electoral factors, or attempt to evaluate both economic and political economy variables.⁴ Few cross-national studies have looked at the developing-country experience, and their incorporation of political factors is preliminary.⁵ There is a pressing need to understand both how politics mediates the impact of macroeconomic factors on exchange rate decisions, and how politics affects such decisions directly. This paper develops a political economy model of exchange rate regime choice, and tests its ability to explain the duration of currency pegs by using a variety of hazard models.

In the model, a government chooses whether to stay on a fixed exchange rate regime or not; if it leaves the peg, it chooses the degree of exchange rate appreciation/depreciation. A government's willingness to sustain a fixed rate depends on the value it places on the anti-inflationary effects of the peg, as opposed to the countervailing value it attaches to gaining the freedom to use the exchange rate to affect the relative price of tradables ("competitiveness"). We derive several propositions of empirical relevance. The greater the political influence of tradables producers, the less likely is the government to sustain a fixed exchange rate regime. In addition, as an election approaches, governments are more likely to sustain a currency peg, but they are more likely to abandon a peg once elected.

³ Eichengreen 1995 presents a general view; Edison and Melvin 1990, Hefeker 1996 and 1997, Frieden 1994 and 1997, Blomberg and Hess 1997, van der Ploeg 1989, Eichengreen and Frieden 2001, Frankel 1994, and Henning 1994 all present analyses of particular episodes or national experiences.

⁴ Work by Bernhard and Leblang, for example Bernhard and Leblang 1999, is a notable exception, as is Frieden, Ghezzi, and Stein (2001).

⁵ The most prominent such work includes Klein and Marion 1997, Collins 1996, and Edwards 1996. Two recent books, Wise and Roett (2000) and Frieden and Stein (2001), look at the Latin American experience, largely with country case studies.

We test the implications of our model with a large data base that includes information on economic and political characteristics of Latin American countries from 1960 to 1994, using a hazard model to investigate the effects of both structural and time-varying characteristics of these countries. We find that political and political economy factors are crucial determinants of the likelihood that a government will sustain its commitment to a fixed rate. The more important is a country's manufacturing sector – which would be expected, in an open economy, to press for a relatively weak currency and thus against a fixed rate – the less likely the government is to be able to sustain a fixed rate. Electoral considerations, too, have a powerful impact. Governments are more likely to abandon fixed exchange rate regimes *after* elections, which is consistent with the idea that voters respond negatively to governments that do not stand by their exchange rate commitments. These findings are consistent with our model. These results are robust to the inclusion of a wide variety of economic variables and specifications. It seems clear from this exercise that political factors have a powerful impact on the sustainability of a fixed exchange rate.

2 The Model

In this section, we develop a model of exchange rate regime choice on which we base our empirical work on the durability of currency pegs. The government chooses whether to leave a fixed exchange rate regime or to maintain it, constrained by characteristics of the economy and by the policy preferences and political influence of its constituents. It begins with a peg to a zero-inflation anchor currency, and can either continue or adopt a flexible currency regime and depreciate the currency at its desired rate. Staying on the

peg leads to a lower rate of inflation by increasing the anti-inflationary credibility of the authorities, but can lead to a real appreciation of the exchange rate with detrimental effects on “competitiveness,” understood as the relative price of tradables. Leaving the peg for a flexible regime permits the government to affect “competitiveness” by depreciating so as to raise the relative price of tradables, but leads to a higher rate of inflation.⁶

The government thus faces a tradeoff between inflation and “competitiveness,” and makes its decision on the basis of political economy considerations. Nontradables producers – more broadly, consumers in general – especially value inflation-fighting and are favorable or indifferent to a real appreciation. Tradables producers prefer a real depreciation that raises the price of their output relative to the price of their nontradable inputs. The government thus faces pressures from the broad electorate, which is more concerned to reduce inflation or keep it low than it is about the relative price of tradables, and from special-interest groups of tradables producers, who want the government to manipulate the currency to raise the relative price of their products. The smaller the political influence of tradables producers, the more likely the government will be to leave the peg. At the same time, inasmuch as politicians’ desire to address the concerns of the more numerous consumer-voters rises near elections, the likelihood of sustaining a currency peg is higher before elections than in post-election or non-electoral conditions.

⁶ It might be objected that there is no necessary relationship between the exchange rate regime and the real exchange rate or its movements. Frieden, Ghezzi, and Stein (2001), especially Table 2, show however that in the Latin American case there is in fact a clear such relationship. The average country on a fixed rate has a real exchange rate 8 percent stronger (more appreciated) than the average country on a floating rate; a floating rate is associated with inflation rates two and a half times higher than a fixed rate; and the average fixed currency appreciates 3 percent per year in real terms more than the average floating currency.

The model is built around a government whose preferences are described by a quadratic loss function of inflation and “competitiveness.” (Again, we use the term “competitiveness” to mean the foreign-currency price of domestically produced tradables, or equivalently the price of tradables relative to nontradables, and henceforth drop the quotation marks.) Government attention to competitiveness might be due to intertemporal or other concerns about external balance; here it is considered a function of the political influence of tradables producers (especially exporters and import competitors) for which competitiveness translates into profitability. As will be seen, other things equal, a greater concern for competitiveness reduces the durability of a peg.

We define the government’s concern for competitiveness as a function of deviations from a target real exchange rate. For convenience, we model this as concern for the target real depreciation needed to obtain the desired real exchange rate, and we denote the target real depreciation k^* .⁷ The exchange rate is defined as the price of domestic currency in terms of the foreign currency, and for simplicity, foreign inflation is assumed to be zero. Deviations from the target depreciation may be written as $d - \pi - k^*$, where d is the nominal rate of depreciation and π is the inflation rate. The inflation rate in turn is merely the weighted average of non-tradable inflation and tradable inflation, with tradable inflation, from PPP, equal to the nominal depreciation rate d . The optimization problem is therefore

$$L = \omega\pi^2 + (1-\omega)(d - \pi - k^*)^2$$

subject to

⁷ Indeed, if we start from a given initial level of the real exchange rate, setting a target real depreciation (or appreciation) is equivalent to setting a target for the level of the real exchange rate. For the time being, we

$$\pi = \alpha\pi_n + (1-\alpha)d$$

where ω and $(1-\omega)$ represent the weights given to the inflation and competitiveness objectives in the government's loss functions, π_n is nontradables inflation, and the weights α and $(1-\alpha)$ represent the share of non-tradables and tradables in output. The weights given the two objectives are not identical to the shares of non-tradables and tradables in output, as these weights respond both to the economic importance of the sectors and to socio-political and political economy factors. The government thus attempts to minimize inflation and deviations from the target real depreciation, cognizant of the fact that because depreciation raises tradable prices it also increases inflation.

The country starts with an exchange rate fixed to the zero-inflation currency. The fixed rate allows the government to commit credibly to a lower inflation rate; this commitment device has the effect of reducing nontradables inflation. Thus we assume that

$$\pi_n = \beta\pi_0,$$

where β is a parameter that measures the degree of inflationary inertia in the nontradable sector and π_0 is previous-period inflation.⁸ The parameter β depends both on price-setting behavior in the nontradables sector, and on the choice of the exchange rate regime. While tradables price movements are completely determined by movements in the nominal exchange rate, nontradables prices depend on the previous inflation rate. This

take k^* as exogenous. However, we later discuss how it may be affected by the sectoral composition of the economy, as well as by elections.

⁸ Note that the fact that we start from a fixed exchange rate to a zero-inflation currency does not necessarily mean that initial inflation has to be zero. A country can be under fixed and have positive initial inflation remaining from past episodes of floating, or from different shocks, which are not treated explicitly in the model.

can be thought of as due to some wage or price stickiness in nontradables.⁹ A fixed rate reduces this inflationary inertia, so that previous-period inflation is not fully reflected in current-period nontradables price increases. Current-period inflation thus depends on previous inflation, on the share of tradables and nontradables in the economy, on the degree of inflationary inertia in nontradables, and – depending on the choice of whether to stay on or go off the peg – either on a credibility effect associated with the fixed rate or on the depreciation rate (through its effects on tradables prices),.

Exchange rate policy involves choosing both the regime and the level of the exchange rate. For simplicity, we start with a government on a fixed rate, and focus on two different exchange rate regime choices. The first is a currency peg, in which the government credibly announces its intention to continue with the peg to a zero-inflation anchor. In this case, the rate of nominal depreciation is set at $d=0$, and tradables inflation (which is fully determined by the depreciation rate) is also zero. Crucially, to the extent that there is any inertial inflation in nontradables, the commitment to a peg *in itself* reduces this through a credibility effect. That is, fixing *both* reduces tradables inflation to zero *and* reduces any persistent nontradables inflation by braking some portion of the inflationary inertia. The second regime is a discretionary or flexible rate, in which the government chooses a depreciation so as to minimize the loss function. We model this by setting $0 \leq \beta \leq 1$ with a peg, so that the currency peg brakes some of the inertial inflation; while $\beta=1$ under discretion, so that nontradables inflation is completely inertial and

⁹ This is similar to the setup used by Vladimir Kliouev (get citation), who arrives at a similar condition by specifying a more formal wage contract. As little is added to our model with such an exercise, we choose this more general condition.

cannot be reduced by movements in the exchange rate. The choice between fixed and discretionary exchange rate is illustrated in Figure 1.

The figure represents the loss under the two different exchange rate regimes as a function of the nominal depreciation. Under a fixed regime, the depreciation rate is 0, so the loss is represented by a point on the vertical axis, such as point A. Under the discretionary regime, if depreciation were set to zero, the loss, represented by point B, would be higher than under fixed (provided $\pi_0, \alpha > 0$, and $\beta < 1$). Compared to the fixed regime, inflation would be higher, and competitiveness would be lower (there would be a greater real appreciation of the currency). However, under discretion point B would not be chosen, since it does not minimize the loss function. Instead, the government would set the rate of depreciation so as to achieve point C. The choice between fixed and discretionary regimes therefore depends on the relative losses at A and C. If the loss at C is smaller, then the government will leave the peg in order to achieve a more preferred outcome: higher inflation that is more than compensated by improved competitiveness. The key in the model is to explore under what conditions A, the zero-depreciation peg, is preferred to C, discretion with an optimal depreciation rate. In other words, the government weighs the cost of sustaining an inflation-reducing currency peg which also reduces tradables competitiveness, against the political cost of the rate of inflation that will result from providing tradables producers with a competitive real exchange rate. To evaluate this, we must first calculate the depreciation rate that would be adopted under a discretionary regime, then compare the loss under discretion to that with the currency peg.

Optimal depreciation under discretion

Minimizing the loss function subject to the inflation equation when $\beta=1$ yields the optimal rate of depreciation under discretion:

$$d = \alpha [(1-\omega)\alpha^2 + \omega(1-\alpha)^2]^{-1} [(1-\omega)k^* + \pi_0(\alpha-\omega)]. \quad (1)$$

This can also be written as

$$d = \phi [(1-\omega) k^* + \pi_0(\alpha-\omega)] \quad (2)$$

where ϕ is an indicator function of α, ω such that $\phi = \alpha [(1-\omega)\alpha^2 + \omega(1-\alpha)^2]^{-1} > 0$.

In equation (2), the size of the nominal depreciation is increasing in k^* , π_0 , and $(\alpha-\omega)$. The first two are straightforward: the higher is the target real depreciation, and previous period inflation, the higher will be the optimal depreciation. The third is somewhat less obvious, but nonetheless intuitive. The higher α , the lower the impact of depreciation on inflation (because the smaller is the share of tradables in output, the smaller the share of goods whose prices are raised by a depreciation). Similarly, ω measures how much the government cares about inflation. Equation (2) suggests that the optimal depreciation is larger the smaller is its impact on inflation (i.e, when α is high enough), or the smaller the weight of inflation in the loss function (i.e, when ω is low enough).

Loss under different regimes

Having determined the optimal depreciation under discretion, we can use it to calculate the government's prospective losses under the two alternative exchange rate regimes.

For discretion, equation (2) provides us with the optimal depreciation to be used in the loss function. We arrive, after some algebra, at the following expression:

$$L(\text{discretion}) = [(\alpha - \omega)^2 + (1 - \omega)\omega]^{-1} [(-1 + \alpha)k^* - \alpha\pi_0]^2 (1 - \omega)\omega$$

The government's loss in the fixed regime is similarly determined, taking into account that by definition there is no depreciation ($d = 0$), and now β may differ from 1:

$$L(\text{fixed}) = \omega [\alpha\beta\pi_0]^2 + (1 - \omega) [-\alpha\beta\pi_0 - k^*]^2$$

The determinant of the choice of regime is the loss differential (LD), that is, the difference between the last two expressions (in Figure 1, this is the difference between the loss at point C and that at point A):

$$\begin{aligned} LD = L(\text{disc}) - L(\text{fix}) &= [(\alpha - \omega)^2 + (1 - \omega)\omega]^{-1} [(-1 + \alpha)k^* - \alpha\pi_0]^2 (1 - \omega)\omega \\ &\quad - \omega [\alpha\beta\pi_0]^2 - (1 - \omega) [-\alpha\beta\pi_0 - k^*]^2 \end{aligned}$$

If $LD > 0$, the loss is higher under discretion than on the peg and the government chooses to stay on the fixed exchange rate regime; if $LD < 0$ it chooses discretion. The critical analytical issue is how the loss differential is affected by the parameters of the model. We are particularly interested on the effects of k^* , the target real depreciation, as this target is (as will be discussed below) a principal channel for the impact of such political economy variables as interest groups and election timing. The derivative of the loss function with respect to k^* is

$$\partial LD / \partial k^* = 2(1 - \omega) \{ [(\alpha - \omega)^2 + (1 - \omega)\omega]^{-1} [(1 - \alpha)[\alpha\pi_0 - (1 - \alpha)k^*] \omega] - (\alpha\beta\pi_0 + k^*) \} \quad (3)$$

The loss differential is decreasing in k^* under two plausible and intuitive conditions.¹⁰

¹⁰ The two conditions under which an increase in k increases the attractiveness of a discretionary regime are

$$d \geq \pi_0 (1 - \beta)$$

and

The principal comparative static property of the model is with regard to k^* : **a decrease in k^* , the target real depreciation, increases the probability of staying on a currency peg**; conversely, an increase in k^* increases the probability of going off the peg. This follows from the fact that a positive loss differential means that the pegged regime is preferred. This makes the determinants of k^* crucial to the determination of government exchange rate policy choice. In the next section, we discuss political economy determinants of k^* . The intuition for the result given by equation (3), that the probability of sustaining a peg declines as k^* rises, is as follows. As the government targets a weaker real exchange rate, it is more likely to adopt a discretionary exchange rate regime so long as the gain to competitiveness outweighs the lost anti-inflationary credibility. In the model, in most plausible circumstances and consistent with the experience of countries in Latin America, the credibility effect leads a peg to result in lower inflation, while the higher depreciation rate in a discretionary regime results in

$$\alpha \geq \omega$$

The first condition is that the actual depreciation rate in the discretionary regime must be greater than the difference between nontradable inflation in the two regimes. (So $d \geq \pi_{(discretion)} - \pi_{(fixed)}$ and since the portion of inflation not affected by d is determined by previous inflation and the degree of inertia ($\pi = \beta\pi_0$), and $\beta = 1$ for the discretionary regime, thus $d \geq \pi_0 - \beta\pi_0$.)

Put differently, the first condition is that for discretion to be attractive, the actual depreciation must be sufficient to make up for the greater nontradables price increases under discretion than under fixed. Clearly tradables producers will only benefit from discretion if in fact the depreciation rate compensates them for the greater increase in nontradables prices realized under discretion.

The second condition is that the government concern for the competitiveness of tradables producers must be at least proportional to their share of the economy.

The intuitive nature of these conditions can perhaps best be seen by examining the implications of their not holding. The first condition does not hold if the depreciation rate under discretion is lower than necessary to compensate tradables producers for the higher rate of nontradables inflation, or if fixing reduces nontradables prices so rapidly that tradables are actually more competitive under fixed than under discretion. In both circumstances, tradables producers will not benefit from discretion and a discretionary regime will not in fact deliver a more competitive real exchange rate. The second condition does not hold if the government is relatively indifferent to the plight of tradables producers, so that it has little or no incentive to implement the exchange rate regime necessary to ensure their competitiveness (i.e. relative price movements in their favor).

more competitiveness.¹¹ Thus a higher target real depreciation (k^*) lowers the probability of choosing or staying on a currency peg.

A related comparative static property has to do with the impact of β , the parameter that captures the inertial component of inflation. Recall that a higher β means that there is *more* inflationary inertia, either because of price-setting behavior in the nontradables sector or because a currency peg has a less powerful impact on anti-inflationary credibility. The loss differential is also decreasing in β , meaning that the more inflation is inertial and/or the less a peg would reduce inflation, the less incentive there is to adopt a fixed rate. This is intuitive: as inflationary inertia rises and the anti-inflationary credibility added by fixing declines, the greater is the real appreciation to which a currency peg gives rise, and the weaker the attractiveness of a fixed rate. In any event, we focus on k^* , which is most directly related to political economy considerations.

Interest groups, elections, and the target real exchange rate

We expect political economy variables to affect the value of k^* , especially interest groups and election timing. So far, we have assumed that the population is

¹¹ But this is not *always* the case. For example, if k^* is negative and initial inflation (π_0) is low enough, inflation may be lower under discretion, since optimizing may require a nominal appreciation to more than compensate for the inertial component of inflation. On the other hand, for some parameter values a fixed currency may result in more competitiveness. For example, if $\alpha = \omega$, and $k^* = 0$, the optimal depreciation rate under discretion will be 0 (from equation 2). Then the nominal exchange rate does not move in either the discretionary or fixed regime. But because fixing provides additional anti-inflationary credibility, it results in a lower inflation rate and a smaller real appreciation. Indeed, for these parameter values, fixing provides delivers both lower inflation and more competitiveness. In this context, the conditions described in footnote 4 ensure that fixing is associated with lower inflation and discretion with more competitiveness. They do so by specifying that the nominal depreciation rate must outstrip inflation, and that the government cannot be relatively indifferent to the competitiveness of tradables producers. If either of these conditions are not met, governments will not adopt flexible currency regimes when more depreciation is targeted because they cannot credibly deliver a more competitive real exchange rate.

homogeneous.¹² We now introduce interest groups made up of agents who produce goods with different characteristics, and who may have different preferences over the real exchange rate. The government's choice of exchange rate regime and level thus has redistributive implications. For simplicity, we assume that there are two groups, one of which produces or is endowed with tradables, and the other with non-tradables, and that the preferences of the government regarding the real exchange rate are a weighted average of the preferences of the groups¹³ Thus,

$$k^* = \delta k^{*N} + (1-\delta) k^{*T} ,$$

where the parameter δ represents the weight given by the policymakers to non-tradable producers, denoted by the letter N. We expect tradables producers to prefer a relatively weaker real exchange rate, which increases the relative price of their output. Thus, we assume that $k^{*N} < k^{*T}$. Given this assumption, it is obvious that $\partial k^*/\partial \delta < 0$. This implies that an increase in the political influence of tradables producers causes an increase in k^* . In turn, this means that, under the conditions discussed in the previous section, **an increase in the political influence of tradable producers will decrease the likelihood of staying on a currency peg.**¹⁴

¹² Homogeneity is not inconsistent with the existence of tradables and non-tradables. As long as everyone is endowed with the same proportions of tradables and non tradables, everyone will have the same preferences regarding the target real exchange rate.

¹³ We group all tradables and all non-tradables for simplicity, although we recognize that not all tradables producers have the same preferences regarding real exchange rates (mine owners may be relatively indifferent to the exchange rate if most of their inputs are imported, for example), that a group's preferences may vary over time, and may depend on other policies in place, such as the existence of trade barriers (see Frieden, Ghezzi and Stein, 2001).

¹⁴ An alternative way to model the differences in the preferences across groups would have been to assume that k^* is the depreciation needed to achieve external balance, and that the differences in the preferences across groups are represented by different weights attaching to ω in the utility function, with $\omega^{NT} > \omega^T$. In other words, both groups care about inflation and external balance, but non-tradable producers care relatively more about inflation. In this case, an increase in the relative size of tradable producers would imply a reduction in ω in the utility function of the government, and thus would increase the likelihood of

If the government were a social planner, then δ and $(1-\delta)$ would represent the proportion of the population producing non-tradable and tradable goods, respectively. The weights in the government's utility function, however, may also reflect other considerations. In particular, the government may care about winning elections, and about obtaining rents from the special interest groups.¹⁵

During the run-up to elections, the government may be more inclined to please the more numerous group, in exchange for votes. During non-electoral periods, however, the government may be able to extract more rents from smaller groups with concentrated benefits, given the logic of collective action.¹⁶ This suggests that the relative size of the two groups is an important consideration for the behavior of exchange rate policy around elections. We assume here that the non-tradable sector is more numerous than the tradable sector. In other words, the median voter belongs to the non-tradable group. We think that this assumption is realistic, in particular if we consider that even workers in the tradable sector may be counted as suppliers of non-tradable services. Under this assumption, we expect δ to increase during the run-up to elections, which in turn implies that k^* will decrease during such times. Therefore, under the conditions discussed in the previous section, we expect that **electoral periods will reduce the likelihood of**

abandoning the peg in favor of increased competitiveness. Thus, both modelling strategies yield similar results.

¹⁵ There are several reasons why the parameter δ may differ from α , the share of non-tradables in output, which we used in the inflation equation. First, as just discussed, the fact that the government is not a social planner implies that the weights in its utility function may not exactly reflect the relative size of groups of producers. Second, the share of the population involved in the production of tradables and non-tradables need not correspond to the share of each type of goods in GDP. For example, if non-tradable production is more labor intensive, then we would expect to find that $\delta > \alpha$, even if the government were a social planner. Finally, even workers in the tradable sector may have preferences that are aligned with those of non-tradable producers, to the extent that they sell their labor, which is non-tradable, another reason for δ to be greater than α .

¹⁶ See Olson 19??

abandoning exchange rate pegs. In contrast, post-electoral periods will increase the likelihood of ending a peg.

It is not necessary to assume irrational voters for the implications of our model to go through. There are models of rational voters, in the tradition of Rogoff (1990) and Rogoff and Sibert (1988), in which electoral cycles can be obtained as a result of a signalling game between the voters and the government, in the context of asymmetric information. While in most papers in this literature the information asymmetries concern the competence of the policymakers, Bonomo and Terra (1999) have developed a model in the same tradition, but in which the asymmetries do not apply to the competence, but rather to the preferences of the policymakers among two groups with conflicting interests over the level of the exchange rate: tradables and non-tradables. Thus, their model is closely linked to the present paper, and yields similar implications: governments tend to delay devaluations in the run-up to elections, and tend to devalue after elections have taken place. Given that assuming rational voters complicates the model considerably, and does not provide many additional insights, a full model of the behavior of voters in the context of a signalling game is beyond the scope of the present paper.

3 Data and Methodology

In this section, we evaluate the empirical implications of the model with a panel of political and economic data developed by Frieden, Ghezzi, and Stein (2001). We begin with a basic hazard model to determine the degree of duration dependence of exchange rate regimes, and particularly currency pegs. Next, we extend the model by including time-varying covariates, to allow us to sort out the importance of political

variables in exchange rate determination. We find, in line with the model, that countries with larger manufacturing sectors tend to have currency pegs of substantially shorter duration, that the approach of an election substantially increases the likelihood that a government will sustain a currency peg, and that the probability of leaving a peg increases in post-electoral periods.

The previous section developed a model of regime choice based on a simple question – given a currency peg at time t , will the country continue to peg its currency or abandon the peg at time $t+1$? We evaluate the evidence empirically with a hazard model. The hazard model has two attractions: its natural interpretation follows our theoretical model, and it can be constructed so as to compensate for shortcomings of the theory imposed for analytical tractability.

The theory presented above is deterministic, in that it predicts an unambiguous regime choice. However, it is not difficult to see that only a small amount of uncertainty would allow us to recast it in probabilistic terms. In this context, the impact of political factors on exchange rate regime duration would be expressed as increasing the *likelihood* of abandoning a peg. Mathematically, we would be interested in examining the likelihood, λ , of abandoning a regime at time $t+1$, given that the regime had not be abandoned at time t . This is by definition a hazard rate. By the same token, the likelihood of *survival* of a fixed exchange rate regime is by definition a survival rate, that is inversely related to the hazard rate. In either case the hazard model explained in greater detail below is appropriate to examination of the durability of currency pegs.

3.1 Data Description

We use data from 26 Latin American and Caribbean countries from 1960 to 1994, drawn from *IFS*, the Economic and Social Database of the Inter-American Development Bank, and a variety of political sources (for more details see Frieden, Ghezzi, and Stein 2001). The original data set is quite rich and contains economic variables such as real exchange rates, GDP growth, inflation, the relative size of various sectors in the economy, along with a wide variety of political variables and a highly differentiated definition of exchange rate regimes. With regards to the political data, the data set includes changes in government, both constitutional and otherwise, elections, the number of effective parties, the government's vote share, along with more traditional measures such as political instability and central bank independence.

The definition of exchange rate regimes used allows for a more nuanced representation of currency regimes than is common, classifying them on a nine-point scale. In most of what follows, in line with our theoretical specification, we collapse this down to a 0-1 choice (with 1 = fixed, 0 otherwise) for our main results. That is, we define duration *only* in terms of currency regimes that involve fixing to a single currency. However, following these results, we expand the range of categories as a way of checking the robustness of our results.

3.2 Basic Empirical Specification

The basic empirical model used here follows Greene (1997). Previous research has analyzed exchange rate regimes by employing probit/logit analysis to estimate the impact different factors have on the probability of being in a given regime [Collins (1996); Klein and Marion (1997); Frieden, Ghezzi, and Stein (2001)]. While these

papers provide very interesting results concerning the relative importance of different factors in influencing regime choice, they do have limitations.

Perhaps the greatest limitation is in these previous models' ability to capture duration dependence within the framework. They are not constructed to directly analyze the *sustainability* of a regime. That is, they cannot directly examine how likely a country is to remain in a regime, given that it has been in that regime for a specified time. While one can enter the previous length of time on a peg as a covariate, such a specification imposes a very specific manner in which the regime choice is dependent on the length of time on a peg. A much less restrictive model would be one that is more naturally designed to capture how duration influences regime choice.

Hazard models allow us to analyze these issues directly, by examining *duration dependenc*, the likelihood that a country will abandon a regime given that it has been in that regime for a specified time. . A series is said to be *positively duration dependent* if the hazard rate increases the longer you remain in the regime, so that a regime is more likely to end the longer a country has been in it; negative duration dependence means that the likelihood of leaving the regime increases with the time already spent in it. Furthermore, given certain functional forms, hazard models yield more intuitive interpretations of coefficient estimates than in the logit/probit framework. These issues can be seen with a rudimentary presentation of our empirical model.

We assume two possible regime arrangements, fixed and flexible.¹⁷ We define the hazard rate, λ , as the rate that the spell in a fixed regime is completed at time $t+1$, given that it had not ended at time t . In this case, we also estimate the probability, p , that the

regime is positively duration dependent ($p > 1$), negatively duration dependent ($p < 1$) or has no memory ($p = 1$). An intuitive representation of the hazard rate, λ , is the likelihood that the fixed regime survives. In this case, our hazard function is merely the negative time derivative of a survival function $S(t)$,

$$\lambda(t) = -d \ln S(t) / dt$$

Hence, whether we concentrate on the hazard or survival function, we can directly observe the shape of the hazard/survival function and determine which factors are important in causing the end of the fixed exchange rate regime *conditional* on the fact that it had not ended previously.

There are a variety of parametric hazard models; for completeness we consider four among the many possible distributions for our hazard model: exponential, Weibull, log-logistic and log-normal. In each case, after a few months, the general shape of these different distributions turns out to be similar (see Figure 2, described in the following section), and so we extend the analysis in future sections using the popular Weibull model.¹⁸

For the general case, estimating the hazard model involves estimating parameters of interest $\theta = (\lambda, p)$ as a maximum likelihood estimation given by the following likelihood function

$$\ln L = \sum [\delta \lambda(t|\theta) + \ln S(t|\theta)].$$

¹⁷ This assumption is obviously not necessary but it helps in the exposition. We relax this assumption in our sensitivity analysis.

¹⁸ This is not always the case, as a classic example in Greene (1997) demonstrates.

Note that there is right-censoring in many cases, as we do not observe the end of the last exchange regime as of 1994. In this case, we allow $\delta = 0$ for censored observations and $\delta = 1$ for the uncensored observations.

3.3 The Extended Model with Time Varying Covariates

The simple hazard model allows us to analyze the shapes of the hazard rates and the duration dependence of the exchange rate regimes. The next step is to allow for different factors or covariates to influence the hazard rate. Now we describe how to include covariates in general, without going into explicit detail, for a more general description is more intuitive and requires less specific background knowledge. A formal description of the time-varying covariate model is given in Petersen (1986).

We estimate the impact of our political and control variables X , in the hazard function, as

$$\lambda = e^{-\beta X}$$

following a Weibull distribution. This implies analogous changes in the likelihood function to support the estimation.

We have up to now assumed that the unit of observation of regime and our covariate is the same. This is inaccurate: for example, if the time in a fixed regime is 24 months, then it does not make sense to include inflation over the entire 24 months, as it changes on a month by month basis and we lose information in the averaging. Similarly, it does not make sense only to include inflation in the initial month, as the initial inflation rate is unlikely to be so important a determinant of the duration of a regime two years later as the inflation rate at that point. It makes more sense to show how each monthly change in inflation affects monthly duration. Hence, we extend the analysis to allow for

such time-varying factors by including these covariates as determinants in our hazard model.

4 The Empirical Results

This section presents the results from estimating the model described above. There are three main results. First, after a few months, there is substantial evidence of negative duration dependence. The longer a country remains on a fixed exchange rate, the less likely it is to leave the peg. Second, political variables play a major role in determining duration, as anticipated by the model. The size of the manufacturing sector helps explain the hazard rate, as does election timing. Finally, these political factors operate independently of the economic channel.

4.1 Basic Hazard Model

We begin by providing estimates from the basic hazard model discussed in Section 3 over the time period 1972-1994. We consider four specifications -- exponential, Weibull, log-logistic, and log-normal – without yet allowing for covariate effects. Table 1 provides the basic coefficient estimates from the model. Column 1 reports the specification, with Columns 2 -3 reporting our estimated λ and p . Column 4 reports the estimated median duration. The estimated standard errors are in parentheses and robust to heteroskedasticity of unknown form. These models are quite similar. In each case, we cannot reject the null that $p < 1$ (except for the exponential case where p is constructed to be 1), which has the interpretation of negative duration dependence. While the magnitudes are different, the general conclusion is the same: the longer a country has

been on a currency peg, the less likely it is to abandon it. Column 4 also shows that median duration is estimated to be between three to five years. While this range may be large, it still shows that regimes are not very short-lived.

These hazard functions are plotted in Figure 2, by month. In each case where the model is allowed to have duration dependence, after a few months we find a strongly negative slope. The shapes of the curves are quite similar, implying not only negative duration dependence but that choice of functional form may not be important. For simplicity, we concentrate on the Weibull model in subsequent sections.

One might object to our imposition of a 0-1 scale of exchange rate regime or the examination of only the post-Bretton Woods time period, 1972-94. We estimated the basic model employing various definitions of exchange rate regime over the entire sample and the post-Bretton Woods sample (1972-1994), and found quite similar results. In each case, across each specification, after a few months there is negative duration dependence. We do, however, report the individual results from the various specifications in the extended model below.

4.2 Explaining the Duration of Regimes

This subsection reports results from the model with time-varying covariates, which estimates the impact of economic and political variables on the hazard rate. We begin with a model that includes only political economy factors, in particular those highlighted by our model. To evaluate the political influence of tradables sectors concerned that a peg might reduce their competitiveness, we include manufacturing as a share of GDP [MAN/GDP], as manufacturers are likely to be particularly wary of forgoing the devaluation option, and/or of the potential real appreciation associated with a

fixed rate.¹⁹ We then include a political dummy variable to capture electoral effects [ELECTION]. This variable takes on the value -1 when an election was held in the previous four months and +1 when an election is to be held in the next eight months. We expect this variable to have a positive effect in that a peg will be more likely to be sustained in the runup to an election, and less likely to be sustained in post-electoral periods as previous political business cycle incentives fade and pre-electoral appreciations have to be unwound. Finally, we include the number of effective parties to capture the degree of political competition [EFFPART]. Although not directly shown in our model, this issue has been found by earlier studies to have an impact on regime choice (Frieden, Ghezzi, and Stein 2001). In their paper, they showed that more political competition, as reflected in a larger number of effective political parties, makes it more difficult for the government to impose adjustment measures to sustain a fixed-rate regime.

Our next specification includes these factors with traditional economic variables to ensure there is no omitted variable bias. The variables considered are GDP growth [DGDP], inflation [LN(INFLATION)] as a non-linear determinant, the current posture of world-wide regimes measured by the percent of countries that are fixed [Regime View] and a 1 - 4 measure of capital controls [KCONT]. The variables DGDP and Regime View should have a positive effect on duration of a fixed regime, while we anticipate that the others will have a negative effect. Duration should rise if the economy is growing, if capital controls are present, and as more countries adopt fixed rate regimes.

In the final column, we consider all of these variables with measures of severe misalignment (observations in the highest and lowest 5th percentile of real exchange rate

¹⁹In other versions, we also included agriculture [AG/GDP], and mining [MIN/GDP] but found neither to

values [High Misalign, Low Misalign]) to examine if these results continue to hold even after controlling for extreme pressures on regime sustainability.²⁰

We examined many other possible variables, but do not include them in the tables because of lost observations and for parsimony. In other specifications, we considered time trends and dummies for the second part of sample (which were significant but did not have a direct interpretation and did not change any of the other results), measures of openness (insignificant), broad measures of liquidity (insignificant), central bank independence (insignificant), political instability (insignificant) and government change (insignificant when ELECTION is included).

Table 2 provides the results for the baseline 0-1 scale hazard model from 1972 to 1994, focusing on the durability of currency pegs. Column 1 reports the variables, Column 2 reports the results for the political model, Column 3 reports the results for the political and economic model, and finally Column 4 also includes the measures of misalignment.

For the basic political model, we find all the coefficients on the political variables are significant and have the expected sign. MAN/GDP has a strong negative influence on duration; the industrial sector appears generally hostile to a fixed exchange rate regime. Pre-electoral and post-electoral shocks together affect regime choice in the manner suggested by the theory. Finally, EFFPART also appears to have a strong negative impact on duration. Interestingly enough, we estimate p to be approximately 1 in each

have an impact on duration.

²⁰ We also considered other measures of misalignment, such as the top and bottom 10th and 25th percentiles. In these different specifications, the impact of misalignments was not statistically significant.

case meaning that these covariates tend to explain away some of the duration dependence in fixed regimes.

When we add the economic variables, we find the results associated with the political variables continue to be quite strong. While the control variable EFFPART is no longer statistically significant, the coefficients associated with our theory's variables of interest ELECTION and MAN/GDP continue to have the expected sign and are statistically significant.

For the economic model, we find most of the coefficients have the expected sign. Stronger GDP growth and lower inflation increase duration. The global prevalence of fixed exchange rates seems to increase the likelihood of adoption of a fixed exchange rate regime (Regime View is positive). On the other hand, more capital controls seems to decrease duration. This somewhat surprising result, repeated in other studies, may well be due to simultaneity problems: countries with greater difficulties sustaining currency pegs may be more likely to adopt capital controls.

As a final check, we include measures of extreme misalignment along with the variables in Column 3. We do this to see if the economic or political variables work independently from severe exchange rate misalignment. Interestingly, the inclusion of the term does not seem to change the results from the other columns. As the coefficients associated with MAN/GDP and ELECTION remain significant, this implies that political variables influence regime duration in a manner independent of the economic channel. We believe we are the first to find such an intriguing result for Latin American exchange rate regimes, although the results do support similar results for the US, Germany and the UK in Blomberg and Hess (1997).

These results allow us to describe the actual economic significance of the variables of greatest interest to us. As we estimate p close to 1, the model collapses to an exponential one. In this case, a one percent increase in MAN/GDP translates into a 10-13 percent *decrease* in the median duration of a regime, which amounts to six months. This means that an increase in the size of the manufacturing sector of just one percentage point reduces the expected duration of a peg by six months. It is also instructive to consider how this affects the hazard rate directly. In this case, a one percent increase in the manufacturing share of GDP translates to a 10-13 percent increase in the hazard rate, the rate at which spells are completed after duration t , given that they last at least until t . This means that an increase in the size of the manufacturing sector of just one percentage point increases the *conditional likelihood of the peg ending* by roughly 10-13 percent. Since the manufacturing share of GDP is likely to vary primarily across countries, or over relatively long periods of time, it is probably most enlightening to think of this as a finding that the size of a country's manufacturing sector as a share of GDP has a very large negative impact on the likelihood that a currency peg in this country will be sustained. The standard deviation of MAN/GDP for the sample is 5.5 percent; a one standard-deviation increase in the share of manufacturing in the economy reduces the expected length of a peg by 33 months, and reduces the conditional probability that a peg will be maintained by 66 percent. This is fully in line with the expectations of the model.

We can similarly estimate the impact of pre- and post-electoral considerations, as seen by the variable ELECTION. An election pending in the coming month leads to a one percent *increase* in the median duration of a currency peg, equal to half a month. By the same token, for every month after an election the expected duration of the peg

decreases by about half a month. These results imply that during the eight months prior to an election, the duration of a currency peg is extended by about four months, while during the four months following an election, a peg's duration is reduced by about two months.²¹ Expressed differently, the impact of an election next month decreases the hazard rate by 1 percent (a 1 percent decrease in the conditional likelihood of the peg ending) whereas past elections increase the hazard rate by 1 percent (a 1 percent increase in the conditional likelihood of the peg ending). Taken together, the results on election timing imply that during the eight months prior to an election, the conditional likelihood of the peg ending is *reduced* by 8 percent, while during the four months following an election, the conditional likelihood of a peg ending is *increased* by 4 percent. Both the size of the manufacturing sector and election timing, then, have statistically significant and economically important effects on the duration of fixed exchange rate regimes. These results tend to confirm the expectations of our model.

4.3 Sensitivity Analysis

Here we attempt to see if our results are sensitive to different specifications, and different definitions of the complex data used in our analysis. In particular we are concerned that our results might be driven by our measures of regime type, or that they might be driven by the post-Bretton Woods period. To take these considerations into account, we repeat the exercises reported in Table 2 using a different scale for exchange rate duration and allowing for different time periods, especially 1960-1994. These are

²¹ The timing of the pre- and post- electoral dummy was selected by the specification which maximized the likelihood function. Small changes in the timing do not greatly influence the results.

reported in Table 3, and demonstrate that the results discussed in the previous section are indeed quite robust.

. Rather than define the currency regime as a 0 or 1 dummy (floating or fixed), our alternative measure of exchange rate regime allows for a finer nine-point grid of regimes. The measure provides more information regarding the nature of exchange rate arrangements than a 0/1 dummy variable.

Formally, the exchange rate regime is defined as:

REGIME₂ = 0. fixed, single currency

1. fixed, basket

2. fixed for less than 6 months (usually the case when authorities were not able to maintain fixed rate for a long enough period)

3. crawling forward peg (preannounced)

4. crawling forward band (preannounced)

5. crawling backward peg (based on changes in some indicators – usually past inflation)

6. crawling backward band (based on changes in some indicators – usually past inflation)

7. dirty floating (floating regime with authorities intervening, or auctions at which Central Banks set the amount of foreign currency to be sold or lowest bid, etc.)

8. flexible

In previous specifications, only the above category of 0 was considered a fixed rate. Table 3 reports the results for the case in which regime choice is 0-8 and over the

different time horizons. When considering the different regime choices, Table 3 examines each possible regime's duration (0-8), allowing each regime to have its own individual life-span. Our theoretical section contains predictions on the manufacturing sector's impact on the likelihood of remaining in fixed regimes, but there are no obvious predictions on the impact for more flexible regimes. Hence, we need to consider another variable to "soak up" this factor. When we employ the 0-8 scale, we therefore also include two other variables as there may be different effects for our variables if the regime is floating or quasi-floating in the 0-8 scale. Hence, we include a dummy for fixed regimes [FIX] and interact it with manufacturing [MAN/GDP*FIX]; we expect MAN/GDP*FIX to have the same negative sign as in Table 2, as larger manufacturing sectors will be better able to resist a currency peg. In this case, we define FIX more generally, as taking on the value of 1 when $REGIME_i=0,2,3,4$.²²

The results reported here are quite similar to Table 2, although the coefficients are generally slightly smaller. This is not surprising, as the finer measure in Table 3 requires the impact to be just as strong for each of the possible regimes. Some regime choices are more binding than others, and a currency peg would certainly be the most binding one. The most interesting difference is seen by examining the coefficient on FIX and MAN/GDP*FIX. The coefficient on FIX is strongly positive as fixed regimes appear to be the longest-lasting. The coefficient on MAN/GDP is positive and almost the equal and opposite sign as MAN/GDP*FIX with both being statistically significant. Hence, there

²² The results are similar when we allow FIX to be 1 when Regime=0 only. However, the statistical significance is slightly larger when employing the more general definition as it allows for a wider application of the regime being fixed.

continues to be strong evidence of political pressure from the manufacturing sector on exchange rate regime duration.

In summary, we find negative duration dependence for these Latin American exchange rate arrangements – the longer a country is on a fixed rate regime, the more likely it is to stay on it. Political factors play a critical role in determining the sustainability of a fixed rate. Specifically, the larger the manufacturing sector, the less likely a currency peg is to be adopted or sustained. At the same time, an impending election increases the likelihood that a fixed rate will be held to, while governments are more likely to leave a peg in the aftermath of an election. The political economy results are robust to a variety of different specifications; they are both statistically significant, and economically important.

5 Conclusions

This paper develops a model of exchange rate regime determination, in which governments face a tradeoff between the competitiveness of domestic tradables producers and anti-inflationary credibility: a currency peg leads to lower inflation at the cost of less competitiveness, and vice versa. The model suggests political factors likely to be important in determining the sustainability of fixed exchange rates. Specifically, the larger the tradables (and especially manufacturing) sector, the less likely the government is to sustain a currency peg. Elections, which lead governments to weigh such broad popular concerns as inflation more heavily, should have a countervailing impact: governments should be more likely to sustain a currency peg in the run-up to an election, but more likely to deviate from it after an election has passed.

We evaluate the model with extensive data on Latin America from 1960 to 1994, including a large number of economic and political variables. The data are analyzed with a duration model that assesses the effects of these variables on the likelihood that a country will remain in a currency peg over time.

In line with the model, we find that countries with larger manufacturing sectors are less likely to maintain a currency peg. For every percentage point increase in the size of a country's manufacturing sector, the duration of a currency peg declines by about six months or, to put it differently, the conditional probability of a peg ending increases by around 12 percent. Similarly, elections have the expected impact on currency pegs. In pre-electoral periods, the conditional probability that a government will leave a currency peg declines by 8 percent, only to rise by 4 percent in post-election months. These results complement other evidence that governments manipulate exchange rates for electoral purposes, typically to engineer a real appreciation and a boost to local purchasing power in pre-electoral periods, which then requires a depreciation after the election. We also find that governments in countries with fragmented political systems are less able to sustain commitments to currency regimes. The results are robust to the inclusion of many economic controls, and to many alternate specifications of time periods and regime definitions.

These results provide support for a *political economy* interpretation of the sustainability of exchange rate commitments in Latin America. Macroeconomic factors clearly affect the ability of governments to stay on fixed rates, which is no surprise. But political factors – special and sectoral interests, elections, political competition – must also be taken into account.

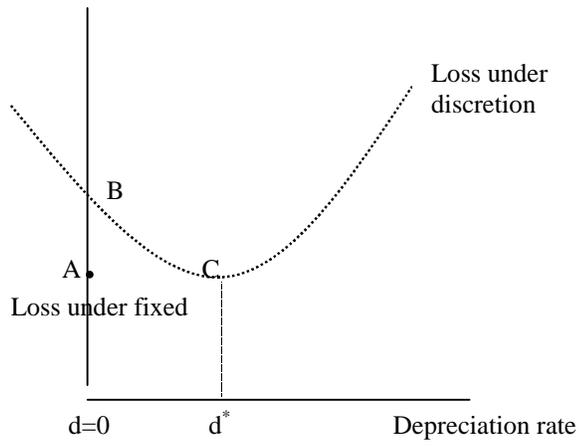
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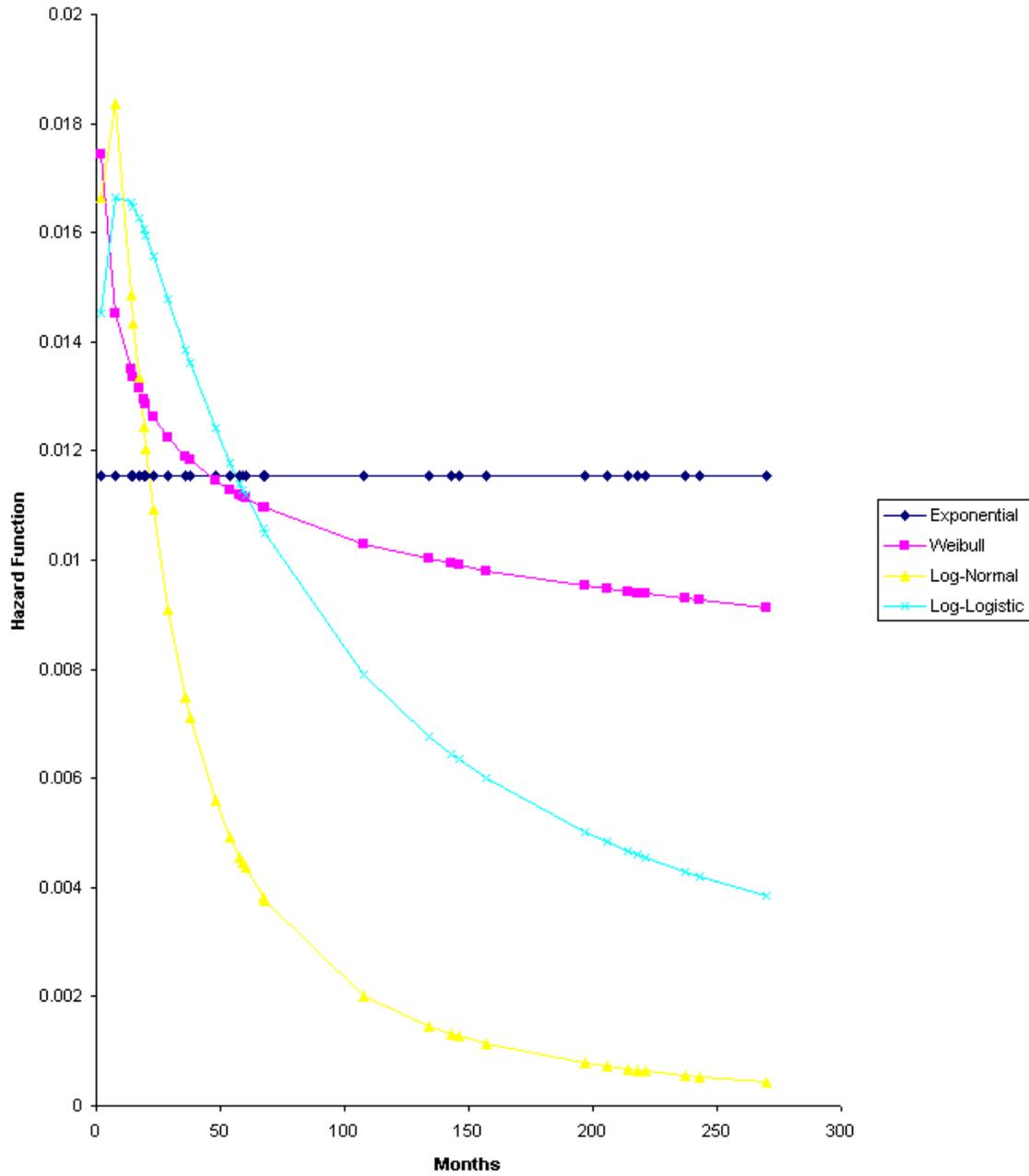
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Figure 1. Loss under fixed and discretionary regimes



**Figure 2: Hazard Functions Show Negative Duration Dependence
After a Few Months
(0-1 Scale 1972-1994)**



**Table 1: Estimated Duration Models Are Similar
(Estimated Robust S. E. in Parenthesis)**

Model	λ	p	Median Duration
Exponential	0.0115 (0.0019)	1.0000 0.0000	60.06
Weibull	0.0123 (0.0026)	0.86830 (0.1573)	52.21
Lognormal	0.0245 (0.0069)	0.6794 (0.1079)	40.81
Log-logistic	0.0216 (0.0056)	1.1682 (0.2048)	46.29

**Table 2: Including Covariates in the Weibull Model
(0-1 Scale) 1972-94**

Variable	Political	Political+Econ	All+Misalign
Constant	6.975*** (0.836)	-11.663* (7.205)	-11.306 (7.699)
MAN/GDP	-10.392*** (3.753)	-11.236** (5.453)	-13.178*** (5.351)
ELECTION	1.183*** (0.470)	1.085** (0.492)	0.859* (0.469)
EFFParty	-0.178** (0.090)	-0.107 (0.086)	-0.112 (0.084)
DGDP		108.697** (51.794)	127.150*** (52.723)
LN(INFLATION)		-0.382 (0.289)	-0.294 (0.279)
Regime View		21.184*** (7.972)	20.857*** (8.409)
Kcontrol		-0.161 (0.186)	-0.084 (0.181)
High Misalign			-1.852*** (0.634)
Low Misalign			-0.233 (0.580)
P	1.020*** (0.138)	1.071*** (0.157)	1.142*** (0.198)
pseudo R2	0.436	0.706	0.746

Notes: Standard Errors are in Parenthesis and are robust to heteroskedasticity of unknown form.

**Table 3: Sensitivity Analysis Using Different Scales
And Different Years**

	(0-1 Scale) 1960-94	(0-8 Scale) 1972-94	(0-8) Scale 1960-94
Variable	All+Misalign	All+Misalign	All+Misalign
Constant	-10.456 (7.493)	-8.307* (4.657)	-6.305 (4.074)
Fix		4.872*** (1.147)	4.444*** (1.146)
MAN/GDP	-12.577** (5.909)	12.355*** (4.414)	10.974*** (4.439)
MAN/GDP*Fix		-24.969*** (5.506)	-22.511*** (5.432)
ELECTION	0.909* (0.543)	0.536** (0.253)	0.596** (0.265)
EFFParty	-0.103 (0.091)	-0.083 (0.053)	-0.078 (0.056)
DGDP	134.836*** (54.245)	86.091*** (29.441)	75.672** (31.110)
LN(INFLATION)	-0.203 (0.266)	-0.155 (0.102)	-0.151 (0.107)
Regime View	19.534** (8.131)	12.355*** (4.414)	10.331*** (4.439)
Kcontrol	-0.152 (0.191)	-0.223 (0.151)	-0.285* (0.155)
High Misalign	-1.868*** (0.708)	-0.824** (0.371)	-0.839** (0.391)
Low Misalign	-0.183 (0.602)	0.029 (0.434)	-0.004 (0.455)
P	1.039*** (0.169)	1.060*** (0.102)	0.998*** (0.094)
pseudo R2	0.477	0.539	0.606

Notes: Standard Errors are in Parenthesis and are robust to heteroskedasticity of unknown form.
*=sig at 0.10 level, **=sig at .05 level, ***=sig at .01 level