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Frank Bohn, University College Dublin

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Greed, Impatience and Exchange Rate Determination

Frank Bohn*

University College Dublin

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Abstract

This paper offers a theoretical explanation for the determination of exchange rates under specific conditions which can/could be found in some OECD and newly industrialised countries. In an Obstfeld (1994) framework extended to incorporate government expropriation reneging on a fixed exchange rate promise unambiguously produces short term benefits, but long term losses. The choice of exchange rate regime depends on the combined effect of greediness (expropriation) and impatience (political instability), though not straightforwardly. In particular, similarly stable countries may choose different exchange rate regimes due to different levels of rent-seeking, for instance Mexico and Chile in the 1980s.

JEL classification: E42, F41, H29

Keywords: exchange rate regime, monetary policy, fiscal policy, expropriation, political instability, political economy.

* UCD, School of Economics, Newman Building, Belfield, Dublin 4, Ireland.
Email: frank.bohn@ucd.ie, phone: +353-1-716-8357 (fax: +353-1-283-0068).

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1 Introduction

In a growing literature on the institutional determinants of exchange rate regimes, there seems to be a consensus on an empirical result by Edwards (1996) that "more unstable countries have a lower probability of selecting a pegged-exchange-rate system." A recent study by Alesina and Wagner (2006) is more problematic because they consider political instability to be one of several indicators of institutional quality and find that "typically ... better institutions are associated with more pegged [exchange rate] regimes". More precisely, their results suggest a "U-shaped relationship" according to which "countries that float tend to be either very low ... or very high in the institutional quality scale". However, Alesina and Wagner's paper cannot explain what happens when bad governance or corruption (or, indeed, state capture) do not go together with political instability. Take a country like Indonesia which maintained fixed exchange rates for 20 years until 1997. It is haunted by corruption and defective governance, which according to Alesina and Wagner would point towards floating exchange rates. Yet there was a high level of political stability with Suharto in power for 32 years which would suggest fixed exchange rates. Take another example. Mexico and Chile were both very stable countries in the 1980s (though one even less democratic than the other). Nonetheless, Chile was committed to fixed exchange rates whereas Mexico allowed the exchange rate to float. One difference between the two countries was that Chile had less corruption and better governance.

Neither example can be explained by the empirically driven research on the institutional determinants of exchange rate regimes. We do not really understand what is going on, if we do not have a theory explaining the underlying mechanisms. This paper suggests one possible theory. Models by Obstfeld (1994) and Anderson (1998) are extended to allow for expropriation by the government while taking into account that political instability increases the government's impatience. On the one hand, we study the effect of expropriation on the choice of exchange rate regime through what could be interpreted as fiscal policy. Similar to Agell, Calmfors and Jonsson (1996), the government has both control over fiscal and

monetary policy. We do not model a conflict between independent monetary and fiscal authorities (nor do we model elections) as in Demertzis, Hughes Hallett and Viegi's (2004) extended Barro-Gordon (1983) model.[1] On the other hand, political instability – modelled as an argument of the discount factor as suggested by Edwards (1996) – has the same effect as in Méon and Rizzo (2002) who show that governments tend to renege on fixed exchange rate promises when the country becomes more unstable.

Assuming a fixed exchange rate regime as a starting point, this paper captures the government's optimal choice between reneging on or complying with the fixed regime.[2] The government has social objectives aiming at low inflation and high output to satisfy the electorate. But it also expropriates wealth from society by using fees or taxes which have a negative impact on output. More specifically, the additional fiscal burden could be interpreted as distortionary income tax. Reneging on a fixed exchange rate promise unambiguously produces short term benefits, because the government can achieve lower real wages and boost output by deceitfully increasing inflation above agents' expectations. However, there are long term losses since cheating only works once and inflation including its negative effects persist. It can be shown that reneging on a fixed exchange rate regime is advantageous to the government only if it is sufficiently greedy (i.e. determined to exploit the country) and/or sufficiently impatient (including its fear of losing power). The main result of this paper is that the choice of exchange rate regime depends of the combined effect of greediness and impatience, though not straightforwardly. In particular, similarly stable countries may choose different exchange rate regimes due to different levels of rent-seeking. For instance, Chile was considered to have good governance and little corruption in the 1980s. It chose fixed exchange rates. By contrast, 1980s Mexico with a much worse governance record

[1] In empirical papers, Schuknecht (1999) discusses the reverse causality, i.e. the effect of exchange rate regimes on fiscal policy, Alesina and Summers (1993) study the impact of central bank independence on economic performance, and Bergvall (2005) simulates output and output volatility for alternative exchange rate regimes in Sweden.

[2] We do not consider intermediate exchange rate regimes as in Bénassy-Quéré and Cœure (2002). Edwards (2000) argues that "countries should opt either for floating or for super-fixity (currency boards or dollarization)."

preferred flexible exchange rates.

Obviously, the model is not applicable to all countries and has a number of limitations. First, the surprise inflation argument is only appropriate for countries where wage bargaining is working properly. Only when trade unions are sufficiently free can we assume that workers can secure steady real wages (unless there is a surprise). The list of countries with sufficient labour standards includes, among others, most OECD and many Latin American countries (Aidt and Tsannatos, 2002). Second, the central bank is assumed to be more or less dependent on the government. So most of today's OECD countries would be excluded. But in the past central bank independence was not obvious, even in OECD countries. So Italy and France in the 70s and 80s would be suitable examples for our model. Third, elections are not considered explicitly and there is no feedback effect of economic performance on political stability. Forth, and probably most problematic, we totally ignore the effect of exchange rates on trade (and aggregate demand). All of these limitations offer ample scope for future research.

The remainder of the paper is organised as follows. Section 2 presents the extended Obstfeld (1994) framework. Section 3 discusses the time line and the reneging and complying scenarios. Section 4 determines the overall gain and interprets the results. Section 5 concludes.

2 Political Economy Model

The model extends the Obstfeld (1994) model in two ways: (i) the government can raise an expropriation tax which negatively affects output; and (ii) government behaviour is determined by an expropriation revenue objective in addition to the standard inflation and output objectives.

Output is determined by a modified short run expectations-augmented aggregate supply

curve:

$$y_t = \bar{y} + \phi(\pi_t - \hat{w}_t) - \tau t_t. \tag{1}$$

Output y_t deviates from hypothetical trend output $\bar{y}$ for two reasons: (i) wage inflation $\hat{w}_t$ can differ from price inflation π_t; and (ii) there is a burden from expropriation tax rate t_t (which could also be interpreted as distortionary income taxes).[3] Hence equation (1) could also be called short run aggregate supply curve cum deadweight loss effect of taxes. Wages are assumed to be based on expected price inflation:

$$\hat{w}_t = \pi_t^e. \tag{2}$$

Purchasing power parity links the home country to the rest of the world (foreign country f):

$$\hat{e}_t = \pi_t - \pi_t^f, \tag{3}$$

where the rate of depreciation $\hat{e}_t$ depends on the inflation differential. Analogously for the expected rate of depreciation:

$$\hat{e}_t^e = \pi_t^e - (\pi_t^f)^e, \tag{4}$$

Assuming the home country to be small the foreign inflation rate π_t^f is given and normalised at 0%:

$$\pi_t^f = \bar{\pi}_t^f = 0. \tag{5}$$

After insertions the supply function looks as follows:

$$y_t = \bar{y} + \phi(\hat{e}_t - \hat{e}_t^e) - \tau t_t. \tag{6}$$

[3] It is important to realise that hypothetical trend output $\bar{y}$ is not attainable as long as the government raises expropriation taxes at least to some degree. Confer equation (7).

The monetary component in the supply function now captures any deviation of exchange rates from expected exchange rates. A depreciation is not harmful for output as long as it is expected. In any credible fixed exchange rate regime (including a crawling peg), expectations would always correspond to actual depreciation rates – and there would be no effect on output.

The government's linear quadratic loss function is assumed to comprise the standard components, deviation from desired inflation and deviation from hypothetical trend output, but also an expropriation component:

$$L_t = \frac{1}{2}(\hat{e}_t)^2 + \theta\frac{1}{2}(\bar{y} - y_t)^2 + \delta\frac{1}{2}(R^* - t_t y_t). \tag{7}$$

The government cares for inflation, for instance because inflation produces a deadweight loss and public discontent. The loss increases over-proportionately with increasing inflation. The government is also concerned about output, for instance because a reduction in output causes unemployment which again results in public discontent. The problem increases over-proportionately with more and more unemployment. Theoretically, this formulation implies a loss, if y_t exceeds $\bar{y}$. However, due to the distortionary effect of taxes on output in equation (1), y_t will always be below $\bar{y}$.[4] The inflation objective (weight 1) and the output objective (exogenous weight θ) capture the standard social/economic objectives, here the government's interest in the economy as a whole. These social objectives could be interpreted in terms of the government's investment in securing reelection (thought there is no explicit feedback from the economic conditions to the government's chances of staying in power).

The additional third term in the loss function reflects the government's intention to exploit society. The exogenous weight δ the government puts on expropriation will be called greed. The government is assumed to desire some level of expropriation revenue R^*. The difference to the actual expropriation revenue $t_t y_t$ enters as a loss. The expropriation objective was

[4] To avoid complications, $k\bar{y}$ with $k > 1$ could be used. But that is not instrumental for the findings in this paper.

chosen in linear format. A quadratic form would only drive the actual expropriation revenue closer to the desired level, but would not change anything fundamentally. There would be two problems though. The first issue is conceptual in nature. There is no clear-cut level for R^* which should be reached with urgency. It does not make sense to punish deviations more and more with growing distance to this arbitrary level of R^*. In fact, the linear formulation allows for a gain when the actual expropriation exceeds the target level R^*. Thus R^* could be set to 0 and effectively deleted from the equation, but is left in the equation for expositional reasons. Secondly, there is a technical issue. A quadratic form would complicate the analysis unnecessarily.

We obtain a consolidated loss function by inserting twice the constraint, i.e. supply function (6), into equation (7):

$$L_t = \frac{1}{2}(\hat{e}_t)^2 + \theta\frac{1}{2}(-\phi(\hat{e}_t - \hat{e}_t^e) + \tau t_t)^2 + \delta\frac{1}{2}(R^* - t_t(\bar{y} + \phi(\hat{e}_t - \hat{e}_t^e) - \tau t_t)). \tag{8}$$

The equation contains the exogenous parameters θ, δ, ϕ and τ and the constant variables $\bar{y}$ and R^*. For minimising its loss, the government has one or two policy instruments depending on the situation (scenario). Expropriation taxes t_t are always determined by the government, but the rate of depreciation, $\hat{e}_t$, may be fixed or used as another instrument. The formation of expectations of the rate of depreciation, $\hat{e}_t^e$, will be discussed in the next section. Altogether, the equation has eight components (loss items):

1. *Inflation loss:* Any depreciation relative to the stable foreign currency means a deviation from monetary stability, i.e. inflation, and carries a loss for society. Obviously, a government may choose to attribute only a small relative weight for inflation (by making the other weights θ and δ larger).

2. *Inflation expectation induced output "gain":* A surprise depreciation, i.e. a switch to flexible exchange rates while private agents still believe in the fixed rate, means decreasing real wages and, therefore, lower production costs and increasing output.

Nonetheless, squaring $(-\phi(\hat{e}_t - \hat{e}_t^e))$ produces a positive term, i.e. a loss. Only the cross factor component (next item) is negative. Items 2 and 3 appear together and are only present, when there is a surprise depreciation.

3. *Cross factor component:* Combining 2 and 4 due to the squaring, this is negative, i.e. a gain.

4. *Expropriation tax induced output loss:* There is always an expropriation tax and its deadweight loss effect reduces output, thereby producing a loss for the government – assuming it values society's output at least to some degree.

5. *Desired revenue loss:* The loss increases with the magnitude of the expropriation revenue desired by the government (target level R^*). It is, however, reduced or offset by the actual expropriation revenue (determined by items 6 to 8 together).

6. *Trend output induced revenue gain (offsetting loss 5):* Higher hypothetical trend output represents a gain as it reduces the gap to the desired expropriation revenue.

7. *Inflation expectation induced revenue gain (offsetting loss 5):* A surprise depreciation has a positive effect on output and therefore on the expropriation revenue. Thus a gain.

8. *Expropriation tax induced revenue loss:* The last term τt_t signifies that the expropriation tax has a negative impact on output, thereby reducing the expropriation revenue, hence reducing the positive effect of items 6 and 7. In other words, it represents a loss.

3 Time Line and Two Scenarios

In the following, we assume that the government in question has made a commitment to keep exchange rates fixed. The country holds enough foreign reserves to make this a credible

commitment. In fact, we assume that the public trusts the government and does not know that there might be reasons for the government to renege on its promise. By contrast, the government acts rationally on the basis of loss function (8). To determine whether to comply with or renege on its promise the government compares the losses in both cases (scenarios) and calculates its net loss for each period.[5] Introducing a discount factor we can then consolidate the net losses of all periods and determine the overall gain from reneging (which may be positive or negative).

If the country commits to fixed exchange rates in period T monetary policies are necessarily stability-oriented. Expansionary monetary policies are not possible as they would only result in pressure on the exchange rate which would require foreign exchange market interventions, thus offsetting the expansionary policies. In a stylised setting with zero inflation abroad, this means there will be no inflation at home either. Therefore, private agents will not demand wage rises. Once wage bargaining is complete, however, the government can decide, if it will go along with its promise or renege on it. If it reneges, there will be short-term effects (compared to complying), because real wage costs decrease and output expands. Raising output above its optimal level will prompt the government to make adjustments in its optimal choice of policy, in particular it will be able to increase the expropriation tax in period T t_T which has a negative impact on output.

Following the literature, the model is set up such that there are no intertemporal linkages. The policy game played in period T is separate from the policy game in period T+1, which, in turn, is separate from that in period T+2, etc. There is one exception though: the government's decision to renege affects agents' depreciation expectations in the future. Let us, therefore, describe the time line of events in more detail. In period T, there is wage bargaining first, then the government's decision to comply (thus defining the complying scenario)

[5] Another interpretation is possible. Assume that the public wants to verify, whether they can trust the government or not. If private agents determine that upholding its promise is not the government's best choice, then the public would stop believing in the fixed exchange rate regime and it would collapse even before the government can take the decision to renege on its promise.

or renege (reneging scenario). The outcome of the wage bargaining in T+1 and all following periods is determined by the government's period T decision. So is the government's decision in period T+1 and thereafter.

For simplicity, we assume that the government has only got one chance of reneging in period T. If it does, it is stuck with a flexible exchange rate in the future. The government can no longer exploit private agents' trust. From T+1 onwards, agents correctly expect the inflationary policies of the government and demand wage increases accordingly. Going back to fixed exchange rates is not possible, because the presence of inflationary wages means that the government's stability-oriented policies would only cause real wage increases and output losses. Thus it is optimal for the government to stick to the high inflation (depreciation) scenario. We also assume that complying in period T means complying in all future periods. The argument is that, if it were optimal for the government to comply in period T, there would be no reason why it should not be optimal in T+1 or thereafter.

Consider what happens in the complying scenario. There are no demands for wage increases and the government sticks to monetary commitment throughout. In period T as well as in periods T+1, T+2, ... it optimises with respect to the expropriation tax only. The government's expropriation revenue will be smaller than desired because taxes also have a negative impact on output, thus trading off the negative output effect for the positive expropriation revenue effect. The loss in each period (confer appendix A) consists of the expropriation tax induced output loss (aforementioned loss item 4), the desired revenue loss (item 5), the trend output gain (item 6), and the expropriation tax induced revenue loss (item 8).

Next, let us look at the reneging scenario. The government reneges on its monetary commitment in period T which leads to a permanent switch to flexible exchange rates. In period T agents had not asked for a wage increase because they still believed in the government's promise. Once wage bargaining is complete, the government reoptimises with respect to taxes *and* inflation. It can boost output by increasing inflation above the expected level.

While doing so, it is optimal to increase expropriation taxation which damages output. Overall, there is an increase in output in period T. In period T+1 agents do not trust the government and will demand wage increases in accordance with the government's optimal ex post decision irrespective of its intensions. Therefore, it will be optimal for the government to optimise and validate private agents' expectations. Inflation will be higher now, but there will be no beneficial effect on output. Hence expropriation taxes will be set optimally at the same level as in the complying scenario.

The loss in the reneging scenario is different in T compared to the subsequent periods (confer appendices B and C). In period T, there is – compared to the complying scenario – an additional inflation loss (aforementioned loss item 1), but at least partly offset by inflation expectation induced gains both in terms of output (items 2 and 3) and revenue (item 7). At higher levels of taxation there will also be higher expropriation tax induced losses both in terms of output (item 4) and revenue (item 8). In period T+1 and all other future periods, taxes are back to "normal" (complying scenario level) even though inflation has increased (with inflation correctly being anticipated). Therefore, inflation expectation induced gains and additional expropriation tax induced losses will be gone – compared to period T.

4 Greed, Impatience and Overall Gain

We can now compare the two scenarios quantitatively in each period. Concerning any future period (T+1, T+2, etc.) the loss in the complying scenario is smaller than the loss in the reneging scenario. In other words, it would be advantageous to keep the monetary commitment. In each future period, permanently switching to flexible exchange rates produces a higher loss because of the additional negative inflation loss (item 1). There are no offsetting positive effects. The situation is very different when comparing the complying and the reneging scenarios in period T. Effects are countervailing. The reneging scenario again

bears the additional negative inflation loss (item 1). However, there are further additional positive and negative induced output effects (items 2, 3 and 4) and induced revenue effects (items 7 and 8). Nonetheless, the comparison for period T is unambiguous as well. Reneging on the monetary commitment is advantageous in period T because the gain from increases in terms of output and expropriation revenue dominate the additional inflation loss.

So far, we know that reneging produces a net gain in period T and a net loss in all future periods – compared to the complying scenario. To determine which scenario is more advantageous overall for a government (and hence chosen by it) we must make assumptions about how the government discounts its future. It is straightforward to assume a constant time preference rate. However, the effective discount factor ρ ($0 < \rho < 1$) will also be influenced by the government's chances to stay in power. This may depend on more or less rigged elections (like in Egypt) or on the chances for a revolution or a coup d'état (like in most Latin American countries in the 1970s or 80s). In any case, modeling the chance to stay in power as a response to the government's behaviour is difficult and somewhat arbitrary. Even in democracies election outcomes are often strongly influenced by random events like foreign policy incidents, terror attacks (e.g. Madrid bombings in Spain) or natural disasters (e.g. river Oder flooding in Germany). A simpler alternative is to assume a constant (or variable) exogenous chance of losing power in each period. Even more simplistically, one could model the chance of losing power just once. No matter how this is modeled, incorporating political instability into the analysis has only one effect: the effective discount factor ρ is reduced.[6] Following Edwards (1996) we assume, therefore, that the effective discount factor is a function of political instability. So, effective discount factor ρ captures both normal impatience and political instability. Henceforth, effective discount factor, impatience and political instability will be used interchangeably.

[6] This is straightforward, because the (non-discounted) net loss of reneging relative to complying is identical for *all future periods*. – This is confirmed by Méon and Rizzo (2002) who discuss explicitly the effects of political instability on a government's choice of the exchange rate regime. But it also applies in other contexts, for instance, in the government finance decision under political instability discussed in Bohn (2006).

The overall gain G^O from a permanent switch to flexible exchange rates, i.e. the net gain in T minus the discounted net losses in all future periods (T+1, T+2, etc.), turns out to be:

$$G^O = \frac{A[(1-2\rho)B + \rho C]}{B^2[B-C](1-\rho)} \tag{9}$$

with

$$\begin{aligned} A &= \frac{1}{2}(\frac{1}{2}\delta\bar{y})^2\phi^2(\theta\tau + \frac{1}{2}\delta)^2 > 0, \\ B &= \tau(\theta\tau + \delta) > 0, \\ C &= \phi^2(\frac{1}{2})^2\delta^2 > 0. \\ B &- C > 0 \qquad \text{according to appendix B.} \end{aligned}$$

The exogenous parameters θ, δ, ϕ and τ as well as exogenous discount factor ρ determine, if the overall gain of switching is positive or negative. Hypothetical trend $\bar{y}$ only matters for the magnitude of the overall gain or loss. Unsurprisingly, arbitrary expropriation objective R^* does not matter at all. If the overall gain is positive the government chooses to switch to flexible exchange rates in period T and sticks with flexible rates thereafter. If there is a negative gain, the government chooses to uphold its fixed exchange rate commitment indefinitely.

Since $0 \leq \rho \leq 1$ the denominator must be positive. The numerator is positive for $\rho \leq \frac{1}{2}$, but may or may not be positive otherwise:

$$G^O > 0 \iff \rho < \frac{1}{2} + \frac{C}{2(2B-C)} \tag{10}$$

$$\text{with} \qquad 0 \geq \frac{C}{2(2B-C)} < \frac{1}{2} \quad \text{since} \quad B > C.$$

For given exogenous parameters θ, ϕ and τ, equation (10) establishes a relationship between ρ, δ and G^O which is sketched in figure 1. As the government becomes more and more greedy,

i.e. δ goes up, it is expropriating the economy more and more by increasing expropriation tax t_t, thereby choking back output. The sufficient condition for the minimisation problem in period T of the reneging scenario requires that $B > C$. Confer appendix B. The limiting case $B = C$ defines a quadratic equation in δ which has only one positive root, δ^{max}. We can show that δ must be smaller than δ^{max}. The overall gain G^O goes to infinity for δ approaching δ^{max}, but decreases for smaller values of δ. Realistically, we cannot be close to δ^{max}, however, because there would be a lasting effect on output capacity and hence output in the following periods. This is not envisaged in this model since we treat all periods independently. We would also assume that the effective discount factor is below, say, .95, even if there is no political instability at all (due to normal time preference considerations).

Figure 1: Greed and Impatience

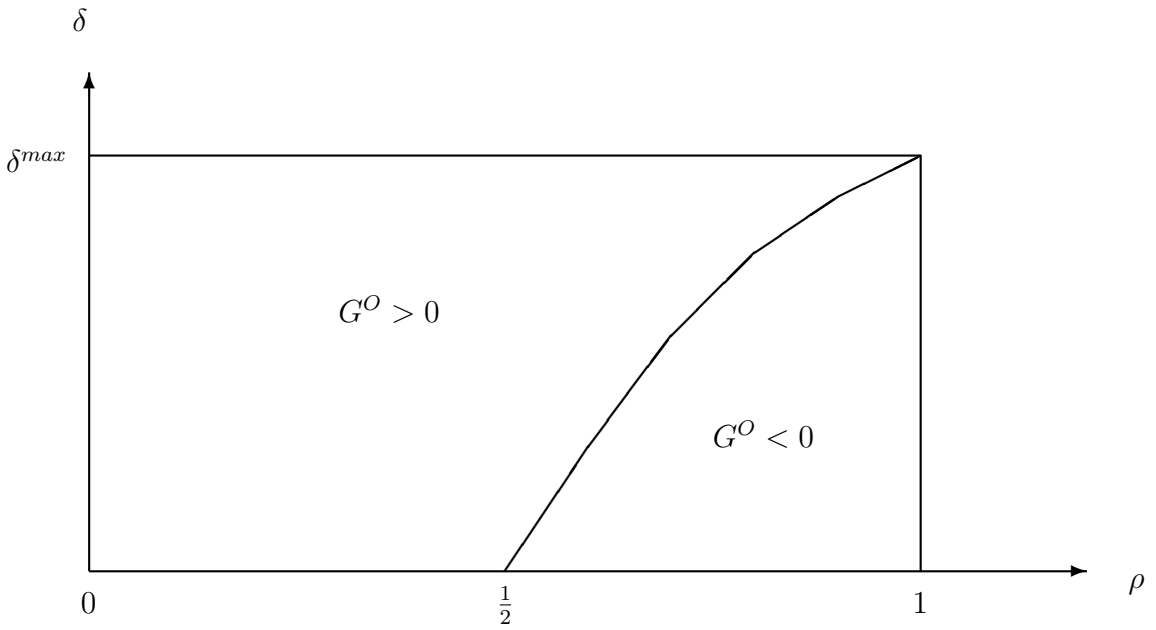

Figure 1 shows the region of positive overall gain in a $\rho - \delta$ diagram. As long as $\rho \leq \frac{1}{2}$ (extreme discounting), the overall gain will always be positive. This means that a fixed exchange rate regime can never be an option for a rational government in a very unstable

environment. For $\rho > \frac{1}{2}$, the overall gain will turn negative at some stage for decreasing values of δ. A smooth and slightly concave curve connecting the points ($\frac{1}{2}$,0) and (1,δ^{max}) defines the border between positive (above) and negative overall gains (below). This implies that even a very greedy government would want to stick to fixed exchange rates, as long as there is very little political instability. It would also be rational to keep fixed exchange rates, if greed is low, even though there is quite a lot of political instability (but $\rho > \frac{1}{2}$). Between those two extremes, political stability can be traded off for greed.

5 Conclusion

In an extended Obstfeld (1994) model we have investigated a government's rational choice of the exchange rate regime. Ceteris paribus, higher levels of greed favour reneging on the fixed exchange rate promise, because the increase in expropriation taxes possible with a surprise inflation is valued more. However, the results suggest that it can be rational for the government to stick to fixed exchange rates despite high levels of greed, if there is a lot of political stability (little impatience). Conversely, low levels of political instability (i.e. little impatience) tempt a government to forego the short run benefit in favour of the long run advantage of low inflation. In other words, the government would want to comply with the fixed exchange rate regime as in the case of Chile. However, it can be rational for a government to renege despite high levels of political stability, if the government is very greedy. This would be the case of Mexico.

Despite numerous empirical studies, it may still be useful to explain the determinants of exchange rate regimes in theoretical papers. This can help us understand the underlying mechanisms and explain real world observations which might be washed out in econometric studies. At the same time, empirical papers based on institutional variables are still facing some serious problems. For instance, there are unresolved endogeneity issues, there are problems based on the fact that some variables are only available as time-invariant data,

and often data sets are not sufficiently large. For all these reasons, it would be worth while exploring the impact of other institutional variables in theoretical models.

Furthermore, all limitations mentioned in the introduction offer ample scope for future research. In a similar model framework, one could analyse the impact of exchange rate regimes on alternative labour market structures (for instance, falling real wages when there are devaluations). Dual labour markets similar to the Harris-Todaro (1970) model could be analysed. Also, the implications of elections or feedback effects of economic performance on political stability could be studied. A different model framework would be needed to include central bank independence or to study the effect of devaluations on trade. In any case, there is still a long way to go before we really understand the impact of institutions on the choice of exchange rate regimes.

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Appendix

A Complying Scenario

The government's minimisation problem is identical in all periods:

$$\begin{aligned} & \max_{t_t} \quad L_t \quad \text{s.t.} \quad \pi_t = 0 \qquad\qquad t = T, T+1, T+2, ... \\ \iff & \max_{t_t} \quad \theta\frac{1}{2}\tau^2 t_t^2 + \delta\frac{1}{2}(R^* - t_t\bar{y} + \tau t_t^2) \qquad\qquad t = T, T+1, T+2, ... \end{aligned} \tag{A.1}$$

The loss in each period is:

$$L_t = \delta\frac{1}{2}R^* - \frac{\frac{1}{2}(\frac{1}{2}\delta\bar{y})^2}{\tau(\theta\tau+\delta)} \qquad\qquad t = T, T+1, T+2, ... \tag{A.2}$$

B Sufficient Condition for Reneging Scenario, Period T

To ensure that our problem is a well-defined minimisation problem, we have to check the semi-definiteness condition:

$$\begin{aligned} & L_{t_T t_T} L_{\pi_T \pi_T} > (L_{\pi_T t_T})^2 \\ \iff & \tau(\theta\tau+\delta) > \phi^2(\frac{1}{2})^2\delta^2 \end{aligned} \tag{B.1}$$

This condition will be imposed. It implies that the denominator in equation (C.2) is positive.

C Reneging Scenario

The government's minimisation problem in period T is:

$$\begin{aligned} & \max_{t_T} \quad L_T \quad \text{s.t.} \quad \pi_T^e = 0 \\ \iff & \max_{t_T} \quad \frac{1}{2}(\hat{e}_t)^2 + \theta\frac{1}{2}(-\phi\hat{e}_t + \tau t_t)^2 + \delta\frac{1}{2}(R^* - t_t(\bar{y} + \phi\hat{e}_t - \tau t_t)) \end{aligned} \tag{C.1}$$

The loss in period T is:

$$L_T = \delta\frac{1}{2}R^* - \frac{\frac{1}{2}(\frac{1}{2}\delta\bar{y})^2(1+\theta\phi^2)}{B-C} \tag{C.2}$$

with

$$\begin{aligned} B &= \tau(\theta\tau + \delta) > 0, \\ C &= \phi^2(\frac{1}{2})^2\delta^2 > 0. \\ B &- C > 0 \qquad \text{according to appendix B.} \end{aligned}$$

The government's minimisation problem in the following periods is:

$$\begin{aligned} & \max_{t_t} \quad L_t \qquad\qquad t = T+1, T+2, ... \\ \iff & \max_{t_t} \quad \frac{1}{2}(\hat{e}_t)^2 \\ & \qquad +\theta\frac{1}{2}(-\phi(\hat{e}_t - \hat{e}_t^e) + \tau t_t)^2 \\ & \qquad +\delta\frac{1}{2}(R^* - t_t(\bar{y} + \phi(\hat{e}_t - \hat{e}_t^e) - \tau t_t)) \qquad\qquad t = T+1, T+2, ... \end{aligned} \tag{C.3}$$

The loss in each period is:

$$L_t = \delta\frac{1}{2}R^* - \frac{\frac{1}{2}(\frac{1}{2}\delta\bar{y})^2(\tau(\theta\tau+\delta) - \phi^2(\theta\tau + \frac{1}{2}\delta))}{\tau^2(\theta\tau+\delta)^2} \qquad t = T, T+1, T+2, ... \tag{C.4}$$