Visibility and Credibility:
On nominal anchors and other ways to send clear signals[†]

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Abstract: We investigate the interplay between government credibility and the visibility of policy-making, using the choice of a nominal anchor as an important example of how governments control visibility. We show that visibility has an important influence on how governments acquire credibility, and for this reason is a variable that governments use strategically. Policy-makers with stronger commitment to reform opt for more visible policies (e.g., an exchange-rate anchor) whereas policy-makers who cannot carry through with serious reform opt for noisier signals (e.g., a money anchor). Our logic is that greater visibility makes it easier for the public to learn the government's preferences, and only policy-makers committed to reform want this to happen. Among other things, our analysis provides a rationale for the prevalence of temporary exchange-rate targets in inflation-stabilization programs.

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1. Introduction

A government introducing painful but necessary reforms invariably faces a credibility problem: it must persuade a skeptical public that it is committed to seeing the reforms through to their fruition. But public skepticism tends to be stubborn. Mere promises have little effect because they are cheap talk. And even the government's actions early on may not carry enough information to convince the public beyond a doubt that the government will be true to its word.

Much of the work that tries to explain why it is so hard for a reform-minded government to establish credibility stresses what can be called the "pooling problem." Some disingenuous policy-makers may feign a greater zeal for reform than they really have by adopting, at least early in their term, policies advocated by dyed-in-the-wool reformers. For example, looser trade restrictions could be the work of a government truly committed to free trade. But it could also be the work of a government trying to lure new investment with free-trade policies that it has no intention of sticking to. So even a substantial trade reform may not be enough to persuade the public of the government's free-trade credentials.[1] This is the problem that arises in pooling equilibria of games of incomplete information.

But there is another reason why credibility may be hard-earned, which we call the "visibility problem." This problem arises because the public has trouble observing signals from the government. For example, even a drastic anti-inflation plan, with a sharp cut in the deficit and slowdown in money growth, may not immediately inspire confidence if the public cannot observe important fiscal or monetary variables in a timely and precise way. The government would still have trouble signaling its commitment to low inflation, not because of the pooling problem, but because the public receives vague rather than clear evidence of the government's deeds.

We study implications of the visibility problem for the political economy of reform, and especially the interaction between the visibility and the pooling problems. That is, we analyze what happens when the public has trouble observing not only the government's intentions but also its actions. Our aim is not simply to add another layer of complexity—that of imperfect visibility—to the already vexatious issue of incomplete information. Rather, we want to study how a government with private information about its preferences behaves when it can control how easily the public can observe its actions. Given the power to control

[1]See Rodrik (1989) for a model along these lines.

visibility, what kind of policy-maker elects to send a very clear message to the public and what kind tries to obfuscate?

We consider the relationship between visibility and credibility in a specific context—the choice of a nominal anchor for an anti-inflation program. We assume that the government can target either of two variables, the nominal exchange rate or a monetary aggregate. In our simple model the two kinds of anchors are identical in every respect except that an exchange-rate anchor makes monetary policy more visible (an assumption we expand on below). This assumption is enough to make the choice of a nominal anchor a salient one.

Although our model is constructed for a narrow context, we believe its insights have broader implications for the literature on the political economy of reform. Two implications come to mind immediately. One is that governments may have trouble acquiring credibility not because they haven't taken the steps needed to earn credibility but because the public cannot clearly see what steps the government has taken. The literature has largely ignored the latter problem. The second implication is that, if the government has some control over the visibility of its policies, then we should expect that many aspects of reform packages are efforts to improve the quality of the signal from the government to the public. This may be a rationale for bundling reform policies together rather than introducing them in sequence, incorporating IMF surveillance into stabilization programs, joining multilateral organizations such as the OECD and World Trade Organization, and soliciting ratings from Standard and Poor's and Moody's. If these actions are partly meant to make policy more visible, then our model provides the calculus that lies behind them.

Using as an example the choice of a nominal anchor has more than heuristic value, however. It is often asserted without formal justification that the benefit of an exchange-rate anchor is its visibility. Bruno advocates the use of the exchange rate as a nominal anchor because "[stabilizing] a key price in the economy, which is observable on a daily basis (unlike the price index, usually published once a month and with some delay), ...provides a more important and clearer signal to the rest of the system than the indirect signal embodied in the quantity of money." (Bruno (1991), p. 23) But his assertion is, as he puts it, a quasi-practical advantage of exchange-rate anchors, which is to say that it is not firmly grounded in theory. Persson and Tabellini also suggest that the exchange rate may be a more suitable nominal anchor because it is "easily observable, so the private sector can directly monitor any broken promises by the central bank." But they add: "we know of no convincing argument that turns these properties into an explanation for why it would be a more efficient method to achieve credibility to target the exchange rate rather than, say, the money growth rate." (Persson and Tabellini (1994) p. 17).

To analyze the interplay of visibility and credibility we need a model in which credibility is problematic and in which the public has trouble observing the government's actions. We build such a model by starting with two simple assumptions. First, there is incomplete information: the public is unsure of the government's true preferences and tries to divine these by studying the government's actions early in the game. The second assumption is of imperfect monitoring: the public cannot observe the government's actions directly but must instead rely on noisy proxies for these actions. Central to our model is the fact that visibility is endogenous—the government can control how well or how poorly the public can observe government actions, and chooses the level of visibility optimally.

The government's strategic calculus, and the intuition behind the model, is easy to grasp. If the government adopts very visible policies, then the signals it sends to the public carry a great deal of information about its preferences. Knowing this, the public places more weight on the actions it observes early on and less on its prior beliefs when it is trying to gauge the government's commitment to reform. But, under the close scrutiny of the public eye, the government must work hard to create the impression that it truly wants reform. This means adopting painful reforms early on to establish its credentials as a *bona fide* reformer. The cost of greater visibility is the extra pain incurred early in the game because the reform is more draconian than the government would choose otherwise. But this cost must be compared to the gain later in the game that comes from greater credibility.

Part of the boost to credibility comes precisely because the government adopts visible policies early on, since this signals to the public that the government is willing to submit its actions to close scrutiny. In other words, adopting more visible policies is a signal in and of itself, not just a way to make it easier for the public to read other signals. Policy-makers earn the public's trust not only by taking the right steps towards reform but also by doing so in the open.

For the analysis of the choice of a nominal anchor for an inflation-stabilization plan, incomplete information means that the government cannot convince the public by proclamations alone that it is determined to reduce inflation. The policy-maker must demonstrate its will with actions rather than announcements, and a commitment to a nominal anchor, such as a fixed exchange rate, is one such action. The problem of imperfect monitoring is captured by the assumption that an exchange rate anchor makes it easier for the public to monitor the behavior of policy-makers. We can think of at least two justifications for this assumption. It may be that the nominal exchange rate is easier to monitor than other nominal variables that might serve as an anchor. The public can quickly and easily detect changes in the exchange rate (e.g., depreciation) whereas a surge in the monetary base can go unnoticed for months. Or it may be that, in an open economy, changes in the exchange rate often explain much of the variance in many other nominal variables, such as inflation and interest rates. Hence, minimizing the variance of the exchange rate makes the entire array of nominal variables the public watches a better (that is, less noisy) barometer of monetary policy. Our model is constructed in a way that encompasses both of these justifications.

We proceed in two steps. First, we build a model with an explicit parameter that we interpret as visibility, whether of the anchor variable itself or of monetary policy generally. We assume that a policy-maker chooses between two kinds of nominal anchors to stabilize inflation, and that these anchors can be ranked according to their visibility. The measure of visibility is straightforward. We simply insert a wedge of white noise between the policy-maker's action and the public's observation of this action. Selecting a policy with less white noise is equivalent to selecting an anchor with more visibility.

The second step is to show what kind of nominal anchor different policy-makers select in equilibrium. It turns out that policy-makers who are prone to high inflation prefer less visibility, whereas policy-makers who by nature adopt non-inflationary policies prefer more. This is because the public does not know the policy-maker's true preferences, so that a policy-maker given to high inflation nevertheless has an incentive to create the false impression that it wants low inflation. A noisy signal makes this kind of dissembling behavior easier because it makes it harder for the public to divine the policy-maker's true intentions. Inflation-averse policy-makers, on the other hand, want to reveal their true intentions, in part to distinguish themselves from inflation-prone policy-makers. Thus, they prefer to emit a clean signal, because this makes it easier for the public to discern a policy-maker's preferences.

We should note that while our model provides a rationale for an exchange-rate anchor, the anchor need not be permanent. The role of the anchor is to resolve the public's uncertainty as efficiently as possible. Once this uncertainty has been resolved (i.e., once information is complete), the exchange-rate anchor has no other role to play in our simple model. The policy-maker is indifferent between targeting the exchange rate and targeting money. Thus, our model explains why exchange-rate anchors are so frequently used as a temporary tactic against high inflation rather than a permanent cornerstone of monetary policy.[2]

We present our analysis using the familiar Barro-Gordon (1983a,b) set-up, which clarifies the analysis in two ways. First, our results can be compared easily to those from other analyses using the same set-up. Second, and more important, we allow monetary policies to vary only in how easily the public can observe them, which isolates the role of visibility without imposing special constraints on the structure of the economy. This we believe makes our results quite general.

2. Visibility

Those who favor the exchange rate as the nominal anchor in stabilization plans frequently point to the exchange rate's visibility (among other qualities) to support their view. Indeed, one can defensibly call this view a conventional wisdom. As with all conventional wisdoms, however, this one is sustained by an ambiguity, in this case the ambiguous definition of "visibility."

Visibility obviously refers to the ease with which the public can observe something. The ambiguity regarding nominal anchors is over what it is that the public is observing. Is it the anchor variable itself (e.g., the exchange rate when an exchange-rate-based stabilization plan is in place), is it monetary policy, of which the anchor variable is a mere reflection, or is it something else entirely?

One possible view is that the visibility of a nominal anchor refers to the ease with which the public can observe the anchor variable. Under an exchange-rate-based stabilization program, this variable would be the nominal exchange rate; under a money-based stabilization program it would be one of the monetary aggregates. Under this formulation, an exchange rate anchor is more visible because the public can more easily gather and interpret information about the exchange rate than about monetary aggregates. Exchange rate quotes are available almost instantaneously, and devaluations become evident in a matter of hours, if not minutes. In contrast, information about a monetary aggregate flows to the public slowly and is often very difficult to decipher.

This view—that the public trains its sights on the anchor variable—seems to lie behind the assertion of Persson and Tabellini (1994) quoted above, that the

[2]See Helpman, Leiderman and Bufman (1994) for examples and a discussion of temporary exchange-rate anchors.

exchange rate "...is easily observable, so the private sector can directly monitor any broken promises by the central bank."

This view implicitly makes strong assumptions about what information the public uses when it is building its forecasts of the future. It assumes, first of all, that the public actually looks at the anchor variable, and not some other variable. This seems like a harmless assumption. Less harmless is the assumption that the public ignores a host of other pieces of information—prices, interest rates, measures of economic activity—that may also contain information relevant for forecasts.

An alternative view is that the public makes inferences and forecasts about macroeconomic policy using all of the information it can observe, including inflation, interest and exchange rates, official data on monetary and fiscal policy, and so on. The public does the best it can, but using this information is a poor alternative to observing policy directly and instantaneously, because it is contaminated with money market shocks, lags in the release of official statistics, uncertainty about how policies influence certain variables, etc. Visibility refers to the quality of observable variables as signals of underlying macroeconomic policy.

Using this definition, one could plausibly argue that an exchange-rate target provides more visibility than a money target because it reduces the variance of many other nominal variables, such as the price level and interest rates, that the public pays close attention to. Less variance in turn increases the public's confidence in its own forecasts (e.g., because it narrows the confidence intervals corresponding to the forecasts). This may be what Bruno has in mind when he writes that

> In a small, open economy the relationship between the general price level and the exchange rate is considerably tighter than between money and prices, primarily because import prices play a large role in the input-output system.... For this reason there is an advantage in anchoring the price level primarily to the exchange rate... (Bruno, in Dornbusch (1993b), p. 29)

In our model, visibility is measured simply as the variance of a stochastic wedge between the government's actions and the public's observations of these actions. Thus, what follows is consistent with either definition of visibility. However, to add flesh to the model, we describe monetary policy in some detail and in a way that corresponds more closely to the second definition of visibility.

3. The Model

We present a two-period game of incomplete information with imperfect monitoring. Thus, we examine a situation in which the public is unable to identify the policy-maker's true preferences and is instead forced to infer these from the policy-maker's actions. Moreover, the public can only observe noisy proxies of the policy-maker's actions, not the actions themselves. So that our logic applies to a broad class of settings, we endow the economy with a very simple structure, namely, that the public has rational expectations and that the policy-maker faces a trade-off (described presently) when it chooses monetary policy.

We simplify the economy so that money growth is the only tool the policy-maker has to manipulate the economy. The problem of imperfect monitoring is formally captured by the assumption that the policy-maker's action, μ, is related to the proxy of this action that is visible to the public, (labeled π) by the following equation:

$$\pi = \mu + \phi\varepsilon$$

The policy-maker's action and the visible proxy are linearly related, and the noise, labeled $\phi\varepsilon$, enters additively. The variable ε represents the source of the noise in the proxy, and the coefficient ϕ is a parameter that the policy-maker can control, which enables it to control the level of noise in the proxy and hence the visibility of its action, μ.

The relationship between the policy-maker's action and the public's proxy for this action is simple and general, and could be justified in many ways. One way is as follows. Suppose that in each period (indexed by t) of the game the public observes an imperfect proxy, labeled π_t, of money growth. We will refer to the proxy as inflation, although it should be thought of as an index of all the observable variables relevant to forecasts. Assume that $\pi_t = \mu_t^* + \varepsilon_t$, which is to say that inflation is equal to money growth plus some random noise due to, say, a money-market shock. The policy-maker sets money growth after observing the money market shock.[3] Money growth can be decomposed into the policy-maker's desired rate of money growth—hereafter called the *inflation target*—plus some deviation designed to offset the money market shock: $\mu_t^* = \mu_t - \overline{\phi}_t\varepsilon_t$, where μ_t is the policy-maker's inflation target in the

[3] The model can easily be extended to the case in which the policy-maker must offset several shocks each period, and the public receives several signals of monetary policy each period. None of the results that followed would change; indeed, changing the number of shocks and associated signals amounts formally to changing the precision of the noise in the signal-extraction problem, which is an explicit variable in what follows. The details of this point are available from the authors on request.

first period and $\overline{\phi}_t$ is the proportion by which the policy-maker offsets money market shocks in the first period. The public observes

$$\begin{aligned} \pi_t &= \mu_t + (1-\overline{\phi}_t)\varepsilon_t \\ &\equiv \mu_t + \phi_t \varepsilon_t \end{aligned} \tag{3.1}$$

and ϕ_t is one minus the proportion by which the policy-maker offsets shocks.

The choice of monetary policy amounts to a choice of the couple (μ_t, ϕ_t) each period. In other words, the policy-maker can independently set the mean and variance of the variable that the public observes. The mean is the policy-maker's inflation target, as we have already labeled it, and the variance controls how far the public's observation is likely to deviate from the policy-maker's inflation target. This representation makes room for a variety of types of monetary policy. For example, a policy-maker who targets the growth rate of high-powered money—what can be called a money-based stabilization program or a floating exchange rate policy—would set ϕ_t to one, letting inflation feel the full impact of the shock. If instead the policy-maker targeted the exchange rate by, say, using a crawling peg, it would set μ_t to a modest value (this would be the rate of depreciation) but set ϕ_t to a value close to zero. The money supply would on average grow modestly, but it could differ considerably from the policy-maker's desired rate of money growth because of the need to offset the shock in order to minimize the variance of the observable variable. Under a fixed exchange rate policy, both μ_t and ϕ_t would be close to zero.

In what follows we assume that a policy-maker can choose between only two values for ϕ_t, one high and one low. Choosing a low value for ϕ_t—that is, one that keeps the variance of the observable variable to a minimum—means that the policy-maker has adopted an exchange-rate target, whereas choosing a high value means that it has adopted a money target and let the exchange rate float. This assumption is not too restrictive, for we impose no limits on the choice of μ_t. Hence, our set-up can still capture the essential variety of exchange rate policies we observe in small open economies, ranging from Argentina's fixed exchange rate (both μ_t and ϕ_t close to zero) through Mexico's pre-devaluation target zone (modest μ_t but low ϕ_t) to the current floating exchange rate policies of policy-makers in countries such as Chile and Colombia who target the real exchange rate (modest μ_t and high ϕ_t).

The policy-maker chooses its monetary policy to maximize an objective function that captures the trade-off between price stability, summarized by its inflation target, and the desire for activist policy. A simple version of the benchmark

Barro-Gordon utility function serves our purpose. Thus, a policy-maker of type i strives to maximize

$$(3.2) \qquad Ev_i = E\left\{A_i(\mu_1 - \mu_1^e) - \frac{\mu_1^2}{2} + \beta\left[A_i(\mu_2 - \mu_2^e) - \frac{\mu_2^2}{2}\right]\right\}$$

where μ_1 and μ_2 are, respectively, the inflation targets in the first and second periods, μ_1^e and μ_2^e are the public's first- and second-period expectations of inflation, β is a discount factor, and A_i is for policy-maker i the trade-off between the direct cost of higher inflation and the benefit it brings when it exceeds the public's expectations. This last parameter is often referred to as the "inflationary bias."

The policy-maker's preferences can be justified in a few different ways. Perhaps the most common is the assertion that there is a Phillips curve trade-off between inflation and unemployment, at least in the short run, and that the policy-maker has a temptation to exploit this trade-off by expanding the money supply faster than the public expects. Or perhaps the policy-maker is tempted to extract seigniorage by surprising the public with a burst of money growth. A third justification of this utility function is that the government is tempted to cause a surprise devaluation or depreciation of the nominal exchange rate in order to reduce real wages and boost balance-of-payments inflows (either for mercantilistic reasons or to raise international reserves).[4] The direct cost of inflation may take various forms, and we think of it as analogous to the cost of anticipated inflation, which requires buyers to minimize their real balances, price-setters to change nominal prices frequently, and producers and consumers to worry more about relative price variability.

The policy-maker's utility is defined in terms of its inflation target rather than the actual rate of money growth (which would include the policy-maker's reaction to the money-market shock) or inflation. If it were defined in terms of actual money growth or inflation, then the stochastic shock ε would have two effects on the policy-maker's utility. One is to add randomness to the policy-maker's choice variable (money growth or inflation). Since the policy-maker is risk-averse, this randomness would affect its decisions in a predictable way. The second is to make it harder for the public to observe the policy-maker's actions, which could affect the policy-maker's utility by influencing the public's inflation expectations in the second

[4]These motivations are discussed is much greater detail in Cukierman (1992), Part I.

period. By assuming that utility is defined in terms of the inflation target, we simply ignore the well-understood effect of risk aversion in order to isolate the effects of the visibility problem.

The sequence of play of this two-period game is as follows.

0. Nature chooses A_i, the government type.
1. The public sets its first period expectations, μ_1^e, based on any information it has coming into the game as well as an understanding of how the game is played.
2. The policy-maker chooses its inflation target and intervention rule, (μ_1, ϕ_1).
3. The policy-maker observes a realization of the shock, ε_1, and sets money growth in response to each shock in a way dictated by (μ_1, ϕ_1).
4. The public observes a noisy proxy of the policy-makers inflation target, π_1, and it observes the intervention rule, ϕ_1. Based on this information it sets its second-period expectations, μ_2^e.
5. The policy-maker sets its second-period monetary policy and implements it as in step 3. With this the game ends.

A few points about the sequence of play merit comment. The first is that the policy-maker observes the shock only after it has chosen its inflation target and the intervention rule. This is meant to capture the real-world conduct of monetary policy. Typically, a policy-making body meets periodically (say, every several weeks or months) to set general guidelines that direct day-to-day central bank operations. Thus, the guidelines are set before the policy-maker knows what shocks it will have to offset, even though intervention takes place in the wake of the shock (indeed, it is the shock that often prompts the intervention). For example, one can think of the selection of (μ_1, ϕ_1) as the choice of the central parity and width of a target zone,[5] which in turn determines how the central bank will intervene in currency markets when the nominal exchange rate approaches the target zone's upper or lower bounds.

We also assume that the public observes the intervention rule perfectly well. This assumption simplifies the mathematics considerably, since the public need only learn about one of the parameters of monetary policy, not both. A justification for this assumption is that it is obvious to the public whether or not the policy-maker has adopted an exchange rate target, such as a fixed exchange rate or pre-announced crawling peg. Even if the public cannot observe exchange-rate policy directly,

[5] Although, strictly speaking, the intervention rule for a target zone is a non-linear function of the money-market shock.

another way to justify it is to imagine that over the course of the first period the public gathers enough information to infer the value of ϕ_1 with almost complete certainty. This, too, is a defensible assumption. Even though we assume that the public receives only one signal per period, this is simply a normalization; we can equivalently assume that the public receives several signals, an alteration to the model that is equivalent to changing the variance of ε. And if indeed the public receives several signals each period, it plausible to assume that the public receives enough information to distinguish with virtual certainty between the two values of ϕ. Indeed, if the two values are far enough apart, then the public should have little trouble discerning the actual value of ϕ_1.[6] If the two values are very close together, on the other hand, the public would have considerably more trouble deciding which of the two values prevailed in the first period. Yet assuming that the two values of ϕ_1 are far apart is the interesting case to consider; if they are very close to each other, then the public's signal extraction problem is more vexing, but it is also less important: the difference between the two intervention rules is negligible.

Finally, note that first-period expectations are not a function of the intervention rule. That is, we assume that the policy-maker cannot influence expectations by simply announcing the kind of monetary policy it will adopt for the coming period. Cheap talk is not informative in our model, since all policy-maker types would prefer to send the same message.

We find the Perfect Bayesian equilibrium to this game by backward induction. By the time the public must set its second-period expectations, it is engaged in a one-shot game with the policy-maker. So the first step to finding a Perfect Bayesian equilibrium is to solve for the Nash equilibrium to the stage game that constitutes the second period. Doing so is quite straightforward once one appreciates two useful facts about the second-period stage game. The first useful fact is that ϕ does not explicitly enter the policy-maker's utility function. As we show below, the choice of ϕ matters only because of its influence over the public's expectations. Since the game ends after the second period, the choice of ϕ_2 is irrelevant to the policy-maker's payoffs—there is no third period in which the public builds expectations based on what the policy-maker has done in the second period. Thus, we can restrict our attention to the choice of μ_2 and ignore the choice of ϕ_2.

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[6]Consider the extreme case in which the low value of ϕ is zero and the high value is unity. An observed variance of inflation greater than zero reveals with certainty that the high value of ϕ is operational. An observed variance of zero is possible if ϕ equals zero or if the shocks incurred during the period were all exactly the same value, an event with near zero probability.

The second useful fact is that the policy-maker's utility function is linear in the public's action (that is, expectations), so its reaction function for the second-period stage game is independent of the public's action; the policy-maker has a dominant strategy, which is to set $\mu_2(A_i) = A_i$.[7]

Given the policy-maker's second-period strategy, the public's second-period expectations are $\mu_2^e(\pi_1, \phi_1) = E(A_i | \pi_1, \phi_1)$, where $\phi_1 \in \{\phi_l, \phi_h\}$ is the value of ϕ observed in the first period and which can take on a high or a low value. This expectation is conditioned on the realizations of inflation observed during the first period. In keeping with the concept of a Perfect Bayesian equilibrium, the public's second-period expectations are constructed according to Bayes's rule. Below we will describe exactly how Bayes's rule is applied.

Proceeding by backward induction, the next move to consider is the policy-maker's choice of a monetary policy in the first period. Because the public conditions its second-period expectations on what it has observed in the first period, the policy-maker must choose first-period monetary policy by anticipating the influence that its first-period action will have on second-period expectations. This means considering the effect of both μ_1 and ϕ_1. A convenient way to find the optimal value of these two variables is first to find the optimal value of μ_1 holding ϕ_1 constant and then to compare the payoffs to each value of ϕ_1 given that μ_1 is chosen optimally. But keep in mind that ϕ_1 is an endogenous variable in our model; we treat it as a parameter only for now, but we will show below which intervention rule different policy-maker types select in equilibrium.

Assuming that the policy-maker's utility is differentiable in μ_1 and that an interior solution exists (below we will show this to be true), the first-order condition for μ_1 given an arbitrary value of ϕ_1 yields

(3.3) $$\mu_1(A_i, \phi_1) = A_i\left[1 - \beta \tfrac{\partial}{\partial \mu_1} E_0(\mu_2^e)\right]$$

where the expectation is taken at the beginning of period one, hence before the policy-maker knows the values of the money-market shocks it will have to offset in the first period.

Note that this first-order condition is of the form $\mu_1(A_i, \phi_1) = A_i k(\phi_1)$. We will show below that k is a function only of ϕ_1 and the other known parameters (i.e., it

[7]This is derived simply by differentiating second-period payoffs with respect to μ_2, setting the derivative to zero and solving for μ_2.

does not depend on the policy-maker's type) and does not depend on the realizations of the money-market shock. These two facts simplify the analysis considerably. The first fact implies that we can rewrite the public's second-period expectations as

$$\mu_2^e = E(A_i | \pi_1, \phi_1) = \frac{1}{k} E(\mu_1 | \pi_1, \phi_1). \tag{3.4}$$

And since k is independent of the realizations of the shock, it is known to the policy-maker at the beginning of the first period. This allows us to rewrite the policy-maker's first-order condition as $\mu_1(A_i, \phi_1) = A_i[1 - \Gamma\beta/k]$, where

$$\Gamma(\phi_1) \equiv \frac{\partial}{\partial \mu_1} E_0\left[E(\mu_1 | \pi_1, \phi_1)\right]. \tag{3.5}$$

Notice that this first-order condition implies that $k = 1 - \Gamma\beta/k$, or that

$$k(\phi_1) = \frac{1}{2}\left[1 \pm \sqrt{1 - 4\beta\Gamma(\phi_1)}\right] \tag{3.6}$$

We can eliminate one of the roots by noting that $k = 1$ when $\beta = 0$. This simply recognizes that the policy-maker will play the dynamic game as a sequence of two one-shot games if it does not care about the future. Hence, the equilibrium of the dynamic game is merely a repetition of the Nash equilibrium to the one-shot stage game, in which we know that the policy-maker will set $\mu(A_i) = A_i$. Thus,

$$k(\phi_1) = \frac{1}{2}\left[1 + \sqrt{1 - 4\beta\Gamma(\phi_1)}\right] \tag{3.7}$$

The first-order condition for μ_1 can now be written as

$$\mu(A_i, \phi_1) = \frac{A_i}{2}\left[1 + \sqrt{1 - 4\beta\Gamma(\phi_1)}\right] \tag{3.8}$$

Armed with this information we can complete the specification of the public's second-period expectations, and in so doing justify some of the assumptions we have made so far.

The essence of incomplete information is the public's ignorance of the policy-maker's type. We formalize this ignorance as follows. Prior to the beginning of the game, the public believes that policy-maker types are distributed along some interval $\left[A^{\min}, A^{\max}\right]$. Suppose that, having observed ϕ_1, the public concludes that the policy-maker type comes from one of two subsets of $\left[A^{\min}, A^{\max}\right]$. The public might decide, for example, that witnessing an exchange-rate target, ϕ_l, means that the policy-maker in power is one whose value of A_i lies below some threshold value A^*, so that it is contained in $\left[A^{\min}, A^*\right]$. On the other hand, observing a floating exchange rate, ϕ_h, means that the policy-maker comes from the interval $\left(A^*, A^{\max}\right]$. This is only one way the public can partition the real line after observing ϕ_j, but we show below that this partition emerges in a perfect Bayesian equilibrium.

By proceeding in this manner, the public has reduced, but not eliminated, the uncertainty surrounding the policy-maker's identity. Having started the game with a prior distribution of types over the range $\left[A^{\min}, A^{\max}\right]$, the public has by the beginning of the second period updated this distribution so that it only ranges over one of the two subsets of $\left[A^{\min}, A^{\max}\right]$. But there is still residual uncertainty. This uncertainty is captured by a distribution over policy-maker types contained in the subset in question. For simplicity, we assume that the distribution over each subset is symmetric and uni-modal. We also assume that it can be approximated by a normal distribution. Thus, we set the distribution, conditional on the observation of ϕ_1, to $A(\phi_1) \sim N\left(m(\phi_1), p(\phi_1)\right)$, where $m(\phi_1)$ is the mean of the distribution of policy-maker types given ϕ_1 and $p(\phi_1)$ is the precision (that is, the inverse of the variance) of the distribution given ϕ_1. Later we will set each mean to be the mid-point of its respective partition.

Assuming that the distribution over each subset is normal is a relatively strong assumption: the partitioning that takes place after the public has observed ϕ_1 clearly leaves behind two bounded sets, yet we use an unbounded distribution. We think of the distribution as only an approximation. If the variance of the normal distribution is small enough (i.e., if p is large enough), then the tails that extend beyond the bounds can be safely ignored.

The essence of imperfect monitoring is the public's inability to observe the policy-maker's inflation target directly. We capture this by assuming that the money-market shock has a normal distribution with mean zero and a precision of p_ε. That is, $\varepsilon_t \sim N(0, p_\varepsilon)$. Given that $\pi_1 = \mu_1 + \phi_1 \varepsilon$ and $\mu_1 = A_i k$, the public constructs its expectations under the assumption that inflation is generated by a normal distribution with mean $A_i k$ and precision p_ε / ϕ_1^2. That is,

$$(3.9) \qquad \pi_1(\phi_1) \sim N\left(A_i k, \frac{p_\varepsilon}{\phi_1^2} \right)$$

where the mean of this distribution is thought of by the public to be a random variable with a normal distribution such that

$$(3.10) \qquad A_i k = \mu_1(\phi_1) \sim N\left(km, \frac{p}{k^2}; \phi_1 \right)$$

The public's second-period expectations can be found by recognizing that the public faces a standard problem in Bayesian decision theory:[8] it must estimate the unknown mean of a normal distribution with a known precision, and it does so by using a prior normal distribution for the mean. Under these circumstances, the posterior distribution of the mean, given the observation of π_1, is also normal, and has a mean of

$$(3.11) \qquad E(\mu_1 | \pi_1, \phi_1) = \frac{\frac{p}{k^2}}{\frac{p}{k^2} + \frac{p_\varepsilon}{\phi_1^2}} km + \frac{\frac{p_\varepsilon}{\phi_1^2}}{\frac{p}{k^2} + \frac{p_\varepsilon}{\phi_1^2}} \pi_1$$

where π_1 is the inflation realization observed in the first period. This ungainly expression is in fact easy to interpret. It simply states that the posterior mean of μ_1 is a weighted average of two means: the mean of the prior distribution of μ_1 (after the observation of ϕ_1) and the sample mean. The weights placed on these means simply reflect the precision of each piece of information. If, for example, p_ε is very large, then the sample mean is very precise and the public places more weight on the sample mean and less on the prior mean. Indeed, as p_ε tends to infinity, the weight on the prior mean falls to zero.

To keep the math tractable and free of clutter we set $p_\varepsilon = 1$ and $p = k^2$.[9] Then

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[8] All one needs to know for this problem is contained in Theorem 1, Section 9.5, of DeGroot (1969).

[9] The second assumption means that, once the public has observed policy in the first period, the precision of the public's prior distribution over policy-maker types is an endogenous

$$(3.12)\quad E\left(\mu_1 \middle| \pi_1, \phi_1\right) = \frac{\phi_1^2}{\phi_1^2+1}km + \frac{1}{\phi_1^2+1}\pi_1$$

The policy-maker must forecast this expectation, but based only on information available at the beginning of the first period. That is, the policy-maker must base its expectation only on (μ_1, ϕ_1). Thus

$$(3.13)\quad E_0\left[E\left(\mu_1 \middle| \pi_1, \phi_1\right)\right] = \frac{\phi_1^2}{\phi_1^2+1}km + \frac{1}{\phi_1^2+1}\mu_1$$

The policy-maker's first-order condition for μ_1 includes the derivative of this expression with respect to μ_1 (what we have defined as Γ). It is now evident that

$$(3.14)\quad \Gamma(\phi_1) \equiv \frac{\partial}{\partial \mu_1} E_0\left[E\left(\mu_1 \middle| \pi_1, \phi_1\right)\right] = \frac{1}{\phi_1^2+1}$$

This derivative confirms the assumptions we have made so far, namely that the policy-maker's first-period forecast of second-period expectations is differentiable, that an interior solution exists (since we impose no bounds on μ_1), and that the parameters of Γ are known to the public by the end of the first period and independent of the realizations of the shock. With this we can rewrite the policy-maker's first-order condition as

$$(3.15)\quad \mu_1\left(A_i, \phi_1^2\right) = \frac{A_i}{2}\left[1 + \sqrt{1 - \frac{4\beta}{\phi_1^2+1}}\right].$$

Note that the inflation target is lower when the policy-maker is sending a cleaner signal to the public (that is, when ϕ_1 is small). A more precise signal carries more information about the identity of the policy-maker. Thus, the public will place more weight on the signal, and correspondingly less on its priors, when constructing second-period expectations. This gives the policy-maker a stronger incentive to influence second-period expectations by striving to keep first-period inflation low.

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variable rather than an arbitrary parameter. Without this assumption, *k* is the root of a forbidding cubic function.

One can already see the trade-off a policy-maker faces when choosing an exchange rate policy. An exchange rate target may reduce second-period expectations by inspiring the public's confidence in the policy-maker's commitment to low inflation. But it also forces the policy-maker to keep first-period inflation lower than it would under a floating exchange rate, which comes at a cost.

Note also that first-period money growth falls as the discount factor β rises. This is a standard result in related models of incomplete information. The more the policy-maker cares about future payoffs, the more it is willing to sacrifice in the present to increase its utility in the future. Thus, it is prepared to keep its first-period inflation target low in order to keep second-period expectations low. If the policy-maker does not care at all about future payoffs (i.e., $\beta = 0$), then $\mu_1(A_i) = A_i$, which is the Nash equilibrium to the one-shot game.

4. The Choice of an Exchange-Rate Policy

So far we have analyzed how a policy-maker chooses its inflation target once it has chosen its intervention rule ϕ_1. Since our aim is to assemble a model in which the intervention rule (that is, exchange rate policy) is endogenous, we must now consider how a policy-maker chooses ϕ_1. If the policy-maker chooses $\phi_1 = \phi_l$, which keeps the noise in the signal to a minimum, then we say that the policy-maker has adopted an exchange-rate anchor. If, on the other hand, the policy-maker chooses $\phi_1 = \phi_h$, then we say that the policy-maker has chosen a money anchor and has let the exchange rate float. The heart of what comes next is an analysis of when and why a policy-maker would choose the nominal exchange rate as an anchor—or, more generally, when a policy-maker would choose to send clear signals and when it would choose to obfuscate.

Answering the question, What types choose more visible exchange-rate anchors? is fairly straightforward. A policy-maker can only choose between two values of ϕ_1, one high and one low. So one simply needs to compare the utility that flows from each value of ϕ_1 under the assumption that μ_1 is selected to maximize utility subject to the choice of ϕ_1. This identifies the policy-maker types who gain more from an exchange-rate anchor that from a money anchor.

The first step is to solve for utility when the policy-maker is choosing the optimal value of μ_1 given ϕ_1. Substituting the policy-maker's first-order condition into its expected utility function gives (after some rearrangement)

(4.1) $$Ev^{*}\left(A_i \middle| \phi_j\right) = \frac{A_i^2}{2}\left(2k_j - k_j^2 + \beta\right) - A_i\beta\left[\left(1-\Gamma_j\right)m_j + \Gamma_j A_i\right] - A_i\mu_1^e$$

where k_j, m_j and Γ_j are the values of k, m and Γ given $\phi_j \in \{\phi_l, \phi_h\}$.

A policy-maker of type i will choose ϕ_h (read: floating exchange rate) in the first period if the utility to doing so exceeds the utility from choosing ϕ_l (read: exchange rate target). Letting $\Delta Ev_i^* \equiv Ev_i^*(\phi_h) - Ev_i^*(\phi_l)$, then those policy-makers for whom $\Delta Ev_i^* > 0$ will choose to float. By substitution one can expand ΔEv_i^* into

(4.3) $$\Delta Ev_i^* = \frac{A_i^2}{2}\left[\left(2k_h - k_h^2\right) - \left(2k_l - k_l^2\right)\right] - A_i\beta\Delta E\mu_2^e$$

where k_h and k_l correspond to the values of k for ϕ_h and ϕ_l, respectively, and where

(4.4) $$\begin{aligned}\Delta E\mu_2^e &\equiv E\mu_2^e(\phi_h) - E\mu_2^e(\phi_l) \\ &= \left(1-\Gamma_h\right)m_h - \left(1-\Gamma_l\right)m_l + A_i\left(\Gamma_h - \Gamma_l\right)\end{aligned}$$

Before proceeding to the solution, it is useful to consider the term $\Delta E\mu_2^e$, which measures the expected change in second-period inflation expectations when the policy-maker chooses a floating exchange rate rather than an exchange-rate target. This term is a linear and declining function of A_i, and turns negative for

(4.5) $$A_i > \frac{(1-\Gamma_h)m_h - (1-\Gamma_l)m_l}{\Gamma_l - \Gamma_h}$$

In other words, adopting a floating exchange rate actually reduces second-period inflation expectations (on average, at least) for policy-makers with high inflationary biases. This is because adopting a floating exchange rate makes the public place more weight on its priors and less on first-period inflation when it is constructing its second-period expectations. Policy-makers who are prone to very high inflation prefer this, since the public's prior is likely to be lower than first-period inflation, even if the policy-makers is trying to keep inflation down. Thus, policy-makers with very high values of A_i do not face a trade-off when they choose an exchange-rate policy: a floating exchange allows them to run higher inflation in the first period and enjoy lower inflation expectations in the second period compared to the situation under an exchange rate target.

It is only types for whom (4.5) does not hold that face an interesting trade-off in the selection of an exchange-rate policy. For these types, an exchange-rate target means lower second-period expectations, which raises utility. But it also means lower inflation in the first period, which reduces utility.

One can rewrite ΔEv^* as

$$(4.6)\qquad \Delta Ev^* = \frac{A_i^2}{2}\left(k_h^2 - k_l^2\right) - A_i\beta\left[\left(1-\Gamma_h\right)m_h - \left(1-\Gamma_l\right)m_l\right]$$

Since $k_h^2 - k_l^2 > 0$, a policy-maker of type i will choose a floating exchange rate if

$$(4.7)\qquad \frac{A_i}{2} > \frac{A^*}{2} \equiv \frac{\beta\left[\left(1-\Gamma_h\right)m_h - \left(1-\Gamma_l\right)m_l\right]}{k_h^2 - k_l^2}$$

This means that inflation-prone policy-maker types (those with high values of A_i) adopt a monetary anchor and let the exchange rate float while inflation-averse types adopt an exchange-rate target.

To complete the analysis, we must pin down the relative values of m_h and m_l, which so far have been left arbitrary. Recall that, having observed the policy-maker's choice of a nominal anchor, the public believes that m_h is the mean of the distribution of types who choose ϕ_h (a money target) in the first period, and that m_l is the mean of types who choose an exchange rate anchor. Equation (4.7) demonstrates that types with higher values of A_i choose ϕ_h and vice versa, regardless of the public's beliefs about m_h and m_l. Hence, the assumption that $m_h > m_l$ is the only one consistent with (4.7).

If we furthermore assume that the public's prior means coincide with the center of each subset, after $\left[A^{\min}, A^{\max}\right]$ has been bisected by A^*, then $m_l = \left(A^* + A^{\min}\right)/2$ and $m_h = (A^* + A^{\max})/2$ and[10]

$$(4.8)\qquad A^* = \frac{\beta\left[(1-\Gamma_h)A^{\max} - (1-\Gamma_l)A^{\min}\right]}{k_h - k_l}$$

The cut-off A^* summarizes the Perfect Bayesian equilibrium we have proposed. Policy-makers types below A^* choose the strategy $\left(k_l A_i, \phi_l\right)$ and those

[10]We restrict our attention to parameters that guarantee that $A^{\min} < A^* < A^{\max}$.

above choose $(k_h A_i, \phi_h)$. To be sure that this is indeed a perfect Bayesian equilibrium, however, we must demonstrate that the policy-maker has no incentive to deviate and adopt some other strategy.[11] This requirement is easily satisfied. The policy-maker has chosen $(k_j A_i, \phi_j)$ optimally given the way the public updates its beliefs and forms expectations in equilibrium. Yet even if the policy-maker were to choose a different strategy—one that is off the equilibrium path we have proposed—the public would not change the way it updates its beliefs. Every observation of π_1 is possible, thanks to the assumption that the white noise wedge between the policy-makers actions and the public's observation of these actions is unbounded. Hence, there is no need to specify out-of-equilibrium beliefs. And if the public does not change its behavior in the face of a deviation by the policy-maker, then $(k_j A_i, \phi_j)$ is indeed an equilibrium strategy.

One way to interpret this result is in terms of the pooling and separating equilibria found in the models of incomplete information of Backus and Driffill (1985), Vickers (1986), Barro (1986), and Cukierman and Liviatan (1991). In these models, policy-makers prone to high inflation may choose a pooling strategy; that is, they may mimic the behavior of inflation-fighters in order to bring down inflation expectations later in the game. For inflation-averse policy-maker types, the possibility that they may be mimicked can force them to try harder to separate themselves from inflation-prone types by reducing inflation below the level they would choose if information were complete.

In our game there is neither pure separation nor pure pooling.[12] However, the incentives of policy-makers can be understood by thinking of a preference for a high value of ϕ as a preference for pooling rather than separating, since a noisier signal makes it harder for the public to distinguish among policy-maker types. Low-inflation types favor separation: they want to distinguish themselves from high inflation types in order to keep second-period expectations as low as possible. Less noise makes it easier to accomplish this task, even though pure separation is

[11]The public has no strategic choices to make. It simply guesses the policy-maker's type as efficiently as possible using all the information available.

[12]Pure separation is not possible because ε is drawn from an unbounded distribution. This means that any realization of inflation is conceivable given any policy maker type, so that no set of policy maker types can separate from another set. Loosely speaking, this means that pure pooling is not an optimal strategy for any policy maker type: Suppose two different policy maker types have set the same value of μ_{i1}. The policy maker with a higher A_i has a strong incentive to raise its mean money growth slightly: it gains by raising its utility, and it does not run the risk of separating itself from the low A_i type because of the noise in the game.

impossible. In contrast, high-inflation types prefer pooling: they want the public to believe that the policy-maker in power truly prefers low inflation; this reduces second-period inflation expectations and increases the utility the policy-maker derives from surprise money growth in the second period. More noise facilitates pooling behavior.

5. Discussion

The results from our model suggest several specific points about the role of exchange-rate targets to fight inflation and, more generally, about the interplay between visibility and credibility in the political economy of reform. We state them as informal propositions.

Proposition 1: Visibility matters when there is a credibility problem.

Our analysis suggests that, in the presence of a credibility problem (i.e., incomplete information), policy-makers face a salient choice between high and low visibility that they would not face if there were no credibility problem. This is obvious once one considers the equilibrium to the game when information is complete. The last period is played as a one-shot game, in which the policy-maker sets $\mu = A_i$ and the public expects precisely this because information is complete. In other words, the play in the last period is not influenced in any way by play in previous periods, so each of the previous periods is also played as a one-shot game. The only Nash equilibrium to the repeated game is for the policy-maker to set $\mu = A_i$ in each period. Since ϕ has no direct impact on the policy-maker's payoffs, it is a completely irrelevant choice variable.

This is not so when information is incomplete. We have shown that ϕ does indeed have an impact on the policy-maker's payoffs when credibility is problematic, because ϕ affects the quality of the information the public uses to divine the preferences of the policy-maker. Visibility is an issue—and a strategic variable—precisely because there is a credibility problem.

In the simple model we build, the policy-maker's sole motivation for choosing an exchange-rate target is to manipulate the quality of the signal received by the public. That exchange-rate policy is only relevant when information is incomplete follows from our assumption that exchange-rate policy has no direct impact on the policy-maker's utility; it affects it only indirectly by influencing the public's expectations. Yet we suspect that our basic result would remain even if one modified the model (by, for example, assuming that the policy-maker also cares about the variance of money growth), as long as exchange-rate policy influenced expectations as it does in the model we have constructed.

We should note that the credibility problem also has a more conventional effect on monetary policy, and that is to bring first-period inflation below what it would be if information were complete (in which case $k = 1$ and the dynamic game would be simply a one-shot game played twice). This is the same as the result found in Backus and Driffill (1985), Vickers (1986), Barro (1986) and others. Inflation-prone policy-makers may play tough early in the game in an effort to trick the public into believing that the policy-maker really is tough. Inflation-averse policy-makers may have to act even more conservatively than they would were information complete, because this is the only way they can distinguish themselves from inflation-prone types. Both forces, the urges to mimic and to separate, can keep inflation low early in the game.

Proposition 2: Policy-makers who choose highly visible policies are those who are more committed to reform.

Our model suggests that governments that intend to follow through with reforms want to telegraph this to the public as efficiently as possible, and so conduct their business as visibly as possible. Governments that know that they are too weak to carry though with reform nevertheless want to appear committed, so they carry out their policies behind a cloak of noise to reveal as little about their preferences as possible.

In our model, this means that inflation-averse policy-makers target the nominal exchange rate whereas inflation-prone policy-makers let it float. An inflation-averse policy-maker keeps money growth low in the first period to signal to the public its preferences for low inflation, and it targets the exchange rate because this makes it easier for the public to see that money growth is low. An inflation-prone policy-maker, on the other hand, wants relatively high money growth in the first period but wants to hide this from the public so that second-period expectations are not too high. This kind of dissembling behavior requires a noisy signal, one that does not reveal too much about the policy-maker's type. Allowing the exchange rate to float is one way to introduce this noise.

It is often observed that stabilization plans with exchange rate anchors stand a better chance of bringing down inflation than plans without them. The tacit claim is that exchange-rate policy determines, at least in part, the future path of inflation and other macroeconomic variables. For instance, Edwards (1995) presents econometric evidence showing that countries with fixed exchange rates in 1980 experienced lower inflation over the following decade than countries with floating exchange rate in 1980.

Our model predicts that one should observe the pattern that Edwards highlights. A stabilization plan with an exchange rate anchor is likely to be followed by inflation that is lower than it would be if it were preceded by a stabilization plan without an exchange rate anchor. But our model also suggests that one should be careful about interpreting causation. Second-period inflation is low solely because the policy-maker in power is averse to inflation. It so happens that this is the kind of policy-maker who also chooses an exchange-rate anchor in the first period. In other words, one should expect a correlation between exchange-rate-based stabilization plans and lower subsequent inflation. But it would be improper to conclude that the exchange-rate policy itself caused later inflation to be low.

Proposition 3: Greater visibility requires a more intense reform effort.

More visible policy-making enhances a government's credibility as a reformer, but it does not allow the government to pursue reform with any less intensity. In fact, quite the opposite is true in our model. When a government adopts more visible policies, it must redouble its effort to persuade the public that it is committed to reform. Visibility and the intensity of reform are not substitutes for each other.

In the context of exchange-rate policy to fight inflation, this means that a policy-maker opting for an exchange-rate target must set money growth lower than it would were it to adopt a money target. This is because an exchange-rate target increases the marginal gain from lower money growth, since the greater visibility encourages the public to put more weight on first-period inflation when it is updating its priors. Thus, the policy-maker is willing to suffer additional marginal cost from lower money growth in the first period.

Proposition 4: Greater uncertainty about the government's tenure widens the range of policy-maker types who choose highly visible policies.

Reformers in government are often uncertain of how long they will remain in power—a revolution or coup could take place; the cabinet could be reshuffled, etc. We call this "tenure uncertainty" and represent it as a lower discount factor.

Our model suggests that more tenure uncertainty widens the range of government types that opt for high visibility. This may seem counter-intuitive: if the benefits from visibility accrue in the future, one would expect a lower discount factor to diminish the attraction of high visibility, and thus narrow the range of policy-maker types who opt for high visibility. But the fall in the discount factor has an offsetting effect: a government that discounts the future heavily expects to gain little from painful reform, so it adopts a policy that does not deviate very far from its one-period bliss point. In the case of inflation stabilization, a lower discount factor means that the policy-maker does not reduce its inflation target far below what it would set in a one-shot game against the public. So even when visibility is high, the cost of an exchange-rate target is modest. In short, a lower discount factor reduces the expected future gains from high visibility, but it also reduces the first-period costs of visibility. In our model, this latter effect outweighs the former.

One can derive this result from differentiating A^* with respect to β. From the expression for A^* one can see that this derivative is negative if and only if

$$(5.1) \qquad k_h - k_l < \beta \frac{\partial}{\partial \beta}\left[k_h - k_l\right]$$

which, upon carrying out the differentiation, is

$$(5.2) \qquad k_h - k_l < \frac{\beta\Gamma_l}{\sqrt{1-4\beta\Gamma_l}} - \frac{\beta\Gamma_h}{\sqrt{1-4\beta\Gamma_h}}.$$

Noting that $\beta\Gamma_j = k_j(1-k_j)$ and $\sqrt{1-4\beta\Gamma_j} = 2k_j - 1$ for $j = h, l$, one gets

$$(5.3) \qquad k_h - k_l < \frac{k_l(1-k_l)}{2k_l - 1} - \frac{k_h(1-k_h)}{2k_h - 1}$$

which can be rearranged into

$$(5.4) \qquad \frac{k_h^2}{2k_h - 1} < \frac{k_l^2}{2k_l - 1}$$

The function $k_j^2 \big/ \left(2k_j - 1\right)$ decreases monotonically when $k_j \in (.5, 1)$, so the inequality is satisfied given that $k_h > k_l$.

The proposition that greater tenure uncertainty widens the range of those who adopt exchange-rate targets has a corollary, which is that a randomly chosen policy-maker type is more likely to choose an exchange-rate target when fighting inflation.

This result squares loosely with evidence in Lane (1995).[13] Lane considers a panel of 110 countries between 1982 and 1991. Among those countries with flexible exchange rates during at least part of this period, he finds that those countries with unrestricted floating exchange rates during the entire period had the lowest degree of tenure uncertainty (as measured by an index of revolutions and coups during the period). Those countries that switched back and forth between a floating exchange rate and an exchange rate target had the highest degree of tenure uncertainty.

Proposition 5: Greater type uncertainty widens the range of policy-makers types who choose high visibility.

There is a second kind of political uncertainty when information is incomplete, and that is the uncertainty in the public's mind over what type of policy-maker is in power. We refer to this as "type uncertainty." In a setting with a great deal of type uncertainty, one might expect the public to believe that policy-makers are distributed across a very wide range, including some zealously committed to reform and others utterly incapable of making any policy changes.

Our model suggests that greater type uncertainty widens the range of policy-maker types who choose high visibility. A convenient way to demonstrate this is to redefine A^* (the policy-maker type indifferent between greater and less visibility) in terms of deviations from the midpoint of the range $\left[A^{\min}, A^{\max}\right]$, which we define as $\overline{A}$. Let $A^{\max} \equiv \overline{A} + \delta$ and $A^{\min} = \overline{A} - \delta$. Then A^* can be rewritten as

$$A^* = \frac{\beta\left[\left(\Gamma_l - \Gamma_h\right)\overline{A} + \left(2 - \Gamma_l - \Gamma_h\right)\delta\right]}{k_h - k_l} \tag{5.5}$$

Now an increase in type uncertainty, proxied by the range of $\left[A^{\min}, A^{\max}\right]$, is commensurate with an increase in δ.

An increase in type uncertainty (a higher δ) pushes down the lower bound of the distribution. It is also evident from (5.5) that it raises the value of A^*, since the coefficient on A^* and the denominator in (5.5) are both positive when $\phi_h > \phi_l$. Thus, the distance between A^* and $A^{\min}$ increases; the range of policy-maker types who adopt an exchange-rate anchor widens.

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[13] To be fair, Lane (1995) states explicitly that he is not studying exchange rate anchors when they are part of stabilization plans, but rather when they are long-term policy choices. Edwards (1995) studies both kinds of exchange-rate anchors.

To understand the implication of this result, consider the following thought experiment. Imagine two countries that are the same in every respect except that type uncertainty is much higher (i.e., δ is higher) in one country than in the other. The cut-off point A^* will be higher in the country with greater type uncertainty. Thus, it is possible to choose a value of A_i that is above the cut-off point in the country with little type uncertainty but is below in the country with a great deal of type uncertainty. In other words, there are policy-maker types with intermediate values of A_i who would adopt an exchange-rate anchor in the country with greater type uncertainty but adopt a money anchor in the country with less type uncertainty.

One can also informally predict that greater type uncertainty raises the probability that a randomly chosen policy-maker type will choose an exchange-rate target when fighting inflation. Let $(A^* - A^{\min})/(A^{\max} - A^{\min})$ serve as a proxy for the probability of an exchange-rate target. Then

(5.6)
$$\frac{\partial}{\partial\delta}\frac{A^* - A^{\min}}{A^{\max} - A^{\min}} = \frac{\partial}{\partial\delta}\frac{A^* - \overline{A} + \delta}{2\delta} = \frac{1}{2\delta^2}\left(\frac{\partial}{\partial\delta}A^* - A^* + \overline{A}\right)$$

Using (5.5) one can show that this derivative simplifies to

(5.7)
$$\frac{\overline{A}}{2\delta^2}\left(2 - k_h - k_l\right)$$

which is greater than zero so long as $k_l < 1$.

Another way to analyze the role of type uncertainty is to consider an increase in the range of policy-maker types holding the minimum of the range constant. In other words, suppose that the public believes that the value of $A^{\min}$ is always the same, and that an increase in type uncertainty means an increase in the value of $A^{\max}$ (which implies both a wider range of possible types and a higher midpoint). Since $A^{\max} = A^{\min} + 2\delta$, one can rewrite A^* as

(5.8)
$$A^* = \frac{\beta\left(\Gamma_l - \Gamma_h\right)}{k_h - k_l}A^{\min} + \frac{2\beta\left(1 - \Gamma_h\right)}{k_h - k_l}\delta$$

The marginal impact of greater type uncertainty is

(5.9) $$\frac{\partial A^*}{\partial \delta} = \frac{2\beta(1-\Gamma_h)}{k_h - k_l} > 0$$

Analyzing the effect of type uncertainty this way provides an interpretation for Edwards's (1995) finding that countries that have adopted exchange-rate targets tend to experience higher inflation later on if they have a history of high inflation. A higher historical inflation average can be represented as a larger value of δ holding $A^{\min}$ constant. Equation (5.9) shows that a history of high inflation means a high value of A^* and a wider range of policy-maker types who prefer an exchange-rate anchor to a money anchor. In a country with high past inflation, even governments that generate moderately high inflation rates are wont to adopt exchange-rate anchors.

6. Concluding Remarks

This paper investigates the interplay between government credibility and the visibility of policy-making. It begins from the premise that governments can control how easily the public can monitor the policy-making process. Visibility is enhanced when, for example, a government invites the IMF or World Bank to report on the progress of reform, or asks a respected rating agency to issue regular credit reports, or begins publishing official statistics in a timely and clear fashion. Conventional wisdom also has it that an exchange-rate target, such as a fixed exchange rate or crawling peg, makes it easier for the public to monitor the progress of anti-inflation efforts.

If indeed a government can control how easily its actions are monitored, we ask two questions: How does visibility affect the acquisition of credibility? and, How does a government use its control over visibility strategically? Since its visibility is such a commonly cited advantage of an exchange-rate nominal anchor, we carry out our analysis using as an example the choice between two nominal anchors for an inflation-stabilization program. However, our model is cast in very general terms: the policy-maker has generic payoffs and visibility is introduced in a very simple way. Hence, we believe our analysis carries implications for the role of visibility in the political economy of reform generally, not just for exchange-rate policy.

Our analysis shows that visibility does, indeed, have an important influence on how governments acquire credibility, and for this reason is a variable that government use strategically. Our analysis also suggests that policy-makers with stronger commitment to reform are the ones that opt for more visible policies (an exchange-rate anchor in the case we study) whereas policy-makers who cannot carry through with serious reform opt to send more confusing signals to the public. The logic of the argument is simple: greater visibility makes it easier for the public to uncover the true identity of the government, and only those policy-maker types who are truly committed to reform want this to happen quickly.

It is important to stress that the influence of exchange-rate policy on beliefs is the same whether or not the policy remains in place in the second period. Thus, an exchange-rate target is effective even if it is abandoned towards the end of the game. This is why the model provides a rationale for temporary, not permanent, exchange-rate targets.

We should also note that ours is not the only argument in favor of exchange-rate targets. The debate over the role of exchange rates in stabilization plans is not only contentious but rich with formal theory, and there are at least two other good reasons for temporary exchange-rate targets. One is that they allow the money supply to respond endogenously to higher money demand without jeopardizing the stabilization program.[14] The other is that an exchange-rate anchor can help many agents overcome coordination difficulties and converge to the new, low-inflation, equilibrium (Dornbusch and Simonsen (1986)). Our purpose has been to give content to an argument often put forth but rarely formalized.

[14]See Bruno (1991) for an elaboration of this and other arguments.

References

Agenor, P.-R. (1994). "Credibility and Exchange Rate Management in Developing Countries." *Journal of Development Economics* 45, 1-16.

Aghelvi, B., M. Khan and P. Montiel (1991). "Exchange Rate Policies in Developing Countries: Some Analytical Issues," IMF Occasional Paper No. 78.

Backus, D. and J. Driffill (1985), "Inflation and Reputation," *American Economic Review*, 75, 530-38

Barro, Robert (1986), "Reputation in a Model of Monetary Policy with Incomplete Information," *Journal of Monetary Economics*, 17, 1-20.

Barro, R. and D. Gordon (1983a), "Rules, Discretion and Reputation in a Model of Monetary Policy," *Journal of Monetary Economics*, 12, 101-22

Barro, R. and D. Gordon (1983b), "A Positive Theory of Monetary Policy in a Natural Rate Model," *Journal of Political Economy,* 91, 589-610

Bruno, M. (1991). *High Inflation and the Nominal Anchors of an Open Economy*. Essays in International Finance no. 183, International Finance Section, Department of Economics, Princeton University.

Bruno, M. (1993). "Monetary Policy Rules for a Small, Open Economy," Ch. 2 in *Policymaking in the Open Economy: Concepts and Case Studies in Economic Performance*, R. Dornbusch, , ed., (New York: Oxford University Press).

Calvo, Guillermo and C. Vegh (1994), "Inflation Stabilization and Nominal Anchors," *Contemporary Economic Policy*, 1994.

Cukierman, A. (1992). *Central Bank Strategy, Credibility, and Independence* (Cambridge, MA: The MIT Press).

Cukierman, A. and N. Liviatan (1991), "Optimal Accommodation by Strong Policy-makers under Incomplete Information," *Journal of Monetary Economics* 27, 99-127.

Cukierman, Alex and Allan Meltzer (1986). "A Theory of Ambiguity, Credibility, and Inflation under Discretion and Asymmetric Information." *Econometrica* 54, 1099-1128.

DeGroot, M. (1969), *Optimal Statistical Decisions*, (New York: McGraw Hill).

Devarajan, Shantayanan and Dani Rodrik (1992), "Do the Benefits of Fixed Exchange Rates Outweigh their Costs? The CFA Zone in Africa," in Ian Goldin and Alan Winters, eds., *Open Economies: Structural Adjustment and Agriculture* (Cambridge, England: CEPR and Cambridge University Press).

Dornbusch, R. (1993a) *Stabilization, Debt and Reform* (Englewood Cliffs, N.J.: Prentice Hall).

Dornbusch, R. and M.H. Simonsen (1986), "Inflation Stabilization with Incomes Policy Support: a review of the experience in Argentina, Brazil and Israel." Group of Thirty.

Edwards, Sebastian (1995), "Exchange Rate Anchors and Inflation: a Political Economy Approach," UCLA.

Edwards, Sebastian (1995) *Crisis and Reform in Latin America: From despair to hope* (Oxford: Oxford University Press).

Frenkel, J., M. Goldstein and P. Masson (1991). "Characteristics of a Successful Exchange Rate System." IMF Occasional Paper No. 82.

Giavazzi, Francesco and Marco Pagano (1988). "The Advantage of Tying One's Hands: EMS Discipline and Central Bank Credibility." *European Economic Review* 32, 1055-75.

Helpman, E., L. Leiderman and G. Bufman (1994). "A New Breed of Exchange Rate Bands: Chile, Israel and Mexico." *Economic Policy*, 260-306.

Lane, Philip (1995), "Determinants of Pegged Exchange Rates, 1982-1991," Harvard University.

Paredes, Carlos and J. Sachs (1991), *Peru's Path to Recovery: A Plan for Economic Stabilization and Growth* (Brookings Institution: Washington, D.C.)

Persson, T. and G. Tabellini, eds. (1994), *Monetary and Fiscal Policy*, vol. 1 (Cambridge, MA: MIT Press)

Sachs, J. and C. Paredes (1991). *Peru's Path to Recovery: A plan for economic stabilization and growth* (Washington, D.C.: Brookings Institution).

Sargent, T.J. (1982), "The Ends of Four Big Inflations," in *Inflation: Causes and Effects*, ed. R. Hall, Chicago: Chicago University Press.

Tornell, Aaron and A. Velasco (1995), "Money-Based versus Exchange Rate-Based Stabilization with Endogenous Fiscal Policy," C.V. Starr Center for Applied Economics, New York University.

Vegh, Carlos (1992). "Stopping High Inflation: An analytical overview," *IMF Staff Papers* 39(3), 626-695.

Vickers, J. (1986), "Signaling in a Model of Monetary Policy with Incomplete Information," *Oxford Economic Papers*, 38, 443-455.

Visibility and Credibility:
On nominal anchors and other ways to send clear signals†

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Abstract: We investigate the interplay between government credibility and the visibility of policy-making, using the choice of a nominal anchor as an important example of how governments control visibility. We show that visibility has an important influence on how governments acquire credibility, and for this reason is a variable that governments use strategically. Policy-makers with stronger commitment to reform opt for more visible policies (e.g., an exchange-rate anchor) whereas policy-makers who cannot carry through with serious reform opt for noisier signals (e.g., a money anchor). Our logic is that greater visibility makes it easier for the public to learn the government's, and only policy-makers committed to reform want this to happen. Among other things, our analysis provides a rationale for the prevalence of temporary exchange-rate targets in inflation-stabilization programs.

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