The credibility of monetary policy: A survey of the literature with some simple applications to Canada

Robert Amano, Paul Fenton, David Tessier and Simon van Norden*

Introduction

"Where large sums of money are concerned it is advisable to trust nobody". Agatha Christie

Since Kydland and Prescott published their famous article on rules versus discretion defining the time-inconsistency problem of economic policy in 1977, at least 330 economics articles have been published with the words time-inconsistency and/or credibility in the title. This is truly a voluminous literature and one that is expanding at a rapid rate. While much of the literature is highly technical and can seem esoteric, there is generally an underlying practicality to it, especially of the recent literature focusing on institutional reform. Accordingly, the purpose of this paper is to survey the literature from the perspective of a central bank practitioner. We have three specific objectives. The first is to get a sense of why the credibility problem is important for the economy and for policymakers. The second is to draw some lessons from the literature that a monetary authority can use to enhance the credibility of its policy. And the third is to apply some simple tests of credibility from the literature to assess whether initiatives by the Bank of Canada to make the conduct of monetary policy more transparent and predictable have

* ***We'd like to thank***

been successful. The paper is divided into three main parts; each devoted to one of these objectives. There is also a brief concluding section.

1. Why is credibility important?

When we talk about the credibility of a policy or institution, we are concerned with what people expect policy to be in the future and how they think it may change. Before we can talk about what might or should influence these beliefs, we need to review a few basic issues. Section 1.1 reviews how changes (and expected changes) in policy affect the behaviour of financial assets such as exchange rates. Section 1.2 defines what we mean by "credibility" and reviews the standard model of how it matters to monetary policy and macroeconomic welfare.

1.1 Policy Changes and International Financial Markets

To understand how policy change can affect financial markets, such as those for foreign exchange, we'll use a simple model of financial market behaviour. A more thorough review of these questions may be found in Evans (1995).

First, let's assume that we can measure policy as some variables Z_t. To make our examples as simple as possible, let's suppose that Z_t is always equal to 0 or 1. For realism, we might want to think of 0 as meaning that there is no change in policy, while 1 means that policy changes to follow some new rule. We'll refer to the cases where $Z_t = 1$ and $Z_t = 0$ as two distinct policy *regimes*. Changes in Z_t may be hard to predict, so we'll treat Z_t as a random variable and use z_t to represent its realizations.

Another random variable is the financial return on assets held from time t to $t+1$, which we'll call R_{t+1} (and its realizations will be r_{t+1}.) The amount that agents expect to make from holding an asset, like foreign exchange, will depend on the set of information Ω_t that is available to them. This means that the unexpected or excess portion of returns they receive will be

$$e_{t+1} = R_{t+1} - E(R_{t+1} | \Omega_t) \tag{1}$$

where E() is the expectations operator and we'll assume that e_t has a mean of zero and is serially uncorrelated.[1]

Since policy can affect financial variables such as exchanger rates, it seems reasonable to allow the state of policy in the next period, Z_{t+1}, to affect actual returns

and expected returns.[2] Therefore, we can also define the unexpected or excess return *for a particular regime* as

$$w_{t+1} = R_{t+1}(Z_{t+1}) - E(R_{t+1}|\Omega_t, Z_{t+1}) \tag{2}$$

The difference between e_t and w_t is that the latter does not take into account the possiblity that policy might change. In particular, with some algebra one can show that

$$e_{t+1} = w_{t+1} + \nabla E(R_{t+1}|\Omega_t) \cdot (Z_{t+1} - E(Z_{t+1}|\Omega_t)) \tag{3}$$

where $\nabla E(R_{t+1}|\Omega_t) = E(R_{t+1}(1)|\Omega_t) - E(R_{t+1}(0)|\Omega_t)$ is the expected difference in returns caused by a change in policy. Since Z_t can only take on the values 0 and 1, $E(Z_{t+1}|\Omega_t)$ is the probability with which regime 1 was expected and $z_{t+1} - E(Z_{t+1}|\Omega_t)$ is a measure of the degree to which the regime was a "surprise".

If the probability of observing regime 1 is not very high, one can expect to see long runs of $z_t = 0$ in the data. For each of these runs, the excess returns we observe are not e_t, but w_t. Although e_t is assumed to have a mean of 0, Equation 3 shows that the mean of w_t will generally not be zero. In particular, it will be non-zero so long as neither $z_{t+1} - E(Z_{t+1}|\Omega_t) = 0$ nor $\nabla E(R_{t+1}|\Omega_t) = 0$. Put another way, so long as the regime matters to expected returns and the frequency of regimes was not precisely as expected, the mean of w_t is non-zero. This problem should only arise in small samples, since in large samples the law of large numbers will ensure that

---

1.These assumptions on e_t are equivalent to assuming that markets are speculatively efficient in the sense of Fama (1970?). We could easily generalize our analysis to take into account a constant risk premium, or a time-varying risk premium that is unaffected by changes in policy. The more realistic case where changing policy regimes affect risk and therefore risk premia is difficult and is only just beginning to be studied. See Evans (1995) for a review.

2.A simple example of this is the case where the price of the asset P can be expressed as the discounted value of some other variable X that is affected by the policy regime

$$P_t = \theta \cdot (1-\rho) \cdot \sum_{i=0}^{\infty} \rho^i \cdot E(X_{t+i}|\Omega_t, Z_{t+1}) + \theta_0$$

$z_{t+1} - E(Z_{t+1}|\Omega_t) = 0$ (unless agents systematically mispredict the frequency with which the regimes occur.)

This is an example of what is known as the "peso problem."[3] The peso problem arises when the expected distribution of z differs in some way from what we observe in the data; in this case they differ because we restricted our attention to "runs" of the same regime. As a results, the returns we observe may appear to be abnormally high or low. This abnormality arises from the fact that we are observing w_t, not e_t. The possiblity of policy changes therefore tends to create peso problems as marketsallow for the possibility of changes in policy but these changes may be realized either sooner or later than expected.

In the above example, it was assumed that agents can immediately tell when policy changes; they just observe z_t. For example, the policy may be a fixed exchange rate. Changes in the fixed rate are then public knowledge. However, suppose that the policy is something which is not announced publically (like the targetted rate of inflation or money growth in some nations.) Instead, agents might have to gradually infer whether a change has taken place by observing actual inflation or money growth. This is known as a "learning problem" since agents learn only gradually whether a change in policy has taken place. This gives rise to a condition very similar to Equation 3

$$e_{t+1} = w_{t+1} + \nabla E(R_{t+1}|\Omega_t) \cdot \Pr(Z_{t+1}|\Omega_t) \tag{4}$$

where $\Pr(Z_{t+1}|\Omega_t)$ is the probability with which agents thought the regime had not changed from 0 to 1. As they learn that the regime has changed, this probability approaches 0 so w_{t+1} approaches e_{t+1}.

The learning and the peso problem are similar, but distinct. Peso problems occur when no change in regime has occured, but one was expected. Learning problems occur when a change in regime has occured, but agents are uncertain whether this is the case. The law of large numbers implies that both are small sample problems so long as agents

3.This term was invented by Ken Rogoff in his 1979 doctoral dissertation, in which he examined the apparently biased forecasts of the forward exchange rate for the Mexican peso prior to a major foreign exchange crisis (i.e. a regime change.)

do not make systematic mistakes about the probability of a change in regime. Both may cause returns to appear unusually high or low.

1.2 Time-Inconsistency -- The Policymaker‘s Problem

In the previous section, we’ve seen how policy changes and the anticipation of policy changes can matter to financial markets. In this section, we’ll discuss how they can matter to the macroeconomy and to monetary policy. The basic framework we’ll be using is well known (Barro and Gordon (19??)), so our discussion of it will be kept as simple as possible.[4]

Consider the problem faced by private sector agents (A) and a Central Banker (B). In this stylized example, suppose that B gets to choose the rate of inflation π every period, which for simplicity can be either Hi or Lo. Each period, agents form their expectations of inflations π^e by guessing whether B will choose Hi or Lo that period. Both A and B dislike inflation; other things equal they prefer Lo to Hi. However, both also like high levels of output Y. Y is in turn determined by the difference between π and π^e. When $\pi = \pi^e$ Y is average; when $\pi > \pi^e$ Y is higher, and when $\pi^e > \pi$ Y is lower. We can summarize this situation with the following Table

Table

Value of Y	π^e **is Lo**	π^e **is Hi**
π **is Lo**	Average	Lower
π **is Hi**	Higher	Average

In any kind of a steady-state or equilibrium, we’ll assume for the moment that $\pi = \pi^e$ to avoid the possiblity that expectations are consistently wrong. This means that Y will be average in the steady state and that π could be Hi or Lo. Since both parties dislike inflation, the preferred solution is the one where π is Lo. The important question is whether these two agents are able to ensure that they get to the preferred solution. The important answer is that they may not. To understand why not, we need to consider the strategy both sides may adopt.

4.For more rigourous treatments, see ???

Suppose that the gains to A from having Y higher than normal are outweighed by other losses whenever $\pi > \pi^e$. We can think of this as something related to the real losses incurred when there are pre-determined nominal contracts (for labour or debt) and inflation is higher than expected, causing the real value of the contract's payments to be lower than expected. This means that if A thinks B will choose Hi, then A should choose Hi. Similarly, A should choose Lo only if it thinks B will choose Lo.

Now suppose that the gains to B from having π Lo are outweighed by having Y higher than normal (and at normal levels rather than low.) This might simply represent the weight they attatch to Y, or perhaps a desire to keep real interest rates low. This means that if π^e is Lo then B should choose π Hi and if π^e is Hi then B should also choose π Hi. If A knows this, they will always choose π^e Hi to avoid the losses caused when $\pi > \pi^e$. Therefore, both sides choose the $\pi = \pi^e =$ Hi steady state, even though the $\pi = \pi^e =$ Lo steady state makes both better off.

The crux of the problem is that the central bank (B) has an incentive to generate more inflation than private agents (A) expect, since this tends to improve output for little cost in inflation. Knowing this, agents expect the central bank to be more inflationary than is socially optimal. The optimal thing in such a simple model would be to **precommit** the Bank (via a constitutional admendment or some equally irrevocable means) to keep inflation low.[5] Agents could then expect a low rate of inflation and make the low-inflation steady state feasable.

This shows us that the quality of social outcome the central bank can hope to achieve will depend in an important way on how private agents expect the central bank to act in the future, and in particular how they expect it to react to their own actions. Although the central bank may truthfully express a preference for low inflation, agents understand that the bank has an incentive to make inflation somewhat higher than expected. We'll define "Credibility" to be the extent to which agents believe that policy makers will carry out their announced plans (or in the absence of explicit announcements, the extent to which they believe that current policies will continue into the future.) The key to making the low-inflation steady state attainable in our model is to make B's policy of low inflation credible to A. Given the importance of private sector expectations in

5.To be sure, there is a significant literature on whether such "deep" structural forms of precommitment are a worthwhile solution given the possiblity of unforeseen economic shocks.

determining the range of options available to monetary policymakers in the real world, it should be no surprise that the existence and sources of crediblity are key elements in controling inflation. In the next two sections, we'll survey some of the literature on these subjects before turning to examine some of the Canadian evidence.

2. How can credibility be enhanced?

Once the problem of time-inconsistency was recognized, a literature began to develope on how policy credibility might be established or enhanced. This literature can be divided into three main strands. The initial strand focused on how the actions of policymakers could be revealing for private agents (reputation models). Next a literature began to develope on instutional reforms supportive of policy credibility. And more recently, several articles have been written on what might be described as the importance of policy coherence -- policies that are mutually compatible are more likely to be credible than policies working in opposing directions. We review these strands of the literature briefly in this section. [The following sections will be reorganized into the three groups just mentionned.]

2.1 Announcements (Cheap Talk)

Casual observation suggests that policymakers can sometimes move bond and exchange rates with mere words. That is, simply talking about the appropriate level for interest and exchange rates, even when such talk is not accompanied by any immediate policy actions, can move these rates. At first blush, this ability is not surprising -- surely the Governor of the Bank of Canada must have some private information about his preferences and surely he is in a position to translate these preferences into policy actions. This suggests that a central bank could use “cheap talk” to pursue time-inconsistent policies. For instance, if cheap talk is effective then there will always be a tendency for a monetary authority to exaggerate its concern with inflation, and claim that future policy will be relatively restrictive. But if wage setters take the monetary authority at its word, the monetary authority then has an incentive to be less restrictive than it had announced originally. This example suggests that it would be very difficult to sustain an equilibrium where cheap talk is informative and that such an equilibrium is incentive incompatible.

In the real world, however, we sometimes observe announcements by policymakers moving interest and exchange rate markets. Given that cheap talk leads to an incentive incompatible solution, why then do we observe real-world markets reacting to mere words or cheap talk? Stein (1989) draws upon the work in Crawford and Sobel (1982) and argues that when cheap talk is precise it is incentive incompatible but when an announcement is vague and imprecise it can, in some cases, be incentive compatible. This

point can be illustrated by considering a modified version of an exchange rate example given in Stein (1989). Suppose the Canadian dollar trades currently for 0.80 U.S. dollars but that the Bank of Canada would prefer a Canadian dollar closer to 0.70 U.S. dollars, due perhaps to a concern about Canada's current account balance. At the same time, however, suppose domestic economy considerations make the Bank of Canada reluctant to pursue the expansionary monetary policy that is necessary to depreciate the dollar.

This tension between external and internal policy considerations will lead to a credibility problem; the Bank now has an incentive to "talk down the dollar" rather than take explicit action. If the Bank is able to make the public believe that its target for the Canada/U.S. exchange rate is 0.70 rather than 0.80, then the public would expect a substantial future easing in monetary policy. This expectation would lead to an immediate depreciation of the Canadian dollar which would satisfy the Bank's exchange rate objective at no cost. However, when actual policy is implemented, it will be less expansive than the public expects due to the Bank's countervailing concerns with the domestic economy. This version of the time-inconsistency problem displays why precise words cannot credibly communicate information about its future monetary policy.

Instead of a precise target, suppose that the Bank announced a broad range for its desired Canada/U.S. exchange rate of say 0.75 to 0.65. In practice, this range may be characterized with vaguely worded announcements such as "moderate depreciation" versus "substantial depreciation". Stein argues that the ability to communicate only crudely makes it less attractive for a monetary authority to mislead the public since if it wishes to mislead the public, the misleading must be done in a big way. If the Bank announces substantial depreciation instead of moderate depreciation, the Bank may make the exchange rate overreact and decline in value more than it would like. With vague announcements, the potential for market overreaction serves as a disciplinary device and restores the incentive compatibility condition.

This example suggests that cheap talk can only be used to communicate certain types of private information about monetary policy. As Stein (1989) shows, cheap talk does not have meaning if a monetary authority always uses it to manipulate expectations in the same direction. The cheap talk approach, therefore, would not work if a central bank wished to communicate private information about its distaste for inflation since the monetary authority would always want to announce that it is a staunch inflation fighter.

The reason cheap talk is effective in the exchange rate example is because the manipulation of expectations would not always be in the same direction -- that is, the monetary authority would not always want its currency to depreciate.

2.2 Targets and Target Zones[6]

A related literature to the cheap talk literature is that of the exchange-rate target-zone. In a standard target-zone model, the monetary authority simply announces that it will allow its currency to float within a given range and that it commits itself to intervene in the foreign exchange market whenever the target bands are threatened. These models allow us to study the behaviour of exchange rates in the presence of an announced governmental commitment to pursue an easily verifiable policy.

The first generation of exchange-rate target-zone models is due to Krugman (1991). Krugman developed a model that allows us to study the behaviour of exchange rates under the assumption of perfect credibility. From the perspective of current survey, one interesting implication for exchange-rate dynamics arises from these models: A credible target zone stabilizes the exchange rate; that is, exogeneous shocks have a smaller impact on the exchange rate in a target zone than in a free float. Since policy actions of both free-float and target-zone monetary authorities are identical when the exchange rate is within the target range, the stabilization of the exchange rate is costless to the monetary authority. This implication is known as the “honeymoon effect”. The intuition behind the honeymoon effect is as follows. Since the monetary authority stands ready to intervene in the foreign exchange market as the exchange rate approaches a boundary, the likelihood of a policy intervention is also greater. Therefore, forward-looking agents will change their expectations of future fundamentals, and accordingly the spot exchange rate also changes. In contrast to the free-float result, the expected change in the exchange rate (or expected future fundamentals) is non-zero; this expectation is captured in the spot price of the foreign exchange instantaneously, and results in the target boundaries acting as reflecting barriers.

Although the standard target-zone model yields interesting insights with respect to exchange-rate dynamics, the principal predictions of the model have been strongly

6.The discussion in this section draws heavily on a great survey by three cool, good-looking dudes: Amano, Black and Kasumovich (1996).

rejected by the data. This has led researchers to question a number of assumptions associated with the first-generation models. Most notably, perhaps, is the assumption of perfect credibility. Bertola and Caballero (1992) and Bertola and Svensson (1993) argue that the perfect credibility assumption is inconsistent with the data since we often observe realignments. Flood, Mathieson and Rose (1991) and Svensson (1991) provide additional evidence to support this view. This has led to the development of second-generation exchange-rate target-zone models. Second-generation models have relaxed, *inter alia*, the perfect credibility assumption. These models maintain the same underlying structure of the standard model but assume that the announcement is only partially credible.

Bertola and Svensson (1993) extend the basic target-zone model by incorporating stochastic realignment risk into the model. In this extended model, stochastic realignment risk is represented by a stochastic jump in central parity. In contrast to the standard model, the forward-looking agent's expected change in the exchange rate has two components: (i) the expected change in the exchange rate within the target zone; and (ii) the expected change in central parity (expected rate of realignment). The implications for exchange-rate dynamics in this imperfect credibility setting, unlike the standard model, depend on the parameterization of the model. For instance, for some parameterizations, the announcement of imperfectly credible target bands can actually make the exchange rate move though the target zone at a faster rate than in the free-float case. Given the sensitivity of these models to the choice of parameters, these models shed little light on the relationship between announcements and credibility.

2.3 Reputation

The term "reputation" is sometimes used interchangeably with "credibility," but in this discussion we want to treat them as two distinct ideas. As mentioned above, crediblity is the extent to which agents believe that policy makers will carry out their announced plans. For this discussion, reputation rests on agent's beliefs about the policy maker's preferences. Credibility considers whether plans, once announced, are believed. Reputation asks how the policymaker values different outcomes, independent of what may have been announced.

Reputation arises in models where agents are uncertain about the goals of policy (perhaps because they dismiss official announcements as being incredible.) In a simple

case, we can think of them being unsure whether policy is chosen by someone who dislikes inflation a great deal or dislikes it hardly at all. We'll call the former kind of policy maker a "tough" (T) and the latter a "wet" (W).[7] Agents believe that policy will be tighter in the future if the policy maker is T rather than W. Improving the crediblity of policy therefore requires that the policy maker can convince agents that he is of the type most consistent with the announced policy. But how do agents form their beliefs about the policy maker's type?

These models assume that agents try to infer the type by observing the past actions of the policy maker - their "track record." Policy makers who have shown great distaste for inflation in the past will be judged to be T while others will be judged to be W. These judgements are usually based on a Bayesian-updating rule which formalizes how agents learn. Each period agents modify their prior beliefs about the probability that the policy maker is type T (or W) by considering the relative probabilities that a policy maker of a given type would have behaved in the observed way.[8] Given enough observations, agents eventually learn the true type of the policy maker. It also allows us to study how and why reputation varies over time.

Influential papers using this kind of approach include Baxter (1989), Lewis (1989a,b), and Kaminsky and Peruga (1991). Most of the early work simplified the model by assuming that the type of the policy maker would not be subject to future changes (or that any changes would be permanent.) However, later work by Hamilton (1988), Engel and Hamilton (1990), Kaminsky (1993), Evans and Lewis (1995) and Ruge-Murcia (1995) generalized this to allow for the possibility of random infrequent changes in the policy-maker's type (from T to W or vice versa.) Most of these papers study the behaviour

---

7.This follows the terminology used in Masson and Drazen (1994).

8.Specifically, let $\phi(x_t|T)$, $\phi(x_t|W)$ be the probability that a policy maker of the given type could have generated observation x_t. If $Pr(T|\Omega_t)$ is the probability of T given all observations on x up to *t*, then this evolves over time according to the formula

$$Pr(T|x_t) = \frac{Pr(T|x_{t-1}) \cdot \phi(x_t|T)}{Pr(T|x_{t-1}) \cdot \phi(x_t|T) + (1 - Pr(T|x)) \cdot \phi(x_t|W)} \quad (1)$$

Such a rule can also be rationalized as the maximum likelihood (conditional on some starting beliefs) estimate of the true type of the policy maker.

of either interest rates and/or exchange rates from 1979 through the early 1980s as US monetary policy changed direction.[9]

This approach to modeling crediblity has some empirical and theoretical drawbacks. First, several of the empirical studies mentioned above show that agents observing monetary aggregates should learn about the change in policy over the space of a couple of years, but the foreign exchange data show that it took several years more than that for the change to become credible. Therefore, reputation models suggest that learning should happen more quickly than it sometimes seems to. One possible explanation is that by focussing entirely on past information, reputation models omit important forward-looking behaviour in which agents assume that policy changes happen in a non-random (or at least partly predictable) manner.

Recent work by Drazen and Masson (1994) and Masson (1995) shows that this omission can have important implications. If agents view policy changes as exogenous, then one way to build credibility is to simply persistently pursue the same policy, to extremes if need be, until agents come to learn and understand it. However, Masson and Drazen consider models where agents distinguish between the reputation of the policymaker and the crediblity of the policy. They assume that in the event of adverse shocks to the economy, policymakers will follow the announced policy until some threshold level of unemployment is reached and thereafter revert to a looser monetary policy. The difference between types T and W is that T has a higher threshold unemployment rate than W ($\overline{u^W} < \overline{u^T}$). By observing how the policymaker reacts to shocks, agents gradually learn whether they are type T or W.

Now consider what happens as the economy is hit by a sequence of shocks that rais e the unemployment rate. As the rate approaches and then surpasses $\overline{u^W}$ without a change in policy, agents become increasingly convinced that the policy maker is type T, which increases the probability that policy will not switch. However, if unemployment increases further and now approaches $\overline{u^T}$, agents understand that the probability of a change in policy is increasing even as they become still more convinced that the government's type is T. The point is that the relationship between reputation and crediblity may not be monotonic. If agents believe that a rational policy-maker will change policy at some point,

9.See Ricketts and Rose (199?) for an application to Canadian inflation and monetary policy crediblity.

then conditions which make the type of the policy maker clearer (i.e. enhance reputation) also bring the change-point closer, possiblity harming credibility.

As a concrete example, consider the recent experience of Sweden from this perspective.[10] When its exchange rate peg came under severe market pressure in August of 1992, the Sveriges Riksbank tried to defend the krona by raising its overnight lending rate for bank reserves first to 75 and then to 500 per cent. Presumably this clearly signalled that the policy maker was the type which put a very high value on defending the target. However, the dramatic rise in interest rates (which did not stay long at the peak level but remained high) put considerable strain on both macroeconomic activity and the integrity of the country's financial sector. Clearly, any rational central bank would be forced to loosen policy in the face of such problems. As a result, the speculative pressures persisted and the krona was forced to devalue in November.

2.4 Institutional Reforms [11]

Although reputational models are able to generate lower equilibrium inflation rates, they have a number of unappealing aspects. In particular, there is an infinite number of punishment strategies, and it is not obvious which one is correct, or how to coordinate the actions of agents in relatively atomistic labour markets such as those prevailing in North America to provide an effective deterrent to inflation surprises. As well, the reputation approach tends to focus on the individual central banker rather than on the institutional reputation of the central bank. If the inflation bias arises because the institutional structure provides the wrong incentives to the central banker, however, it would seem logical to change the institutional structure. This is the focus of the institutional-design approach which seeks legislative means to alter the central bank's objective function.

The institutional-reform literature has three main strands, which not surprisingly are often inter-related, focussing on: rules for monetary policy, performance contracts for central bankers and central bank independence[12].

10.Masson (1995) and Drazen and Masson (1994) use this model to explain the departure of the UK from the European Exchange Rate Mechanism (ERM) in 1992. Ireland's experience at the time was similar to that of Sweden, with the central bank raising interest rates to 300% in a failing attempt to defend the punt.

11.For good surveys of this literature, see the introduction to Persson and Tabellini (1994), Debelle and Fischer (1995), and Waller (1996).

Rules for monetary policy

Requiring the monetary authority to follow a binding rule is perhaps the most straightforward legislative restriction addressing the dynamic-inconsistency problem. If policymakers cannot depart from their announced policy, there is no barrier to pursuing low-inflation.

While this clearly would be beneficial, several authors (Canzoneri (1985), Lohmann (1992), and Garfinkel and Oh (1993)) have argued that such rules come with a cost -- they impose a trade-off between reducing inflation and stabilizing output. McCallum (1995) argues, however, that there need not be a trade-off between flexibility and commitment. Central banks can both act sensibly and avoid exploiting the expectations of the private sector -- it simply requires the correct policy rule and the appropriate institutional set-up.

Performance Contracts

The intuition of performance contracts for central bankers is also straightforward. Central bankers, like everyone else, respond to financial incentives. Therefore, by tying the financial rewards of central bankers -- either their salary or the bank's budget -- to the performance of macroeconomic aggregates that society cares about, social welfare can be maximized. The only requirement of a performance contract is that it makes the central bank pay more attention to inflation than society does[13]. Because the inflation bias is constant and independent of the output shock, a simple linear penality will deter the central bank from inflating without causing it to forsake its stabilization responsibilities.

McCallum (1995) argues that the inflation bias is not the result of a principal-agent problem in the classic sense, and therefore a performance contract might not be credible or effective. The existence of a rogue central banker seeking to raise output above trend against society's wishes seems a bit remote, it is more likely that there are elected officials that would like to do so and exert pressure on the central bank. If that is the case, it is not certain that the performance contract would actually be enforced. Nevertheless, it seems

12.More recently there has been literature on designing institutions to cope with ignorance, see for example, Romer and Romer (1996). They argue that limited knowledge about how the economy operates and the effects of policy have been a much more pervasive obstacle to good policy than the time-inconsistency problem.

13.Instituting a performance contract is equivalent to appointing a "conservative" central banker (Rogoff (1985)).

plausible that by making the goals of the monetary authorities more transparent and requiring public accountability at specified intervals of time, performance contracts can lead to better policy actions[14].

Central Bank Independence

It is possible that the source of the inflation bias is pressure exerted on the central bank by elected officials. If the incentives of politicians diverge from those of the general public, society's interest would be served by granting the central bank independence[15]. An autonomous central bank is more likely to pursue low inflation and stabilize output as the general public wishes.

Finally, in closing this subsection it is worth noting that these solutions are not mutually exclusive. Indeed they are probably mutually reinforcing[16]. Also, while a perfect commitent technology or institutional design may not exist, it is possible to raise the costs of reneging on promises significantly, thereby rendering monetary policy more credible. The basic goal of the institutional-design literature is to make it costly to renege on a good policy. The costs can take the form of monetary penalties, loss of prestige, or removal of policymakers from their positions.

[The above subsection will be reworked to build to the conclusion that while there are "good" things to do, there is no magic bullet.]

2.5 Debt as an Incentive

The previous section showed that by treating government policy as a conscious choice by a rational policy maker, we are lead to conclusions different from those produced by the assumption that policy is exogenous. This leads naturally once more into the question of how credibility behaves if agents think policymakers are rational. We've looked at some aspects of this question previously -- rationality was central to the discussion of dynamic inconsistency and cheap talk. In this section, we'll focus on another

---

14.As well, individuals or groups seeking to exert pressure on the central bank would be brought into the spotlight which might deter such behaviour.

15.Characteristics of central banks such as their legal independence, the average tenure of their governors, and the objectives in their charters are highly correlated with average inflation rates (see, for example, Alesina 1988, Grilli,Masciandro, and Tabellini 1991 and Cukierman, Webb and Neyapti 1992).

16.See Walsh (1995b) on New Zealand.

aspect of this literature; the interaction of rationality, debt structure (or debt management) and credibility.

By the structure of the debt or debt management, we mean the terms under which the government sells its debt. There are three variables; *maturity* refers to how frequently the debt must be refinanced (and therefore repriced), *index* refers to whether the amount the government promises to pay at maturity is fixed or is linked to some other index (such as the price of oil or the rate of inflation), and *currency* refers to the currency in which the amount to be paid is donominated (i.e. foreign or domestic.)

Most of the papers in this literature start by assuming that there is a single policy maker in charge of deciding both fiscal and monetary policy, or more accurately, that the monetary policy authority cares (among other things) about the government's fiscal position. Rationales for this differ. This could be because financial markets are imperfect and therefore social welfare may be enhanced by limiting the volitility of the government's debt. This may reflect the central bank's susceptabilty to political pressure from the Treasury. Certainly many industrial-country central banks are less then fully independent in this sense; witness the major monetary policy announcements that are made jointly by the Governor of the Central Bank and the Minister of Finance (or equivalent.) Alternatively, even were the central bank to be fully insulated from political pressure, at some point a government financial crisis undermines the stability of the domestic financial sector. Therefore even a fully independent bank which was mindful of its responsiblity to ensure the integrity of the financial system must at some point take government fiscal affairs into account. The point is that if agents know that the monetary policy maker cares about the government's fiscal position, then that policy maker's credibility will depend in part on how his or her actions affect the fiscal position.

Older analyses of how debt structure matters to monetary policy credibility focussed on the possiblity that the central bank might monetize the government's debts.[17] Monetization refers to the monetary policy authority's ability to reduce *ex post* the real value that government debtholders receive when the debt matures. This occurs by contracting debt with a fixed nominal value at maturity and then creating higher than expected inflation.[18] Structuring the debt in a way that limits its monetization enhances the credibility of monetary policy in models where the monetary policy maker is

concerned about the government's fiscal position. Limiting the potential extent of monetization can be done in a number of ways, such as issuing short-term rather than long-term debt, inflation-indexed (real interest rate) debt instead of nominal debt, or foreign rather domestic currency denominated debt. In this framework, since each of these choices has the same effect on the potential for monetizing the debt, it makes no difference which of them (or which combination of them) is chosen. Missale and Blanchard (1994) argue that once government debts become large enough to make repudiation a concern, further increases in government debt force a reduction in the effective maturity of the debt. In this way governments can maintain the crediblity of their pledge not to repudiate, and thereby finance their debts at more reasonable costs.

Persson, Persson and Svensson (1987) argued that by exploiting the effects of debt structure, the policymaker should not only improve the credibility of monetary policy but he should even be able to overcome the basic dynamic inconsistency problem mentioned at the outset of this chapter and achieve the same welfare outcome as if he had been able to perfectly precommit. In their model, the marginal fiscal benefit to the government of creating unexpected inflation is proportional to the outstanding stock of money plus the market-value of the government's outstanding long-term nominal debt. So long as this sum is positive, the dynamic inconsistency problem exists. The optimal course of action for the government is then to become a net *buyer* of long-term debt (i.e. make its outstanding stock of such debt negative) and a net seller of short-term debt, thereby taking a large speculative position in the bond market. When this speculative position is precisely equal to the size of the outstanding monetary base, then any fiscal gains to the government from the effect of surprise inflation on the monetary base are precisely offset by its effects

17.One question consistently ignored in this literature is the extent to which the government's debt exposure matches the structure of its debts. For example, we know that Canadian provincial governments issue widely differing amounts of foreign-currency denominated debt, but that much of this debt may subsequently be swapped back into Canadian dollars. Therefore their remaining foreign currency exposure is not directly observable. If the federal government can use similar methods to hide the *effective* structure of its debt, then debt structure issues should be irrelevant to credibility. For the sake of discussion, we will assume that the government is sufficiently large relative to the rest of the rest of the market that it is unable to conceal its effective debt structure.

18.Instead of just monetization, some authors talk more generally about (partial) debt repudiation, which can happen via monetarization, taxation of interest payments, or direct repudiation.

on the government's debt portfolio.[19] This gives the government no incentive to create surprise inflation and therefore resolves the dynamic inconsistency problem.

Unfortunately, this solution is probably more of a theoretic feature than a policy prescription since several features may be unfeasible in practise. Persson, Persson and Svensson note explicitly that this argument fails to carry through in the case of a small open economy where the government influence over real and nominal interest rates may be limited by the effects of foreign shocks. Bohn (1991) notes that the time inconsistency problem in open economies can be created just by the existence of nominal *private* debt held by foreigners. The analysis also fails to consider the degree to which the government would expose itself to liquidity risk by constantly refinancing not only itself but also a large amount of private debt on a short-term basis.[20]

So far we have only discussed how the ability to monetize government debts may affect the credibility of monetary policy. A more recent strand of the literature focusses on what some (such as Missale (1995)) describe as the *insurance* aspect of monetary-fiscal policy interaction, but which will here be refered to as *consistency* of monetary and fiscal goals. These models can lead to quite different views on the appropriate structure of the debt.

Suppose the Chancellor of the Exchequer stakes his reputation on achieving a set of short-term deficit-reduction targets. The models in this literature predict that, other things equal, such an announcement makes any inflation-control policy less credible. Why? Assume that tighter monetary policy has the short-term effect of lowering the level of economic activity and raising real interest rates. This means that government tax receipts will be lower, entitlement payments higher and interest payments on existing debt higher.[21] All of these serve to increase the deficit in the short run. Exactly the same reasons would lead us to expect that looser monetary policy will

---

19. Persson, Persson and Svensson credit Robert King for first suggesting this in a seminar at Rochester. Their analysis also examines how manipulation of the maturity structure of indexed debt can make the government's intertemporal taxation problem dynamically consistent.

20. For example, see the articles by Alesina, Prati and Tabellini and by Giavazzi and Pagano in the conference volume by Dornbusch and Draghi (1990).

21. It will also lower seigneurage revenue if the central bank is on the efficient side of the seigneurage Laffer curve. However, seigneurage is typically a minor contribution to government revenues in the contexts we are considering.

lower the deficit in the short run. If we think that the Chancellor of the Exchequer can influence (however indirectly) the Governor of the Central Bank, then the chancellor's announcement must make us expect at least somewhat looser monetary policy on average in the future.

To understand what this implies for debt-management policy, recall that the monetization models could treat short-term, inflation-indexed or foreign-currency debt as equivalent; all three protect the investor from suprise domestic inflation and therefore had equivalent implications for monetary policy credibility. In consistency models, these three debt-structure variables have different effects on monetary policy crediblity. To see this, consider the effects of a monetary policy shock. This will affect short-term nominal interest rates more than long-term nominal interest rates. Therefore, lowering the average maturity of the debt increases the sensitivity of debt finance costs (and therefore the budget deficit) to monetary policy. Now suppose that instead of lowering the maturity of the debt, we had instead issued debt in foreign rather than domestic currency. A monetary tightening presumably causes an appreciation of the domestic currency and thereby lower debt-service costs, while a loosening should depreciate the currency and thereby raise debt-service costs. This means the cost of servicing the debt will tend to offset the other cyclical effects of monetary policy on the defict, so the government's fiscal position is now less sensitive to the stance of monetary policy. Finally, suppose that inflation-indexed long-term debt had been issued instead of nominal long-term debt. Assuming that monetary policy shifts have no effect on long-term real interest rates but move long-term inflation expectations (and therefore nominal long-term interest rates via the Fisher effect) countercyclically, issuing the indexed rather than nominal long-term debt makes the government's fiscal position more sensitive to the stance of monetary policy. Therefore issuing more foreign currency debt should make monetary policy more credible while issuing more short-term or inflation-indexed debt should make monetary policy less credible.

In summary, if the public believes (1) that montary policy will be influenced at the margin by government budgetary concerns, and (2) that shifts in monetary policy are determined rationally, then the structure of the government debt will influence monetary policy credibility. On the one hand, the temptation to monetize part of the debt means that short-term or inflation-indexed or foreign-currency debt make tight

monetary policy more credible when debt burdens are significant. On the other hand, the temptation to relax monetary policy to improve the fiscal position (i.e. the "Fortin effect") means that short-term or inflation-indexed debt make tight monetary policy less credible while foreign-currency debt has the opposite effect.

2.6 Self-Fulfilling Beliefs

All of the models of crediblity that have been discussed to this point show how the policymakers' crediblity is determined by their announcements, their reputation, the incentives they face, or other factors. Since these determinants of crediblity are under the control of the monetary or fiscal policymakers, one could hope that these models might help make policy actions more credible and produce better policy outcomes. However, another strand of the literature presents models in which policymakers have much less control over their crediblity. In particular, for a given set of circumstances (announcements, track record, incentives) there may be multiple equilibrium levels of credibility. Policy actions in these models are credible only if the market believes them to be credible, because market beliefs can be self-fulfilling.[22]

The importance of this problem was first emphasised by Calvo (1988), who presented a model where the benevolent policymaker much choose the optimal rate of inflation. Although inflation reduces welfare in this model, it also monetizes the government's nominal debt and is therefore a less-distortionary source of taxation than conventional taxes. Consequently, the policymaker chooses to create inflation only if the tax burden becomes too high.

Government debt in this model is held by rational bondholders who understand the government's policy problem and who require a fixed expected real rate of return on their investments. This creates a strategic complementarity that makes multiple equilbria possible. These multiple equilbria can be unambiguously ranked, with welfare decreasing as equilibrium inflation rises.

22.The intuition is esseantially the same as that which is found in the Diamond-Dybvig model of banking panics. If depositors are confident that the banks will not fail, they will not withdraw deposits from the banking system and *therefore* banks will not fail. However, if they lack such confidence, they will attempt to withdraw their deposits and thereby *cause* the banking system to collapse.

In the low-inflation equilibrium, bondholders expect no inflation and therefore demand low nominal interest rates. The low nominal interest rates keep the tax burden manageable and therefore the policymaker does not restort to inflation finance. Since bondholders' inflation expectations turn out to be correct, this is an equilibrium.

In the high-inflation equilibrim, bondholders expect significant inflation and therefore demand high nominal interest rates. The high nominal interest rates greatly increase the tax burden and therefore the policymaker restorts to inflation finance. Since bondholders' inflation expectations turn out to be correct, this is also an equilibrium.

The key point is that both the high and the no inflation equilibrium are possible equilibria for the same set of economic fundamentals (e.g. debt, tax and inflation costs, real interest rates, etc.) The equilibrium which is choosen depends on bondholders' expectations, which will be self-fulfilling.

In the particular example discussed above, the government might be able to restructure its debt so as to eliminate the possiblity of multiple equilibria. For example, by issuing long-term rather than short-term debt, its interest payments (and therefore its financing requirements) will be less subject to changes in bondholder confidence, reducing the scope for self-fulfilling expectations. On the other hand, Obstfeld (1994, 1995) notes that similar multiple equilibria problems can arise in models without any government debt but where the central bank cares about inflation and unemployment, or the fragility of the financial sector, or the distribution of income, or the effects on real interest rates.

To be sure, the empirical relevance of mutliple equilibria to explaining crediblity is uncertain. The subject is most commonly scrutinized and debated in the context of defending an exchange-rate target, particularly in the context of either a program of disinflation, or the European Exchange Rate Machanism (ERM) or the most recent collapse of the Mexican peso. Some, such as Eichengreen, Rose and Wyploz (1996)) note the potential importance of this kind of explanation, while others such as Bordo and ?? (1996), argue that fundamental factors are sufficient to account for exchange-rate crises.[23]

23.See also Krugman (1996).

3. Is Canadian monetary policy credible?

Recently, Canada has implemented many of the sorts of institutional reforms discussed in the previous section in an effort to make monetary policy more understandable, more predictable and more credible. These measures are discussed in some detail in section ...., but they include an explicit target for inflation and initiatives to render policy actions more transparent. In this part of the paper, we conduct several simple tests of the credibility of recent Canadian monetary policy in an effort to shed some light on whether these institutional changes have proven helpful.

This part of the paper is organized in three main sections. The first section is a brief overview of monetary policy and macroeconomic developments in Canada and the United States, during the current period of floating exchange rates, since June 1970. The United States is included because our focus is the credibility of monetary policy as exhibited by the behaviour of the exchange rate and international interest rate differentials, and monetary policy in the United States has important implications for these variables. The next section uses an atheoretical econometric technique to filter the data to see if there is reason to think that there has been at least one change in the monetary policy regime in Canada to be investigated. To anticipate the results, the data suggest that there was a change in the monetary policy regime in Canada relative to the United States beginning in the second half of the 1980s. The third section investigates whether the increased emphasis on low inflation in Canadian monetary policy has been recognized by and is credible to financial markets.

4. The Monetary Policy Background

4.1 The United States[24]

In broad terms, the conduct of monetary policy in the United States since the early 1970s can be divided into three regimes, at least in terms of operating targets, if not underlying inflation objectives. During the first regime from approximately 1970 to 1979 the federal funds rate was the primary instrument of monetary policy and arguably served as the target of policy as well. During this period, the funds rate was maintained within a

24.This description of U.S. developments draws in particular on Bernanke and Mishkin (1992) and Mussa (1994).

narrow target band, of roughly 50-75 basis points, which was adjusted smoothly in response to macroeconomic developments. Officially, the Federal Reserve was concerned about monetary aggregates, announcing targets for money growth beginning in 1975. In retrospect, however, it appears that the Federal Reserve cared more about trying to reduce the unemployment rate than the rate of growth of the monetary aggregates. M1 growth accelerated after 1975 despite announced reductions of the target ranges. The unemployment rate declined steadily from 1975 to 1978 period and inflation pressures were evident even before the second oil price shock.

The first fed funds targeting regime ended on 6 October 1979 with the announcement by Fed Chairman Paul Volcker of a committment to reduce inflation by a change in Fed operating procedures to targeting non-borrowed bank reserves. The new operating procedure did not of necessity require a change in the conduct of monetary policy, except perhaps for a willingness to tolerate greater volatity in interest rates at very high frequencies[25]. However, it seems to have been accompanied by a decision by the Fed to place greater weight on monetary targets in order to reduce inflation[26]. The new policy focus achieved its disinflationary goals, but contributed to a deep recession in 1981-82.

In the autumn of 1982 the Fed changed tactics again, adopting a borrowed reserves operating procedure. This third regime can be characterized as a de facto return to interest rate smoothing, owing to a tight link between desired borrowed reserves and the federal funds rate. With an important difference from the earlier period, however, during the most recent period, the Federal Reserve has maintained a clearer focus on controlling inflation and has endeavoured to take early action to prevent inflation from accelerating. For example, between early 1987 and the middle of 1989 the Fed implemented a series of tightening moves in an effort to slow the pace of demand growth and offset emerging inflation pressures. And in the main the Fed has been successful with inflation remaining comparatively low and stable in the latter part of the 1980s and the early 1990s[27].

25.Cook (1989) argues that the introduction of the nonborrowed reserve procedure was a smokescreen, with nonborrowed reserves targets being adjusted to produce the high interest rates considered necessary to bring down inflation.

26.Fed reaction functions estimated by McNees (1986) and by Karamouzis and Lombra (1989) show that the Fed placed a greater weight on deviations of the money supply from target during 1979-82, relative to earlier and later periods.

4.2 Canada

[This subsection will be redrafted to make the similarities and differences with the U.S. more explicit.

On Monday 1 June 1970 Canada returned to a floating exchange rate in order to break the link with mounting inflation pressures in the United States and to cope with a significant improvement in the terms of trade and strong capital inflows. For the first half of the ensuing decade, nominal monetary conditions were used as a guide to policy decisions and, in retrospect, the Bank of Canada proved unwilling to countenace the significant increases in interest rates and/or exchange rates that would have been necessary to maintain low inflation. As a result, inflation pressures accumulated in Canada, as in other industrial countries, leading to a change in monetary policy startegy in the mid-1970s.

On 6 November 1975, the Governor of the Bank of Canada announced a policy of targeting the narrow monetary aggregate M1, with the objective of gradually reducing inflation. While the Bank was successful in achieving a series of successively lower target growth rates for M1 in the latter half of the decade, the underlying objective for inflation was not met, owing to instability in the relationship between the growth of M1 and inflation[28]. Indeed, after some initial improvement inflationary pressures began to increase during this period. By 1981, the rate of increase in both the CPI and the Implict GDP deflator was higher than at the start of the program of monetary gradualism.

Recognizing this problem, in the early 1980s the Bank of Canada moved to a more eclectic approach to implementing monetary policy, still with the objective of gradually reducing inflation[29]. At this time, the Bank de-emphasized the monetary aggregates and took into account a wide array of information -- both real and financial indicators of economic activity -- when implementing monetary policy[30]. This was a period when both short- and long-term interest rates in the United States reached unusually high levels and

---

27.Indeed, Dueker and Fisher (1996) suggest that U.S. monetary policy can be characterized as pursuing a 4 to 6 percent target range for the inflation rate from 1971 until 1991, when the target inflation range was lowered to 2 to 3 percent.

28.See Freedman (1989) and Thiessen (1992).

29.Howitt (1993) suggests that the press release of 3 April 1978, citing currency depreciation rather than monetary growth as the reason for the announced increase in the Bank Rate, as a key turning point.

30.Targets for monetary aggregates were formally abandoned in November 1982.

were very volatile (Chart). Because macroeconomic conditions and, in particular, inflation pressures were broadly similar to those in the United States, Canadian interest rates followed a similar course, although the movements were somewhat smoother[31]. During this period the Bank of Canada was successful in reducing the rate of increase in the CPI from 12.4 per cent in 1981 to 4.0 per cent in 1985.

However, with inflation stalled in the 4 to 4 1/2 per cent range, the Bank of Canada increasingly began to focus the explanation of policy on the goal of attaining price stability. In January 1988, Governor John Crow signalled this direction for monetary policy in the Hansen Lecture. [32] This was the clearest, most unequivocal statement to date of the Bank's objective. Following this pronouncement, the Bank of Canada allowed interest rates and exchange rates to fluctuate more widely than in the past. From 1987 through 1989, when the Canadian economy was growing more rapidly than the American economy, domestic interest rates rose substantially and the Canadian dollar appreciated significantly. In the spring of 1990, as the speculative bubble in housing burst and the demand-dampening effects of previous monetary tightening were felt, the Canadian economy entered a recession which lasted until the spring of 1991. Owing to the serious economic distortions that had built up during the period of excess demand and the uncertainty arising from world events the recession was relatively severe by historical standards. By early 1991 the economy was in a position of substantial excess supply.

In February of 1991 the Governor of the Bank of Canada and the Minister of Finance jointly announced a target path for the reduction of inflation. The targets specified reducing the year-over-year rate of increase in the CPI to 3 per cent by the end of 1992, 2 1/2 per cent by mid-1994 and 2 per cent by the end of 1995. In December 1993, a further set of inflation-control targets was jointly announced by the Bank and the government, which extended the band of 1 to 3% through 1998. This is to be followed by a movement to price stability, to be defined operationally by 1998. After undershooting the target band

---

31.For a discussion of the problems that movements in U.S. interest rates can pose for monetary policy in a small open economy such as Canada, see Freedman (1983).

32.In fact the desirability of returning to price stability has long been recognized by Canadian monetary authorities, but the goal of price stability only had operational significance for policy beginning in the late 1980s. See J. Crow and P. Duguay and S. Poloz

in 1992, the core rate of inflation has been consistently in the lower part of the inflation-control band since.

The Bank of Canada has also undertaken a number of steps in addition to the inflation control targets to inject greater transparency into actions. In mid-1994, the Bank of Canada introduced greater transparency in its operations by becoming more explicit about the near-term range for the one-day interest rate. Since that time there has been a target range of fifty basis points for the one-day rate which is signalled to the market by the Bank's interventions in the overnight market, and recently the Bank has begun to issue a press release providing the rationale for any change in the range. This greater transparency is intended to reduce the uncertainty about the Bank of Canada's intentions which can interfere with the transmission of monetary plicy actions to interest rates further out along the yield curve and to the exchange rate.

As well, the Bank of Canada has taken a number of steps to reduce uncertanity about monetary policy by providing more public information on monetary policy operations and the interpretation of economic and financial developments. Since 1987, excerpts of the briefing on monetary policy provided to the directors of the Bank at regular board meetings have been published. Since early 1993, a discussion of monetary policy has been included each quarter in the Bank of Canada Review. And in May 1995, the Bank began publishing a more detailed account of inflation developments and the conduct of monetary policy in a semi-annual Monetary Policy Report.

5. Has There Been a Change in the Monetary Policy Regime?

The objective of this sub-section is to determine whether there has been one or more changes in the monetary policy regime in Canada to be studied. Has the policy reaction function or feedback rule of the Bank of Canada changed through time? Since we are interested in the policy reaction function, we need a technique that can suggest whether one variable might be reacting to another. Granger causality, which is a measure of the significance of one variable in forecasting another, is well suited to this purpose; it was designed to test whether one event statistically preceeds another.[33] Following

33.Granger causality can also be used to search for forward looking behaviour on part of monetary authorities, see Hamilton (1994) chapter 11, and for an application see Alameida and Goodhart (1996).

standard prtactice, we embed the test for Granger causality within a VAR, which enables us to take account of the interactions among key macroeconomic and policy variables without imposing a lot of a priori restrictions on the data.

The VAR estimated to search for changes in monetary policy behaviour in Canada includes the kind of variables that would enter a reaction function or a policy feedback rule of the type advocated prominently by Taylor (1993) and McCallum (1987,1989), among others. The VAR has three variables: 1) The differential between the overnight interest rate in Canada and the federal funds rate in the United States. -- this variable indicates the monetary policy decisions being taken in Canada, given the stance of monetary policy in the United States. The overnight interest rate is often thought of as the policy instrument of the central bank because it is directly impacted by the central bank's decisions on settlement balances. Armour et al find that the overnight rate is a good indicator of the stance of monetary policy in Canada over the period since the 1950s; while Taylor (1993) and Bernanke and Blinder (1992) , among others, have argued that the federal funds rate is the best single measure of monetary policy in the United States.; 2) The CPI excluding food and energy -- this variable is a good measure of the underlying inflation pressures that are of concern to a central bank. Indeed, when the Bank of Canada announced its inflation-reduction targets for the total CPI it also declared an operational target for the CPI ex food, energy and indirect taxes, noting that ... (give reason from announcement of targets , something like: to avoid sharp changes in monetaring of monetary instruments as a result of transitory shocks to these variables) While there have been episodes when sharp increases in food and/or energy prices have contributed significantly to an overall increase in the CPI, through time, food and energy price shocks have been largely self-correcting, and since 1970 these prices have increased on average by about the same amount as other prices; 3) the unemployment gap -- which is a summary measure of cyclical movements in the real economy (the gap estimate is provided by Dupasquier et al, this conference)[34].

Because we are interested in changes in behaviour, we estimate a series of VARs using OLS and rolling five-year sample periods covering the period from ..... 1975 to April 1996. As a check on the robustness of the results, we also estimate for 10-year sample

34.Owing to the problems associated with generated regressors, we also estimated the VARs with the change in the actual unemployment rate instead of the gap and the results were virtually identical.

periods. The lag length of the VARs is chosen with the widely used Schwarz criteria and the Hannan-Quinn criteria. The results are relatively invariant to lag lengths between one and three.[35]

The statistic used to infer non-causality (and therefore causality) is the likelihood ratio statistic, that is :

[expression]

where L( ) and L( ) are the log-likelihood function evaluated respectively at the non-constrained and the constrained value of the estimator. For a VAR ( ) written:

[expression]

where... is a standard white noise process, the null hyporthesis:

[expression]

can be seen as equivalent to:

[expression]

Even though the more commonly used Wald Statistic is asymptotically equivalent, we have chosen the likelihood ratio statistic because it is more powerful in small samples, especially when applied to non-causality tests (see Guilket-Salemi (1982)). In order to have comparable results for the different likelihood ratio statistics, we perform all of the rolling regressions with VARs of order three.

Chart ? depicts the evolution of the likelihood ratio statistics (for a null hypothesis of no causality) for the Granger causality tests of inflation on the differential between overnight interest rates in Canada and the United States from the 5-year and 10-year rolling VARs. The results from the two sample sizes are very similar. They suggest a change in the monetary policy regime in Canada relative to the United States in the period from 1988 to 1992 (based on the 5-year sample) , with the Bank of Canada placing greater emphasis on inflation after that time than it had previously. Prior to the latter half of the 1980s the likelihood ratio statistics are insignificant, after that time they are consistently significant. This five year period encompasses both the Hansen Lecture in which Governor

35.Of these three series, the only potential problem with regard to non-stationarity is the inflation rate. A number of studies have concluded that the inflation rate is stationary, however, Dupasquier et al (this conference) using simulations to find the correct critical values for the test statistics conclude that the inflation rate in Canada is not stationary. To take account of this possible problem, we estimate the Var in two forms; one with the inflation rate and the other with the first difference of the inflation rate. The results are essentially the same which is consistent with a theorem of Haugh and Pierce (1977).

Crow stressed the goal of price stability and the introduction of the inflation-control targets.

6. Testing for Credibility

Given that there is reason to think, both a priori and empirically, that the Bank of Canada changed its inflation objective in the second half of the 1980s or early 1990s, how can we test the reponse of the exchange rate and international interest rate differentials to the change in regime? In deciding on an approach, two factors must be borne in mind. First, there is only a single change in the monetary policy regime in Canada relative to the United States, therefore an approach that is parsimonious with the data is required. Second, floating exchange rates are notoriously difficult to model, and interest rate differentials are not much easier to explain[36]. Taking these factors into account, we have opted for a "news" approach for testing the credibility of the change in monetary policy regime in Canada.

The news approach is based on the asset market view of exchange rate determination. An important implication of the asset view of exchange rate determination -- as developed by Dornbush (1976), Frenkel (1976) and Mussa (1976), among others -- is that the market for foreign exchange is efficient. In an 'efficient' market, prices reflect all available information, including the economic model relevant for their determination. This means that the spot exchange rate reflects the expectations of market participants about all of the future values of the determinants of the exchange rate. Consequently, when new information arrives that leads market participants to revise their expectations, the exchange rate will change. The response of the exchange rate to certain types of news can shed light on the market's expectations of future policy, and hence policy credibility. The news approach also has the advantage that it can be implemented using simple OLS regressions that are very parsimionious with the data.

Since the behaviour of the Bank of Canada appears to have changed in the late 1980s and early 1990s, it would be interesting to examine the market response to inflation data before and after the mid-1980s. Unfortuneately, the market surveys going back in time needed for such a study are not available. Money Market Services International (the

36.On the former, see Meese and Rogoff (197..) and the body of literature they spawned.

source of expectations data used in many studies of announcement effects in the United States) only began surveying participants in Canadian financial markets in January 1992 Therefore we are going to concentrate our efforts in the sample period from January 1992 to April 1996. Fortunately, this period largely coincides with the introduction of inflation reduction and control targets in Canada, so we can test whether current monetary policy is credible. However, to try to get some handle on whether market participants perceived Canadian monetary policy differently after the mid-1980s than they did before, we will use a VAR to generate inflation forecasts over a longer period of time and use these forecasts as the basis of an event study

6.1 The Methodology and the Tests

6.1.1 The Methodology

To evaluate the impact of the announcements, we estimate OLS regressions of the following basic form,

[equation]

where y is the change in the price of the asset being used to gauge credibility, x is the CPI surprise and u is a random error term.

6.1.2 The Tests

Using this regression approach, we conduct two tests of the credibility of recent Canadian monetary policy; one based on the response of the exchange rate to inflation surprises, and the other based on the response of longer-term international interest rate differentials to inflation surprises.

Test1: a simple OLS regression of the change in the exchange rate surrounding the time of the CPI announcement against the inflation surprise (controlling for other sources of news). If the estimated parameter is positive, indicating an appreciation of the currency when inflation is higher than expected, monetary policy is credible.

Test2: simple OLS regressions of the change in the international interest rate differential at 5- and 10-year maturites on the day of the CPI announcement against the inflation surprise. If the estimated parameter is zero, monetary policy is credible. [37]

The intuition underlying these tests is straightforward. With regard to the exchange-rate test, an appreciation of the currency in response to higher inflation indicates

that the market expects the central bank to tighten monetary conditions to keep inflation in line with its objective -- the policy is credible[38]. If the central bank were not expected to resist the increase in inflationary pressure, the exchange rate would depreciate. With regard to the interest-rate-differential test, a zero response of longer-term differentials is consistent only with monetary policy credibility. If the central bank is expected to achieve its inflation target with consistencey though time, an inflation surprise in any given month will not alter long-term interest rates, the estimated parameter will not be statistically significantly different from zero. If monetary policy is not credible, longer-term interest rate differentials could be expected to widen in response to a positive inflation surprise, owing to the Fisher effect. For completeness, long-term interest differentials might also widen in response to higher-than-expected inflation even if monetary policy is credible; provided that markets think that inflationary pressures are such that tighter monetary conditions will be required for a considerable period of time and incorporate this expectation along the yield curve.

6.2 The Data and Empirical Results

6.2.1 The Data

The Canadian CPI is usually published during the third week of the month, typically a few days after the U.S. CPI is published. And it is comparatively rare that other significant data are published on the same day (this will be discussed further later). The CPI data are released at 7:00 a.m. eastern time. The expected inflation rate is the median forecast of the year-over-year inflation rate from the Money Market Services International (MMSI) survey. MMSI surveys approximately X participants in Canadian financial markets each week for their forecasts of economic data to be released imminently. The inflation surprise is defined as the expected value minus the actual value. The exchange

37.The response of short-term interest rate differentials is not a good indicator of monetary policy credibility because, a priori, these differentials are apt to widen in the face of an inflationary surprise irregardless of whether monetary policy is credible. If the central bank is perceived as credible on inflation, domestic short-term interest rates may rise as part of the tightening in monetary conditions required to resist the inflation surprise. If monetary policy is not credible, and inflation is expected to be higher following the CPI surprise, short-term interest rates may rise as a result of the Fisher effect.

38.Engle and Frankel (1984) and Deaves (1990), set out theoretical models based on Dornbusch (1976) that give this result/ support this interpretation.

rate response to the CPI announcement is defined as the change in the log of the bilateral exchange rate (bid-ask average) from the close on the day preceeding the release to noon of the day of the release. The response of international interest rate differentials (5-year bonds and 10-year bonds) to the CPI announcement is defined as the change in the differential from the close on the day preceeding the release to the close on the day of the release.

Before turning to the estimation results, it is worth briefly discussing some of the properties of the MMSI inflation survey. After all, the results of a study based on the MMSI survey of expectations will be more "credible" if the surveyed expectations have desirable properties -- are rational. Tests reveal that the MMSI survey data for expected inflation are an unbiased predictor of actual inflation (see Annex 1). The MMSI forecasts of inflation are inefficient, however. Forecast accuracy could be improved, if the markets were to take account of information, such as recent changes in exchange rates and the unemployment rate, already known at the time the forecast is made.

6.2.2 The Estimation Results

For Test1, the results are supportive of monetary policy crediblity. The coefficient on the inflation surprise term is positive -- although small with a 10 % inflation surprise leading to a ... % appreciation of the exchange rate -- and is significant at the 5 % level for a one-tailed test.[39] There is no evidence of autocorrelation. The F-statistic for the equation as a whole is significant and the equation explains 17% of the daily movement in the exchange rate. Most of the explanatory power of the equation derives from the change in aggregate commodity prices, measured in U.S. dollars, on the day of the CPI announcement. Commodity prices are included in the regression because they are one of the factors known to influence the Canadian dollar and are observable daily.[40]

39.We are only concerned with whether the coefficient is positive or not.

40.Many papers have investigated the response of the exchange rate to economic news in the United States (see, for example, Edwards (1982,1983), Hardouvelis (1984, 1985, 1988), Engle and Frankel (1984), Hakkio and Pearce (1985)). A common finding is that larger-than-expected money supply announcements induce an appreciation of the domestic currency rather than the depreciation a simple monetary model of the exchange rate would predict. Engle and Frankel (1984) attribute the negative correlation between exchange rate changes and monetary innovations to the transitory nature of the monetary shocks.

While the above results are encouraging, further investigation is required before strong statements can be made on this basis about the credibility of current monetary policy in Canada. In particular, there is a possibility that the regression results might falsely attribute the effect of other events happening at the same time to the CPI surprise. We have tried to control for this potential problem in a number of ways including, keeping the observation window on the dependent variable as narrow as possible, incorporating the change in commodity prices on the announcement day (other than interest rates this is the only variable that might prove an important determinant of the Canadian exchange rate that is observed daily) and using dummy variables to test the influence of events, such as treasury bill auctions, known to have occurred on the day of a CPI release.

In addition, to check whether there might be particular observations that are significantly affecting the results, we have done a scatter plot of the change in the exchange rate against the inflation surprise. Three of the obsevations might be considered outliers -- 21 January 1992, 19 March 1993, and 20 October 1995. We have investigated these dates and have found that on two of them retail sales data for Canada were also released.Unfortuneately we do not have the retail sales forecasts needed to construct surprise values for these data releases, so we are unable to take into account the possible interactions between these surprises and the CPI surprises on those dates. For example, we do not know whether the two types of surprises were mutually reinforcing in terms of their implications for potential inflationary pressures, or offsetting. This undoubtedly would make a difference for the estimation results. However, absent such information we re-estimated the above equation including a dummy variable for these two dates. The results suggest potential fragility in our estimates -- the dummy variable is highly statistically significant, the parameter on the inflation surprise becomes statistically insignificant and there is evidence of higher order autocorrelation in the regression residuals. This is a matter that warrants further study.

Before discussing the results for Test2, it is worth mentionning briefly the results of a few variants of Test1 that we tried. We also tested whether the state of the economy, the sign of the surprise and the position of the inflation rate relative to the target range were important factors in explaining the response of the exchange rate to the CPI announcement. None of these factors were statistically significant. Admittedly, however, it is difficult to discern the possible influence of the state of the economy, as measured by the

unemployment gap, with this sample period because the economy was in excess supply for most of the time. The asset market view may explain the lack of explanatory power of the actual inflation rate relative to the target range -- the expected position of inflation relative to the target range is already discounted in the exchange rate prior to the release of the data, therefore the CPI surprise may be the best overall summary measure of the surprise.

We also estimated the same regression using an inflation surprise based on the MMSI survey for the CPI excluding food and energy, a construct very close to the Bank of Canada's operational inflation target (which excludes indirect taxes as well). The coefficient on the inflation surprise was positive, but it was statistically insignificant, and the overall equation fit the data much less well than the equation incorporating the surprise for the total CPI.

For Test2, the results also suggest that recent Canadian monetary policy has been credible. For interest rate differentials at both 5- and 10-year maturities there is no statistically significant relationship with the inflation surprise variable (Table ?)[41].

6.2.3 A Simple Corroborative Test

In this subsection, we conduct a simple corroborative test of the credibility of Canada's inflation targets in the spirit of Svenson (1994). When a central bank announces a target range or zone for inflation, there are a number of simple tests one can construct of whether the inflation target is credible -- of whether market participants believe that inflation in the future will fall within the target range. When survey data on the inflation expectations of market participants are available, the easiest test of the credibility of the inflation target is to compare the inflation expectations with the maximum and minimum inflation rates of the target range. If inflation expectations fall within the target range, the targets are credible. footnote: Svensson developes similar tests with nominal interest rates and the forward exchange rates as well.

41.Several studies have found U.S. interest rates to be sensitive to inflation and money stock announcements. Smirlock (1986), using interest rate data from 1979 to 1983, found that a 1 percent CPI surprise raised 20-year Treasury bond yields by 9 basis points, while Hardouvelis (1988) , using interest rates from 1979 to 1984, found that a 1 percent CPI surprise increased 20-year bond yields by 18 basis points. Goodhart and Smith (1985), however, found that U.K. releases have no effect on daily changes in either short- or long-term UK interest rates.

In chart ?, two types of inflation expectations are plotted against the inflation target range for Canada; the expectations for the current month of financial market participants surveyed by MMSI, and longer-term expectations of a group of economic forecasters and financial market participants surveyed semi-annually (on this question) by Consensus Economics Inc. To get a sense of the evolution of the latter expectations since the inflation targets have been implemented, we plot the results of the survey in April 1991 and the survey in April 1996. The MMSI survey expectations track actual inflation closely and, therefore, for a considerable portion of the period since the beginning of 1992 are below the lower band of the inflation target range. This suggests that the inflation target was not credible, at least on a very short-term basis, but this result is not surprising. If actual inflation was below the lower band in the preceeding month, the inertia in the inflation process is such that it is extremely difficult for a central bank to achieve the target in the current month (absent a "favourable" shock) and market participants realize this.

In this regard, the evolution of the Consensus Economics Inc. long-term inflation forecast, which are a more forward-looking measure of inflation expectations, might be a better Svennson-test of credibility. These surveys indicate a gain in credibility of monetary policy since 1991. The 1991 survey showed expected inflation slightly above the target range from 1995 through 2001; while the latest long-term expectation is exactly at the mid-point of the current target range, suggesting that the inflation target is now credible[42].

6.3 Have market perceptions of monetary policy changed through time?

[This subsection will be redrafted somewhat and placed at the beginning of this section.]

In addition to knowing whether current Bank of Canada monetary policy is credible with markets, it would be of interest to know whether market's perceptions of monetary policy have changed through time. Unfortuneately, as we mentionned earlier, the required survey data on inflation expectations do not exist for earlier periods. Therefore to examine the credibility of Canadian monetary policy over a longer time horizon we estimate a Var to predict inflation, and, hence, to derive inflation surprises.

---

42. At the time of the April 1991 survey the last specified numerical target was for 1995 with a lower long-term target to be elaborated. In December 1993 the band was extended through 1998.

The VAR estimated to predict inflation (and therefore inflation surprises) builds on the VAR developed to search for changes in monetary policy behaviour in Canada in the previous subsection of the paper. The current Var has two main differences from the earlier VAR. First, it uses the total CPI rather than the core CPI as the measure of inflation because the total CPI worked best for MMSI data. And, second, it includes commodity prices as an indicator of supply/price shocks. As such this VAR comprises the main ingredients a market participant might consider in formulating a forecast for inflation -- the monetary policy rule of the central bank, a measure of the inflation rate, the unemployment gap which encapsulates the business cycle movements of the real macroeconomy, and a measure/indicator of supply shocks.

The VAR is estimated using OLS. As with the previous VAR, we roll the sample period in five-year intervals because there is reason to think that Bank of Canada behaviour changed in the 1980s, so the earlier data would become less useful in predicting inflation. We chose the order of the VAR according to the Schwarz and Hannan-Quinn criteria. Finally the results for the VARs seem to be reasonably robust to sample size -- a ten-year rolling sample gives very similar results.

The distribution of the CPI surprises and the change in the exchange rate on CPI release dates for the period 1975 to 1996 are described in chart? and the accompanying table.

To test the market's perception of monetary policy over this period, we estimate the same equation relating the change in the exchange rate to the inflation surprise and the change in commodity prices measured in U.S. dollars as in section 3.1.2. Unfortuneately the results are not encouraging. The fit of the overall equation is poor and the coefficient on the inflation surprise is statistically insignificant (Table?). It seems unlikely in principle that these factors would not have been of some concern to foreign exchange markets during this period, so it is probable that the inflation forecasts generated by the VAR are not an adequate representation of the inflation expectations of market particpants

7. Conclusions

Credibility -- precisely what it is, how to get it and how to keep it -- is a complicated subject, and there is still much to learn. Nevertheless, economists have

learned a considerable amount already and these lessons are increasingly being applied by policymakers, especially central bankers. For example, the Treaty of Maastricht requires countries participating in the EMU to grant their central banks operational independence; at the present time, at least seven countries have explicit inflation targets and many more have announced numerical objectives for inflation (often in conjunction with other objectives such as intermediate targets for the exchange rate); and, at least, one country, New Zealand, has introduced a contract for the Governor of its central bank along the lines analyzed by Walsh (1995) and others.

For its part, Canada has implemented many of the lessons from the "credibility" literature. Beginning with efforts to build a good reputation by matching rhetoric with actions, and continuing with a series of initiatives intended to render monetary policy more transparent and predictable and the monetary authorities more accountable, the Bank of Canada has endevoured to make its policy more credible. A number of simple tests suggest that these efforts have been fruitful, that Canada's targets for controlling inflation are credible with financial market participants. However, these tests are best viewed as an early effort in assessing the credibility of recent Canadian monetary policy; more experience with the inflation targets and further study are required before strong statements can be made about the credibility of the policy. Also, one should not become complacent -- it is unlikely that a universal panacea for the time-inconsitency problem will ever be found; nature is such that the conduct of monetary policy will probably always be a challenge.

Annex 1: Some Properties of the MMSI Survey of Expected Inflation

One of the key tests for rationality of survey expectations data is unbiasedness. The expectation should be an unbiased predictor of the variable. This property can be tested by an OLS regression of the form:

Unbiasedness implies an intercept equal to zero and a slope coefficient of unity. A regression of the MMSI forecast of inflation on the actual inflation rate has these properties, an intercept that is insignificantly different statistically from zero and a slope

coefficent that is not statistically significantly different from one. The MMSI survey of inflation expectations is an unbiased predictor of actual inflation.

Another common test of the rationality of survey data is a test for efficiency or forecast error unpredictability. The forecast error, defined as the difference between the suvey expectation and the realization of the variable, should not be correlated with any information available at the time the forecast was made. Unfortunealy, the MMSI survey data for inflation expectations do not pass this test. Some simple regressions suggest that there is information in lagged unemployment gaps and lagged changes in the exchange rate that would reduce the size of CPI surprises.

Finally, the distributions of the inflation surprise (forecast error) and of the four variables it will be used to explain (the change in: the exchange rate, the commercial paper differential, the 5-year bond yield differential, and the 10-year bond yield differential) are described in tables x through y with the associated graphs. Generally speaking the variables have similar distributions and there is no reason to think that a simple linear regression is inappropriate.

Bibliography

Almeida, Alvaro and Charles A. E. Goodhart, (1996).“Does The Adoption of Inflation Targets Affect Central Bank Behaviour?”, Manuscript LSE (July).

Anderson, Torben M. and Ole Risager, (1988).“Stabilisation policies, crdibility, and interest rate determinationin a small open economy”, ***European Economic Review***, No. 32.

Armour, J., W. Engert and B. Fung (1996). “Overnight rate innovations as a measure of monetary policy shocks in vector autoregressions”, ***Working Paper 96-4***, Bank of Canada, Ottawa.

Barro, Robert and David B. Gordon (1983). “Rules, discretion and reputation in a model of monetary policy”, ***Journal of Monetary Economics***, Vol. 12 No. 1 (July 1983) pp. 101-21.

Becker, Kent G., Joseph E Finnerty and Kenneth J Kopecky, (1995).“Domestic macroeconomic news and foreign interest rates”, ***Journal of Internaional Money and Finance***, Vol 14 No 6 (December): 763-84.

Bernanke, Ben S. and Alan S. Blinder, (1992).“The Federal Funds Rate and the Channels of Monetary Transmission “, ***American Economic Review*** 82(4): 901-21.

Bernanke, Ben S. and Ilian Mihov, (1995).“Measuring Monetary Policy”, NBER Working Paper 5145.

Bernanke, Ben S. and Frederic Mishkin, (1992). “Central Bank Behaviour and the Strategy oif Monetary Policy: Observations from Six Industrial Countries”, NBER **Macroeconomics Annual 1992** pp 183-238.

Blackburn, Keith and Michael Christensen (1989). “Monetary policy and policy credibility: theories and evidence”, ***Journal of Economic Literature*** Vol. XXVII (March).

Cook, Timothy (1989). “Determinants of the federal funds rate:1979-82” ***Economic Review*** January/February:3-19, Federal Reserve Bank of Richmond.

Crow, John (1988). “The Work of Canadian Monetary Policy” (The Hansen Lecture), ***Bank of Canada Review*** (February:3-17.

Dornbusch, Rudiger, (1976). “Expectations and exchange rate dynamics”, ***Journal of Political Economy*** 84, pp. 1161-1176.

Dueker, Michael J. and Andreas M. Fischer (1996). “Are federal funds rate changes consistent with price stability? results from an indicator model”, Federal Reserve Bank of St. Louis ***Review*** (January/February):45-51.

Dupasquier, Chantal, Rene Lalonde, et Pierre St-Amant (1996). “Les zones monetaires optimales: une application au Canada et aux Etats-Unis”, (this volume).

Edwards, Sebastion, (1982).“Exchange rates and ‘news‘: a multi-currency approach”, ***Journal of International Money and Finance***, (August): 211-24.

Edwards, Sebastion, (1983). “Floating exchange rates, expectations and new information”, ***Journal of Monetary Economics*** 11 (May): 321-36.

Engle, Charles M. and Jeffrey A. Frankel, (1984). “Why interest rates react to money announcements: an explanation from the foreign exchange market”, ***Journal of Monetary Economics*** , (January) 13: pp 31-39.

Freedman, Charles (1983a). “Financial Innovation in Canada: Causes and Consequences, “ ***American Economic Review*** 73 (May)): 101-06.

Freedman, Charles (1983b). “The effect of U.S. policies on foreign countries: The case of Canada”, in **Monetary Policy Issues of the 1980s** (A symposium sponsored by the Federal Reserve Bank of Kansas).

Frenkel, J.A. (1976). " A monetary approach to the exchange rate: doctrinal aspects and empirical evidence", ***Scandinavian Journal of Economics***, 78: 200-24.

Garcia, Rene and Pierre Perron, (1996). " An analysis of the real interest rate under regime shifts" ***The Review of Economics and Statistics*** (February) : Vol. LXXVIII No.1: pp 111-25.

Goodhart, Charles A.E. and Richard G. Smith, (1985). "The impact of news on financial markets in the United Kingdom", ***Journal of Money, Credit and Banking***, (November) 17: pp. 507-11.

Granger, Clive W.J. (1969). "Investigating Causal Relations by Econometric Models and Cross Spectral Methods", ***Econometrica*** 37 (July): 424-38.

Hakkio, Craig S. and Douglas K. Pearce, (1985). "The reaction of exchange rates to economic news" ***Economic Inquiry***, (October) 23: pp 621-36.

Hamilton, James D. (1994) **Time Series Analysis**, Princeton University Press, Princeton, New Jersey.

Hardouvelis, Gikas A. (1984). "Market perceptions of Federal Reserve policy and the weekly monetary announcements", ***Journal of Monetary Economics***, (September) 14: pp 225-40.

Hardouvelis, Gikas A. , (1985). "Exchange rates, interest rates, and money stock announcements: a theoretical exposition", ***Journal of International Money and Finance***, (December) 4: 443-54.

Hardouvelis, Gikas A. , (1988). " Economic news, exchange rates and interest rates", ***Journal of International Money and Finance***, (March) 7: pp 23-35.

Howitt, Peter W. (1993). "Canada" in Michele U. Fratianni and Dominick Salvatore (eds.) **Monetary Policy in Developed Economies**, Handbook of Comparative Economic Policies Volume 3 Greenwood Press Westport , Connecticut London.

Johnson, David R. (1995)."Expected Inflation in Canada 1988-1995: an evaluation Of Bank of Canada credibility and the effect of inflation targets", manuscript Wilfred Laurier University, (October).

Kaminsky, Graciela L. and Karen K. Lewis, (1996). 'Does foreign exchange intervention signal future monetary policy?' ***Journal of Monetary Economics*** 37: 285-312.

Karamouzis, Nicholas and Raymond Lombra (1989). "Federal Reserve policymaking: An overview and analysis of the policy process" in International Debt, Federal Reserve Operations and Other Essays, ***Carnegie-Rochester Conference Series on Public Policy***, vol.30 K. Brunner and A. Meltzer (eds.) Amsterdam: North Holland.

Lucas, Robert E., Jr. (1976). 'Econometric Policy Evaluation: A Critique', in ***Carnegie-Rochester Conference Series on Public Policy***, vol.1 K. Brunner and A. Meltzer (eds.) Amsterdam: North Holland.

Masson, Paul and Michael Mussa, (1995). "Long-Term Tendencies" in **Budget Deficits and Debt: Issues and Options** (A symposium sponsored by the Federal Reserve Bank of Kansas City).

McCallum, Bennett. (1987). "The case for rules in the conduct of monetary policy: a concrete example", Federal Reserve Bank of Richmond ***Economic Review*** (September/ October):10-18.

McCallum, Bennett. (1988). "Robustness Properties of a rule for monetary policy ", in ***Carnegie-Rochester Conference Series on Public Policy***, 29: 179-203, K. Brunner and A. Meltzer (eds.) Amsterdam: North Holland.

McNees, Stephen (1986). "Modeling the Fed: A forward-looking monetary policy reaction function" ***New England Economic Review*** November/December :3-8, Federal Reserve Bank of Boston.

Meese, Richard A. and Kenneth Rogoff, (1983)."Empirical exchange rate models of the seventies: do they fit out of sample?", ***Journal of International Economics***,14:3-24.

Mussa, Michael (1976). "The exchange rate, the balance of payments and monetary and fiscal policy under a regime of controlled floating", ***Scandinavian Journal of Economics***,78: 229-54.

Mussa, Michael (1992), "The dollar, the current account and macroeconomic policy" i n **American Economic Policy in the 1980s** Martin Feldstein (ed.)

Pagan, A. R. (1984). "Econometric issues in the analysis of regressions with generated regressors", ***International Economic Review***, 25:221-47.

Persson, Torsten (1988)."Credibility of macroeconomic policy: an introduction and a broad survey", ***European Economic Review***, Vol. 32, pp. 519-32.

Peruga, Rodrigo, (1996). "Learning and the exchange rate: exchange rate responses to money announcements in the early 1980s", ***Journal of International Money and Finance*** vol. 15 no. 2: 167-90.

Rogoff, Kenneth (1985). "The optimal degree of commitment to an intermediate monetary target", ***Quarterly Journal of Economics***, Vol. 100, No. 4, pp. 1169-90.

Siklos, Pierre (1996). "The connection between exchange rate regimes and credibility: an international perspective" (this conference).

Sims, Christoher A. (1972). “Money, Income and Causality” , ***American Economic Review*** 62 (September) : 540-52.

Smirlock, M., (1986). “Inflation announcements and financial market reaction: Evidence from the long-tern bond market”, ***The Review of Economics and Statistics*** (May) : Vol. 68: pp. 329-333

Svensson, Lars E. O., (1994). “The Simplest Test of Inflation Target Credibility”, ***Centre for Economic Policy Research*** Discussion Paper No. 940 (April).

Taylor, John B. (1993). “Discretion versus Policy Rules in Practice “, ***Carnegie-Rochester Conference Series on Public Policy*** 39: 195-214.

Thiessen, Gordon G. (1983). “The Canadian Experience with Monetary Targeting”, in Paul Meek (ed.) **Central Bank Views on Monetary Targeting** (New York: Federal Reserve Bank of New York).

Thiessen, Gordon G. (1995). Uncertainty and the transmission of monetary policy in Canada, ***The HERMES-Glendon Lecture***, delivered at York University’s Glendon College, Toronto, Ontario, 30 March 1995.

Thoma, Mark A. (1994). “Subsample instability and asymmetries in money-income causality” , ***Journal of Econometrics*** 64 : 279-306.

Toda, Y.H. and P.C.B. Phillips, (1994). “Vector Autoregression and causality: A theoretical overview and simulation study”, ***Econometric Reviews*** 13: 259-89.

[to be merged]

Amano, Robert, Richard Black and Marcel Kasumovich. 1996. “A Band-Aid Solution for Inflation Targeting.” Manuscript. Bank of Canada.

Barro and Gordon

Baxter, Marianne (1989) “Rational Response to Unprecedented Policies: the 1979 Change in Federal Reserve Operating Procedures.” *Carnegie-Rochester Conference Series on Public Policy*, 31, 247-296.

Bertola, Giuseppe and Ricardo J. Caballero. 1992. “Target Zones and Realignments.” *American Economic Review* 82: 520-536.

Bertola, Giuseppe and Lars E. O. Svensson. 1993. “Stochastic Devaluation Risk and the Empirical Fit of Target-Zone Models.” *Review of Economic Studies* 60: 689-712.

Bordo, Michael & ??? (1996) NBER working paper No.

Calvo, Guillermo A. (1988) “Servicing the Public Debt: The Role of Expectations.” *American Economic Review,* 78(4) 647-661.

Crawford, Vincent and Joel Sobel. 1982. “Strategic Information Transmission.” *Econometrica* 50: 1431-51.

Dornbusch, Rudiger and Mario Draghi (1990) *Public Debt Management: Theory and History,* Cambridge University Press.

Eichengreen, Barry, Andrew K Rose and Charles Wyplosz (1996) “Sepculative attacks on pegged exchange rates: an empirical expploration iwth special reference to the European Monetary System” in M. B. Canzoneri, P.R. Massona nd V. U. Grilli (eds) *Transatlantic Economic Issues,* Cambridge University Press, Cambridge.

Engel and Hamilton (1990)

Evans, Martin D. D. (1995) “Peso Problems: Their Theoretical and Empirical Implications”NYU Stern School working paper series, paper #2-95-11, forrthcoming in *The Handbook of Statistics: Statistical Methods in Finance,* Maddala and Rao eds.

Evans and Lewis (1995)

Flood, Robert P., D.J. Mathieson and Andrew K. Rose. 1991. “An Empirical Exploration of Exchange Rate Target Zones.” *Carnegie-Rochester Series on Public Policy* 35: 7-35.

Hamilton (1988)

Kaminsky (1993)

Kaminsky, Graciela and Rodrigo Peruga (1991) “Credibility Crises; the Dollar in the Early 1980s.” *Journal of International Money and Finance*, 10(2), 170-192.

Krugman, Paul. 1991. “Target Zones and Exchange Rate Dynamics.” *Quarterly Journal of Economics* 106: 669-682.

Lewis, Karen (1989) “Changing Beliefs and Systematic Rational Forecast Errors with Evidence from Foreign Exchange.” *American Economic Review,* 79(4) 621-636

Lewis, Karen (1989) “Can Learning Affect Exchange-Rate Behaviour; the Case of the Dollar in the Early 1980s?” *Journal of Monetary Economics*, 23, 79-100

McCallum, Bennett (1995) “Inflation Targeting in Canada, New Zealand, Sweden, the United Kingdom and in General.” *NBER* working paper 5579.

Missale, Alessandro (1995) “How Should the Public Debt Be Managed?” Discussion paper 9507, Universita’ di Brescia e Igier.

Missale, Alessandro and Olivier Jean Blanchard (1994) “The Debt Burden and Debt Maturity” *American Economic Review*, 84(1), 309-319.

Obstfeld, Maurice (1994) “The Logic of Currency Crises” Banque de France Cahiers economique et monetaires N. 43.

Obstfeld, Maurice (1995) “Models of Currency Crises with Self-Fulfiling Features.” *European Economic Review*, ????

Persson, Mats, Torsten Persson and Lars E. O. Svensson (1987) “Time Consistency of Fiscal and Monetary Policy” *Econometrica*, 55(6) 1419-1431.

Ruge-Murcia, Francesco (1995)

Stein, Jeremy C. 1989. “Cheap Talk and the Fed: A Theory of Imprecise Policy Announcements.” *American Economic Review* 79: 32-42.

Svensson, Lars E O. 1991. “The Simplest Test of Target Zone Credibility.” *IMF Staff Papers* 38: 655-665.