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Volume 110, No. 1, January 2011

ISSN 0165-1765

ELSEVIER

economics letters

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Economics Letters 112 (2011) 103–106

Contents lists available at ScienceDirect

Economics Letters

journal homepage: www.elsevier.com/locate/ecolet

Endogenous monetary commitment[☆]

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ARTICLE INFO

Article history:
Received 24 November 2010
Received in revised form
22 March 2011
Accepted 23 March 2011
Available online 7 April 2011

JEL classification:
C72
E52
E61

Keywords:
Commitment
Endogenous timing
Asynchronous games
Strict vs.flexible inflation targeting

ABSTRACT

We develop an asynchronous framework in which each player can optimally select the frequency of his moves based on cost–benefit considerations. To demonstrate how such ability to commit can alleviate coordination problems, we apply the framework to monetary policy.

1. Introduction

Most economic interactions are strategic in nature, and can therefore be modelled as games. While changes to various aspects of the game are often considered, the timing of players' moves is treated as given. In this paper we postulate a simple framework based on Libich and Stehlík (2010) that allows us to endogenize the timing.

Building on alternating move games of Maskin and Tirole (1988) each player j moves with a fixed frequency r_j that he can choose optimally. A low frequency may be beneficial because it serves as a commitment device, and helps improve coordination in games with multiple and/or inefficient equilibria. However, there may be costs associated with committing, $c_j\left(r_j\right)$. Therefore, the players make their optimal r_j^* decision based on cost–benefit calculations.[2]

We apply the framework to monetary policy where the literature has long asked whether some kind of commitment should be adopted. There exist four main ways monetary commitment has been modelled: (i) reputation building of Barro and Gordon (1983), (ii) the degree of conservatism ala Rogoff (1985), (iii) an incentive contract of Walsh (1995), and (iv) a timeless perspective targeting rule by Woodford (1999). Real world institutional design of central banking, as well as observed policy actions, seem to incorporate the main insights of each of these streams of the literature.

Our paper examines a different type of monetary commitment that has not seen such a broad consensus, and the implementation of which has differed across countries—despite potentially large welfare effects. A number of countries have followed New Zealand's lead and legislated a numerical target for average inflation, whereas others such as the United States, Japan, or Switzerland have not done so. To offer an explanation and some policy implications our analysis therefore formally examines the following question: *How explicitly, if at all, should monetary policy be committed to a long-run (LR) inflation target (IT)?*

[☆] We gratefully acknowledge the support by the Australian Research Council (DP0879638).

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[2] Using such a dynamic framework seems desirable especially in various macroeconomic applications. As Tobin (1982) argued: *'Some decisions by economic agents are reconsidered daily or hourly, while others are reviewed at intervals of a year or longer…It would be desirable in principle to allow for differences among variables in frequencies of change and even to make these frequencies endogenous'.*

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doi:10.1016/j.econlet.2011.03.030

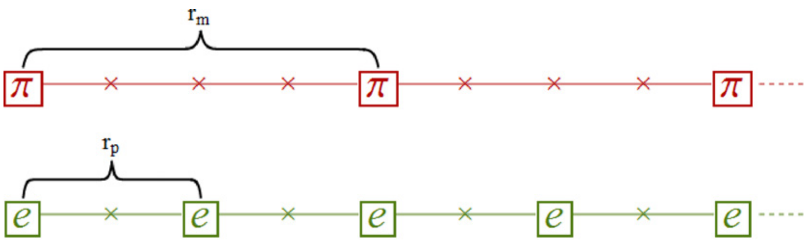

Fig. 1. An example of the timing with $r_m = 4$ and $r_p = 2$.

2. Timing of moves

Denoting (discrete or continuous) time by t, we allow the central bank to reconsider its target for average inflation every r_m periods. The variable r_m thus expresses the *degree of LR monetary commitment*, and can also be interpreted as the *degree of explicitness* with which the IT is stated in the central banking legislation/statutes. This is because a legislated inflation objective is 'institutionalized', and can thus be altered less frequently than an implicit one – due to logistic constraints associated with changing or abandoning the target. The public updates inflation expectations every r_p periods, which can be interpreted as a measure of *expectations stickiness*.

1. At the beginning of the game, in period $t = 0$, the policymaker chooses r_m observing (exogenously given) r_p.
2. Observing r_m, in period $t = 0$ the policymaker sets inflation and simultaneously the public forms expectations.
3. The public and the policymaker then move every r_p and r_m periods observing all past moves (i.e. games of perfect monitoring).
4. The dynamic stage game finishes just before the players make their second simultaneous move, which happens when r_p and r_m reach their least common multiple.[3]

Fig. 1 presents an example of a time line. We can denote *relative* policy commitment by $\frac{r_m}{r_p} = n$, where $n \geq 1$. To make the analysis more illustrative we restrict the amount of asynchrony by focusing on $n \in \mathbb{N}$.[4] Nevertheless, Libich and Stehlík (2010) formally demonstrate that the $n = \mathbb{N}$ case is representative of the more asynchronous cases with $n \notin \mathbb{N}$, in which both players act as the Stackelberg leader at some part of the game. Furthermore, we will focus on the outcomes of the dynamic stage game and abstract from further repetition, as its effects on outcomes through reputation building are well established (in the monetary context by Barro and Gordon, 1983).

3. The macro model

3.1. Preferences and economy

To highlight the intuition of the game we use a New Keynesian reduced-form model. As Woodford (2003) showed, social welfare can be approximated by a quadratic utility function featuring inflation and output stabilization[5]

$$u_t = -(x_t - x^T)^2 - \alpha \left(\pi_t - \pi^T\right)^2 - c(r_m), \tag{1}$$

where $\alpha > 0$ denotes the degree of monetary policy strictness (conservatism). The variables π^T and $x^T \geq 0$ denote a low-IT and the output gap target. The literature has identified several possible reasons for $x^T \neq 0$.[6] The new element $c(r_m)$ is the per-period SR net-cost of explicit LR commitment, which will allow us to endogenize the timing of moves (in line with Bhaskar, 2002). The supply side is described by a Phillips curve

$$\pi_t = \lambda x_t + e_t, \tag{2}$$

where $\lambda > 0$, x expresses the output gap, and e denotes inflation expectations. Both players are assumed to be forward looking and act rationally with complete information about all aspects of the game. Since we are primarily interested in the LR levels, we will not model shocks and their stabilizations directly, but summarize them via $c(r_m)$.

3.2. SR cost

The SR stabilization effects of an explicit IT have been the subject of a heated debate. McCallum (2003) summarized the state of affairs as follows: '*The extent to which inflation targeting regimes impair central bank flexibility is a matter of professional dispute. There is probably no way that this disagreement can be settled in the present state of economic knowledge*'. Possible SR costs as well as SR benefits have been brought forward. Some have expressed the view that an explicit IT may lead to a reduction in the flexibility to stabilize the real economy, and hence a greater real volatility (eg. Friedman, 2004). On the other hand, others have stressed the IT's anchoring effect on expectations (found in the data, eg. Gürkaynak et al., 2005), which may increase rather than decrease policy flexibility (eg. Mishkin, 2004).

Libich (2010) models these SR flexibility and anchoring issues formally. The analysis shows that $c\,(r_m)$ is likely to be nonlinear in r_m, which perhaps explains the disagreement in the literature. Further, $c\,(r_m)$ may be sensitive to the model used, and hence uncovering its 'true' specification is largely an empirical matter beyond the scope of this paper. In order to illustrate the intuition we assume

$$c(r_m) = \gamma (r_m)^\kappa, \tag{3}$$

where $\gamma \in \mathbb{R}$ and $\kappa \in (0, \infty)$. If the SR cost exceeds the SR benefit we have $\frac{\partial c}{\partial r_m} > 0$, and if the reverse is true we have $\frac{\partial c}{\partial r_m} < 0$. Let us note that this specification nests all reasonable (monotone) specifications: concave, $\kappa \in (0, 1)$, linear, $\kappa = 1$, as well as convex, $\kappa > 1$, the latter including the quadratic case, $\kappa = 2$. This generality is an advantage relative to using a micro-founded macro model which would only capture one particular functional form of $c(r_m)$.

4. Results

Following the backwards induction solution, we first examine the effect of given r_m on π^*, and then investigate the endogenously determined r_m^*.

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[3] The policymaker can obviously alter the interest rate (in a way on average consistent with the target) more frequently, but as we are interested in LR outcomes, and shocks have a zero mean, we will suppress this SR instrument and stabilization issues.

[4] While we do not impose it, the reader can think of the case of most macro models in which time is discrete, $t \in \mathbb{N}$, and the representative agent absorbs and uses information without delays, $r^p = 1$.

[5] We will not consider discounting for parsimony—without affecting our conclusions.

[6] For example (i) mismeasurement of potential output, (ii) market imperfections, or (iii) political economy reasons on the fiscal policy side, where x^T is a decreasing function of central bank goal-independence.

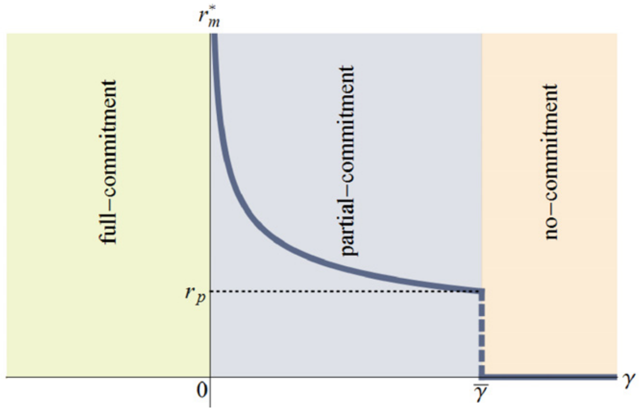

Fig. 2. The optimal degree of LR monetary commitment, r_m^*, as a function of its marginal SR net-cost γ—the plot of (5).

Proposition 1. *A more explicit LR monetary commitment reduces the inflation bias, if any. It is however the degree of commitment relative to expectations stickiness that has an effect, not its absolute level.*

Proof. Appendix A shows that equilibrium LR inflation is

$$\pi^* = \pi^T + \left(\frac{x^T}{\alpha\lambda}\right)\left(\frac{r_p}{r_m}\right). \tag{4}$$

The expression shows that the inflation bias is a (weakly) decreasing function of $\frac{r_m}{r_p}$. □

The potential bias is – for a given strictness of the regime α – reduced due to a smaller temptation to surprise inflate caused by a more explicit LR commitment. This happens since the public can observe the policy action and respond to it, i.e. it is better able to punish the policymaker. Importantly, such punishment is the public's optimal choice, not an arbitrary rule (trigger strategy) of Barro–Gordon.

Proposition 2. (i) *Whether or not the policymaker explicitly commits depends on* r_p, x^T, κ, γ, λ, *and* α. (ii) *The optimal degree (explicitness) of LR monetary commitment,* r_m^*, *is weakly increasing in* r_p, x^T, *and decreasing in* γ, λ, α.

Proof. Appendix B derives the equilibrium degree of LR commitment to be

$$r_m^* = \begin{cases} \infty & \text{(full)} \quad \text{if } \gamma \le 0, \\ \max\left\{ \sqrt[\kappa+2]{\dfrac{2\left(r_p x^T\right)^2}{\alpha\gamma\kappa\lambda^2}}, r_p \right\} & \text{(partial)} \quad \text{if } \gamma \in \left(0, \bar{\gamma} = \dfrac{2\left(x^T\right)^2}{\alpha\kappa\lambda^2 r_p^\kappa}\right), \\ 0 & \text{(none)} \quad \text{if } \gamma \ge \bar{\gamma} \ge 0, \end{cases} \tag{5}$$

which, by inspection, completes the proof. □

Fig. 2 offers a graphical example of these results. It shows that if $\gamma \le 0$ then explicit LR commitment does not constitute a SR stabilization tradeoff, and the policymaker should commit as explicitly as possible.[7] In contrast, if $\gamma \ge \bar{\gamma} \ge 0$ then the policymaker will not commit at all as it is too costly. Finally, if $\gamma \in (0, \bar{\gamma})$ then the policymaker does commit, but only to some extent that reflects the associated tradeoff.

The existing empirical evidence seems to imply the case $\gamma \le 0$. In particular, it shows that the adoption of explicit ITs has been associated with (i) better anchored expectations (see eg. Gürkaynak et al., 2005, but (ii) no change or a decrease in output volatility (eg. Corbo et al., 2001)). Walsh (2009) carefully examines all the available theoretic and empirical evidence, and argues that: '…*the ability to deal with demand shocks and financial crises can be enhanced by a commitment to an explicit target*.' Nevertheless, this flexibility issue is far from settled, more research needs to confirm the robustness of these results—in light of the global financial crisis. We have therefore derived r_m^* for all $\gamma \in \mathbb{R}$.

5. Summary and conclusions

We postulate a simple asynchronous framework with endogenous timing, in which players can optimally choose how long they commit to their actions. As such, they can better coordinate, which may be useful in games with multiple and/or inefficient equilibria. To offer an economic application, we examine the monetary policy game and ask how explicitly central banks should be committed to an IT.

Explicit IT has been modelled most commonly as a conservative central banker ala Rogoff (1985) or a Walsh (1995) incentive contract. The puzzling observation was that while most IT countries have not become 'inflation nutters', nor legislated a formal accountability procedure, the regime still delivered the commitment properties. We offer an alternative to the Rogoff and Walsh channels by highlighting the (desirable) logistic constraints of altering the LR inflation level associated with a legislated commitment.

Our analysis shows that the optimal degree of LR monetary commitment (explicitness of the IT), r_m^*, is *increasing* in (i) the costs of inflation and lacking credibility, (ii) the stickiness with which agents form expectations, (iii) the degrees of government's ambition and central bank goal-independence. Furthermore, r_m^* is *decreasing* in (iv) the slope of the Phillips curve, and (v) the strictness (conservatism) of the regime in terms of short-term inflation control.

These results have several policy implications. Point (ii) implies that higher transparency leads to a lower policy commitment being required as it reduces the cost of updating expectations. Point (iii) offers an explanation for the fact that ITs were adopted primarily by countries with low degrees of central bank independence. Similarly, point (iv) implies that monetary commitment must be more explicit in economies featuring a higher degree of imperfections and rigidities. In addition, point (v) indicates that explicitness and strictness of IT are partial substitutes, not complements as argued by IT opponents.

These findings may explain the observed differences across countries, including the highly debated fact that the United States have not legislated a numerical IT. Our analysis cannot offer a definite answer to whether or not the United States *should* do so as it does not model the SR effects directly. Nevertheless, the existing literature on these effects implies the answer to be affirmative.

Appendix A. Proof of Proposition 1

Proof. Solving by backwards induction, we know that after r_p periods expectations will be revised and set at the observed inflation level, $e^*_{t\in(0,r_m)} = \pi_0$. Then (2) implies $x_t = 0, \forall t \in [r_p, r_m]$. Substituting this information and (2) into (1), the policymaker's utility over the dynamic stage game is

$$u = -r_p\left[\frac{(\pi - e)}{\lambda} - x^T\right]^2 - \left(r_m - r_p\right)\left(-x^T\right)^2 - r_m\alpha(\pi - \pi^T)^2 - r_m c\left(r_m\right). \tag{6}$$

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[7] This result resembles that of Schaumburg and Tambalotti (2007), where commitment should be as strong as possible. It is however apparent that our commitment concept related to LR levels differs substantially from their timeless perspective targeting rule for the SR interest rate instrument. Let us note that under zero mean shocks the two commitment concepts are compatible.

Moving backwards, the policymaker takes this into account in choosing π

$$\frac{\partial u}{\partial \pi} = -\frac{2}{\lambda}\left[\frac{(\pi - e)}{\lambda} - x^T\right] r_p - 2\alpha(\pi - \pi^T) r_m = 0. \tag{7}$$

Under rational expectations and complete information, we will have no inflation surprise even in the initial period, $e_0^* = \pi_0$. Therefore, $x_t^* = 0, \forall t$. Using this with (7) yields (4). □

Appendix B. Proof of Proposition 2

Proof. Using the results of Proposition 1 we have

$$u = -\left(-x^T\right)^2 - \alpha\left[\pi^T + \left(\frac{x^T}{\alpha\lambda}\right)\left(\frac{r_p}{r_m}\right) - \pi^T\right]^2 - c\,(r_m)\,,$$

and therefore

$$\frac{\partial u}{\partial r_m} = \frac{2\left(x^T r_p\right)^2}{\alpha\lambda^2 r_m^3} - \frac{\partial c}{\partial r_m}. \tag{8}$$

Focus first on the $\frac{\partial c}{\partial r_m} > 0$ (i.e. $\gamma > 0$) case. Setting (8) equal to zero yields

$$\bar{r}_m = \sqrt[\kappa+2]{\frac{2\left(x^T r_p\right)^2}{\alpha\gamma\kappa\lambda^2}}. \tag{9}$$

If this unique maximum $\bar{r}_m$ is attained for $r_m \leq r_p$ then $r_m^* = 0$. Solving $\bar{r}_m = r_p$ for γ yields the threshold $\bar{\gamma}$ in (5), which is a function of all the variables stated in claim (i). The first fraction on the right hand side of (8) is always non-negative, which implies that if $\gamma \leq 0$ then $\frac{\partial u}{\partial r_m} > 0$ for all $\gamma, x^T, \alpha, \kappa, r_p$, implying $r_m^* = \infty$. If $\gamma \in (0, \bar{\gamma})$ then $\bar{r}_m > r_p$ and hence $r_m^* = \bar{r}_m$ as reported in (5).[8] □

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[8] Note that due to the technical restriction $n \in \mathbb{N}$ the equilibrium r_m^* must be rounded to the nearest r_m satisfying $n \in \mathbb{N}$.