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Monetary Policy Announcements and Lagged Effects of the Supply Shocks

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Abstract

A monetary targeting procedure affected by lagged supply shocks is analyzed in this paper within a linear quadratic loss function framework. Following the propposition of Stein (1989) we try to develope a slightly different theory of imprecise monetary announcement, where there is no true target, but rather a true expectation. This expectation is private for the central bank, and is contingent on the stream of supply shocks affecting the output inflation tradeoff. While in Stein's model the CB is always better off by truthfully revealing the target, we conclude that this announcement does not bring about gains in terms of a higher or smaller social loss, but rather affects the persistence of the inflationary bias. Other results regarding the variances of output and inflation are compared with the recent literature on optimal contracts for central bankers (Walsh (1995), and Persson & Tabellini (1993)).

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1. Introduction.

This paper extends the analysis on the credibility of Central Bank (CB) monetary policy under asymmetric information suggested by Canzoneri (1985) to the case where there are lagged effects from the productivity shocks. These lags are contemplated assuming that the shocks in the aggregate supply function follow a $MA(q)$ process. Two monetary strategies are set: one in which the monetary authority knows the true structure of the economy and, in the framework of our model, can try to compensate the whole stream of disturbances from the MA process; and the second one in which the strategy is only partial. We will conclude that this last case is a source of trade off between inflation and output stability.

In the present paper, the CB has to make a one period ahead forecast of inflation conditioned on its past information, in order to state the inflation target for the next period. This target strategy does not only affect the inflationary bias but also the variance of both inflation and output. Following Stein (1989) this targeting procedure allows the CB to communicate the range within the *true target* lies in. Stein's *proposition 1* states that the CB is better off if it could reveal the true target, but if it does will not be believed by the private sector. However, in our model the *true target* is endogenously determined. Rather we prefer to talk about a long run inflation *most desirable target*, possibly equal to zero, *i.e.* $\pi^* = 0$. The principal assumption adjacent to this result is the private information of the CB: the MA of the supply shocks, $u_t = \sum_{i=0}^{q} \theta_i \varepsilon_{t-i} = \theta(L)\varepsilon_t$, $\theta_0 = 1$, is the private information, and the public can only know the value of u_t, but *never* the stream of fundamental innovations $\{\varepsilon_{t-i}\}_{i=0}^{q}$. If this informational asymmetry holds inflationary bias can be erased, but the variability of output and inflation can be upward affected.

The recent literature on monetary policy games (Walsh (1995), and Persson & Tabellini (1993)) stresses the possibility to reduce the inflationary bias by properly assigning a *linear inflation contract* to the CB, while keeping the stability of output. This is done by affecting the incentives of the central bankers in committing with an assigned inflation target. The result is that the optimal monetary rule can be consistent. The *perverse policymaker hypothesis* suggested by Roggof (1985) has been challenged since the elimination of the inflationary bias does not necessarily cause stabilization costs.

The paper is organized as follows. Part 2 explains the model to use. Part 3 is an overview of the classical results for simple rules and discretionary policies, but extending the situation to the particularity that shocks follow an $MA(q)$ process. In part 4 a targeting procedure is proposed and part 5 is the concluding section.

2. The Model.

There are two players in this model, the private and the public sector. The private sector has to negotiate a wage for period t, and then needs to estimate the future value of inflation based on the its own information set. The reaction function of the private sector is represented by an augmented Phillips curve of the form:

$$y_t = \alpha(\pi_t - \pi_t^e) + u_t \tag{2.1}$$

where $\pi_t^e = E(\pi_t | I_{t-1})$, denotes the conditional (rational) expectation of inflation, which is equal to the wage contract stated by the wage setters, and conditional on the private sector information set I_{t-1}. π_t is the inflation rate at time t, and y_t is output. u_t is a dynamic productivity shock that follows a $MA(q)$ process:

$$\begin{array}{l} u_t = \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + ... + \theta_q \varepsilon_{t-q} = \theta(L)\, \varepsilon_t \\ \theta(L) = 1 + \theta_1 L + \theta_2 L^2 + ... + \theta_q L^q \\ \varepsilon_t \sim i.i.d.N(0, \sigma^2) \qquad \forall t \end{array} \tag{2.2}$$

As it will be seen later, this specification is crucial for some of the results achieved in the paper, provided that the election of the monetary policy parameters will be affected both by current and past productivity shocks[1].

On the other hand, it is assumed that the CB has to minimize, at time t, a loss function of the form

$$L_t^{cb} = \pi_t^2 + \lambda (y_t - k)^2 \tag{2.3}$$

where k is the output target. The parameter λ is the relative weight that the government assigns to the output control. In may models the agent controls inflation through some monetary aggregate, though here it is assumed that the control of inflation is direct. The trade-off expressed in equation (2.1) suggests that there exist some temptation to inflate by the government in order to affect output growth.

Assume further that the monetary authority is the only one that can observe the realization of ε_t at period t, $\{\varepsilon_{t-i}\}_{i=0}^{\infty} \subset I_t^{cb}$, where I_t^{cb} is the CB's private information set. The value of u_t is revealed at the beginning of time $t+1$, that is after monetary policy for t has been totally implemented. The private sector

[1] The unconditional mean and variance of this process are respectively, $Eu_t = 0$, $\sigma_u^2 = \sum_{i=0}^{q} \theta_i^2 \sigma^2$, with $\theta_0 = 1$.

knows u_t, but not separately $\{\varepsilon_{t-i}\}_{i=0}^{\infty} \notin I_t$, $\{u_{t-i}\}_{i=0}^{\infty} \subset I_t$. Following Persson & Tabellini (1990), we propose the next linear monetary strategy contingent on the present and lagged shocks

$$\begin{aligned} \pi_t &= \beta_t + \phi_0 \varepsilon_t + \phi_1 \varepsilon_{t-1} + ... + \phi_q \varepsilon_{t-q} = \\ &= \beta_t + \phi(L) \varepsilon_t \end{aligned} \tag{2.4}$$

where $\phi(L) = (\phi_0 + \phi_1 L + ... + \phi_q L^q)$. Notice that β_t represents the inflationary bias that arises after the implementation of the monetary policy, provided that ε_t is a white noise process, and $\pi_t^e = E(\pi_t | I_{t-1}) = \beta_t$.

3. The Optimal Monetary Rule and the Discretionary Results.

3.1. Commitment to a Monetary Rule.

If the monetary authority precommits to follow a monetary simple rule at period t, and if the private sector thinks that the temptation to inflate is much smaller than the strength of the commitment, then expectations (*i.e.* wage contracts), can be formed after policy is implemented and targets are publicly announced by the CB. Hence, implicitly it is assumed that the CB is able to control expectations formations somehow. The timing is: first the supply shock ε_t is realized, second the monetary authority chooses π_t, and finally expectations are set. The formal problem is

$$\max_{\phi_t, \beta_t^r} \left\{ E\left[(\beta_t + \phi(L)\varepsilon_t)^2 + \lambda [\alpha\phi(L)\varepsilon_t + \theta(L)\varepsilon_t - k]^2 \left| I_t^{cb} \right. \right] \right\}$$

The optimal response to this situation is defined as the inconsistent Stackelberg equilibrium, in which the CB is the leader of the game. The value of the response parameters from the first order conditions are:

$$\begin{aligned} \phi_i^c &= -\frac{\alpha\lambda}{1+\alpha^2\lambda}\theta_i \\ i &= 0, 1, 2, ..., q \qquad \theta_0 = 1 \end{aligned}$$

$|\phi_i^c|$ can either be out or inside the unit circle depending on the parameters θ_i of the MA process. Inserting these values in (2.4) one obtains a $MA(q)$ process for inflation:

$$\begin{aligned} \pi_t^c &= -\frac{\alpha\lambda}{1+\alpha^2\lambda}[\varepsilon_t + \theta_1\varepsilon_{t-1} + \theta_2\varepsilon_{t-2} + ... + \theta_q\varepsilon_{t-q}] = \\ &= -\frac{\alpha\lambda}{1+\alpha^2\lambda}\theta(L)\varepsilon_t = -\frac{\alpha\lambda}{1+\alpha^2\lambda}u_t \end{aligned} \tag{3.1}$$

Since $u_t \notin I_{t-1}$, and the public does not know the stream $\{\varepsilon_{t-i}\}_{i=0}^{q}$, the private expectation of inflation is $E(\pi_t^c | I_{t-1}) = 0$. Under commitment the inflationary bias is zero. Any positive inflation is fully unexpected by the private sector. The asymmetric information stated implies that the private sector behaves as though it sees the supply shock as a stationary white noise process with $u_t \sim N(0, \sigma_u^2)$, and the CB knowing the true structure of the stationary process $u_t \sim MA(q)$, where the properly identified and relevant supply shocks are $\{\varepsilon_{t-i}\}_{i=0}^{q}$ rather than u_t. Equation (3.1) is often defined as the *optimal monetary rule*, since the inflationary bias is controlled at the target level. Any inflation that arises bellow or above that value is fully unexpected: $0 = \beta_t^c$. However, though optimal, this equilibrium is not time consistent, since the monetary authority always has the temptation to inflate in order to surprise the public. This last sector in turn fully incorporates this CB incentive into their rational expectations through the wage contracts.

On the other hand, the solution for output is

$$y_t = \frac{1}{1+\alpha^2\lambda}\theta(L)\varepsilon_t \tag{3.2}$$

since $u_t = \theta(L)\varepsilon_t$ is stochastic, one cannot say that this policy generates over or underemployment.

3.2. A Fully Discretionary Equilibrium.

Next, the discretionary equilibrium. Assume now that the monetary authority does not precommit to follow the monetary rule. Instead, it prefers to discretionally accommodate the sequence of shocks affecting the economy. The temptation is then estimated higher than the commitment by the public. In this environment, expectations of the wage setters are formed before the monetary policy is implemented. Now the timing is: first expectations are set, second the realization of ε_t is known by the policy maker who, thirdly, chooses the monetary policy π_t. Alike the monetary strategy (2.4), the CB is trying to accommodate the whole stream of disturbances from the MA process, $\{\varepsilon_{t-i}\}_{i=0}^q$. The optimal policy response in this case is defined as a Nash equilibrium, since both the CB and the wage setters take the reaction of the other as given. The formal problem is now

$$\max_{\beta_t,\phi_t^f}\left\{E\left[(\beta_t+\phi(L)\varepsilon_t)^2+\lambda[\alpha(\beta_t+\phi(L)\varepsilon_t-\pi_t^e)+\theta(L)\varepsilon_t-k]^2\,\middle|\,I_t^{cb}\right]\right\}$$

Again, the policy parameters from the first order conditions:

$$\begin{aligned}\beta_t^f &= \alpha\lambda k\\ \phi_i^f &= -\frac{\alpha\lambda}{1+\alpha^2\lambda}\theta_i\\ i &= 0,1,2,\ldots,q \qquad \theta_0 = 1\end{aligned}$$

The only difference is that the expectations of inflation incorporate a positive bias as a consequence of the stabilization policy k, $\beta_t^f = \alpha\lambda k$. People fully incorporate into their rational expectations the intention of the CB to inflate. The suboptimal fully discretionary monetary rule is then

$$\pi_t^f = \alpha\lambda k - \frac{\alpha\lambda}{1+\alpha^2\lambda}\theta(L)\varepsilon_t \tag{3.3}$$

Note that the solutions for output are unaffected by the type of policy implemented, in this case the equilibrium output coincides with equation (3.2). Stabilization policy is fully ineffective, since it does not alter the level of the real variable considered.

3.3. A Partial Monetary Strategy.

Finally, let us consider the case where the CB only compensates a subsequence of shocks, $\{\varepsilon_{t-i}\}_{i=0}^{p}$, where $p \leq q$, maybe due to an imperfect knowledge of the structure of the economy:

$$\begin{aligned} \pi_t &= \beta_t + \varphi_0 \varepsilon_t + \varphi_1 \varepsilon_{t-1} + \dots + \varphi_p \varepsilon_{t-p} = \\ &= \beta_t + \varphi(L)\, \varepsilon_t \end{aligned} \tag{3.4}$$

where $\varphi(L) = (\varphi_0 + \varphi_1 L + \dots + \varphi_p L^p)$.

Using the same timing as in the earlier discretionary result, the formal problem becomes as

$$\max_{\beta_t, \varphi_t^i} \left\{ E\left[(\beta_t + \varphi(L)\, \varepsilon_t)^2 + \lambda \left[\alpha \left(\beta_t + \varphi(L)\, \varepsilon_t - \pi_t^e \right) + \theta(L)\, \varepsilon_t - k \right]^2 \middle| I_t^{cb} \right] \right\}$$

and this yields the next first order conditions

$$\begin{aligned} \beta_t^p &= \alpha \lambda k \\ \varphi_i^p &= -\frac{\alpha \lambda}{1 + \alpha^2 \lambda} \theta_i \\ i &= 0, 1, 2, \dots, q \qquad \theta_0 = 1 \end{aligned}$$

The result for inflation is now equal to

$$\pi_t^p = \alpha \lambda k - \frac{\alpha \lambda}{1 + \alpha^2 \lambda} (u_t - e_t) \tag{3.5}$$

where $e_t = (\theta_{p+1} L^{p+1} + \dots + \theta_q L^q)\, \varepsilon_t$, and $\sigma_e^2 = \left(\theta_{p+1}^2 + \theta_{p+2}^2 + \dots + \theta_q^2 \right) \sigma^2$.

On the opposite, this new strategy does have real effects on output:

$$y_t = \frac{1}{1 + \alpha^2 \lambda} u_t + \frac{\alpha^2 \lambda}{1 + \alpha^2 \lambda} e_t \tag{3.6}$$

Since u_t and e_t are random variables it is early to asses whether these real effects are positive or negative.

However, one interesting conclusion arises in this new environment: there is a trade off in the variances of inflation and output induced from the partial monetary strategy. The closer is e_t towards u_t, the smaller the variance of inflation and the higher the one of the output, regardless the value of the parameters (α, λ). While the variance of inflation can be totally reduced, the variability of output can be at most partially accommodated. (i.e. $\sigma_y^2 \in \left[(1 + \alpha^2 \lambda)^{-2} \sigma_u^2, \sigma_u^2 \right]$, $\sigma_\pi^2 \in \left[0, (\alpha \lambda / (1 + \alpha^2 \lambda))^2 \sigma_u^2 \right]$).

3.4. Welfare Effects.

To see wether these trade-off effect is optimal, one should take a look to the welfare effects involved in the strategies:

$$E L_t = \lambda k^2 + \frac{\lambda}{1 + \alpha^2 \lambda} \sigma_u^2 \tag{3.7}$$

$$EL_t^f = \lambda k^2 \left(1 + \alpha^2\lambda\right) + \frac{\lambda}{1 + \alpha^2\lambda}\sigma_u^2 \tag{3.8}$$

$$EL_t^p = \lambda k^2 \left(1 + \alpha^2\lambda\right) + \frac{\lambda}{1 + \alpha^2\lambda}\left(\sigma_u^2 + \sigma_v^2\right) \tag{3.9}$$

Clearly, the commitment technology stated in (3.1) is the one that yields the highest utility to the monetary authority. On the contrary, whenever a discretionary regime is considered an added cost arises, $EL_t^p > EL_t^f > EL_t^c$. In this last case, the desutility comes from output destabilization.

4. Forecasting and Targeting Inflation.

Let us now concentrate to the fully discretionary case, and consider now that the government decides to assign to the CB a loss function where the target value for inflation is different from zero, $\pi^* \neq 0$. In fact, this is due to the loss of reputation when the CB announced a zero target for inflation at period t, but there was an inflationary bias equal to $\alpha\lambda k$. A high announcement for the target would bring about a higher bias, and very low announcement would not be credible by the wage setters. Now, to answer this policy dilemma, we will proceed as though the CB used the result for inflation stated in the MA (3.3) to forecast inflation. The best linear projection of (3.3) is the optimal forecast of inflation:

$$\begin{aligned} E\left[\pi_{t+1}\middle| I_t^{cb}\right] &= E\left[\pi_{t+1} \middle| \{\varepsilon_{t-i}\}_{i=0}^{q}\right] = \hat{\pi}_{t+1/t} = \\ &= \alpha\lambda k - \frac{\alpha\lambda}{1+\alpha^2\lambda}\left(\theta_1\varepsilon_t + \theta_2\varepsilon_{t-1} + \ldots + \theta_q\varepsilon_{t-q+1}\right) \end{aligned} \tag{4.1}$$

Hence, the conditional expectation of inflation for period $t+1$ is equal to the inflationary bias $\pm$ a stream of fundamental innovations $\{\varepsilon_{t-i}\}_{i=0}^{q-1}$. Suppose that this expression is used to state the inflation target at period $t+1$, π_{t+1}^*, but as we have previously suggested, the CB keeps a part of the information and reveals a target of the form

$$\pi_{t+1}^* = b_{t+1} - \frac{\alpha\lambda}{1+\alpha^2\lambda}\left(\theta_1\varepsilon_t + \theta_2\varepsilon_{t-1} + \ldots + \theta_q\varepsilon_{t-q+1}\right) \tag{4.2}$$

At time $t+1$ the public knows the aggregate value of the shock u_t and perceives an intention like π_{t+1}^*, but does not know the separate values of the stream $\{\varepsilon_{t-i}\}_{i=0}^{q-1}$. b_{t+1} is a policy parameter: it is the part of the announcement controlled by the CB. Note that the unconditional expectation of (4.1) is equal to zero. Now the objective function (2.3) must be reformulated as

$$L_{t+1}^{cb} = \left(\pi_{t+1} - \pi_{t+1}^*\right)^2 + \lambda\left(y_{t+1} - k\right)^2 \tag{4.3}$$

where the optimal target is not necessarily $\pi^* = 0$ as before.

The CB sets a fully monetary strategy similar to (2.4) of the form

$$\pi_{t+1} = \beta_{t+1} + c(L)\,\varepsilon_{t+1} \tag{4.4}$$

where $c(L) = (c_0 + c_1 L + \ldots + c_q L^q)$.

To solve the problem, the timing in this case is just the same as in the discretionary algorithm, and one may follow similar steps to find the first order conditions. The formal problem becomes as

$$\max_{\beta_{t+1},\varphi^{t}_{t+1}} E\left[(\beta_{t+1}+\varphi(L)\varepsilon_{t+1}-\pi^{*}_{t+1})^{2}+\right.$$
$$\left.+\lambda\left[\alpha\left(\beta_{t+1}+\varphi(L)\varepsilon_{t+1}-\pi^{*}_{t+1}\right)+\theta(L)\varepsilon_{t+1}-k\right]^{2}\Big|I^{p}_{t+1}\right]$$

with the first order conditions equal to

$$\begin{aligned}\hat{\beta}_{t+1} &= b_{t+1}+\alpha\lambda k\\ \hat{\varphi}^{t+1}_{0} &= -\frac{\alpha\lambda}{1+\alpha^{2}\lambda}\\ \hat{\varphi}^{t+1}_{i} &= \frac{1-\alpha\lambda}{1+\alpha^{2}\lambda}\theta_{i}\\ i &= 1,2,\ldots q-1\end{aligned}$$

Clearly, if the announcement is indexed with the inflationary bias of the previous period, that is $b_{t+1}=-\alpha\lambda k$, then expected inflation is set at the target level of the previous period, $\pi^{*}_{t}=0$. Since, the public only has perceived an indexed target π^{*}_{t+1}, cannot know the true intention of the CB. If we proceed forward with this mechanism, then we will see how the discretionary regime always require the employment of *lies* when stating the target. This is a source of secretism, since the real intention is never revealed to the private sector, similar to the result of Stein (1989). As Goodfriend (1986) has suggested secretism is then needed in order to avoid commitments for the CB: *The FOMC reluctance to publicize its systematic policy procedure is understandable. Publicity would reduce the cost of becoming informed and thereby increase the intensity of debate about policy. The FOMC would be more uncomfortable because it would be less costly for the public to check outcomes against intentions.* (Goodfriend, 1986, p. 82).

On the other hand, note that the set of policy parameters φ's has been altered, unlike the recent result suggested in the work of Walsh (1995) where the control of the inflationary does not cause stabilizations costs. While the optimal target conditional on the private expectations is

$$\pi^{*}_{t+1}=-\alpha\lambda k-\frac{\alpha\lambda}{1+\alpha^{2}\lambda}\left(\theta(L)-1\right)\varepsilon_{t+1} \tag{4.5}$$

the result for inflation is now

$$\pi_{t+1}=\frac{(1-\alpha\lambda)\theta(L)-1}{1+\alpha^{2}\lambda}\varepsilon_{t+1} \tag{4.6}$$

And the output equilibrium is

$$y_{t+1}=\frac{(1+\alpha)\theta(L)-\alpha}{1+\alpha^{2}\lambda}\varepsilon_{t+1} \tag{4.7}$$

Hence, this strategy affects both the mean levels and the variances of output and inflation.

Finally, in order to analyze the optimality of this targeting strategy we see that the expected value function is

$$EL_{t+1}^{T} = \lambda k^2 \left(1 + \alpha^2\lambda\right) + \frac{\lambda}{1+\alpha^2\lambda}\sigma^2 + \frac{1+\lambda(1+\alpha)^2}{1+\alpha^2\lambda}\left(\sigma_u^2 - 1\right) \qquad (4.8)$$

and hence, compared with (3.8) and (3.9), it is difficult to assert whether the new strategy represents a better optimum.

In the environment developed here one cannot talk about the *true* intention of the CB. Rather the CB must not confuse its desire with the reality, and the only thing that can do is to set a target that contains *imprecise* information of the *true expectation*. The CB would not be better off by revealing the truth, since if the target is set with $b_{t+1} = \alpha\lambda k$, the inflationary bias would become the double of this quantity, $2\alpha\lambda k$, and doing so the result would just be like (4.8). Therefore, although there is no gain nor loss, by revealing the truth there arises a positive inflationary bias. This is similar, but quite different, to Stein's (1989) result.

5. Conclusions.

In most of the monetary policy games models appeared since the works of Kydland & Prescott (1977), and Barro & Gordon (1983) it is common to assume that innovations follow a white noise process. Once the innovation is realized, the monetary authority has to accommodate it. The CB only takes care about the immediate current shock, but maybe these shocks affecting the system are highly or at least slightly persistent. This assumption has been changed in this paper in order to show how the variances of the variables, inflation and output, are affected by the policy parameters.

A one period ahead forecasting is a reference to fix the target for inflation, but not the best one. The variance of inflation may vary both by the degree of independence or by the capability of the CB to accommodate past shocks. The alteration of the white noise assumption allows to give a reasonable explanation of the volatility of the inflation and employment rates as a consequence of direct decisions and independence of the CB. Of course, one should recognize that these results are due to the *ad hoc* assumption on the *MA* process.

In Stein's (1989) model there is an exogenous *true monetary target*. In our game this concept has been substituted to that of *true expectation*, that allows the CB to set a monetary target for the next period. In fact, only two periods have been considered and our interest has been beyond of finding a possible monetary general pattern if this targeting procedure is to be held in the future. Walsh's (1995) normative model shows us that monetary stability can be attained without social stabilization costs by properly assigning an optimal inflation contract to the central banker, that is, by directly affecting the utility function of the governor of the CB. Recently direct targeting of inflation are being experienced in a few countries (U.K., Canada, Sweden, Finland, and, of course, New Zealand), and yet it is soon to evaluate the fors and againsts of this type of policies, although their apparent successes. Mainly, we have been concerned in giving a positive explanation of the different time variability of output and inflation in the last 25 years where these direct targeting of inflation policies have not been employed.

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