INTEREST RATE RULES, PRICE LEVEL DETERMINANCY AND STABILIZATION POLICY

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CONTENTS

Ⅰ. Introduction

The purpose of the paper is twofold. It re-establishes the compatibility of nominal interest rate rules with a determinate price level in equilibrium, rational expectations macromodels. It also shows that, in decentralized economies with an economy-wide capital market, optimal interest rates rules perfectly stabilize output about its full information value. The main implication of the latter result is that the feasibilivey and desirability of active stabilization policy do not hinge on the additional, averaged information conveyed an endogenously determined nominal rate of return on economy-wide traded bonds. Moreover, adoption of lagged feedback interest rate rules facilitates the filtering problem faced by private agents: in fact, only under the above policy regime(and not when money supply control is implemented instead) there is a unique, closed-loop solution to the signal extraction problem.

The scheme of the paper is as fallows. Section Ⅱ reconsiders the price level indeterminacy debate. Section Ⅲ shows that optimal interest rate rules stabilize output perfectly around its full information value. Section Ⅳ is a brief summary of the main results.

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II. INTEREST RATE RULES AND PRICE LEVEL DETERMINACY

One alleged implication of New Classical Macroeconomics is that interest rate rules are not compatible with a determinate price level. This argument has been recently restated by Sargent-Wallace (1982):

> "The real bills doctrne has long been disputed by advocates of classical macroeconomic theories, which usually embody some version of the quentity theory of money. One seemingly tellmg criticism is that, under a real-bills regrme, the economy is exposed to the Wicksellian situation in which both the price level and the money supply ahe indeterminate."

New stimulus to this old debate was provided by Sargent-Wallace(1975) in an earlier model where price level indeterminacy was hagarded to be

> "…the counterpart in this model of the non-stochastic, statics result that in a full-employment model with wages and prices that are instantaneously flexible, it can happen(under suitable restrictions on the IS curve) that the price level is indeterminate if the monetary authority pegs the interest rate."(Sargent, 1979)

The above claim has been qulte influential in economic theory and practice. For example, Griffiths-Wood(1980) argue, on the basis of that result, that if

> "…one is concerned with price level stability…and if expectations are rational, the advice to policy-makers once more becomes quite definite. Under these circumstances, a money supply rule gives a determinate course for the price level; an interest rate rule does not. The economics of this are straightforward. Under an interest rate rule, the public(quite correctly)expects that the authorities will supply whatever nominal money stock is required to maintain the interest rate…. This is not a consequence of choosing the 'wrong' interest rate rule. No interest rate rule yields a stable price level".

It should be clear that the joint hypothesis of rational expectations and continuous market clearing is necessary to obtain the abore result. The problem can be reformulated as follows: in equilibrium models where expectations are rational and the price level is a forward-looking variable, a termmal or transversality condition is required. Sargent-Wallace(1975) argae that such a condition is unlikely to be met under an interest rate rule. Of course, either assuming market clearing and adaptive expectations or rational expectations and sluggish price adjustment would guarantee the existence of a determmate price level, since it would be given only by past events and therefore no transversality condition would be required. In the right of these considerations, Calvo's(1983) recent contention that the price level can be indetermmate in spite of price rigidities is, to some extent, misleading. In his particular model, there may or may not be a unique saddlepath to which the economy converges under an interest rate rule, but this is quite different from the problem under analysis.

The Wicksellian indeterminacy problem applies to models where unique equilibrium values for real variables are compatible with a continuum of solutions for nominal variables; in particular, when the unique equilibrium value for real balances is associated wrth an infinite number of possible equilibrium

values for the nominal money stock and the price level. It then follows that also when the joint hypotheses of continuous market clearing and rational expectations are satisfied, further restrictions are required:

"…the aggregate demand schedule must exclude any components of real wealth that vary with the price level if Wicksell's indeterminacy is to arise."(Sargent-Wallace, 1975)

This is not surprising: if nominally denominated bonds were not net wealth, in contrast to Barro's (1974) Ricardian hypothesis, or in presence of some kind of(institutional) money illusion, the price level would still be determinate.

Turnovsky(1980) has shown, in a Sargent-Wallace framework, that when the hypothesis that government bonds are not net wealth is relaxed the price level is determined. A similar point to the one made by Turnovsky is obtained by assuming that aggregate demand is inversely related to the level of personal income taxation and the tax schedule is not idexed and progressive. This is easily shown in the following model which closely resembles a model proposed by McCallum-Whitaker(1979):

$$Y_t^s = a_1[P_t - E(P_t \mid \Omega_{t-1})] + a_2 Y_{t-1} + u_t \tag{1}$$

$$Y_t^d = 1o_1[E(P_{t+1} \mid \Omega_{t-1}) - E(P_t \mid \Omega_{t-1})] - b_3 x_t + v_t \tag{2}$$

$$Y_t^s = Y_t^d = Y_t \tag{3}$$

$$x_t + p_t = \tau(Y_t + P_t) \tag{4}$$

Where:

d, s≡demand and supply labels

t ≡temporal suffix

Y ≡log of real output

P ≡log of price level

x ≡log of real income-tax revenue

r ≡tax parameter

$a_1, b_1, a_2, b_3 > 0$

E ≡mathematical expectation opeator

Ω ≡information set, containing the model plus the past history of the economy

u, v≡white noise random shocks

All constants have been excluded from equations (1) to (4) for simplicity. Equation (1) is Sargent -Wallace's supply equation; equation (2) is the IS curve; equation (3) is the goods market clearing

condition and equation (4) is the "fiscal-drag" equation. The assumption that the government is adopting an open-loop interest rate rule allows for omitting the "conventional" LM equation. The assumption of progressive income tax implies $\tau > 1$.

The semi-reduced form equation for the price level is:

$$P_t=(a_1/k)\ E(P_t \mid \Omega_{t-1})-(a_2/k)Y_{t-1}+[b_1/k(1+b_3)]\ E(P_{t+1} \mid \Omega_{t-1})+\{1/[(1+b_3)k]\}v_t-(1/k)\,u_t \quad (5)$$

where $k=a_1+\dfrac{b_1+b_3(\tau-1)}{1+b_3\tau}$

From (5) the condrtional path of the price level is given by:

$$E(P_{t+1} \mid \Omega_{t-1})=\frac{b_1/k(1+b_3\tau)}{(k-a_1)/k}\ E(P_{t+1+1} \mid \Omega_{t-1})-\frac{a_2/k}{(k-a_1)k}\ E(Y_{t+1} \mid \Omega_{t-1})$$

Price level determinacy requires that the following inequality holds:

$$\frac{b_1}{b_1+b_3(\tau-1)}<1 \quad (7)$$

which is always satisfied.

Suppose now current taxes do not matter(i.e. $b_3=0$) but consider explicitly real gavernment spending in the IS schedule, i.e. replace (2) with (8).

$$Y^d{}_t=b_1[E(P_{t+1} \mid \Omega_{t-1})-E(P_t \mid \Omega_{t-1})]+b_2g_t+v_t \quad (8)$$

where $b_2>0$ and $g\equiv$real government spending. Assume the government adopts either of the following open-loop spending rules(respectively, real and expected real):

$$g_t=\overline{G} \quad (9)$$

$$f_t=\overline{F} \quad (9')$$

where $g_t=f_t-[P_t-E(Pt \mid \Omega_{t-1})]$ (10)

Under either open-loop spending rules, we would now have price level indeterminacy when the monetary authorities adopt nominal interest rate rules. From (1),(3), (8), (9'), (10), e.g, the expected conditional path of the price level is given by:

$$E(P_{t+1} \mid \Omega_{t-1})=E(P_{t+1+1} \mid \Omega_{t-1})+\frac{b_2}{b_1}\ E(f_{t+1} \mid \Omega_{t-1})-\frac{a_2}{b_1}\ E(Y_{t+1-1}) \quad (11)$$

which is inherently unstable. Suppose instead the government "suffers" from money illusion and adopts the following open-loop rule:

$$h_t\equiv g_t+p_t=\overline{H} \quad (12)$$

The model (1), (3), (8) and (12) gives:

$$E(P_{t+1}|\Omega_{t-1})=\frac{b_1}{b_1+b_2}E(P_{t+l+1}|\Omega_{t-1})+\frac{b_2}{b_1+b_2}E(h_{t+l}|\Omega_{t-1})-\frac{b_2}{b_1+b_2}E(Y_{t+l-1}|\Omega_{t-1}) \quad (13)$$

Analysis of a similar model has led Brezis and Offenbacher(1983) to suggest that the government should not adopt both real spending and nominal interest rate rules at the same time if the price level is to be determined. However, this statement is not correct; in fact, the government can control both, as shown below. Consider the following feedback spending rule:

$$g_t=\chi P_{t-1} \quad (14)$$

The model (1), (3), (8) and (14) yields the expected price level path:

$$E(P_t|\Omega_{t-1})=E(P_{t+1}|\Omega_{t-1})+\frac{b_2}{b_1}E(P_{t-1}|\Omega_{t-1})-\frac{a_2}{b_1}Y_{t-1}) \quad (15)$$

Then a convergent path for the expected price level is obtained by setting:

$$\chi:-\frac{2b_1}{b_2}<\chi<0 \quad (16)$$

This result is particulary important : it shows that open-loop interest rate rules are consistent also with new classical rational expectations models, provided other policy control rules are appropriately set.

Another way to achieve price level determinacy is, as shown by McCallam(1981), when the interest rate rule in designed in older to hit a desired money stock target. The result would carry through for any nominal target, notably nominal income, as proposed by Bean(1983).

III. INTEREST RATE RULES AND STABILIZATION POLICY

Having re-established that nominal interest rate rules are a feasible alternative to direct monetary control, it remains to be assessed which policy regime is to be preferred. Fethke-Jackman(1983) claim that the original Poole's(1970) policy conclusions are exactly restated in a rational expectations framework. Canzoneri et al. (1983) show that feedback monetary rules can save private agents the cost of indexing to the currently observable interest rate. It should be noted that both the obove papers assume predetermined wage contracts of the kind proposed by Fischer(1977) and Gray(1976). However, as shown elsewhere(Marini, 1985b) also Sargent-Wallace's(1975) and McCallum's(1981) models implicitly assume contracting stories(or differential information).

A "proper" new classical model, immune from Barro's(1977) criticism addressed to nominal wage contracting, has been recently proposed by Dotsey-King(1983), where an economy-wide financal market is superimposed on an island-type economy.

The policy conclusions they reach are as follows. The economy-wide nominal ratc of interest provides additional information to agents other than the price signal they observe in their own island.

Lagged feedback monetary rules can alter the informational content of the endogenously determined interest rate, while a(lagged)feedback interest rate rule would deprive agents from those addltional pieces of information. It is argued, therefore, that only direct control of monetary aggregates, via feedback reactions to lagged realizations of relevant variables, can reduce oscillations of equilibrium real output from its full information level. This argument is not correct, as shown below.

Consider the following island model, where the output supply in market Z is as in Dotsey-King (1983) derived according to the Friedman(1968)-Lucas(1973) hypothesis:

$$Y_t^s(Z)=b[P_t(Z)-E_zP_t]+\varepsilon_t^s(Z)+u_t^s \tag{17}$$

Demand for output depends on the locally penceived real interest rate:

$$Y_t^d(Z)=ar_t+aP_t(Z)-aE_zP_{t+1}+u_t^d+\varepsilon_t^d(Z) \tag{18}$$

And the nominal interest rate feeback rule is assumed to be, for simplicity:

$$\gamma P_{t-1}+\delta u_{t-1} \tag{19}$$

where u_t, ε_t are, respectively, the economy-wide and local excess demand shocks, Z is the market index, E_z is the expectational operator conditional on the amount of information available in market Z, which consists of the model, the past history of the economy and the current bit of contemporaneous information provided by the observation of the local equilibrium price. Notice that in our model, in contrast to Barro's(1980), King(1983), Dotsey-King(1983), the economy-wide nominal interest rate does not convey any additional information to agents, since according to(19) it is a control variable, related to perfectly observed past events.

From(17), (18), and (19), the semi-reduced form of the equilibrium local price level is:

$$P_t(Z)=\frac{1}{b-a}\ (bE_z\ P_t-aE_z\ P_{t+1}+u_t+\varepsilon_t+a\gamma P_{t-1}+au_{t-1}) \tag{20}$$

A "minimal state" solution for the local price level can be guessed as[see, e.g. McCallum(1983), Whiteman(1983)]:

$$P_t(Z)=\pi_0P_{t-1}+\pi_1u_{t-1}+\pi_2u_t+\pi_3\varepsilon_t \tag{21}$$

where π's are undetermined coetfficients.

The conditional expectations of the current averaged price level and of the future price are obtained using(21) and solving the signal extraction problem:

$$E_zP_t=\pi_0P_{t-1}+\pi_1u_{t-1}+\theta\pi_2\ u_t+\theta\pi_3\varepsilon_t \tag{22}$$

where $E_z\,u_t=\frac{\theta}{\pi_2}(\pi_2u_t+\pi_3\varepsilon_t)$

$$E_z P_{t+1}=\pi_0^2 P_{t-1}+\pi_0\pi_1 u_{t-1}+\theta(\pi_0\pi_2+\pi_1)u_t+\theta\pi_3\left[\pi_0\frac{\pi_1}{\pi_2}\right]\varepsilon_t \tag{23}$$

Substituting (22), (23), into (20) and equating the caelficient with (21),

we obtain:

$$\bar{\pi}_0^2+\pi_0-\bar{\gamma}=0 \tag{24}$$

From (21), price level determinacy now requires the quadratic equation (24) to have one unstable and one stable root. The latter root, which ensures price level determinancy, will be the one picked by rational agents. The above requinement is met by setting its policy parameter γ in order to satisfy the inequality

$$0<\gamma<2 \tag{25}$$

The value for $\bar{\pi}_0$, under any value of γ, satisfying (25) is defined as $\overline{\pi\gamma}$. The remaining undetermined coefficients are:

$$\bar{\pi}_1=\frac{\delta}{\pi_\gamma-1}$$

$$\bar{\pi}_2=\bar{\pi}_3=\frac{\pi\gamma-1-a\delta\theta}{(\pi_\gamma-1)[b(1-\theta)-a(1-\theta\pi_\gamma)]} \tag{26}$$

Inspection of (20)−(26) immediately reveals that deviations of actual, averaged across markets, output about its full information level are proportional to the term:

$$(\pi_\gamma-1-a\delta\theta)(1-\theta)(u_t+\varepsilon_t) \tag{27}$$

The monetary authorities can then perfectly stabilize real output by optimally setting the policy parameter δ as:

$$\delta=\frac{\pi\gamma-1}{a\theta} \quad > O \tag{28}$$

The optimal policy rule in a counter-cyclical interest rate policy.

This result gives additional support to the proposition that there is new scope for counter-cyclical policies in new classical macroeconomic models. In particular, neither differential information nor the existence of an endogenous (economy-wide) nominal rate of interest, conveying extra-information to agents are required to obtain this effectiveness result. The true channel of effectiveness is the forward -looking nature of these models.

Interest rate rules dominate any other policy rule in the present context, as should be clear from the subsequent considerations.

In this class of economy-wide capital market models, when monetary rules are pursued(and the nominal interest rate is therefore endogenous) agents have access to two heterogeneous signals about

the state of economic activity. In a sense they have too much(incomplete) information. There is no unique solution to the signal extraction problem agents have to face. Although both Barro(1980) and King(1983) seem to regard this non-uniqueness problem to be essentially of a technical nature, the implications for policy design are definite. Dotsey and King(1983) do not find monetary rules which can perfectly stabilize output about its full information level, while we have shown that perfect stabilization is possible under interest rate rules.

In conclusion, given that it is not the availability of heterogenous signals, as argued by Barro (1981) and King (1983), the source of policy effectiveness, the optimal policy should be a feedback nominal interest rate rule which makes the filtering process unique and perfectly stabilizes output.

CONCLUSIONS

There is no compelling reason why the authorities should adopt monetary rules as opposed to interest rate rules: in both cases price level determinacy is possible. In particular, in new classical decentralized economies with an economy-wide bond market, nominal interest rate lagged feedback rules are to be preferred, since they facilitate the signal extraction problem faced by private agents and can perfectly stabilize output about its full information capacity level.

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요 약

본 논문에서는 새로운 고전학파 거시경제학의 균형에서 결정되어지는 가격수준과 그리고 합리적 기대의 거시경제모형과 더불어 명목이자율 준칙에 대한 적합성을 Lucas의 모형과 Sargent-Wallace 모형을 도입하여 재정립하였다. 그리고 경제전반에 걸친 자본시장, 적정이자율 준칙이 완전한 정보가치에 대하여 완전하게 안정화되어진 산출량과 더불어 경제의 집중현상을 배제하는 것도 나타내고 있다.