Working Paper 8710

MONETARY POLICY IN AN ECONOMY WITH NOMINAL WAGE CONTRACTS

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December 1987

Abstract

This paper considers the role of monetary policy in an economy with rational expectations and a nominal wage contracting constraint. To this end, a monetary economy with nominal wage contracting is constructed in a simple neoclassical growth model. **It** is shown that when utility is logarithmic in consumption that a money supply rule designed to either peg nominal interest rates or target nominal output will be optimal for this economy. In more general formulations of utility no specific policy reccomendations can be made, optimal monetary policy can be either procyclical or countercyclical depending on the exact form of the utility function.

I. Introduction

This paper considers the role of monetary policy in an economy with rational expectations and a nominal wage-contracting constraint. Building upon the work of Fischer (1977), households and firms are (by assumption) required to agree on a nominal wage before the realization of the real and monetary shocks. The prototype of the model developed is from Prescott (1983). Prescott reconsidered the nominal wage-contracting model of Fischer and put Fischer's system of equations into a simple neoclassical growth model with rational expectations.

Prescott's model is modified to include economy-wide supply shocks and possible policy responses conditional on these shocks. In addition, money is introduced into the system by including real balances in the utility function instead of a cash-in-advance constraint. This is done so that the introduction of money does not influence any real quantities (assuming that utility is separable). The optimal monetary policy will depend on the money demand equation, so including real balances in the utility function also allows one to easily consider different formulations for money demand.

Because nominal wages are contracted prior to money supply announcements, monetary policy can have real effects by influencing the price level and, hence, real wages. Similarly, since wages are contracted prior to the observance of the productivity shocks, employment cannot adjust to its first best (flex wage) level. Assuming that monetary policy can be made after the real shock is observed, monetary policy can potentially increase the welfare of the representative consumer. The money supply can be inflated or deflated to increase or decrease the real wage and to mimic the spot-market wage that would arise without an ad hoc nominal wage-contracting constraint.

Although monetary policy can stabilize output, it will not generally be desirable to do so. The money-supply rule, which maximizes the utility of the representative consumer and provides that the firm earn zero profits, may be either procyclical or countercyclical. The correct monetary response will depend on the consumption elasticity of money demand and the consumer's relative degree of risk aversion.

Assuming utility is logarithmic in consumption, a policy rule designed either to peg the nominal interest rate at a given level or to stabilize nominal output will produce the first best (flex wage) quantities. The Federal Reserve Board currently targets the nominal interest rate, while several economists have long advocated a policy rule to target nominal output. In the special case in which utility is logarithmic in consumption both policy rules are identical as well as optimal. These rules amount to pursuing a procyclical (countercyclical) money supply rule if the income elasticity of money demand is greater (less) than one.

The case in which utility is not logarithmic in consumption, but is logarithmic in real money balances, leads to similar policy conclusions. The optimal policy can be either procyclical or countercyclical depending on the relative degree of risk aversion of the representative household. Procyclical (countercyclical) monetary policy would be favored if the degree of relative risk aversion is greater (less) than one.

The structure of the paper is as follows: section II describes the environment in terms of tastes, technology, and endowments and then defines an equilibrium for this economy. Section III characterizes the equilibrium and discusses the appropriate policy response to various productivity shocks. The final section discusses whether nominal contracting models can be used for policy purposes given the current information on the form of the utility function and the empirical validity of nominal contracting models.

II. An Economy with Nominal Wage Contracts

The evolution of the economy is as follows: the representative household enters into each period with cash and capital carried over from the previous period (except for the initial period, where cash and capital are given as endowments). The worker then signs a contract with a firm specifying the nominal hourly wage that will be paid in the coming period. By assumption, this wage contract cannot be indexed to either the monetary injection or the price level. However, the number of hours worked can be made conditional on both productivity shocks and monetary shocks. Hours are allowed to depend on the monetary shock in order for monetary injections to have real effects. After the shocks occur, the household rents capital stock to a firm (not necessarily its employer) for a rental rate, u, and works the number of hours specified by the contract, contingent upon the realizations of the monetary injection and the productivity shock.

At the end of the period, the household receives its rental and wage payments in cash from the firm(s). For simplicity, it is assumed that capital depreciates completely after one period. The rental price of capital is thus the purchase price of capital. The household then combines the wage and rental payments with the initial currency holdings and any lump-sum monetary transfers from the monetary authorities to choose the amount of consumption for that period and the amount of capital and cash it wishes to carry over into the next period. Money will be held in equilibrium because of the utility it provides the household.

The per capita money stock evolves according to the following formula: $M_{t+1} = M_t(1+x)$, where x is a random variable and M_t is the economy-wide money stock (which, in equilibrium, will be equal to the amount held by the representative consumer) at the beginning of period t. Increases in the money stock are brought about by lump-sum transfers to the household(s) from the monetary authorities. It is assumed that the probability density function of the monetary injections, x, is $f(x:K_t,M_t,\theta_t)$, where θ_t is the productive shock realized in period t.

Conditioning the distribution on K, M, and θ is due to the assumption that the monetary authorities can choose the money supply after observing the state of the economy in that period. Without the real shock, the optimal monetary policy would be to maintain a constant money stock or given that the monetary authorities have the necessary revenues to deflate the money stock at the rate of time preference.

The productivity shock, 8, is assumed to be a strictly positive random variable that is identically, independently distributed over time with a probability density function of $g(\theta)$. Furthermore, it is assumed that θ affects production multiplicatively. The production function is assumed to have the form $\theta F(k_t,h_t)$, where $F(.,.)$ is assumed to be homogeneous of degree one in labor, h, and capital, k. The technology is further assumed to have the form that capital and the consumption good can be transformed without cost from one to another.

Firms are assumed to be profit maximizers operating in a purely competitive environment. This ensures that capital and labor will be chosen in such a way that the value of the marginal productivity of capital is equal to the rental price of capital and that the value of the marginal productivity of labor is equal to the wage rate. The constant-returns-to-scale assumption ensures that, in equilibrium, firms will earn zero profits. The assumption is not necessary. However, it simplifies the analysis since the dividends households receive from firms no longer have to be considered.

The representative household is assumed to have preferences over consumption, c_t, leisure, $1-h_t$ (where $0 < h_t < 1$), and real money balances, m_{t+1}/p_t, as follows:

$$(2.1) \quad E_0\{\sum_0^\infty \beta^t[u(c_t,1-h_t) + H(m_{t+1}/p_t)]\},$$

where $0 < \beta < 1$ is the discount factor and $u(.,.)$ and $H(.)$ have all of the usual properties: concave, twice differentiable, and increasing in their arguments. The above expectation is taken to be conditional on the information set at time zero, the initial conditions K_o and M_o. Capital letters denote aggregate variables over which the individual has no control, while lower-case letters represent a choice variable for the individual. However, in equilibrium, the quantities chosen by the individual will be equal to those for the economy as a whole.

The equilibrium contract will be chosen so it maximizes the utility of the representative consumer, subject to the capital and labor the firm will hire at the chosen rental and wage rates, and subject to the budget constraint for the individual. The following is the planning problem for this economy:

Problem H:

$$\max_{\substack{w_t, u_t(.), c_t(.) \\ m_{t+1}(.), k_{t+1}(.)}} E_0\{\sum_{o}^{\infty}\beta^t[u(c_t, 1-h_t) + H(m_{t+1}/p_t)]\}$$

s.t.

1) $p_t\theta_t F_k(k_t, h_t) - u_t = 0$

2) $p_t\theta_t F_h(k_t, h_t) - w_t = 0$

3) $w_t h_t + u_t k_t + m_t + M_t x_t - p_t(c_t + k_{t+1}) - m_{t+1} \geq 0$

4) $k_o = K_o, \quad m_o = M_o$

Constraints 1 and 2 are the "reaction functions" for the firm, which specify how much labor and capital will be chosen by the firm at various wage and rental rates. Constraint 3 is the budget constraint for the worker. The notation $u_t(.)$, $c_t(.)$,... etc. denotes the rental rate on capital, consumption, next period's capital, and next period's money stock are all chosen conditional on k_t, M_t, m_t, θ_t, x_t. The wage rate, w_t, denotes $w(k_t, m_t, M_t)$ since, by assumption, wages cannot depend on x or 8.

The price of consumption and capital, p_t, is taken as given by the firm and worker in problem H. In equilibrium, p_t will be chosen in such a way that the money market clears, $M_t = m_t$.

The household's budget constraint consists of income from capital and labor as well as money carried over from the previous period and the lump-sum transfer from the monetary authorities, $M_t x$. The household spends its income on current consumption as well as on the capital and currency it wishes to carry over into the next period.

The problem is stated in this form instead of the "dual" formulation since competition by firms for workers and capital ensures that the wage rate and rental rate of capital will be chosen optimally from the household's point of view. Otherwise, a firm could enter and make positive profits while the household remains at least as well off as before.

We are now ready to define an equilibrium for this economy:

Definition of Equilibrium:

A stationary equilibrium for this economy requires that the following conditions are satisfied:

1) w_t, $u_t(.)$, $k_{t+1}(.)$, $h_t(.)$, $c_t(.)$, $m_{t+1}(.)$ are chosen to satisfy Problem H for $t = 1, 2, \ldots$.

2) P_t is chosen such that the money market clears:

$$m_{t+1}(k_t, M_t) = M_{t+1}$$

3) The unit of account does not matter, that is P_t, W_t, U_t are homogenous of degree one in last period's money stock M_t.

This completes the definition of equilibrium. The next section considers various functional forms for the production function and the utility function in order to talk about the optimal monetary policy.

III. Real Shocks and Monetary Policy

In this section, the utility is assumed to have a constant intertemporal elasticity of substitution, while the production function is assumed to be Cobb-Douglas. The forms for both are as follows:

$$u(c,1-h) = [c^{1-a} - 1]/(1-a) + v(1-h)$$

$$H(m_{t+1}/p_t) = [(m_{t+1}/p_t)^{1-b}-1]/(1-b)$$

$$F(k,h) = k^{\alpha}h^{1-\alpha}$$

where $0 < a < 1$, a .

With these functional forms, the first-order conditions for Problem H are as follows:

(3.1) $\lambda_{3t}p_t = c_t^{-a}$

(3.2) $\lambda_{2t} = \lambda_{3t}K_t$

(3.3) $E_t(\lambda_{1t}) = E_t(\lambda_{3t}h_t)$

(3.4) $\lambda_{3t}p_t = \beta E_{t+1}(\lambda_{3t+1}u_{t+1})$

(3.5) $v'(1-h_t) = \lambda_{3t}w_t + \alpha(\lambda_{3t} - \lambda_{1t}/h_t)$

(3.6) $\lambda_{3t} = m_{t+1}^{-b}(1/p_t)^{1-b} + \beta E_{t+1}(\lambda_{3t+1})$

(3.7) $\lim_{t\to\infty} \beta^t E_{t+1}(\lambda_{3t}m_{t+1}) = 0$

(3.8) $\lim_{t\to\infty} \beta^t E_{t+1}(\lambda_{3t}p_t k_{t+1}) = 0$

where $E_t(.) = E_{x,\theta}(.:K_t,M_t)$ and λ_i $(i = 1,2,3)$ is the costate variable associated with the i^{th} constraint.

Equation 3.1 states that the marginal utility of real balances is equal to the marginal utility of consumption. Equation 3.2 states that the capital market clears. Condition 3.3 is identical except that, because of the nominal wage-contracting constraint, the labor market will only clear "on average." Equation 3.4 states that investment occurs until the marginal cost of investing in terms of forgone consumption is equal to the discounted expected benefits due to increased production next period. Equation 3.6 is the demand for nominal cash balances, while equations 3.7 and 3.8 are the terminal or transversality condition.

Because of the nominal contracting constraint, employment increases (decreases) with money supply increases that are larger (smaller) than expected. Using equations 3.1, 3.3, and 3.5 we can see that, on average, the representative worker will be neither over- or underemployed. Overemployment (underemployment) is defined as when the worker is working more (less) than he would wish to (ex post) in a spot market at the prevailing wage rate. Underemployment occurs when monetary injections are smaller than expected, while overemployment occurs when monetary injections are larger than expected. Although underemployment is akin to involuntary unemployment, the two should not be treated synonymously, since by definition there is only one worker in this artificial economy.

As will be seen, the money supply rule that maximizes the utility of the representative worker will eliminate overemployment and underemployment. However, since underemployment and overemployment are not observable, it is necessary to discuss what the money supply rule should be with respect to observable variables, namely output and prices.

Using the transversality conditions equations, 3.4 and 3.6 can be solved recursively yielding:

$$(3.4') \quad y_t c_t^{-a} = \sum_{s=o}^{\infty}(\alpha\beta)^s E_{t+1}(c_{t+1}^{1-a}) \text{ and}$$

$$(3.6') \quad \lambda_{3t} = \sum_{s=o}^{\infty}\beta^s E_{t+1}(m_{t+s+1}^{-b}(1/p_{t+s})^{1-b}.$$

Equation 3.6' shows that the marginal utility of nominal cash balances, λ_3, is decreasing in both current and expected future monetary injections. Combining 3.6' with 3.1 gives the demand for real cash balances or equivalently shows how the price level is determined in equilibrium, given the market-clearing condition $m_{t+1} = M_{t+1}$:

$$(3.9) \quad m_{t+1}/p_t = c_t^{a/b} B_t^{1/b},$$

where $B_t = \sum_{s=o}^{\infty}\beta^s E_{t+1}\prod_{i=o}^{s}\{[1/(1+\pi_i)]^{1-b}[1/(1+x_i)]^b\}$

$p_{t+i+1} = p_{t+i}(1+\pi_i)$ and $M_{t+i+1} = M_{t+i}(1+x_i)$.

Equation 3.9 shows that real money balances are decreasing in the expectation of future monetary injections. It also indicates that the consumption elasticity of money demand is greater (less) than one when a > (<) b, or when the desire to smooth consumption is greater (less) than the desire to smooth real cash balances over time. The intuition behind this result can be seen most clearly if one assumes that B_t is constant. In this case, when the desire to smooth consumption and the desire to smooth real cash balances are equal, a = b, money balances are proportional to consumption. Similarly, when the desire to smooth consumption over time is greater than it is to smooth real balances over time, a > b, increases or decreases in consumption will be magnified through the price level so that the time series for consumption will be smoother than it is for real money balances.

The nominal interest rate in this economy is given by the following equation:

(3.10) $(1+i) = E_{t+1}\{\lambda_{3t}/\beta\lambda_{3t+1}\}$.

One, plus the nominal rate of interest, equals the ratio of the marginal utility of nominal balances today and the present discounted value of what it is expected to be tomorrow. The optimal money supply rule when wages are flexible is the Friedman/Sidrauski rule of deflating the money supply such that the nominal interest rate approaches zero, or equivalently such that the marginal utility of nominal cash balances grows at the rate of time preference. This will entail deflating the money supply at a constant rate only when b = 1.

IV. Optimal Monetary Policy

This section considers the optimal monetary policy in response to real productivity shocks. We proceed by finding the money supply rule that reproduces the quantities that would be chosen in a world with flexible wages. Since real money balances enter separably in the utility function, this also reproduces the quantities that would be chosen by the social planner in the standard optimal growth model without money.

The first step in discussing the optimal money supply rule is to restate the first-order conditions of problem H when the nominal wage-contracting constraint is lifted. These first-order conditions are identical to those given by equations 3.1 - 3.8 (including 3.4' and 3.6'1, except for the first-order condition with respect to choosing the optimal wage, equation 3.3. This, in turn, affects the labor supply that will be chosen, equation 3.5. When real instead of nominal wages are chosen equations 3.3 and 3.5 become:

(4.1) $\lambda_{1t} = \lambda_{3t}h_t$ and

(4.2) $v'(1-h_t) = \lambda_{3t}w_t$.

Since λ_3 is the marginal utility of consumption divided by the price level, equation 4.2 indicates that workers will never be underemployed or overemployed. This, of course, is not surprising.

The optimal money supply rule due to the nominal contracting constraint will be discussed in two stages: the first stage lets "b" vary but sets a=1, i.e. utility is logarithmic in consumption. The second case lets "a" vary but sets b=1, i.e. utility is logarithmic in real money balances.

A. Logarithmic Consumption, a=l

Setting a=l and replacing equations 3.3, 3.5 with 4.1 and 4.2, the first-order conditions with flexible wages become:

(4.3) $c_t = (1-\alpha\beta)y_t$

(4.4) $k_{t+1} = \alpha\beta y_t$

(4.5) $v'(1-h_t)h_t = (1-\alpha)/(1-\alpha\beta)$ and

(4.6) $m_{t+1}/p_t = B_t^{1/b}c_t^{1/b}$.

where $\lambda_{3t} = \sum_{s=o}^{\infty}\beta^s E_{t+1}(m_{t+s+1}^{-b}(1/p_{t+s})^{1-b})$ and

$$B_t = \sum_{s=o}^{\infty}\beta^s E_{t+1}\prod_{i=o}^{s}\{[1/(1+\pi_i)]^{1-b}[1/(1+x_i)]^b\}.$$

The first three are standard when utility is logarithmic in consumption. Consumption and investment are proportional to output, while labor supply is constant, because with logarithmic consumption and 100 percent depreciation of capital, the income and substitution effects cancel out.

From equations 4.3 and 3.10, the Friedman/Sidrauski rule to pursue a monetary policy such that the nominal interest rate is near zero implies that the monetary authorities should pursue a policy of deflating nominal income at the household's rate of time preference. If the government wishes to collect a given amount of tax revenue over time via the inflation tax, it should let nominal output grow at a predetermined rate.

The employment level that results with a nominal contracting constraint can be seen by noting that $\lambda_3 wh = (1-\alpha)\lambda_3 py$. Labor supply is then:

$$(4.7) \quad h_t = (1-\alpha)/[(1-\alpha\beta)\lambda_3 w_t].$$

Since wages by assumption cannot be indexed to monetary and productivity shocks, employment responds to monetary and real shocks only through their effect on the marginal utility of nominal balances. Equation 4.7 indicates that employment responds negatively to positive productivity shocks when $b < 1$, while employment increases with positive productivity shocks when $b > 1$. These results can be seen from equation 4.6, which shows that prices and productivity shocks are negatively related. Not surprisingly, equation 4.7

also shows that employment increases with monetary innovations. From equation 4.6 this indicates that given a constant money supply, employment will be procyclical (countercyclical) when the income elasticity of money demand is less (greater) than unity. The reason for this can be seen by recalling the second constraint in problem H, $w_t = p_t\theta_t F_l(k_t, l_t)$. When the income elasticity is greater than one, the percentage decrease in prices will be greater than the percentage increase in output. Therefore, py and, hence, θp will necessarily decrease with productivity shocks, implying that employment will decrease when productivity increases. The above argument can be reversed when the income elasticity of money demand is less than one to show that employment will increase with increases in productivity.

Since employment is constant when wages are flexible and utility is logarithmic in consumption, the optimal monetary policy can be either procyclical or countercyclical. The optimal monetary policy will be procyclical when the income elasticity of money demand is less than one ($a=1$, $b>1$) and countercyclical when the income elasticity of money demand is greater than one ($a=1$, $b<1$). Equivalently, when productivity increases by 1 percent, instead of real wages increasing by 1 percent as they would with flexible wages, they increase by more than 1 percent when the income elasticity of money demand is greater than one. Monetary policy should then be procyclical in order to reduce real wages to their spot market level. This also serves to increase employment and to reduce or eliminate underemployment. Underemployment exists in this case since the increase in real wages is more than is optimal. Similarly, when the income elasticity of money demand is less than one, real wages do not increase as much as they would with flexible wages, so that the government should pursue a countercyclical monetary policy.

One caveat to the possibility of procyclical monetary policy should be noted. Procyclical monetary policy applies only if the increase or decrease in output was caused by real factors and not by reckless monetary policy.

Calling for either procyclical or countercyclical monetary policy provides directional guidance; however, it begs the crucial question: By how much? Without answering this question, Friedman's 4 percent money supply rule might be called for on grounds that the cure might be worse than the disease. Fortunately, when utility is logarithmic in consumption, a simple money supply rule to target nominal output will achieve the first best allocation.

Comparing equations 4.5 and 4.7 implies that a policy of stabilizing the marginal utility of nominal balances, λ_3, (or letting it grow or shrink at a predetermined rate) will achieve the first best employment level. From the first-order conditions from problem H, this is equivalent to stabilizing nominal consumption or nominal output. To ensure that employment will indeed be at its first best level, equations 3.3 and 3.5 imply that employment will be deterministic and that employment will be chosen such that $v'(1-h) = \lambda_3 w$ or, equivalently, that employment will be chosen such that there is not any under-/overemployment. From equation 3.1 this implies that equation 4.5 will also be satisfied.

Pursuing a policy to stabilize nominal output implies a procyclical monetary policy when the income elasticity of money demand is greater than one, or a countercyclical monetary policy when the income elasticity of money demand is less than one. Recall that prices fall more (in percentage terms) than the percentage increase in output when the income elasticity of money demand is greater than one. Therefore, nominal output will fall (rise) when there is a good (bad) productivity shock. Stabilizing nominal output in this case necessitates pursuing a procyclical monetary policy. Similarly, **if** the income elasticity of money demand is less than one, productivity and nominal output move together, so stabilizing nominal output will entail a countercyclical monetary policy.

Recalling our earlier result, this policy will also satisfy the Friedman/Sidrauski money supply rule. Similarly, from equation 3.10, a policy to target the nominal interest rate will ensure that quantities are chosen at their optimal level, suggesting that the Federal Reserve Bank's current policy may be correct. This policy also requires the monetary authorities to react to yesterday's recessions and booms, because investment causes independent productivity shocks to translate into serially correlated output over time. Since wage setters can readily observe the current capital stock that was carried over from the previous period, these monetary supply changes will be completely anticipated and reflected in the agreed-upon nominal wage rate.

Unfortunately, as will be seen in the next subsection, the result that targeting nominal interest rates or targeting nominal output is optimal depends on the assumption that utility is logarithmic in consumption. However, the result that the optimal monetary policy might be procyclical is still true depending on the elasticity of substitution of consumption over time, that is whether $a < (>) 1$.

B. Logarithmic Real Balances, $b=1$

This subsection considers the case when utility is logarithmic in real money balances, but "a" is allowed to vary. The optimal labor supply in this case will no longer be constant. Whether the substitution effect or the income effect dominates will depend on the substitutability of consumption over time. From equations 3.3' and 3.4', the optimal (flex wage) labor supply is

$$(4.8)\quad v'(1-h_t)h_t = (1-\alpha)\sum_{s=o}^{\infty}(\alpha\beta)^s E_{t+1}(c_{t+s}^{1-a}).$$

From equation 4.8 labor supply when wages are flexible will increase (decrease) with positive productivity shocks when a < (>) 1. This results because of the assumed concavity of v(.) and because both current and expected future consumption increase with positive productivity shocks.

The way in which the economy evolves given the presence of a nominal contracting constraint is similar to before. The following equations express the way in which output is divided between consumption and investment, the money demand function, and the number of hours worked when the economy is subject to nominal wage contracting and b=1.

$$(4.9)\quad y_t c_t^a = D_t$$

$$(4.10)\quad \lambda_{3t} w_t h_t = (1-\alpha)D_t$$

$$(4.11)\quad m_{t+1}/p_t = c_t^a \sum_{s=o}^{\infty}\beta^s E_{t+1}\prod_{i=o}^{s}[1/(1+x_i)]$$

where $D_t = \sum_{s=o}^{\infty}(\alpha\beta)^s E_{t+1}(c_{t+s}^{1-a})$ and

$$\lambda_{3t} = \sum_{s=o}^{\infty}\beta^s E_{t+1}(1/m_{t+s+1}).$$

Since neither λ_{3t} nor w_t is affected by productivity shocks equation 4.5 shows that as with flexible wages, employment will increase (decrease) with increases in productivity when a < (>) 1. The borderline case is when a=1, or when utility is logarithmic in both consumption and real money. This is the only case in which the monetary authorities should target the money supply. The reason that employment can either increase or decrease with positive productivity shocks is again because, the income elasticity of money demand is greater (less) than one when a < (>) 1.

However, employment would increase or decrease more than would be optimal given an increase in productivity. Using an asterisk to denote the optimal level, equations 4.5 and 4.9 show that employment can only be at the optimal level when $v'(1-h^*) = \lambda_3 w$. However, when b=1, λ_3 does not depend on 8. Therefore, employment will be optimal only when h* is constant, that is when a=1. This is because in a spot market, workers choose their labor supply so that $v'(1-h) = \lambda_3 w$, implying that a worker would not want to change the number of hours he works when productivity changes. When a < 1, h* increases with θ, implying that $v'(1-h^*) > \lambda_3 w$. Thus overemployment occurs when productivity is greater than expected, and underemployment occurs when productivity is less than expected. When real wages are too low in booms and too high in recessions, the monetary authority should pursue a countercyclical monetary policy. Similarly, when a > 1, $v'(1-h^*) < (>) \lambda_3 w$ with good (bad) productivity shocks. In this situation, it would be optimal to follow a procyclical money supply rule.

V. Conclusions

This paper showed that optimal monetary policy in a model where wages are "sticky" because of a nominal contracting constraint can be either procyclical or countercyclical (as measured against output). Perhaps the possibility for unconventional monetary policy arising from such a model is not altogether suprising; however, it points to the need for discussing the policy implications of macroeconomic models in an optimizing framework. The policy objectives that are frequently thought to follow from nominal contracting models, namely stabilizing output, prices, or a constant money supply, are optimal only in extreme cases. For example, if there are no real shocks, all three objectives produce the optimal monetary policy. When a=b=1, a money supply rule also is optimal, or when "a" approaches infinity, so that the household is infinitely risk-averse (a "maxi-min" utility function), a policy rule to stabilize prices is also optimal.

However, in addition to these extreme cases, a slightly more general case when utility is logarithmic in consumption results in a well-defined policy rule for this economy. This case indicates that a policy rule designed either to stabilize nominal output or to peg the nominal interest rate will be optimal. Both of these policies actually correspond to either a procyclical or countercyclical money supply rule, depending on "b", or the income elasticity of money demand.

Although this paper discusses optimal monetary policy, actual policy prescriptions should be tempered with the reliance of these policy rules on the form of the utility function. Policy conclusions from the model are tentative at best, given that the model assumes that nominal wage-contracting exists but does not explain why parties contract in nominal instead of real terms. For example, it is likely that an explanation for nominal contracting will be to have noisy observations of the price level similar to Lucas (1972). The correct policy prescription, if this were the case, would undoubtedly call for a well-defined money supply rule.

Given the limited data available, the model tentatively suggests that the proper monetary policy in a world with nominal wage contracts is procyclical. This rests on studies (for example, Grossman and Shiller [1981], and Friend and Blume [1975]) that estimate the relative degree of risk aversion, "a", to be between two and four. However, given the lack of data on "b", the policy rule for when utility is logarithmic in consumption would probably be preferred, because the optimal policy is well-defined and is independent of "b" in this special case. Monetary policy designed to peg the nominal interest rate or to target nominal output will be optimal in this case.

This paper has sought to map Fischer into an optimization framework, and to discuss whether these differences have different policy implications. The first difference is that Fischer's two-period nominal contracts are collapsed into one period. In Fischer's model, policymakers cannot act instantaneously to economy-wide shocks, as they can in this paper. Policy in his paper resulted from the assumption that shocks were correlated over time, which allowed policymakers to use information about the previous period's shock in order to predict the shock that would occur in the current period. This paper has one-period wage contracts; however, it retains the essence of Fischer's paper since contracts are drawn up in advance of both monetary and real shocks. Policymakers are assumed to have perfect information in which to react to outside shocks instead of a noisy signal, as in Fischer's original paper. Incorporating this element does not seem to affect the policy rules derived in this paper. However, this difference would make it even harder to prescribe monetary policy.

The second difference between the optimization model set up in this paper and the set of equations formulated by Fischer is the type of shocks assumed to affect the economy. Real productivity shocks are assumed in this paper, while Fischer had shocks affecting aggregate demand, aggregate supply, and money demand. Keynesians might not accept that shifts in the aggregate supply schedule are caused by real productivity shocks. However, given that Fischer assumed rational expectations, it seems reasonable to treat shocks to aggregate supply as productivity shocks. Assumed shocks to aggregate demand would have to be modeled as shocks to the utility function.

Although the model shows that a procyclical money supply with respect to output may be optimal, it nevertheless has conventional countercyclical monetary policy implications with respect to employment. Similarly, using the evidence we have on "a", the model suggests that given a constant money supply, employment would be countercyclical. However, this result depends on the assumption of 100 percent depreciation as well as the assumption that consumption and leisure are separable.

If nominal contracting models are going to be useful for policy analysis, then future work is necessary in order to address two concerns. The first is to build a model in which nominal contracts arise endogenously. The second area of future research is to determine if nominal contracts are empirically relevant for the study of business cycles. This question has been tested by Ahmed (1985), who showed that in Canada the amount to which employment and output responded to money shocks was insignificantly correlated with the amount of indexing in labor contracts. This provides some evidence against nominal contracting models. However, future work is still needed because industries that naturally respond more to monetary disturbances would probably have larger incentives to index their wage contracts. Until such work is done, nominal wage-contracting models should not be used for policy analysis.

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