Reversing the Phillips Curve: A Microfoundation

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Cross-country comparisons have indicated that high inflation may be correlated with reduced levels of output and employment. This paper offers a microfoundation for this phenomenon in a rational expectations framework. A further result of the approach chosen is that anticipated money supply changes have real effects while unanticipated changes have none. Both of these results conflict with popular macroeconomic preconceptions and thus sound a cautionary note in the construction of macroeconomic models.

1 Introduction

Even before the 1973 oil shock the breakdown of the traditional Phillips' curve relationship had been evident. Two widely accepted explanations of observed 'stagflationary' phenomena are concisely stated by Friedman (1977). Friedman suggests that changing expectations and input price shocks may account for the positive relationship between inflation and unemployment apparent since the mid-1960s. This leads him to expect that the "positively sloped Phillips curve" will disappear in the long-run, although his discussion of the possible impact of increased inflation uncertainty tempers his conclusion.

A number of subsequent studies have focused on the possible long term impacts of increased inflation uncertainty on employment and output [e.g., Evans (1984), Gertler and Grinols (1982), Holthausen (1976), Mascaro and Meltzer (1983), and Sandmo (1971)]. Yet equivalent roles for inflation qua inflation remain relatively unanalyzed. Studies of the investment decision of firms in an inflationary environment, a notable exception, suggest that investment may fall as inflation interacts with prevalent tax structures to increase the user cost of capital [e.g., Nelson (1976)]. This paper examines the impact of inflation on the supply of another productive input: labor. It is shown that higher rates of inflation can reduce employment and output even in the long-run.

Output variation in the model presented below results from shifts in the real return on the available asset: money. In a more complex model the interaction between inflation, asset returns, and a progressive tax structure could be introduced. However, the model chosen offers a simple and clear analysis which highlights the two central themes: anticipated money supply changes do matter, and higher average inflation reduces output and employment.

2 Individual Optimization

This model is a simple variant of the popular consumption loan model of Samuelson (1958). Each period there is a representative young worker who uses part of his labor endowment, L_y, in a decreasing returns

to scale production process, $f(\cdot)$, and a retired individual who enjoys the fruits of his earlier labors. The economy is assumed to be monetized so that the self-employed worker can trade his perishable produce, c, for the money holdings of the retiree. This allows the worker to purchase consumption later as a retiree. Leisure and consumption are assumed to be normal goods.

The production function for the single, perishable commodity is differentiable, monotonically increasing, and concave. This implies it has an inverse, $L(c)$, which is differentiable, monotonically increasing, and convex, i.e., $L' > 0$, $L'' \geq 0$. The retiree simply buys consumption with all of his money holdings, $M_{y,t-1}+T_t$. Here $M_{y,t-1}$ is the money he accumulated as a worker and T_t is a money transfer to the retiree in period t, the only source of changes in the money supply. Thus, the money supply in period t can be written as

$$M_t = M_{t-l} + T_t \tag{1}$$

Assuming rational expectations and expected utility maximization the worker's objective function at time t can be written as

$$\max_{M_y} EU[L_y - L(p_t, M_y), p_{t+1}M_y + p_{t+1}T_{t+1}] \tag{2}$$

where L_y = the labor endowment $L(\cdot)$ = labor supply, My = money balances of the young (workers), E = the expectations operator conditional on current information, p = the commodity price of money, T = the transfer received as a retiree, and U = an increasing, differentiable, strictly concave utility index. Consistent with this, let $U_i[.,.]$ = the partial derivative of $U[.,.]$ with respect to the i-th argument, M = the nominal money supply, and m = the real money supply, in the following sections.

3 Macroeconomic Equilibrium

In a manner similar to Brock and Scheinkman (1980), define a rational expectations equilibrium given a random sequence $\{M_s\}_{s=t}^{\infty}$ as a sequence of random variables $\{p_t, p_{t+1}, p_{t+2}, \dots\}$ such that the goods and money markets clear each period for almost every realization of $\{M_s\}_{s=t}^{\infty}$. That is at time t, given the process governing the money supply, there is a price p_s such that

$$p_s M_{ys} = p_s M_s \tag{3}$$

for all $s \geq t$. This, along with the first order conditions for the workers maximization implies that a rational expectations equilibrium will satisfy

$$p_t L' E\{U_1[L_y - L(p_t M_t), p_{t+1}M_{t+1}]\} = E\{p_{t+1}U_2[L_y - L(p_t M_t), p_{t+1}M_{t+1}]\} \tag{4}$$

The implications of this condition for a rational expectations equilibrium are clarified when the process determining the evolution of the money supply is specified. Transfers are governed by

$$T_{t+1} = \sigma_{t+1} M_t \tag{5}$$

where

$$\sigma_{t+1} = \sigma + u_{t+1} \tag{6}$$

Here σ is the constant expected growth rate of the money supply and u_t is a mean zero random shock to the growth rate in period t. A requirement that $T(t) \geq 0$ eliminates possible demonetization of the economy. Now consider a possible rational expectations equilibrium of the form $p_t M_t = m$, i.e., one constant in real balances. The implied first order condition in such an economy is

$$L'(m)U_1[Ly - L(m), m]/U_2[Ly - L(m), m] = E\{1/[1 + \sigma + u_{t+1}]\} \tag{7}$$

where $p_t = m/M_t$ and $E\{M_t/M_{t+1}\} = E\{1/[1 + \sigma + u_{t+1}]\}$. In other words, prices move in proportion to money supply changes each period. Given the definition above, such a random price sequence clearly represents a rational expectations equilibrium for this economy. Note that the actual realization of u_{t+1}, which cannot be anticipated, has no real effects. That is, unanticipated monetary shocks are completely neutral. This short-run neutrality of money in th absence of real shocks recalls the work of Lucas (1972). Note, however, that the model presented above has not assumed that transfers are proportional to the money holdings of each agent.

4 Reversing the Phillips Curve

In accordance with the bulk of the literature on rational expectations, agents in this paper are not influenced by the possibility of a monetary policy regime change unless one is announced. If new regime is introduced at time t, workers now solve their optimization problem based on the new random sequence $\{M_s^*\}_{s=t}^{\infty}$. Retirees, as always, simply offer their money holdings for consumption.

Consider a new constant in the growth rate of the money supply, $\sigma^* > 0$. Call the new level of constant real balances chosen a rational expectations equilibrium m^*. Note that the first order conditions imply

$$L'(m^*)U_1[L_y - L(m^*), m^*]/U_2[L_y - L(m^*), m^*] < L'(m)U_1[L_y - L(m), m]/U_2[L_y - L(m), m] \qquad (8)$$

which guarantees that $m^* < m$. This follows from the convexity an monotonicity of $L(\cdot)$ and the assumption that consumption and leisure are normal goods. This implies that employment, the labor input to the production process, has fallen: less of the consumption good is now produced. The higher expected inflation rate due to a higher expected money growth rate reduces the value of laboring now to consume later. As a result, output and employment in this economy fall. In this sense, the Phillips' curve has been reversed. More precisely, it has been shown that there exists a long-run trade- off between inflation and employment.

5 Conclusion

This paper has focused on the leisure/consumption trade-off in order to explore the microfoundations of output and employment responses to inflationary monetary regimes. The focus on the response of labor supply to perceived returns is, of course, not new in the microfoundations literature. For example, Lucas (1972, 1973) shows that models incorporating such responses can generate "business cycles." In particular, unanticipated general price level increases may stimulate output if workers mistakenly assume they face a higher real return to their labor. However, the structure of these models insures that fully anticipated changes in the general price level have no such effect. A key message of this and many other rational expectations models is that only unanticipated price movements have real effects.

This paper offers an opposing view. It shows that in a rational expectations framework both employment and output can depend on fully anticipated monetary policy. This conclusion is also found or implied in much recent work on inflation variability and on investment in an inflationary environment. The impact of inflation on the leisure/consumption decision is therefore an additional mechanism through which inflationary monetary regimes may permanently lower output and employment.

The results of this paper should be robust to any model specification which incorporates a negative impact of inflation on real asset returns, yet numerous remaining technically interesting exercises are suggested. This paper has followed the mainstream of the rational expectations literature in treating monetary regimes as fixed from the point of view of optimizing economic agents yet occasionally changing for unexplained reasons. Ideally, monetary policy should follow from the optimizing behavior of a monetary authority and other agents would incorporate this additional structure in their decisions. A more tractable extension would allow agents to incorporate the probability of "regime shifts" in their optimization problem. These remain areas for future research.

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