SMALL MENU COSTS AND LARGE BUSINESS CYCLES: AN EXTENSION OF THE MANKIW MODEL

Hiranya K. Nath, Sam Houston State University
Robert Stretcher, Sam Houston State University

ABSTRACT

Using a multi-period general equilibrium model, this paper can be used to enhance classroom presentation of new Keynesian theory by extending the results of Mankiw (1991) by showing that monopolistically competitive firms may require 'relatively large' menu costs to dissuade them from changing prices in response to an aggregate demand shock that is perceived to be permanent. Thus, "small" menu costs may be insufficient to contribute to large business cycles.

INTRODUCTION

It is by now a commonly accepted view among economists that nominal rigidities are the most apt characterization of the short run behavior of the economy. However, the theories that have been proposed to explain sluggish adjustments of prices and wages are varied and numerous. [1] One of the theories that gained popularity among a section of economists in recent years suggests that firms are required to incur some costs to change prices. These costs are often associated with printing menus, and therefore referred to as 'menu costs'. According to this menu costs theory, since changing prices is costly, many firms do not respond immediately to a shock by changing prices, and as a result, real variables such as output have to bear the brunt. Some economists, however, cast doubts about this explanation because these menu costs are evidently small.

Using partial as well as general equilibrium models, Mankiw (1991) shows that these small menu costs are in fact capable of producing large business cycles. Considering monopolistically competitive firms that set prices, he shows that though menu costs may be small, the incremental profits that result from price changes may be even smaller and, therefore, firms are better off by not changing prices in response to a demand shock. In Mankiw's model the decision of the firm depends on a comparison between one-time menu costs and the change in single-period profit. This paper argues that if the firms consider changes in their future stream of profits that would result from the decision to change price then 'small menu costs' may not be able to dissuade them from changing prices. It essentially extends the results of Stretcher (2002), which presents a partial equilibrium analysis of non-market clearing firm to show that introduction of the opportunity cost of capital to discount future incremental profits will reduce the ability of 'small menu costs' to generate large business cycles. In this paper, we build a general equilibrium model which differs from the one in Mankiw (1991) in two ways: first, the representative consumer maximizes life-time utility that involves inter-temporal transfer of resources. Second and more importantly, the monopolistically competitive firm bases its decision to change price on a comparison of the menu costs either with the change in single-period profit, or with the discounted present value of the changes in all future profits, depending upon whether it perceives the aggregate demand shock to be temporary or permanent.

The rest of the paper is organized as follows. Section 2 presents a general equilibrium model, with maximizing rules for consumers and firms. In section 3, we introduce menu costs and discuss how they affect firms' price setting behavior. This section also includes the main propositions of this paper. Section 4 includes a few concluding remarks.

A GENERAL EQUILIBRIUM MODEL WITH MONOPOLISTICALLY COMPETITIVE FIRMS

The economy consists of a continuum of monopolistically competitive firms, distributed along the unit interval.

Consumers and Preferences

We assume that the economy is populated by a large number of identical infinitely-lived consumers. The representative consumer has time-separable preferences summarized by the following utility function:

$$U=\sum_{t=0}^{\infty}\beta^{t}\left((1-\phi)^{-1}\int_{0}^{1}y_{i,t}^{1-\phi}di+\theta\log\left(\frac{M_t^d}{P_t}\right)-L_t\right) \tag{1}$$

where $0<\beta<1$ is the discount factor, $y_{i,t}$ is the quantity of good i consumed in period t, ϕ is the reciprocal of the elasticity of substitution between different goods produced by the firms and $0<\phi<1$, M_t^d is the individual's money demand in period t, P_t is the general price level, L_t is the labor supply[2], and θ is the money demand parameter ($\theta>0$). The general price level P_t is the geometric average of all $P_{i,t}$s, where $P_{i,t}$ is the nominal price of the good produced by firm i in period t, and is given as follows:

$$P_t=\exp\left(\int_{0}^{1}\log P_{i,t}di\right) \tag{2}$$

The consumer earns wage income by supplying labor, and interest income from lending in the previous period. She also receives money supply. In addition to spending on consumption, the consumer lends. Thus the budget constraint for the representative consumer is given by

$$\int_{0}^{1}P_{i,t}y_{i,t}di+B_t+M_t^d=W_tL_t+R_{t-1}B_{t-1}+M_t+\Pi_t \tag{3}$$

where W_t is the nominal wage[3] in period t, B_t is the amount lent in period t, R_t is the interest rate in period t, M_t is the money supply and Π_t is the total profits of the firms. Note that Walras's Law requires that the profits of the firms go to the individual. The individual, however, considers profits as fixed in her utility maximization problem.

Firms and Production

Each firm produces its output using labor only, and the technology is given by the production function:

$$y_{i,t} = L_{i,t} \tag{4}$$

where $L_{i,t}$ is the labor input used by firm i in period t. Thus the cost function of the firm is given by:

$$C_{i,t} = W_t L_{i,t} = W_t y_{i,t} \tag{5}$$

The firm faces a demand function implied by the utility maximization and the firm chooses $y_{i,t}$ and $P_{i,t}$ in each period such that its profit is maximized.

Utility and Profit Maximization

The representative consumer maximizes her life-time utility given by equation (1) subject to her budget constraint given by equation (3). The first-order conditions are given below:

$$\beta^t y_{i,t}^{-\phi} - \lambda_t P_{i,t} = 0 \tag{6}$$

$$\beta^t \theta \frac{1}{\frac{M_t^d}{P_t}} \frac{1}{P_t} - \lambda_t = 0 \tag{7}$$

$$-\beta^t + \lambda_t W_t = 0 \tag{8}$$

$$\lambda_t - E_t \lambda_{t+1} R_t = 0 \tag{9}$$

$$\int_0^1 P_{i,t} y_{i,t} di + B_t + M_t^d - W_t L_t - R_{t-1} B_{t-1} - M_t - \Pi_t = 0 \quad (10)$$

Note that λ_t is the Lagrange multiplier for the budget constraint (3) in the consumer's utility maximization problem. Rearranging equation (8), we have

$$\lambda_t = \frac{\beta^t}{W_t} \quad (11)$$

Substituting into equations (6), (7) and (9), and rearranging we obtain

$$y_{i,t} = \left(\frac{W_t}{P_{i,t}} \right)^{\frac{1}{\phi}} \quad (12)$$

$$W_t = \frac{M_t^d}{\theta} \quad (13)$$

$$R_t = \frac{1}{\beta} E_t \frac{W_{t+1}}{W_t} \quad (14)$$

Equilibrium in the money market implies that money supply equals money demand. Thus,

$$M_t = M_t^d \quad (15)$$

Substituting (15) into (13), we obtain:

$$W_t = \frac{M_t}{\theta} \quad (16)$$

Then substituting (16) into (12) and (14),

$$y_{i,t} = \left(\frac{M_t}{\theta P_{i,t}} \right)^{\frac{1}{\phi}} \tag{17}$$

and

$$R_t = \frac{1}{\beta} E_t \frac{M_{t+1}}{M_t} \tag{18}$$

Rearranging equation (17)

$$P_{i,t} = \frac{M_t}{\theta y_{i,t}^{\phi}} \tag{19}$$

This is the inverse demand function faced by firm i in period t. Also, substituting for W_t from (16) into the cost function (5), we obtain

$$C_{i,t} = \frac{M_t}{\theta} y_{i,t} \tag{20}$$

The implied profit function can be written as:

$$\pi_{i,t} = \left(y_{i,t}^{1-\phi} - y_{i,t} \right) \frac{M_t}{\theta} \tag{21}$$

Firm i chooses $y_{i,t}$ in such a way that $\pi_{i,t}$ is maximized. The first-order condition of profit maximization yields:

$$\left((1-\phi) y_{i,t}^{-\phi} - 1 \right) = 0$$

This implies

$$y^*_{i,t} = (1-\phi)^{\frac{1}{\phi}} \qquad (22)$$

where $y^*_{i,t}$ is the profit maximizing output of firm i in period t. Substituting for $y_{i,t}$ into equation (19) we obtain the following profit-maximizing price for firm i in period t:

$$P^*_{i,t} = \frac{M_t}{\theta(1-\phi)} \qquad (23)$$

As we can see from equations (22) and (23), a change in money supply does not affect the profit-maximizing choice of output of firm i. It affects price only. Under *ceteris paribus,* a one percent increase in money supply will increase the price of firm by one percent. Thus, if all firms fully adjust prices in response to a monetary shock, then the general price level will take the entire brunt of the shock leaving output unaltered.

Menu Costs and the Firm's Decision to Change Price

Suppose the firm is required to incur a cost to change price. Following Mankiw (1991), we assume that changing price involves a small labor input g. Thus, let the menu cost of firm i be

$$z_{i,t} = g_t(i)\, W_t = g_t(i)\, \frac{M_t}{\theta} \qquad (24)$$

The firm's decision to change price depends on a comparison of these costs with potential gains from such a change.

To start with, suppose the money supply is M_0 in each period and each firm chooses quantity and price according to equations (22) and (23), that maximize its profits. Let y_0 and P_0 be the profit-maximizing quantity and price in each period corresponding to this money supply. Suppose that suddenly the money supply is changed to M_1 in period t. If the firm decides

to change its price, then the new price will be given by (23). Otherwise, it remains at

$$P_0 = \frac{M_0}{\theta(1-\phi)}$$

.

The nominal wage, however, changes from

$$W_0 = \frac{M_0}{\theta} \qquad \text{to} \qquad W_1 = \frac{M_1}{\theta} \ .$$

Through product demand (equation (17)), output changes from

$$y_0 \qquad \text{to} \qquad y_1 = \left(\frac{M_1}{M_0}\right)^{\frac{1}{\phi}} y_0 \ .$$

The firm's decision to change price is based on whether the incremental profit that results from the change in price outweighs the menu cost. However, it is important to consider whether the firm perceives the shock to be transitory or permanent.

When the Monetary Shock is Perceived to be Transitory

If the firm perceives the change in money supply to be transitory, it will compare the menu cost with the increment in profit in period t only. Because if the shock is temporary then the money supply in the next periods will be M_0, and y_0 and P_0 will still be the profit-maximizing quantity and price. In that case, the marginal firm I that is indifferent over changing price would be

$$I = g^{-1}\left(\frac{\Delta\pi_{i,t}}{W_1}\right) = g^{-1}\left(\left(y_0^{1-\phi} - y_1^{1-\phi}\right) - \left(y_0 - y_1\right)\right) \qquad (25)$$

If i<I, then the firm finds it profitable to change price even though it has to incur the menu cost. If i>I, on the other hand, the firm leaves its price unaltered at P_0 and produces y_1. Thus:[4]

PROPOSITION 1: Following a monetary shock that is perceived to be transitory, if $zi > \left(\left(y_0^{1-\phi} - y_1^{1-\phi}\right) - \left(y_0 - y_1\right)\right)W_1$, *then the firm does not change its price to* P_1.

When the Monetary Shock is Perceived to be Permanent

If the firm perceives the change in money supply to be permanent, on the other hand, it will compare the menu cost with the discounted present value of all future increments in profit in period t onwards. Because if the shock is permanent then the money supply in all subsequent periods will remain at M_1. If the firm does not change price then y_1 will be the output in period t and in all subsequent periods. In that case, the marginal firm I that is indifferent over changing price would be

$$I = g^{-1}\left(\sum_{k=0}^{\infty}\left(\prod_{l=1}^{k} R_{t+l-1}\right)\frac{\Delta\pi_{t+k}}{W_1}\right) = g^{-1}\left(\left[\left(y_0^{1-\phi} - y_1^{1-\phi}\right) - \left(y_0 - y_1\right)\right]\left[1 + R_t^{-1} + \left(R_t R_{t+1}\right)^{-1} + \ldots\right]\right) \tag{26}$$

From equation (18),

$$R_{t+l} = \frac{1}{\beta} \qquad \text{for all } l = 0,1,2,3\ldots.. \tag{27}$$

Thus, (26) becomes

$$I = g^{-1}\left(\sum_{k=0}^{\infty}\left(\prod_{l=1}^{k} R_{t+l-1}\right)\frac{\Delta\pi_{t+k}}{W_1}\right) = g^{-1}\left(\left[\left(y_0^{1-\phi} - y_1^{1-\phi}\right) - \left(y_0 - y_1\right)\right]\left[1 + \beta + \beta^2 + \ldots\ldots\right]\right) \tag{28}$$

$$= g^{-1}\left(\left[\left(y_0^{1-\phi} - y_1^{1-\phi}\right) - \left(y_0 - y_1\right)\right]\frac{1}{(1-\beta)}\right)$$

If i<I, then the firm changes price; otherwise, it leaves its price unchanged at P_0. Thus,

PROPOSITION 2: Following a monetary shock that is perceived to be permanent, if $z_i > \left(\left[\left(y_0^{1-\phi} - y_1^{1-\phi}\right) - \left(y_0 - y_1\right)\right]\frac{1}{(1-\beta)}\right)W_1$, *then the firm does not change its price to* P_1.

It is not difficult to show that[5]

$$\left(\left[\left(y_0^{1-\phi} - y_1^{1-\phi}\right) - \left(y_0 - y_1\right)\right]\frac{1}{(1-\beta)}\right) > \left(\left(y_0^{1-\phi} - y_1^{1-\phi}\right) - \left(y_0 - y_1\right)\right)$$

Thus for given menu costs, the number of firms changing prices in the latter case will be larger than in the former. In other words, if the firms perceive the monetary shock to be permanent they will require relatively larger menu costs to dissuade them from changing prices. In both cases, total output is

$$Y_t = \int_0^1 y_{i,t}\,di = Iy_0 + (1-I)y_1$$

The general price level is

$$P_t = \exp\left(\int_0^1 \log P_{i,t}\,di\right) = \exp\left(I\log P_1 + (1-I)\log P_0\right)$$

When a monetary shock is perceived to be transitory, for given zis (even if it is small), I will be closer to 0, and most firms will not change price. We will thus observe a relatively larger effect of the monetary shock on output. On the other hand, if the monetary shock is perceived to be permanent, I will be closer to 1 and most of the shock will be absorbed by changes in prices. In that case, small menu costs may not be a likely cause of large business cycles.

CONCLUDING REMARKS

Using a simple general equilibrium framework, this paper shows that if the firms perceive the aggregate demand shock to be permanent they may require 'not small' but 'relatively large' menu costs to dissuade them from changing prices. In that case, their decision to change prices will depend on a comparison between one-time menu costs and discounted present value of all future incremental profits that would result from such price changes. This enhances the traditional presentation of the Mankiw price rigidity model to include discounting of future profits when comparing to menu costs. This is especially useful when consistency (concerning a positive opportunity cost of capital) between macro results and microfoundational models is desired.

ENDNOTES

1. For a comprehensive survey of these competing theories, see Blinder et al (1998) and Taylor (1998)

2. We may split this labor supply, by making the consumer decide the amount of labor she is willing to supply to each firm. But since labor is perfectly mobile across firms this 'twist' in the model is inconsequential. Also, the market clearing in the labor market requires that this labor supply is exactly equal to the total demand for labor by the firms in the economy.

3. Since labor is mobile across firms, nominal wage rate is the same in all firms.

4. If the shock is, in fact, temporary and the firm responds to the shock by changing its price to P_1 then in the next period it will have to change the price back to P_0. In that case, the firm will incur the menu costs twice and therefore will compare $2z_i$ with the incremental profit in order to make a decision about price change. It reinforces Mankiw's (1991) result.

5. For example, for a value $\beta = 0.95$, the first term of this inequality is 20 times higher than the second term.

REFERENCES

Blinder, A. S, Elie E.D. Canetti, D. E. Lebow & J. B. Rudd. (1998). *Asking About Prices: A New Approach to Understanding Price Stickiness.* New York: Russell Sage Foundation.

Mankiw, N. G. (1991). Small Menu Costs and Large Business Cycles: A Macroeconomic Model of Monopoly. In N. Gregory Mankiw & David Romer (eds): *New Keynesian Economics,* vol 1, Cambridge, MA: The MIT Press.

Stretcher, R. (2002), Discounting Price Rigidities, *Journal of Economics and Economic Education Research, 3*(2), 93-103.

Taylor, J. B. (1998). Staggered Price and Wage Setting in Macroeconomics, NBER Working Paper # 6754, Cambridge, MA.