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Quadratic Labor Adjustment Costs and the New-Keynesian Model

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Abstract:

We build quadratic labor adjustment costs into an otherwise standard New-Keynesian model of the business cycle and show that this is sufficient to increase both, output and inflation persistence.

Keywords: Monetary Persistence, Labor Adjustment Costs

JEL classification: E24, E32, E52, J23

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1 Introduction

In the standard New-Keynesian model, prices are sluggish whereas outputs are assumed completely flexible.[1] Price sluggishness is conventionally generated through Taylor- or Calvo-staggering (Taylor (1980), Calvo (1983)). An unsurprising consequence of this combination of sluggish prices and flexible outputs is that, when these New Keynesian models are calibrated, output persistence in response to monetary shocks turns out to be unrealistically low. Specifically, the models under-predict the rate at which the after-effects of monetary shocks - viz., shocks to money growth or the monetary authority's nominal interest target - on output die out through time.

A large body of empirical evidence indicates that costs of quantity adjustment - and particularly those associated with costs of adjusting employment (e.g. hiring, training and firing costs) are often large relative to costs of price adjustment. Thus the New Keynesian models leave out something important when they assign adjustment costs to prices but not to quantities. Correcting this omission may be expected to have important implications not just for the time path of output and employment in response to shocks, but also to the time path of prices. The reason is that the more sluggish is the output response to a shock, the more prices are likely to respond.

Recently, there have been many attempts to build labor adjustment costs into the New-Keynesian model, most prominently the search and matching framework (see e.g. Trigari (2004), Krause and Lubik (2005), Christoffel and Linzert(2005), Blanchard and Gali (2007)). A more micro-founded approach can be found in Lechthaler et al (2008). One of the main findings of these papers is that labor adjustment costs increase the persistence of output. In this paper we show that a much simpler approach (namely quadratic labor adjustment costs) is sufficient to generate the same outcome.

The paper is organized as follows. Section 2 presents the underlying model. Section 3 discusses our simulation results, covering the the price-quantity responses to both monetary shocks. Section 4 concludes.

2 The Model

2.1 Households

Households have a standard utility function of the form:

$$U = \sum_{t=0} \beta^t \left(\frac{C_t^{1-\sigma}}{1-\sigma} + \frac{\left(\frac{M_t(h)}{P_t}\right)^{1-\nu}}{1-\nu} - \frac{L_t^{1+\varphi}}{1+\varphi} \right) \tag{1}$$

[1] In this respect, they resemble the early micro-founded Keynesian models, in which prices were assumed fixed and quantities were assumed flexible (e.g. Barro and Grossman (1976), Malinvaud (1977)).

Utility depends positively on consumption C, real money balances M/P (where P is the price index) and negatively on labor input L. Households maximize utility with respect to the budget constraint:

$$B_t + C_t P_t = W_t L_t + (1 + i_{t-1}) B_{t-1} + \Pi_t \tag{2}$$

where B are bond holdings, W is the wage, i is the interest rate and Π are nominal profits. Utility maximization yields the standard consumption Euler equation, labor supply and money demand:

$$C_t = C_{t+1} \left((1 + i_t) \beta \frac{P_t}{P_{t+1}} \right)^{-\frac{1}{\sigma}} \tag{3}$$

$$L_t^{\varphi} = C_t^{-\sigma} \frac{W_t}{P_t} \tag{4}$$

$$C_t = \frac{i_t}{1 + i_t} \left(\frac{M_t}{P_t} \right)^{\nu} \tag{5}$$

2.2 Production

We follow the recent literature (see e.g. Trigari (2004) or Chritoffel and Linzert (2005)) in separating the markup pricing decision from the labor demand decision. This implies that there are three types of firms. Intermediate good producing firms employ labor to produce the intermediate good. Firms in the wholesale sector take the intermediate goods as input, and differentiate those. Subject to price setting impediments a la Calvo (1983), they sell to a final retail sector under monopolistic competition. Retailers bundle the differentiated goods to a consumption basket C_t.

2.2.1 Intermediate-good firms

Intermediate-good firms hire labor to produce the intermediate good Z. Their production function is: $Z_t = A_t L_t$. However, the labor input is subject to quadratic adjustments costs. Thus, profits in real terms are given by:

$$E_t \sum_{t=0} \beta^t \left[\frac{P_{z,t}}{P_t} A_t L_t^{\alpha} - \frac{W_t}{P_t} L_t - \frac{\Psi}{2} (L_t - L_{t-1})^2 \right]$$

where P_z is the price of the intermediate good and the last term inside the brackets is the real adjustment cost expressed in units of the final good.

Maximizing profits with respect to L_t, we obtain the optimal labor input, which now depends on the labor input of the previous period and the the expected labor input of the following period:

$$\frac{P_{z,t}}{P_t} A_t \alpha L_t^{\alpha-1} = \frac{W_t}{P_t} + \Psi (1 + \beta) L_t - \Psi L_{t-1} - \Psi \beta E_t L_{t+1} \tag{6}$$

2.2.2 Wholesale Sector

Firms in the wholesale sector take the intermediate good and transform it into the differentiated good $Y_{i,t}$. They sell the good to the final retail sector under monopolistic competition. We assume Calvo-staggering, which means that in any period a firm can reset its price only with probability $1-\theta$. Once a firm can reset its price it will choose the price:

$$P_{i,t} = \left(\frac{\varepsilon}{\varepsilon-1}\right) \frac{E_t \sum_{j=0}^{\infty} (\theta\beta)^j \left[P_{t+j}^{\varepsilon} Y_{t+j} \frac{P_{z,t+j}}{P_{t+j}}\right]}{E_t \sum_{j=0}^{\infty} (\theta\beta)^j \left[P_{t+j}^{\varepsilon-1} Y_{t+j}\right]} \tag{7}$$

to maximize its profits.

2.2.3 Final Retail Sector

The final retailer operates in a competitive market and buys differentiated wholesale goods to arrange them into a representative basket, producing the final consumption bundle Y, according to

$$Y_t = \left(\int Y_{i,t}^{\frac{\varepsilon-1}{\varepsilon}} di\right)^{\frac{\varepsilon}{\varepsilon-1}} \tag{8}$$

which delivers the standard price index $P_t = \left(\int P_{i,t}^{1-\varepsilon} di\right)^{\frac{1}{1-\varepsilon}}$ from the cost minimization problem of the firm.

3 Simulations

The model is calibrated in a standard way, the probability of a wholesale firm to reset its price is 0.25, the annual interest rate is 4%, the elasticity of substitution among intermediate goods is 10 and the elasticities of the utility function are $\sigma = 1$, $\varphi = 1$ and $\nu = 1$.

Proposition 1 *Output adjustment:*
i)For a temporary and a permanent money growth shock, the higher the employment adjustment costs, (a) the lower is the initial output adjustment and (b) the higher is output persistence.
ii) The overshooting of output after a permanent money growth shock vanishes if labor adjustment costs are high enough.
iii) In case of an autocorrelated temporary money growth shock, labor adjustment costs can lead to a hump-shaped response in output.

Fig. 1 graphically illustrates part i) and ii) of proposition 1 - the left-hand panel shows the output response after a one-period increase in the money growth rate while the right-hand panel shows the reaction to a permanent increase in the money growth rate. In the case of zero-adjustment costs, there is a large adjustment in the initial period but output drops very quickly after the shock

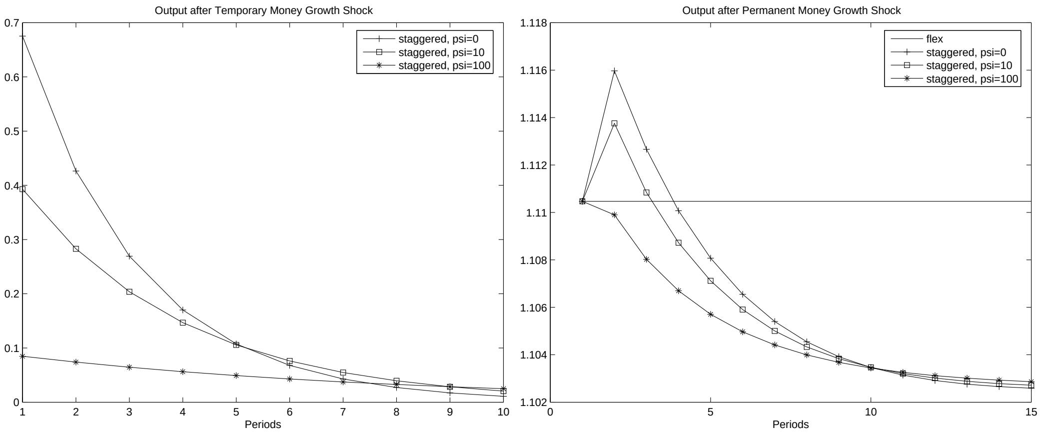

Figure 1: Output-response

has vanished. By contrast, when adjustment costs are high, the initial increase is very small but it is very persistent so that output in the economy is highest from period 9 onwards, while it was lowest up to period 7 (compared to the regimes with lower adjustment costs). The intuition for the results is straight-forward: Costs of adjusting output lead to smoothing of output.

The persistence created by labor adjustment costs can even be so large that the output response after a temporary growth shock with autocorrelation shows a hump shape. This is illustrated in fig. 2, showing the output-response after a money growth shock with an autocorrelation coefficient of 0.8.

Proposition 2 *Inflation adjustment: For temporary and permanent money growth shocks, the greater are the labor market adjustment costs, (a) the greater is the adjustment of inflation in the first period and (b) the higher is inflation persistence.*

For an illustration see fig. 3, showing the impulse response of inflation after a temporary money growth shock in the left-hand panel and the transition from a steady state with zero inflation to a steady state with positive inflation in the right-hand panel. In both cases the initial adjustment is higher, the larger adjustment costs are. This initial jump in inflation is driven by the fact that adjustment costs are reflected in the consumer price. As already seen in fig. 1, by far the largest adjustment is taking place in the first period. This is adjustment is costly and therefore inflation jumps up immediately.

After the first period only small adjustments take place. Naturally, these further adjustments are smaller, the higher adjustment costs are but this also implies that inflation is more persistent in subsequent periods. This last point is illustrated more clearly in fig. 4 which shows inflation for periods 8 to 20.

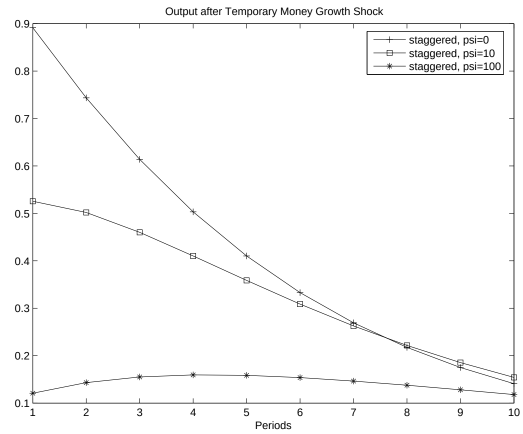

Figure 2: Hump-shaped Output-response

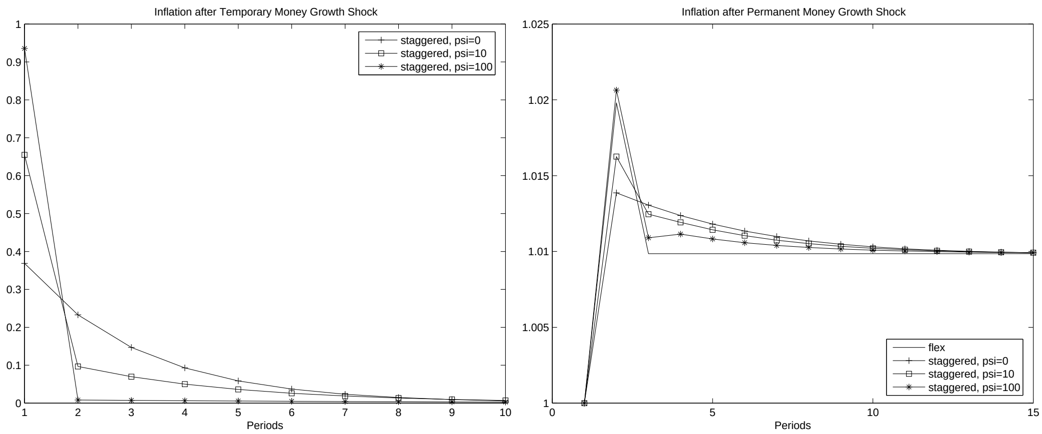

Figure 3: Inflation-response

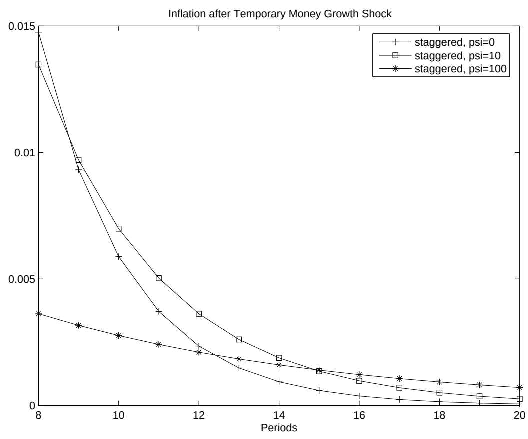

Figure 4: Inflation-response, periods 8-20

From this figure it becomes very clear, that inflation drops much faster in the absence of adjustment costs.

Proposition 3 *Labor adjustment costs and flexible prices: For a temporary money growth shock, the greater is the labor market adjustment cost, the closer the inflation path and the output-response fit to their response under flexible prices.*

Again refer to fig. 1 and fig. 3 and note that in the absence of labor adjustment costs and price rigidities, a temporary shock would be solely absorbed by price-changes. Inflation surges upwards for one period, while output does not move at all. Something very similar happens when there is price-staggering, but very high labor adjustment costs. The higher these costs are, the lower the adjustment the output, thus coming closer to the result under flexible prices. Although the adjustments become smaller and smaller, they also become more expansive and thus the jump in inflation comes closer and closer to flex-price case.

Note that the same is not true after a permanent money-growth shock. This is due to the fact, that a permanent change in the inflation rate implies a shift in steady states and thus even under flexible prices a change in employment and output takes place. The jump in inflation can even be bigger under price-staggering (compared to flexible prices),[2] namely in those cases where the adjustment costs prohibit the overshooting of output.

[2]See fig. 3 where the jump in inflation for the economy with high adjustment costs is even higher than the one in the flex-price case.

4 Conclusion

In a very simple framework we are able to demonstrate some interesting implications of labor market adjustment costs. In response to a money shock, the initial movement in output is dampened but persistence in increased. In contrast, for inflation the initial movement is increased but again persistence is increased. Another interesting feature of the model with quadratic labor adjustment costs is, that it moves the inflation dynamics of the staggering model closer to the dynamics of the model with flexible prices.

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