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Endogenous markups in the new Keynesian model: Implications for inflation–output trade-off and welfare

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ABSTRACT

This paper extends the standard new Keynesian (NK) model by using the endogenous markup setting a la Kimball (1995). In this setting, consumers' price elasticity of demand for a good is increasing in the good's relative price level, which affects the desired price markup of firms. In the literature, this setting is mainly used to improve the NK models in matching sluggishness of prices in the data. Our paper analyzes the monetary policy implications of the model. It is shown that unlike the cases of real wage rigidity and exogenous markup shocks, the endogenous markup setting does not improve the NK models in generating the inflation–output trade-off. It is also discussed that the optimal monetary policy in this environment is to target the flexible price equilibrium.

1. Introduction

A well-known result in the literature is that the standard NK model with nominal rigidities is unable to create the inflation–output trade-off faced by the central banks. As an illustration of this, let y_t^n represent the potential output under flexible prices, y_t represent the actual output in the presence of a fraction of firms with fixed prices, and $\tilde{y}_t = y_t - y_t^n$ is the output gap. Using these definitions, the following new Keynesian Phillips Curve (NKPC) equation

$$\pi_t = \beta E_t\{\pi_{t+1}\} + \kappa\tilde{y}_t \tag{1}$$

indicates that stabilizing the output gap leads to the stabilization of inflation, called the divine coincidence by Blanchard and Galí (2007).[1] A common way of obtaining inflation–output trade-off from NK models is to modify Eq. (1) by adding a cost push shock (exogenous changes in price or wage markups; Clarida et al., 1999) as follows:

$$\pi_t = \beta E_t\{\pi_{t+1}\} + \kappa\tilde{y}_t + u_t. \tag{2}$$

According to (2), a positive cost push shock raises current inflation, unless the level of output is reduced via contractionary monetary policies. As a result, the divine coincidence no longer holds.[2] The weak side of this approach is that the cost push shocks are exogenous. In an attempt to obtain inflation–output policy trade-off in response to more conventional shocks, Blanchard and Galí (2007) use a model with real wage rigidity, and Divino (2009) uses an open economy model.[3] Our paper, on the other hand, uses a real price rigidity, the endogenous markup setting, and asks whether this setting can generate inflation–output trade-off from NK models. The paper then investigates the optimal monetary policy under this setting.

A real price rigidity is a source that makes firms unwilling to change their relative prices. The need for such rigidities stems from the fact that the monetary non-neutralities cannot be fully explained by nominal rigidities of simple NK models.[4] With regard to the theoretical ways of obtaining real price rigidities, Rotemberg and Woodford (1992) use strategic pricing decisions between colluding firms, Galí (1994) uses a

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[1] In the AS–AD (aggregate demand–aggregate supply) framework, the divine coincidence can be described as the ability of the monetary authority to keep inflation constant and output equal to its natural level by counteracting to the changes in AD and LRAS (long-run aggregate supply) curves.

[2] In the AS–AD framework, cost push shock is a shift in the SRAS (short-run aggregate supply) curve. Or, put it differently, it is a shock to the Phillips curve that does not change the potential output. In response, monetary authority can stabilize either the price or the output level.

[3] Blanchard and Galí (2007) show that under the real wage rigidity—i.e. the sluggish adjustment of real wages for a fraction of workers at each point in time—the difference between natural rate of output and first best output—that occurs when there is no market imperfection or distortion such as nonzero markups—is not constant. Therefore, stabilizing the output gap $(y_t - y_t^n)$ is no longer equal to stabilizing the welfare relevant output gap $(y_t - y_t^{fb})$ and is no longer desirable from the welfare point of view. Divino (2009) offers a model in which both foreign and domestic demand shocks increase the real marginal cost of production, which makes the same effect with the exogenous cost push shocks in (2).

[4] Ball and Romer (1990) is the first study emphasizing that real rigidities have a crucial role in explaining nominal rigidities and non-neutrality of money. Christiano et al. (1999) and Romer and Romer (2004) provide a more recent discussion on monetary non-neutralities. Klenow and Kryvtsov (2008) supply micro empirical findings indicating that nominal rigidities based on the frequency of firms' price changes are not enough to explain price sluggishness in the data.

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setting in which the elasticity of substitution across goods in consumption to differ from that in production, Altig et al. (2011) use short run marginal cost curve of firms that is increasing in its own output in the presence of firm-specific capital. Importance of these studies arises from the fact that all of them improve the fit between a theoretical model and the real data. Yet, probably the most common way of obtaining real price rigidity in the monetarist models is the endogenous markup setting of Kimball (1995). This model, instead of using the constant elasticity of demand assumption of Dixit and Stiglitz (1977), assumes increasing price elasticity of demand so that the desired markups of firms are decreasing in their relative prices. For instance, when a negative supply shock hits the economy, the firms that are able to increase their prices will be confronted with higher elasticity of demand, leaving them with less incentive to increase their prices. Likewise, at the time of a positive supply shock, the firms that are able to lower their prices will be confronted with lower elasticity of demand, leaving them with less incentive to reduce their prices. Consequently, the change in prices is lower, and as a result, the change in output gap is higher in this setting compared to the case with constant elasticity of demand assumption. In this paper we analyze if this countercyclicality between prices and output gap changes the implications of the standard NK model for the inflation–output policy trade-off. Since strategic interactions between the pricing decisions of the firms are used to enhance NK models towards a more realistic picture of the world markets, we also study the optimal monetary policy implications of the model. In this regard, Blanchard and Galí (2007) note that " Rotemberg and Woodford (1992, 1996) *restricted their analysis to the real implications of endogenous markups, without exploring their consequences for inflation and monetary policy in the presence of nominal frictions*". Hence, the aim of our paper is to fill this gap in the literature.

The method we follow in this study is to incorporate the endogenous markup setting into the standard new Keynesian framework and then use it together with the same economic model of Blanchard and Galí (2007). The results show that the endogenous markup setting does not lead to the inflation output trade-off but only creates a real rigidity in prices that results in lower volatility in inflation and higher volatility in output gap when compared to the case with constant markups. With regard to the optimal monetary policy in this environment, the results show that stabilizing inflation ensures not only stabilization of the output gap but also stabilization of the welfare relevant output gap, which is the discrepancy between the actual output and the first best level of output with zero markups. Therefore, the optimal monetary policy is to target the flexible price level of output and zero inflation.

The rest of the paper is organized as follows. Section 2 explains the model and analyzes its implications for the inflation–output trade-off of central banks. Section 3 investigates the optimal monetary policy in this environment. Section 4 discusses the results and Section 5 concludes.

2. The model

We borrow the baseline model from Blanchard and Galí (2007) and extend it with endogenous markup setting.

2.1. Consumers

An infinitely living representative consumer seeks to maximize the expected value of his/her discounted future utilities

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, N_t)$$

where the utility function is given by

$$U(C_t, N_t) = \log(C_t) - \exp\{\xi\} \frac{N_t^{1+\phi}}{1+\phi}.$$

Here, β is the discount factor for future utility, C is composite consumption—defined below—,N is employment, ϕ is the inverse of the elasticity of labor supply with respect, ξ is a preference parameter between consumption and leisure. This utility function is subject to the following sequence of budget constraints

$$P_t C_t + Q_t B_t \leq B_{t-1} + W_t N_t + T_t,$$

where P is the aggregate price index for consumption goods, B represent purchases of one-period bonds, Q is the bond price, W is the nominal wages and T is a lump-sum component of income.

Under the assumption of perfect competition in the labor market, the above-defined consumer problem can be used to obtain the following intratemporal optimality condition between the real wages and the marginal rate of substitution of leisure for consumption

$$MRS = -\frac{U_n}{U_c} = \frac{\exp\{\xi\} N^{\phi}}{1/C} = \frac{W}{P} \quad (\text{in logs}: \quad mrs = w = c + \phi n + \xi), \quad (3)$$

and also the following intertemporal optimality condition between saving and consumption

$$Q_t = \beta E_t \left\{ \frac{U_{c,t+1}}{U_{c,t}} \frac{P_t}{P_{t+1}} \right\}.$$

2.1.1. The consumption aggregate and the endogenous markup setup

The consumption aggregate, C, is defined as (time and firm specific subscripts are suppressed unless they are necessary)

$$\int_0^1 \psi\left(\frac{C_i}{C}\right) di = 1, \quad (4)$$

where $\psi(\rho_i)$ satisfies $\psi(1) = 1, \psi'(\rho_i) > 0, \psi''(\rho_i) < 0$ for all $\rho_i = C_i/C \geq 0$, where ρ_i is the share of good i in the consumption basket (this share, in the case of a representative consumer model of ours, is also equal to the market share of the firm producing that good). Note that when $\psi(\rho) = (\rho)^{(\epsilon-1)/\epsilon}$, so that $\psi(C_i/C) = (C_i/C)^{(\epsilon-1)/\epsilon}$, the consumption function in (4) results in

$$C = \left(\int_0^1 C_i^{(\epsilon-1)/\epsilon} di \right)^{\epsilon/(\epsilon-1)},$$

which is the Dixit–Stiglitz type consumption aggregator that assumes constant elasticity of substitution (ϵ) between different goods. The specification in (4), on the other hand, follows Kimball's (1995) approach and uses consumers' price elasticity of demand for a good that is increasing in its price level. To derive the formula for this elasticity, we start with the cost minimization problem of the consumer, which can be written as follows

$$\min \int_0^1 P_i Y_i di \;\; s.t. \;\; 1 = \int_0^1 \psi\left(\frac{C_i}{C}\right) di.$$

In this setup, the goods are non-storable and are consumed within their production period. In a closed economy environment, this assumption implies $C = Y$. Using this equality, the solution of the above