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Policy trade-off in the long run: A new Keynesian model with technological change and money growth

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ABSTRACT

In this study, we introduce a constant rate of technological change and money growth into the standard new Keynesian model, in which both prices and nominal wages are supposed to be sticky. Using such a model, we examine whether a policy trade-off exists between curbing inflation and stabilizing the welfare-relevant output gap in the steady state. If we take only price stickiness into consideration, a policy trade-off does not occur. However, if both nominal wage stickiness and price stickiness are taken into consideration, a policy trade-off occurs.

1. Introduction

In recent years, many studies have been conducted on the properties of the New Keynesian (NK) model, in which prices and nominal wages are supposed to be sticky.[1] Generally, in the NK models, three output levels are defined as follows:

- First-best level: The goods (labor) market is perfectly competitive and prices (nominal wages) are perfectly flexible.
- Second-best level: The goods (labor) market is monopolistically competitive and prices (nominal wages) are perfectly flexible.
- Actual level: The goods (labor) market is monopolistically competitive and prices (nominal wages) are sticky.

The output gap is defined as the gap between the second-best level and the actual level, and the welfare-relevant output gap is defined as the gap between the first-best level and the actual level.

The relationship between the output gap (welfare-relevant output gap) and the inflation rate has been examined in the NK model. In the standard NK model, in which only prices are supposed to be sticky, there is no trade-off between stabilizing the output gap (welfare-relevant output gap) and the inflation rate.

Erceg et al. (2000) propose an NK model in which nominal wage stickiness and price stickiness are introduced, and show that a trade-off occurs in three variables: the output gap, the price inflation rate, and the wage inflation rate.

In addition, Blanchard and Galí (2007) regard the absence of a trade-off between stabilizing the welfare-relevant output gap and the inflation rate in the standard NK model as unrealistic because it does not fit our experience, and call it a "divine coincidence." They show that the divine coincidence can be eliminated by introducing real wage rigidities to the model.[2] In the standard NK model, the gap between first- and second-best levels remains constant when there is a technology shock, but in Blanchard and Galí's (2007) model, the gap can fluctuate, and therefore trade-off occurs.

These studies examine whether a policy trade-off occurs when a temporary technology shock occurs. In this study, we develop an argument about the policy trade-off in the long run. That is, we introduce a constant rate of productivity growth (technological change) and money growth to the NK model,[3] and analyze whether the authority can stabilize the welfare-relevant output gap and inflation rate simultaneously in the steady state, when a change occurs in the technological change rate.

First, we consider the case where prices are sticky but nominal wages are not. Next, we consider the case where both prices and nominal wages are sticky. Whether or not the nominal wage stickiness is taken into consideration will make a huge difference in the result.

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[1] For details of the NK model, see Woodford (2003) and Galí (2008).

[2] Fujiwara (2007) also shows that the divine coincidence can be eliminated by introducing a mechanism of endogenous entry of firms into the NK model.

[3] Christiano et al. (2003) also propose an NK model that introduces a constant rate of productivity growth.

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Our model does not introduce real imperfections such as real wage rigidities, unlike in Blanchard and Galí (2007). Hence, the gap between first- and second-best levels remains constant when a change occurs in the technological change rate. In this respect, our model is closer to Erceg et al.'s (2000) model than to Blanchard and Galí's (2007).

Despite this, we do not consider the stabilization of the output gap as the central bank's target, but rather the stabilization of the welfare-relevant output gap. This is because in our model, the central bank can achieve the first-best output level by conducting a proper policy.[4] In such a case, the central bank should set its target to stabilize the welfare-relevant output gap.

2. Model

We assume an economy in which there are many final-goods-producing firms under perfect competition, many intermediate-goods-producing firms under monopolistic competition, and many households under monopolistic competition in the labor market.

2.1. Final-goods-producing firms

There exist differentiated intermediate goods $y_{i,t}$ ($i \in [0, 1]$). A final-goods-producing firm aggregates them according to the Dixit–Stiglitz function as follows:[5]

$$y_t = \left[\int_0^1 y_{i,t}^{\frac{\phi-1}{\phi}} di\right]^{\frac{\phi}{\phi-1}}, \tag{1}$$

where y_t is the output of final goods and ϕ (>1) denotes the elasticity of the substitution of intermediate goods.

The cost minimization of a final-goods-producing firm gives the demand function for intermediate good i as follows:

$$y_{i,t} = \left(\frac{p_{i,t}}{p_t}\right)^{-\phi} y_t, \tag{2}$$

where $p_{i,t}$ is the price of intermediate good i and p_t is the price level.[6]

2.2. Intermediate-goods-producing firms' intratemporal optimization

There exists differentiated labor $l_{j,t}$ ($j \in [0, 1]$). An intermediate-goods-producing firm aggregates labor according to the Dixit–Stiglitz function as follows:

$$l_t = \left[\int_0^1 l_{j,t}^{\frac{\eta-1}{\eta}} dj\right]^{\frac{\eta}{\eta-1}}, \tag{3}$$

where l_t is the total figure of employment and η (>1) denotes the elasticity of the substitution of labor.

The cost minimization of an intermediate-goods-producing firm gives the demand function for labor j as follows:

$$l_{j,t} = \left(\frac{W_{j,t}}{W_t}\right)^{-\eta} l_t, \tag{4}$$

where $W_{j,t}$ is the nominal wage of labor j and W_t is the nominal wage level in the economy.

2.3. Intermediate-goods-producing firms' intertemporal optimization

We represent the production function of an intermediate-goods-producing firm i as

$$y_{i,t} = z_t l_{i,t}, \tag{5}$$

[4] In other words, the central bank can bring the actual level closer to the first-best level than to the second-best level. This means that the output gap may become negative. Consequently, the analysis becomes quite different, depending on whether we use the output gap or the welfare-relevant output gap as the gap to be stabilized. In the main text, we focus on the latter case. The former case is examined in Appendix A.2.

[5] See Dixit and Stiglitz (1977).

[6] See Blanchard and Kiyotaki (1987) for details.