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Optimal monetary policy with international trade in intermediate inputs



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ABSTRACT

This paper examines optimal monetary policy in a two-country New Keynesian model with international trade in intermediate inputs. We derive the loss function of a cooperative monetary policymaker and find that the optimal monetary policy must target intermediate-goods price inflation rates, final-goods price inflation rates, final-goods output gaps, and relative-price gaps. We use the welfare loss under the optimal monetary policy as a benchmark to evaluate the welfare implications of three Taylor-type monetary policy rules. A main finding is that the degree of price stickiness at the stage of intermediate-goods production is a key factor to determine which policy rule should be followed. Specifically, when the degree of price stickiness at the stage of intermediate-goods production is high, the policymaker should follow intermediate-goods PPI-based Taylor rule, whereas CPI-based Taylor rule should be followed when the degree of price stickiness at the stage of intermediate-goods production is intermediate or low.

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1. Introduction

The global economy is increasingly integrated by vertical production and trade,¹ more and more countries are trading not only in final consumption goods but also a large quantity of intermediate

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¹ Naturally, vertical production and trade involves international trade in intermediate inputs.

inputs (Bridgman, 2012; Feenstra, 1998; Hummels et al., 1998, 2001; Johnson, 2014; Yi, 2003, 2010).² A natural question arises: what can we say about the effect of international trade in intermediate inputs on the design of optimal monetary policy? The question is important both for policy practice and academic research. However, the research on the point is scant.³ In fact, in Clarida et al. (2002), a canonical article using the New Keynesian framework to analyze open-economy monetary policy, the authors believe that allowing trade in intermediate inputs is particularly interesting, as it introduces an additional effect of openness on marginal cost.⁴ Therefore, they recommend this topic to be further researched. In this paper, we fill the gap and examine the role of international trade in intermediate inputs in shaping optimal monetary policy in open economies theoretically. For the sake of practicality, we also examine what kind of rule is the best choice for monetary policymakers in the sense that the welfare attained by following the rule is the nearest approximation to that attained by following the optimal monetary policy.

Building on Clarida et al. (2002), Gali and Monacelli (2005), and Engel (2011), we introduce vertical production and trade into an open-economy monetary model with nominal rigidities to examine optimal monetary policy.⁵ In our model, there are two stages of production and trade. We take the home country as an example to illustrate vertical production and trade. At the stage of final-goods production, a continuum of firms use home and foreign intermediate goods to produce differentiated goods, which then are consumed by home and foreign households. At the stage of intermediate-goods production, a continuum of firms use domestic labor to produce differentiated goods, which then are used as inputs by home and foreign final-goods producers. At each stage of production, the prices are set in a staggered fashion, as in Calvo (1983). Thus, there are two natural candidates for PPI: final-goods PPI and intermediate-goods PPI. As usual, the price index facing households is CPI. As will be evident, the distinction between various price indexes is important to analyze the macroeconomic dynamics and the relative welfare ranking of three Taylor-type rules. In Huang and Liu (2001, 2005, 2006, 2007), the degree of price stickiness is identical at both stages of production. However, substantial empirical studies find that the degree of price stickiness at the different stages of production is different,⁶ thus we depart from Huang and Liu (2001, 2005, 2006, 2007) and assume different degrees of price stickiness at both stages of production.⁷ In addition, different from Devereux and Engel (2003) and Engel (2011), we set aside the empirically relevant case of local-currency pricing (LCP) and assume that firms at both stages set prices in their own currency (producer-currency pricing or PCP).

As predicted by Clarida et al. (2002), the introduction of international trade in intermediate inputs indeed results in an additional effect of openness on marginal cost. In Clarida et al. (2002) and Engel (2011), the real marginal cost depends on home and foreign output gaps. In our model, the real marginal costs at both stages of production are determined not only by home and foreign output gaps but also by home and foreign relative-price gaps. In addition, labor demands in both countries are

² In the field of international trade, the literature on vertical production and trade is voluminous; we just mentioned some prominent examples. See Huang and Liu (2007) for many relevant references.

³ As far as we know, Obstfeld (2001), Devereux and Engel (2007), Shi and Xu (2007), and Wang and Zou (2015) are several exceptions. However, these models assume that prices are set one period in advance. As a comparison, we consider Calvo-type staggered price-setting, which allows for richer dynamics. In addition, staggered price setting leads to relative price distortions and implies a cost from inflation, which is absent from models in which all prices are set one period in advance.

⁴ As defined in Monacelli (2013), it is production openness.

⁵ Within the limit of our knowledge, Huang and Liu (2001) first introduce vertical production chains in a closed economy with nominal rigidities to discuss aggregate dynamics following a monetary shock. Thereafter, in Huang and Liu (2005), they examine optimal monetary policy in a closed economy with two-stage production structure, and find that a simple monetary policy rule which requires the interest rate to respond to CPI inflation and PPI inflation will result in a welfare level close to the optimum; in Huang and Liu (2006), they consider vertical production and trade in an open economy to study international transmissions and welfare implications of monetary shocks; in Huang and Liu (2007), they introduce vertical production and trade in an open economy to study international business cycle.

⁶ Murphy et al. (1989) and Clark (1999) find that for the aggregate US PPI, intermediate goods, raw materials in particular, are much more volatile than final goods. Based on the data at the micro level, Bils and Klenow (2004) estimate that the prices of raw goods are 3–4 times more volatile than processed goods. Using the data underlying the US CPI and PPI, Nakamura and Steinsson (2008) estimate that final-goods prices are stickier than intermediate goods.

⁷ On this point, we follow Devereux and Engel (2007). But, in their model, prices are set one period in advance.

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