J. Japanese Int. Economies 24 (2010) 259–281

Contents lists available at ScienceDirect

Journal of The Japanese and International Economies

journal homepage: www.elsevier.com/locate/jjie

Inventories and real rigidities in New Keynesian business cycle models ☆

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ARTICLE INFO

Article history:
Received 1 December 2008
Revised 23 July 2009
Available online 23 December 2009

JEL classifications:
E31
F12

Keywords:
Inventories
Calvo pricing
Real rigidities

ABSTRACT

Kryvtsov, Oleksiy, and Midrigan, Virgiliu—Inventories and real rigidities in New Keynesian business cycle models

Kryvtsov and Midrigan (2008) study the behavior of inventories in an economy with menu costs, fixed ordering costs and the possibility of stockouts. This paper extends their analysis to a richer setting that is capable of more closely accounting for the dynamics of the US business cycle. We find that the original conclusion survives in this setting: namely, the model requires an elasticity of real marginal cost to output approximately equal to the inverse intertemporal elasticity of substitution in consumption in order to account for the countercyclicality of the aggregate inventory-to-sales ratio in the data. *J. Japanese Int. Economies* **24** (2) (2010) 259–281. Bank of Canada, Canada; New York University, USA.

1. Introduction

Real rigidities are factors that dampen the responsiveness of a firm's desired price to a monetary disturbance. Recent work with New Keynesian sticky price models[1] has argued that real rigidites are a key ingredient necessary to reconcile the apparently slow response of prices to nominal disturbances

☆ The views expressed in this paper are those of the authors. No responsibility for them should be attributed to the Bank of Canada. We thank participants at the TRIO Conference in Tokyo, December 2008, as well as Jordi Gali, for numerous comments and suggestions. We also thank Thomas Carter for excellent research assistance.

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[1] Christiano et al. (2005) and Smets and Wouters (2007) are two well-known examples.

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doi:10.1016/j.jjie.2009.12.004

at the aggregate level[2] with the fairly rapid rate at which individual price setters update their nominal prices.[3]

Models with real rigidities can be broadly categorized into two classes.[4] The first class of models is characterized by assumptions on preferences or technology that make it costly for firms to charge prices that are too different from those of their competitors. Those firms that choose to reset their nominal prices in time of a monetary disturbance thus choose to not fully respond to this disturbance in order to avoid the losses associated with deviating from their competitor's prices.[5] Thus even though prices change frequently in nominal terms, they initially respond little to the monetary injection because of the pricing complementarity arising from non-constant demand elasticities and/or upward sloping marginal cost at the individual producer's level. Although measuring price elasticities or scale returns in the production function is difficult in practice, recent work using micro-price data has argued that simple versions of models that feature this first class of real rigidities are difficult to reconcile with the observed dispersion in relative prices in very narrowly defined product groups within outlets.[6]

In this paper, we focus on a second class of real rigidities that lower the elasticity of economy-wide real marginal cost to output. In this second class of models, assumptions on preferences, the degree to which factor utilization can vary, or frictions in the labor market or in the market for intermediate inputs generate slow adjustment of (nominal) factor prices to a monetary shock. As a result, real marginal costs of production respond little to a monetary disturbance, thus amplifying real effect of the shock.[7]

Notice that this second class of real rigidities is, in effect, a set of assumptions on aggregate quantities, and in particular, on the firms' (collective) ability to hire additional labor during booms (or hoard labor during recessions), purchase intermediate inputs, and vary capital's work-week. Even when real rigidities take the form of sticky wages or intermediate good's prices, as in much of the recent work, an important assumption made is that these sticky prices are allocative and quantities are demand-determined. These assumptions, that quantities can be relatively costlessly varied during the cycle, and that factor adjustment costs are small, are clearly other key ingredients that are necessary to lower the elasticity of economy-wide marginal cost of production to output.

The discussion above suggests that inferring the elasticity of real marginal cost to output, a measure of the strength of real rigidities in this second class of models, is difficult in practice. In particular, the researcher must be able to measure the relative importance of factor adjustment costs, the degree to which factor prices are allocative, the cost of varying the work-week of capital and labor, as well as the degree of frictions in the labor and intermediate goods market.

Bils and Kahn (2000) show that the behavior of inventories over the cycle is informative about the cyclicality of costs. In Kryvtsov and Midrigan (2008) we use Bils and Kahn's insights to gauge the implications of models of the second class of real rigidities for the behavior of inventories. If the marginal cost of acquiring and holding inventories is indeed lower in times of monetary expansions, we should see this lower cost reflected not only in a slow adjustment of prices to a monetary shock, but also in an increase in the firm's inventory holdings. In fact, models with inventories predict that a firm's price is proportional to its shadow valuation of its inventories. In turn, when the firm's cost of buying and holding inventories decreases (as it does in times of a monetary expansion), the firm purchases more inventories so as to equalize its shadow valuation of inventories to their marginal cost. Thus real rigidities of this second class must operate through inventories: an increase in the stock of inventories held by the firm is necessary for the shadow valuation of inventories (given concavity of the value function) to decrease and thus for the firm's real price (relative to the money stock) to fall. If the firm is unable to purchase more inventories, either because of the quantity restrictions by suppliers, or because of other costs of adjusting the stock of

[2] Christiano et al. (1999), Romer and Romer (2004), and Friedman (1968).

[3] Bils and Klenow (2004), Klenow and Kryvtsov (2008), and Nakamura and Steinsson (2008).

[4] Ball and Romer (1990).

[5] Kimball (1995), Eichenbaum and Fisher (2004), and Altig et al. (2004).

[6] Klenow and Willis (2006), Dotsey and King (2005), and Burstein and Hellwig (2007).

[7] Values of elasticities of real marginal cost to output in models with real rigidities include: 0.15 in Woodford (2003), 0.33 in Dotsey and King (2005), 0.34 in Smets and Wouters (2007). In Chari et al.'s (2000) model without real rigidities the elasticity is 2.25.