Journal of Economic Dynamics & Control 33 (2009) 538–553

Contents lists available at ScienceDirect

Journal of Economic Dynamics & Control

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

Sticky wages and sectoral labor comovement

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ARTICLE INFO

Article history:
Received 17 May 2006
Accepted 15 August 2008
Available online 2 September 2008

JEL classification:
E20
E32
O41
O42

Keywords:
Comovement
Business cycles
Sticky wages

ABSTRACT

A defining feature of business cycles is the comovement of inputs at the sectoral level with aggregate activity. Standard models cannot account for this phenomenon. This paper develops and estimates a two-sector dynamic general equilibrium model that can account for this key regularity. My model incorporates three shocks to the economy: monetary policy shocks, neutral technology shocks, and embodied technology shocks in the capital-producing sector. The estimated model is able to account for the response of the U.S. economy to all three shocks. Using this model, I argue that the key friction underlying sectoral comovement is rigidity in nominal wages.

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1. Introduction

Comovement refers to the fact that, empirically, the level of economic activity across different sectors of the economy tends to move in the same direction along the business cycle: When the economy is in a boom, the majority of sectors use more inputs (capital and labor) and produce more output.

This paper develops and estimates a two-sector dynamic general equilibrium model that can account for this key regularity. My model incorporates three shocks to the economy: neutral technology shocks in the consumption and investment goods sectors, embodied technology shocks in the capital-producing sector, and monetary policy shocks.

Nominal wage stickiness is the feature of the model that is crucial for obtaining comovement in response to technology shocks of either kind. Both consumption and investment increase in response to positive technology shocks. Households' desire to smooth consumption translates into a relative shift of demand from consumption to investment goods. Labor demand increases, but wage rigidities prevent the wage from fully adjusting. Firms in the consumption goods sector face an increase in demand and a (relatively small) increase in the wage rate. The first effect dominates and firms hire more workers.

Standard models cannot account for comovement in response to technology shocks. Both neutral and embodied technology shocks produce a countercyclical labor input for the consumption goods sector.

In standard real business cycle (RBC) models,[1] the nominal wage fully adjusts to the increase in labor demand. The effect of the higher wage offsets the increase in demand for consumption goods, and firms in the consumption goods sector hire

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[1] For an exposition of the standard RBC model see Hansen (1985) and Prescott (1986).

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doi:10.1016/j.jedc.2008.08.003

fewer workers. Economy-wide competitive factor markets imply that the capital-to-labor ratio is equated across sectors. Hence, capital is also reallocated to the investment goods sector in response to a positive technology shock. In other words, standard RBC models predict that inputs in the consumption goods sector comove *negatively* with inputs in the investment goods sector and with aggregate output.[2]

Monetary policy is the third source of fluctuations in the model. Monetary policy shocks generate an increase in economic activity in both sectors and would produce comovement even if wages were flexible. However, nominal wage rigidities play an important role in generating a persistent response of economic activity to monetary policy shocks.

A quantitative assessment of the role of sticky wages in generating comovement requires a rich model. My model incorporates frictions that are standard in the literature studying the effects of monetary policy.[3] The real side of the model incorporates investment adjustment costs, variable capital utilization, and habit formation preferences in consumption. Moreover, firms must borrow working capital to finance the wage bill. The model incorporates nominal price rigidities, in the form of sticky prices à la Calvo (1983).

The estimated model generates comovement of sectoral labor inputs in accordance with the data. Furthermore, my model is able to account for the response of the U.S. economy to all three shocks. The parameter estimates imply a plausible wage rigidity (3.7 quarters) and a modest degree of price stickiness. Estimates of the other parameters of the model, when comparable, and the model responses to neutral technology and monetary policy shocks are consistent with results in the literature.

Sticky wages deliver plausible empirical implications for my model by creating a countercyclical wedge between the real wage and the marginal rate of substitution between consumption and leisure. The existence of a 'wage markup' over the marginal rate of substitution between consumption and leisure has been extensively documented empirically (see Galí et al., 2007).[4] My model generates a wage markup whose cyclical component has properties similar to its empirical counterpart.

The following section presents comovement in the U.S. data, the counterfactual implications of standard business cycle models, and shows how sticky wages generate comovement. Section 3 describes the model economy in detail. Section 4 is devoted to the model estimation and to the analysis of the comovement properties of the estimated model. Section 5 concludes. An appendix provides details on the data used.

2. The comovement puzzle

Comovement is a defining feature of business fluctuations. According to Burns and Mitchell (1946, p. 3),

> a cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle,

a definition endorsed by Gordon (1986).[5] Lucas (1977), Long and Plosser (1983), and Christiano and Fitzgerald (1998) define business cycles in a similar way.[6]

In this section I document comovement of sectoral inputs and outputs with aggregate output at business cycle frequencies for U.S. data. I then illustrate why the standard RBC model implies negative comovement and how the inclusion of sticky wages solves the comovement puzzle.

2.1. Comovement in the U.S. data

Fig. 1 displays the cyclical components[7,8] of output, consumption, investment, and the corresponding labor inputs for the U.S. over the period 1964:Q1–2001:Q4.

Sectoral outputs (consumption and investment) and labor inputs comove with aggregate output. Table 1 reports correlations of sectoral outputs and labor inputs with aggregate output at business cycle frequencies (third column). The second column displays the standard deviations of sectoral outputs/inputs relative to the standard deviation of aggregate output. Consumption is half as volatile as output. Investment is 3.7 times more volatile than output. Both consumption and

[2] Despite using fewer resources, the consumption goods sector produces more output because of the increased productivity.

[3] See, for example, Christiano et al. (2005), Altig et al. (2002), and Smets and Wouters (2003, 2005). The last three papers also examine the effect of other shocks to the economy.

[4] See also Hall (1997) and Chari et al. (2007).

[5] The NBER Business Cycle Dating Committee (Hall et al., 2003), defines a recession as follows: 'A recession is a significant decline in activity spread across the economy, lasting more than a few months, visible in industrial production, employment, real income, and wholesale-retail sales.'

[6] Other authors, such as Schumpeter (1939, p. 200), Prescott (1986, p. 10) and Sargent (1987, p. 282), focus on the comovement of economy-wide variables in defining business fluctuations.

[7] See Christiano and Fitzgerald (1998) for a more disaggregated analysis of the comovement properties of the U.S. economy.

[8] The business cycle component is extracted using an HP_{1600} filter applied to the series in logs. See Appendix A for a description of the data used.

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