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Sectoral price rigidity and aggregate dynamics

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ABSTRACT

This paper studies the business cycle implications of sectoral heterogeneity in price rigidity using a highly disaggregated multi-sector model. The model is estimated by the Simulated Method of Moments using a mix of aggregate and sectoral U.S. data. The frequencies of price changes implied by our estimates are consistent with those reported in micro-based studies. We show that heterogeneity in price rigidity is the primary factor explaining the heterogeneity in the responses of sectoral output and inflation to a monetary policy shock. We also find that ignoring sectoral heterogeneity in price rigidity leads to the mismeasurement of the relative importance of aggregate and sector-specific shocks in aggregate and sectoral fluctuations.

1. Introduction

There is now abundant evidence from studies based on micro data that the frequency of price adjustments differs greatly across goods.[1] Accordingly, the last few years have witnessed the emergence of an important literature that extends standard sticky-price models by relaxing the assumption of identical price rigidity across firms and sectors. The findings from this literature highlight the importance of this source of heterogeneity in accounting for the behavior of aggregate output and inflation. For instance, Carvalho (2006), Nakamura and Steinsson (2010), Vavra (2010), and Dixon and Kara (2011) find that monetary policy shocks have larger and more persistent effects on aggregate output in a model with heterogeneous price rigidity than in a model with identical rigidity, holding constant the average frequency of price changes. Carvalho and Schwartzman (2008) show that similar effects carry over to a larger class of sticky price and sticky information models.[2] Álvarez and Burriel (2001) and Dixon and Kara (2010) find that allowing for a distribution of contract duration and for different types of price setting across firms increases aggregate inflation persistence, bringing it closer to what is observed in the data.[3]

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[1] See Bils and Klenow (2004), Klenow and Kryvtson (2008), Nakamura and Steinsson (2008), Gagnon (2009), and Eichenbaum et al. (2011) for final goods; and Carlton (1986) for intermediate goods.

[2] Also, see Carvalho and Nechio (2011) who find that heterogeneity in price rigidity induces larger and more persistent movements in the real exchange rate compared with identical price rigidity.

[3] On the other hand, Sheedy (2007) shows that adding heterogeneity in the frequency of price changes to an otherwise standard Calvo model reduces intrinsic inflation persistence. Kehoe and Midrigan (2010) build a New Keynesian model that distinguishes between temporary and regular price changes, and find that even if prices change frequently at the micro level, there is a significant degree of low-frequency price stickiness that induces stickiness at the

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While this literature provides useful insights on the role of heterogeneous price rigidity in understanding the responses of aggregate prices and quantities to monetary policy shocks, two important questions remain unanswered: (i) the extent to which heterogeneity in price rigidity accounts for differences in sectoral sensitivities to monetary policy shocks, and (ii) the implications of heterogeneity in price rigidity for the relative contribution of structural shocks to aggregate and sectoral fluctuations at business cycle frequencies. Addressing these questions requires a multi-sector model with a realistic production structure in terms of intersectoral linkages and multiple sources of sectoral heterogeneity, including sectoral productivity shocks. This paper aims to answer these questions using a highly disaggregated version of the multi-sector model developed by Bouakez et al. (2009). In that earlier paper, we were concerned with the role of input–output interactions in the transmission of monetary policy shocks and, for empirical purposes, focused on six broad sectors of the U.S. economy.[4] Since a fine level of disaggregation is essential to generate the cross-sectional variation needed to address the questions of interest, we estimate and analyze a 30-sector model of the US economy, where the sectors roughly correspond to the two-digit level of the Standard Industry Classification (SIC).

Production sectors in the model economy differ in price rigidity, factor intensities, and productivity shocks, and are interconnected through a roundabout production structure whereby they provide materials and investment inputs to each other following the actual Input–Output Matrix and Capital Flow Table of the U.S. economy. The model parameters are estimated by the Simulated Method of Moments (SMM) using a mix of sectoral and aggregate U.S. data.[5] Estimation results show that there is considerable heterogeneity in price rigidity across sectors, and that the hypothesis that price rigidity is the same in all sectors is strongly rejected by the data. Importantly, the frequencies of price changes implied by our estimates are generally consistent with micro-based estimates, and the price duration implied by our median estimate (2.4 quarters) is well within the range of durations reported in micro studies. The empirical success of standard sticky-price models generally hinges on assuming long price durations, ranging from 4 to 10 quarters, which are now considered implausible in light of the recent micro evidence on price stickiness.[6] Thus, a first important contribution of this study is to demonstrate that modeling explicitly sectoral heterogeneity can help reconcile New Keynesian models with the micro data on price rigidity.

Using the estimated model, we establish the following results. First, there is substantial heterogeneity in the responses of sectoral inflation and output to a monetary policy shock. In the case of sectoral inflation, this heterogeneity is primarily due to the heterogeneity in the degree of price rigidity, whereas the cross-sectional variation in sectoral output responses is both due to the heterogeneity in price rigidity and to whether or not the sectors produce capital goods. Capital-good sectors adjust their output by more than nondurable-goods sector and this is so regardless of whether their prices are flexible or rigid. This result reflects the sparsity of the actual Capital-Flow Table whereby the production of capital goods is concentrated in a small number of sectors.

Second, we show that modeling heterogeneity in price rigidity has crucial implications regarding the relative importance of the various shocks in accounting for aggregate fluctuations. Some studies have examined this question in the context of real business cycle (RBC) models with flexible prices and found that sector-specific shocks are an important source of aggregate volatility (e.g., Long and Plosser, 1983; Horvath, 1998, 2000; and Conley and Dupor, 2003). Other papers, such as those by Long and Plosser (1987) and Foester et al. (2011), have used factor models to show that aggregate shocks are the main drivers of aggregate fluctuations.[7] A benchmark version of our multi-sector model with identical price rigidity in all sectors attributes most (97%) of the unconditional variance of output to sectoral productivity shocks and less than 1% to the monetary policy shock, as in the RBC literature discussed above. However, allowing for heterogeneity in price rigidity across sectors overturns this prediction, attributing about 72% of the unconditional variance of output to aggregate shocks and only about 28% to sectoral shocks. Among the latter, oil shocks explain roughly 10% of output fluctuations, consistent with recent evidence reported by Lippi and Nobili (2012). It is worth emphasizing, however, that these results crucially depend on the remaining sources of sectoral heterogeneity being taken into account and modeled in a realistic manner. More specifically, counterfactual experiments reveal that versions of the model that assume identical processes for the sectoral shocks, identical consumption weights and production-function parameters across sectors, or a symmetric input–output table, largely overestimate the contribution of sectoral shocks to the variance of aggregate output. In particular, under a symmetric input–output table, the fraction of output variability accounted for by oil shocks rises from 10 to about 30%.

While heterogeneity in price rigidity downplays the role of sectoral shocks in aggregate fluctuations, it amplifies the relative importance of monetary policy shocks for aggregate output. The fraction of output variability attributed to these

(*footnote continued*)
aggregate level. Altissimo et al. (2009) argue that heterogeneity can increase inflation persistence due to the averaging of industry-specific inflation rates with different persistence levels.

[4] Other papers that study the role of input–output interactions include Carvalho (2006), Shamloo and Silverman (2010), Bouakez et al. (2011), and Carvalho and Lee (2011).

[5] In a closely related paper, Carvalho and Lee (2011) estimate a multisector model with heterogenous price setting across sectors, input–output production linkages, and sector-specific shocks. Compared with our work, the main objective of their paper is to account for the differential responses of prices to aggregate and sectoral shocks.

[6] See, among others, Gali and Gertler (1999), Kim (2000), Ireland (2001, 2003), Smets and Wouters (2003), Christiano et al. (2005), and Bouakez et al. (2005).

[7] Also, see Dupor (1999), who argues that under certain assumptions about the structure of the input–output matrix, the effects of sectoral shocks cancel each other out by the law of large numbers.