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The reset inflation puzzle and the heterogeneity in price stickiness ☆

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ABSTRACT

New Keynesian models have been criticised on the grounds that they require implausibly large price shocks to explain inflation. Bils et al. (2012) show that, while these shocks are needed to reduce the excessive inflation persistence generated by the models, they give rise to unrealistically volatile reset price inflation. This paper shows that introducing heterogeneity in price stickiness in the models overcomes these criticisms directed at them. The incorporation of heterogeneity in price stickiness reduces the need for large price shocks. With smaller price shocks, the new model comes close to matching the data on reset inflation.

1. Introduction

The New Keynesian Dynamic Stochastic General Equilibrium model developed by Smets and Wouters (2003, 2007), which is based on the model proposed by Christiano et al. (2005), has become a standard tool for monetary policy analysis. The model features several frictions such as sticky prices, sticky wages, habit formation in consumption, variable capital utilisation and strategic complementarities in price setting. Smets and Wouters (2007) (hereafter SW) show that such a richly specified micro-founded model fits the macroeconomic data such as GDP and inflation almost as well as large Bayesian VARs. Reflecting Smets and Wouters's success, an increasing number of central banks and other policy institutions have started to use the model for macroeconomic forecasting and policy analysis.

However, recent papers by Bils et al. (2012) (hereafter BKM) and Chari et al. (2009) (hereafter CKM) have criticised the SW model on the basis that the model can explain the behaviour of inflation only when assuming implausibly large exogenous price mark-up shocks. CKM note that this is a concern since these shocks are difficult to interpret. BKM show that these shocks make reset price inflation too volatile relative to the data. The reset price is the price chosen by firms that can change their price in the current period. It is different from the aggregate price level since the aggregate price level includes the prices of firms that do not change their prices in the current period. Reset price inflation is the rate of change of all reset prices. BKM's finding suggests that the model might not be consistent with firm-level pricing decisions. This suggestion is particularly important in the light of the findings of Levin et al. (2008), who establish that policy recommendations that

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arise from New Keynesian models are sensitive to the microeconomic structure of the model even when the models explain the macroeconomic data equally well.

BKM show that two features of the model that are commonly used to generate greater monetary non-neutrality are the reasons for the failure of the model. These features are price stickiness modelled using Calvo pricing and strategic complementarities in price setting, which take the form of kinked demand, as in Kimball (1995). Without price mark-up shocks, the model with these features generates too much persistence in inflation. To match the lower degree of inflation persistence in the data, the model assumes large and transitory price markup shocks. These shocks succeed in cutting the persistence in inflation but at the cost of creating variability in reset price inflation that is far above that seen in the data.

Strategic complementarities in price setting, as in Kimball (1995), mute the response of reset prices, since firms face an elasticity of demand that is increasing in their products' relative prices and, therefore, are reluctant to pass increases in marginal costs into their prices. Inflation in the model responds even more sluggishly than reset price inflation because each period only a fraction of firms are allowed to change prices. Moreover, in the model, the firms that adjust prices are chosen randomly, implying that in the model there is no "selection effect" as to which firms change their price. This means that a firm whose price is close to the desired price is as likely to change price as a firm whose price is far away from the desired price. This feature of the model further slows the response of prices to changes in reset prices.

This paper takes up the challenge put forward by BKM. To achieve this, I add heterogeneity in price stickiness to the model to make it consistent with an implication of the micro-evidence on prices (see Klenow and Malin, 2011 for a survey). Following Carvalho (2006), the heterogeneity in price stickiness is modelled according to the Multiple Calvo (MC) model in which there are many sectors, each with a different Calvo style contract. In the MC, firms are divided into sectors according to the probability of adjusting their prices. When all hazard rates in each sector are equal, the model gives the standard Calvo model with a single economy-wide hazard rate. For the purpose of this paper, the MC is an ideal model since it enables a clean comparison of the SW model with and without heterogeneity in price stickiness. I replace Calvo pricing in the SW model with the MC assumption, in which the share of each product sector is calibrated according to micro-evidence; estimate the resulting SW-MC model with Bayesian techniques using US data; and, finally, compare its empirical performance to the SW framework with Calvo pricing.

The findings reported in the paper suggest that adding heterogeneity in price stickiness to the SW model helps to overcome the two criticisms of the model. While the SW-MC model fits the macroeconomic data as well as the SW model, the variance of price mark-up shocks implied by the SW-MC is much smaller than that implied by the SW model. The SW-MC matches both the low degree of persistence in actual inflation and the low variability of reset price inflation relative to actual inflation. Importantly, this is true even though both models exhibit a similar degree of strategic complementarity in price setting.

These results can be understood in terms of the selection effect. Carvalho and Schwartzman (2014) analytically show that heterogeneity in price stickiness is associated with a smaller selection effect. A smaller selection effect means that fewer firms are chosen from sectors with lower hazard rates. This implies that MC firms that change their prices in a given period are disproportionately drawn from sectors with higher hazard rates. As a consequence, the price adjustment process is mainly driven by sectors with higher hazard rates. Since, with lower price stickiness, the average price levels in these sectors change more in response to temporary shocks, inflation in the SW-MC varies more than in the SW. This increased volatility of inflation reduces the need for highly volatile reset price inflation and, in turn, large price mark-up shocks in order for the model to match the volatility of actual inflation. My findings support the conclusion reached by Carvalho and Schwartzman (2014) that it is the degree of the selection effect that drives the properties of time-dependent models.[1]

The remainder of the paper is organised as follows. Section 2 presents the model. Section 3 presents Bayesian estimation results. Section 4 compares the empirical performance of the models (the SW-MC and the SW) at the macro level using different measures of relative fit. Section 5 discusses in detail what it is about SW-MC that explains the macroeconomic data as well as the SW but with smaller price mark-up shocks. Section 6 discusses the BKM critique of the New Keynesian models. Section 7 presents robustness exercises and, finally, Section 8 concludes the paper.[2]

2. Multiple Calvo (MC) in the SW model

The model presented here incorporates heterogeneity in price stickiness into the SW model using the MC approach. In this section, I will first present the equations describing price setting in the MC and then the remaining model equations, which are identical to a special case of the SW model with logarithmic consumption utility, no discounting and no indexation (price and wage). The first two assumptions (logarithmic consumption utility and no discounting) are made for simplicity but without significant loss of generality.[3] Following BKM, price and wage indexations are removed from the model to make it consistent with an implication of the microdata that prices and wages remain fixed for several months.

[1] Carvalho and Schwartzman (2014) also show that their finding holds in the sticky information model of Mankiw and Reis (2002).

[2] The Matlab/Dynare codes used to generate the results are available in an online appendix.

[3] Estimating the discounting parameter and the intertemporal elasticity of substitution does not change the results significantly. Perhaps this is not surprising as the estimates for these parameters are similar to the assumed values.