Reconciling microeconomic and macroeconomic estimates of price stickiness ☆

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ABSTRACT

This paper attempts to reconcile the high estimates of price stickiness from macroeconomic estimates of a New-Keynesian Phillips curve (NKPC) with the lower values obtained from surveys of firms' pricing behaviour. This microeconomic evidence also suggests that the frequency with which firms adjust their prices varies across sectors. Building on the insights of Carvalho (2006), we present Monte Carlo evidence that suggests that in the presence of this heterogeneity estimates of the NKPC obtained using conventional methods, such as GMM, are likely to considerably overstate the degree of aggregate price stickiness. Furthermore, if roundabout production is a characteristic of the economy the NKPC will falsely suggest that a sizeable fraction of prices are indexed to past inflation. These problems arise because of a type of misspecification and a lack of suitable instruments.

1. Introduction

The degree of price stickiness has a major influence on the behaviour of inflation and is an important determinant of the effects of monetary policy; all else equal, the stickier are prices, the larger is the response of economic activity to a monetary policy shock.

A common way of modelling price stickiness is to assume that the opportunity for firms to reset their prices in any particular period is a random event. The probability that they are unable to do so is known as the Calvo probability (Calvo, 1983), which provides a natural measure of the degree of price stickiness. Measures of the Calvo probability have been estimated using both macroeconomic and microeconomic data. The two approaches tend to deliver very different estimates of the degree of aggregate price stickiness.

One approach to making inferences about an economy-wide Calvo probability is to estimate a New-Keynesian Phillips Curve (NKPC) using aggregate data on inflation and either output or real marginal costs. When prices are stickier, larger changes in output are required to change the rate of inflation. In other words, the Calvo probability is inversely related to the slope of the Phillips Curve. We will refer to an estimate of the Calvo probability obtained from the NKPC as $\theta_{\text{NKPC}}^{\text{macro}}$;

typically this is estimated using quarterly data to be at least 0.75, which implies that the average duration between price changes is at least four quarters.[1]

A second approach is to use data from surveys of firms or microeconomic-level price data (for example, see Blinder et al., 1998). By measuring the average time that a price remains unchanged within a sector and taking a weighted average of these durations across sectors, it is possible to calculate an economy-wide average duration of prices. An aggregate measure of the Calvo probability can then be inferred from the average duration of prices, which we refer to as θ^{micro}. Microeconomic studies using the data from the Bureau of Labour Statistics suggest that prices remain fixed on average for between one to three quarters (Bils and Klenow, 2004; Klenow and Kryvtsov, 2008; Nakamura and Steinsson, 2008). This duration implies that at a quarterly frequency, θ^{micro} is around 0.5.

The microeconomic data also reveal that considerable heterogeneity exists in the frequency with which prices are reset across sectors – see Klenow and Kryvtsov (2008). We show that in the presence of this heterogeneity, aggregate estimates of the Calvo probability from microeconomic and macroeconomic studies should not be expected to be equal. Further, we derive an aggregate measure of the Calvo probability that should be obtained from the aggregate data and used in macroeconomic modelling when heterogeneity exists, which we label θ^{macro}_{theory}.

We show that θ^{macro}_{theory} is *lower* than θ^{micro}, whereas (as already noted) θ^{macro}_{NKPC} is typically much higher than θ^{micro}. We argue that θ^{macro}_{NKPC} is a poor estimator of θ^{macro}_{theory} due to econometric problems stemming from the heterogeneity in price stickiness evident in the microeconomic data.

The macroeconomic consequences of heterogeneity in the Calvo parameter were first studied in the paper by Carvalho (2006). Carvalho (2006) demonstrates that it "...leads monetary shocks to have larger and more persistent real effects than in identical-firm economies..." (p. 1) and that to match the impulse responses of the heterogeneous economy the Calvo parameter in an identical-firm economy needs to be increased threefold. Our paper complements his analysis. The introduction of heterogeneity raises the issue of how firms interact with each other. Distinct from Carvalho (2006), the approach that we adopt is to allow firms to use the output of all other firms as intermediate inputs, which is known as roundabout production (Basu, 1995). The aim of this paper is to examine the consequences of heterogeneity and roundabout production for estimates of the NKPC and the extent of price stickiness using conventional econometric methods. We show that in such an economy, estimates of the extent of price stickiness will be upwardly biased, in part due to the measure of real marginal costs that is typically used, namely labour's share of income, no longer being suitable.

As the standard NKPC is typically unable to capture the persistence evident in inflation, a lag of inflation is often included. This may be motivated by the possibility that some firms index their prices to past inflation instead of setting their prices optimally when they have the opportunity to reset prices (see, for example Galí and Gertler, 1999). However, Chari et al. (2009) argue that "...the problem with this backward indexation assumption is that it is counterfactual...evidence on price behaviour at the micro level strongly suggests that the backward price indexing assumption is greatly at odds with the data" (p. 262). Similarly Blanchard (2009) states that it is "...an assumption which, as far as I know, is simply factually wrong" (p. 25). The resulting Phillips curve is referred to as the hybrid NKPC; some estimates from estimating these equations imply that 80% of firms index their prices to past inflation (see Schorfheide, 2008). We show that a more realistic model with roundabout technology can generate the persistence in inflation evident in the data without resorting to ad hoc assumptions about the behaviour of prices. Further, if heterogeneity is also present, estimates of the hybrid NKPC will falsely suggest that the indexation of some prices exists when in reality there is none.

We also demonstrate that a standard New-Keynesian model without roundabout production or heterogeneity but with a high degree of price stickiness and indexation has similar inflation dynamics to a richer model with these features, although the dynamics of other variables are not necessarily captured as well.

We believe these results are of practical importance in at least two ways. Firstly, both in academia and central banks, Bayesian techniques are now often used to estimate DSGE models, motivated in part by the availability of microeconomic data as a source of prior information about key parameters. Our results, and those of Carvalho (2006), highlight the need for considerable care to be taken in mapping microeconomic evidence to macroeconomic parameters.[2] Secondly, while treating all firms as if they are identical obviously greatly simplifies macroeconomic modelling, this simplicity is likely to come at a cost. The parameters of such a NKPC may not be structural, but simply those that enable it to mimic the behaviour of aggregate inflation, limiting its potential applications. Essentially, the Lucas (1976) critique will apply, making these models unsuitable for the type of counterfactual policy analysis sometimes conducted in central banks.

In the next section, we review the relationship between estimates of the Calvo probability obtained using macroeconomic and microeconomic data. Section 3 briefly describes the model used to generate data for the econometric analysis presented in Section 4. The macroeconomic implications of those estimates are discussed in Section 5 and Section 6 concludes.

2. Comparisons of economy-wide Calvo probabilities

Macroeconomic estimates of price stickiness typically rely on the assumption that all firms have the opportunity to reset their prices with the same probability. We relax this assumption and show that, at least in theory, the macroeconomic esti-

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[1] For a range of values, see Dennis (2006) and Schorfheide (2008).

[2] Similar, and perhaps even more extreme, conclusions can be drawn from Rogerson and Wallenius (2009) with respect to labour supply elasticities.