



## The price puzzle revisited: Can the cost channel explain a rise in inflation after a monetary policy shock?

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### ABSTRACT

This paper explores whether the cost channel solves the price puzzle. We set-up a New Keynesian DSGE model and estimate it for the euro area by adopting a minimum distance approach. Our findings suggest that – under certain parameter restrictions which are not rejected by the data – the cost channel helps to generate an initial rise of inflation after a monetary contraction.

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## 1. Introduction

Vector autoregressive (VAR) models have become a popular tool for analyzing the effects of monetary policy on the aggregate economy. Despite the popularity, VAR models have been criticized as they occasionally display a controversial result, namely a rise in inflation – that prevails at least temporarily – after a monetary contraction. Sims (1992) originally commented on this phenomenon, which has been labeled the *price puzzle* (Eichenbaum, 1992).

In a VAR model, the presence of a price puzzle casts serious doubts on the possibility of properly identifying a monetary policy shock. Sims (1992) points out that central banks focus on a variety of variables useful for forecasting future inflation that are possibly neglected in the econometric specification, which implies that the unexpected part of a monetary policy shock is insufficiently measured. Consequently, the price puzzle should be mitigated once indicators of nascent inflation – such as commodity prices – are additionally accounted for (Sims, 1992; Leeper et al., 1996; Christiano et al., 1999).

In contrast, Barth and Ramey (2001) refer to the cost channel of monetary policy as an alternative explanation for an increase in inflation after a monetary tightening. The cost channel is operating alongside the interest rate channel – i.e. the standard aggregate demand channel – by stating that firms depend on credit to finance production, which means that their

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pricing decisions are directly related to credit conditions since marginal production costs are affected by interest rates. Accordingly, a shift of inflation in response to a monetary policy shock is not necessarily evidence for misspecification but follows from a worsening of credit conditions due to an increase in interest rates.<sup>1</sup>

This paper estimates a New Keynesian DSGE model for the euro area with the intention to explore whether the cost channel is capable to explain an initial rise in inflation after a monetary contraction. The model comprises three sectors, namely firms, households and banks, which are assumed to have some monopoly power over prices, wages and interest rates that are all set – as in Calvo (1983) – in a staggered way. The cost channel is accounted for by noting that firms require loans from banks as they are obliged to pre-finance their production, which implies that price setting, and hence inflation, is directly affected by interest rates. The relevance of the cost channel of monetary transmission is supported by micro-evidence for the euro area that underlines the relative importance of financial costs as a driving factor for price changes.<sup>2</sup>

As in Rotemberg and Woodford (1998) and Christiano et al. (2005), we estimate the DSGE model by using a minimum distance approach, which comprises two steps. In the first step, we specify a VAR model to generate empirical impulse responses to a monetary policy shock. Even though we explicitly incorporate commodity prices, inflation initially rises after a monetary contraction. In the second step, we estimate the parameters of the DSGE model by matching the theoretical impulse responses as closely as possible to the empirical impulse responses.

Our analysis is related to the study of Rabanal (2007), who explores the relevance of the cost channel in the US on the basis of a DSGE model with sticky prices and wages that is estimated by adopting a Bayesian procedure. His results suggest that the cost channel fails as an explanation for the price puzzle as he finds that “*the presence of the cost channel is not enough to generate a positive response of inflation after a monetary policy contraction*” (Rabanal, 2007, p. 919). An initial rise of inflation is stimulated by an increase in interest rates that enter marginal production costs, but the shift is completely offset by declines in the real wage and the real rental rate of capital, even when wages are set in a staggered way and capital utilization is assumed to be highly variable, which makes the rental rate of capital less volatile. In a similar vein, Christiano et al. (2005) estimate a general equilibrium model and conclude that the importance of the cost channel in the US is only minor. Even though a price puzzle emerges in the empirical impulse responses they use for minimizing the distance, the cost channel only contributes to explain inflation inertia, which emerges after a monetary contraction, while inflation immediately falls.

Other studies using a single equation approach report empirical evidence for the cost channel that is more promising. For the US, Ravenna and Walsh (2006) estimate an augmented New Keynesian Phillips curve by generalized method of moments (GMM) and find that the evolution of inflation is significantly affected by changes in interest rates. Using a similar approach, Chowdhury et al. (2006) show that the cost channel is relevant in the US and the UK, but not in Germany and in Japan, which possibly indicates that the structure of the financial system – a market-based system versus a bank-based system – has an impact on the consequences of monetary policy actions.<sup>3</sup>

Our analysis departs from the work of Rabanal (2007) in several distinctive aspects: (i) instead of modeling banks as neutral conveyors of monetary impulses, we take explicitly into account the empirical evidence of an incomplete interest rate pass-through in the euro area – see de Bondt (2005), Hofmann and Mizen (2004) and Sander and Kleimeier (2002) among others – and incorporate a banking sector that sets the loan rate according to a Calvo-type staggered price setting approach; (ii) instead of using a full-information Bayesian estimation technique, we explore the VAR-related price puzzle by adopting a minimum distance estimation, which is limited to the response of the model’s variables to a monetary policy shock; and (iii) instead of focusing on the US, we apply our model to the euro area, where the financial system is bank-based, i.e. banks provide the bulk of external finance to firms, rather than market-based.<sup>4</sup>

Our findings suggest that the cost channel in the euro area is incapable to produce a price puzzle in an unrestricted regression, but – in contrast to the findings of Rabanal (2007) – its presence helps to generate an initially concave response of inflation to a monetary contraction. The fall in inflation is delayed in the first quarters following the shock, before it pursues the traditional hump-shaped and convex response, which can be attributed to the sluggish reaction of real marginal costs that comes along with the simultaneous increase in interest rates – i.e. a tightening of credit conditions – and decreases in the real wage and the real rental rate of capital. An immediate increase of inflation only arises after imposing a higher nominal wage rigidity and/or a lower degree of price stickiness. Interestingly, already small deviations from the estimated parameters are sufficient to create the price puzzle, so that the restrictions are not rejected by the data. To our knowledge, this is the first empirical paper showing that the cost channel helps to explain the price puzzle in a general equilibrium framework.

The paper is structured as follows. In Section 2, the New Keynesian model with the cost channel of monetary policy is set out. Section 3 presents the results of the minimum distance estimation, including several checks on weak identification. In

<sup>1</sup> Barth and Ramey (2001) reach this conclusion by exploring industry level data for the US which shows that prices increase after a monetary tightening even if commodity prices are explicitly accounted for. However, the cost channel may be capable to explain an initial shift in inflation after a monetary tightening, but it is hardly capable to explain a price puzzle that lasts for several years.

<sup>2</sup> In the surveys conducted by the ECB’s Inflation Persistence Network (see Fabiani et al., 2006) firms in major euro area countries were asked to assign scores between 4 (greater importance) and 1 (minor importance) to cost factors according to their importance for price adjustments. Financial costs received an average score of 2.1. With 2.6 the average score of labor costs was only slightly higher.

<sup>3</sup> On the contrary, Gabriel et al. (2008) report evidence for the US based on GMM estimation that demonstrates that the importance of the cost channel is minor.

<sup>4</sup> In a related study, Rabanal (2003) also explores the effects of the cost channel in the euro area and draws similar conclusions as in Rabanal (2007). Notice however that except for item (iii) our analysis departs likewise from this work.

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