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The dynamic effects of monetary policy: A structural factor model approach ☆

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ABSTRACT

A structural factor model for 112 US monthly macroeconomic series is used to study the effects of monetary policy. Monetary policy shocks are identified using a standard recursive scheme, in which the impact effects on both industrial production and prices are zero. The main findings are the following. First, the maximal effect on bilateral real exchange rates is observed on impact, so that the "delayed overshooting" puzzle disappears. Second, after a contractionary shock prices fall at all horizons, so that the price puzzle is not there. Finally, monetary policy has a sizable effect on both real and nominal variables.

1. Introduction

Mainstream theory predicts that a monetary policy tightening reduces prices and produces an immediate appreciation of the domestic currency followed by a depreciation. Empirical studies based on structural VAR analysis fail to find evidence supporting such theoretical predictions. Sims (1992) finds that, after a monetary contraction, prices increase, a result known as the *price puzzle*. Eichenbaum and Evans (1995) and Grilli and Roubini (1996) find that exchange rates react with a long delay, being barely affected on impact, a result known as the *delayed overshooting puzzle*.

In recent years there have been many attempts to reconcile empirical results with the theory. On the one hand, some authors call into question the standard recursiveness assumption and propose alternative identification schemes. A notable example is Kim and Roubini (2000), where a substantial mitigation of the delayed overshooting puzzle is obtained. However their identifying restrictions have been questioned by other authors (see e.g. Faust and Rogers, 2003); moreover, it has been shown that, under very mild sign restrictions, the overshooting puzzle is restored (Scholl and Uhlig, 2005).

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On the other hand, influential papers argue convincingly that the puzzles could be due to a deficient information set: if the VAR includes less information than that used by Central Banks and private economic agents, empirical results can be completely wrong. As a matter of fact, the price puzzle can be solved by adding to the VAR data set either commodity prices or suitable linear combinations of variables (Sims, 1992; Bernanke, Boivin and Eliasz, 2005, BBE from now on).

Nevertheless, even including commodity prices, the estimated reaction of prices to monetary policy is negligible in size and disproportionately small as compared to the large response of output (see e.g. Christiano, Eichenbaum and Evans, 1999, CEE from now on). This finding, somewhat understated in the literature, can hardly be reconciled with mainstream theories. Moreover, the delayed overshooting puzzle seems to be robust to different VAR specifications within the recursive approach.

Adding further variables to the data set could in principle enlarge the estimated response of prices and/or solve the delayed overshooting puzzle. Unfortunately, there are no obvious criteria to determine *a priori* how many and which variables should be added. Furthermore, adding too many variables would lead to inaccurate estimates. In short, insufficient information is a problem which cannot be easily solved within the VAR framework (see however Banbura et al., 2007, where it is shown that large Bayesian VARs can be successfully used for both forecasting and structural analysis, provided that suitable priors are set).

In the last decade, a relevant stream of research has focused on models specifically designed to handle a large amount of information, i.e. the generalized (or approximate) dynamic factor models (early works are Forni et al., 2000, 2005; Forni and Lippi, 2001; Stock and Watson, 2002a, 2002b; Bai and Ng, 2002; Bai, 2003). Such models, successfully used for forecasting and the construction of coincident indicators,[1] have recently been proposed for structural macroeconomic analysis, (Forni, Giannone, Lippi and Reichlin, 2009, FGLR from now on). Macroeconomic variables are represented as the sum of a common component and an idiosyncratic component. The idiosyncratic components represent measurement errors or sectoral variations and are not of direct interest for the analysis. The common components are driven by a few macroeconomic shocks which are loaded with different impulse response functions. Identification can be obtained in just the same way as in VAR models. Factor models like FGLR are compatible with neoclassic or neo-Keynesian DSGE models augmented with measurement errors (see Sargent, 1989; Altug, 1989; Ireland, 2004 and the literature mentioned therein).

In this paper the FGLR model and the related estimation procedure are used to analyze the effects of exogenous monetary policy shocks. The data set is made up of 112 US monthly macroeconomic series covering the flexible exchange rate period March 1973–November 2007. The monetary policy shock is identified by imposing a standard recursive scheme on industrial production, the consumer price index, the federal funds rate, and a real exchange rate. Within a VAR model, such identification produces both the price and the delayed overshooting puzzles. The main finding is that in the factor model both puzzles disappear. Moreover, the response of prices in the medium run is relatively large and similar in size to that of industrial production. Finally, reasonable responses for many economic variables are found.

This paper is closely related to BBE. The general line of research is the same. The difference is that here a pure structural factor model is employed, whereas BBE use a mixture of a factor model and a VAR model (the FAVAR model). From this point of view, this paper is closer to Stock and Watson (2005) and Giannone et al. (2004). Mumtaz and Surico (2009), using a FAVAR model, find that the delayed overshooting puzzle is somewhat reduced for the UK. Yet, it is argued in Section 3.6 that the puzzle cannot be solved within a FAVAR approach with US data.

The paper is structured as follows. Section 2 presents the factor model and the estimation procedure and discusses the relation with VAR and FAVAR. Section 3 is devoted to the empirical analysis and shows the results. Section 4 concludes.

2. Theory

This section provides a presentation of the FGLR model and the related estimator. FGLR is a special case of the generalized dynamic factor model proposed by Forni et al. (2000) and Forni and Lippi (2001). Such models differ from the traditional dynamic factor model of Sargent and Sims (1977) and Geweke (1977) in that the number of cross-sectional variables is infinite and the idiosyncratic components are allowed to be mutually correlated to some extent, along the lines of Chamberlain (1983), Chamberlain and Rothschild (1983) and Connor and Korajczyk (1988). Closely related models have been studied by Stock and Watson (2002a, 2002b, 2005), Bai and Ng (2002, 2007), and Bai (2003).

2.1. The factor model

Each variable x_{it} is the sum of two mutually orthogonal unobservable components, the common component χ_{it} and the idiosyncratic component ξ_{it}:

$$x_{it} = \chi_{it} + \xi_{it}. \tag{1}$$

The idiosyncratic components are poorly correlated in the cross-sectional dimension (see FGLR, Assumption 5 for a precise statement). They arise from shocks or sources of variation which considerably affect only a single variable or a small group of variables; in this sense, they are not "macroeconomic" shocks. For variables related to particular sectors, the

[1] See Altissimo et al. (2006).