Monograph:
Arestis, P., Karoglou, M. and Mouratidis, K. (2013) The price puzzle: fact or artefact? Working Paper. Department of Economics, University of Sheffield ISSN 1749-8368

2013008

Sheffield Economic Research Paper Series

SERP Number: 2013008

ISSN 1749-8368

Philip Arestis
Michail Karoglou
Konstantinos Mouratidis

The Price Puzzle: Fact or Artefact?

May 2013

Department of Economics
University of Sheffield
9 Mappin Street
Sheffield
S1 4DT
United Kingdom
www.shef.ac.uk/economics

The Price Puzzle: Fact or Artefact?

Philip Arestis

Department of Land Economics, University of Cambridge, 19 Silver Street, Cambridge CB3 9EP, United Kingdom, Tel: +44(0)122 376 6971, Email: pa207@cam.ac.uk.

Michail Karoglou

Aston Business School, Aston University, Aston Triangle, Birmingham B4 7ET, United Kingdom, Tel: +44(0)121 204 3338, Email: m.karoglou@aston.ac.uk

Kostas Mouratidis[1]

Department of Economics, University of Sheffield, 9 Mappin Street, Sheffield S1 4DT, United Kingdom, Tel: +44(0)114 222 3407, Email: k.mouratidis@sheffield.ac.uk

Abstract: A conventional finding of recursive structural VAR (SVAR) analyses is the price puzzle namely the positive relationship between interest rates and inflation. We employ a Markov regime-switching structural VAR (MRS-SVAR) to investigate whether the price puzzle is present at regimes where there is violation of the Taylor principle. Our results suggest that the price puzzle is a regime-dependent phenomenon driven by passive monetary policy and Choleski identifying restrictions.

Keywords: *Monetary policy, price puzzle, Markov regime-switching, structural VAR.*
JEL Classification: *C32, C34, C51, E50, E52, E58.*

---

[1] Corresponding author.

1. Introduction

Structural vector autoregressions (SVARs) are widely used to study the impact of monetary policy shocks on economic growth. Their popularity is often attributed to the fact that log-linearization of Dynamic Stochastic General Equilibrium (DSGE) models around the steady-state yields a first-order VAR (VAR(1)) the parameters of which are complicated functions of the underlying preference, technology and policy parameters.

While most of the results in the VAR literature are consistent with macroeconomic theory, Sims (1992), using a recursive identification scheme finds a positive reaction on the price level of the impact of a monetary policy shock. Sims (1992) argues that this anomaly, named price puzzle is due to an omitted variable problem. Castelnuovo and Surico (2010) show that the omitted variable is the by-product of passive monetary policy, which leads to violation of the Taylor principle and indeterminacy. Thus, the price puzzle is expected to be present only in the indeterminate regime. [2]

Following a different rute, Carlson, Fuest and Paustin (2009) show that the price puzzle is the outcome of the Choleski-identification approach. In line with this argument, Canova and Pina (1999) and Canova and De Nicolo (2002) show that while a wide range of DSGE models rarely deliver zero restrictions they often embody sign restrictions. However, Castelnuovo and Surico (2010) show that the price puzzle is robust in terms of the implementation of zero and model consistent (i.e. sign) restrictions.

The aim of this empirical contribution is to show that the price puzzle is an artefact of a recursive identification scheme rather than an inherent problem of the structural VAR approach. To this aim, and unlike previous studies, we adopt a Markov regime-switching structural VAR rather than a linear framework following the rationale of Davig and Leeper

[2] Benati and Surico (2009) show under indeterminacy the minimal state-space representation of the DGSE model includes an additional state variable in comparison to the determinate regime. Canova (2006) argues that the additional state variable under indeterminacy is the expected inflation.

(2007) who show that on-going regime changes create expectation formation effects, which expand the region of determinacy as compared to the constant-parameter setup. [3]

The remainder of the paper is as follows. Section 2 presents the econometric methodology. Section 3 describes the data and our empirical results. The final section contains our concluding remarks.

2. Econometric Methodology

An MRS SVAR can be considered as a two-step procedure, which introduces Markov regime-switching and identification into the VAR approach. In the first step we estimate the following MRS-VAR model:

$$Y_t = \sum_{j=1}^{p} \Phi(s_t) Y_{t-j} + e(s_t) \tag{1}$$

where all parameters are assumed to be state-dependent. The unobserved state variable s_t takes values from the finite set $\Omega = \{1,...,n\}$ and follows a Markov process with transition probability $P = (p_{ij})'_{i,j\in\Omega}$ where $p_{ij} = P(s_{t+1} = j \mid s_t = i)$. In the second step the state-dependent structural shocks $u(s_t) = A(s_t)e(s_t)$ are identified.

Let $Y_t = [spr_t, y_t, \pi_t, i_t]'$ where spr_t is the spread between the six-year long-term and the three-month money market rate, y_t is the output growth rate π_t is the inflation rate and i_t is the three-month money market rate. We choose a recursive form of identification by imposing the restriction that the policy instrument does not enter into the inflation and output equations. We also impose the restriction that inflation does not affect output growth contemporaneously. Note that impulse responses are regime-dependent and computed based on the Choleski factor of

$$\Sigma_\varepsilon(s_t) = E_t\,[e(s_t)e(s_t)'] = \tilde{A}(s_t)A(s_t)' \tag{2}$$

[3] Davig and Leeper (2010) introduce the concept of long-run Taylor principle which allows departures from the Taylor principle that are either substantial, but brief, or persistent, but modest.

Alternatively, we impose sign restrictions using the QR decomposition of $\Sigma_{\varepsilon}(s_t)$. In particular, we draw an $n \times n$ random matrix K from the $N(0,1)$ where $K = QR$ and compute the structural impact matrix as $\tilde{A}(s_t) = A(s_t)Q'$, where Q is a unitary matrix and R is an upper triangular matrix. If the draw satisfies the restriction we keep it or otherwise we discard it. To achieve identification of the VAR system, we impose the condition that the response of inflation and the spread between the long-term and short-term of interest rates would not increase and that of money market rate would not decrease.

3. Data and Empirical Results

Our empirical analysis is based on monthly data obtained from the International Financial Statistics database for the UK, and comprises of series for the industrial production, the consumer price index, the six-year government bond interest rate and the three-month short-term interest rate, and spans the period between March 1979 and December 2008.

We build a VAR model allowing for 1 lags in the logarithmic difference form of the series with the exception of the short-term interest rate, which is used in levels. [4] The model considers two states based on the difference in volatilities across the two regimes. Regime 1 depicts the low volatility state and regime 2 depicts the high volatility state.

Empirical analysis is implemented in two steps. First, we estimate a trivariate model where Y_t includes only output, inflation and the short-term interest rate. In doing so we test both for the trivariate VAR being subject to an omitted variable problem (i.e., expected inflation) and for the spread between the long-term and the short-term interest rate being a good proxy for expected inflation. Second, we augmented the trivariate model by adding the spread between the 6-year long-term and the 3-month short-term interest rate as a proxy for expected inflation.

[4] The lag structure of the variables in the model is based on the BIC criterion.

The upper part of Figure 1 shows the impulse response of the trivariate VAR model under the recursive identification strategy. There is evidence of price puzzle in both regimes but it is a lot more persistent and stronger in the high volatility regime (i.e., regime 2). Although this might reflect an omitted variable problem, the price puzzle is still present in the augmented four-variable MRS-SVAR model presented in the lower part of Figure 1.

Figure 1 around here

The upper part of Figure 2 shows that in the trivariate model although we impose model-consistent sign restrictions the price puzzle cannot be eliminated. However, in the quadravariate model, the lower part of Figure 2 shows that after accounting for expected inflation the price puzzle disappears only in the low volatility regime (i.e. regime 1). In the high volatility regime there is a strong evidence of the price puzzle.

Figure 2 around here

The filter probability presented in Figure 3 shows that the high volatility regime covers the period before the European Monetary System (EMS) crisis in September 1992. Benati (2008) shows that for the period before the introduction of the inflation targeting regime in October 1992 there was violation of the Taylor principle. This implies that the high volatility regime is an indeterminate regime where expected inflation becomes self-fulfilling. Thus, our results suggest that the price puzzle is not only an artefact of the Choleski identification strategy but also of indeterminacy. It is worth noting that the long-run Taylor principle introduced by Davig and Leeper (2007) and developed by Farmer et al. (2010) allows for either brief or/and modest violation of the Taylor principle. In this set up, evidence of indeterminacy and price puzzle in the high volatility regime does not necessarily imply that indeterminacy and price puzzle characterized the full sample.

Figure 3 around here

4. Summary and Concluding Remarks

The widespread use of SVAR models to estimate the impact of monetary policy on economic activity has been heavily criticized for the lack of connection with the underlying DSGE model when identification is based on the conventional zero restrictions approach. In the face of this criticism researchers have modelled consistent restrictions (i.e. sign restrictions). However, the price puzzle, the positive relationship between inflation and interest rates, seems to be robust to identification strategy for linear SVAR models.

In this paper, we adopt the general framework introduced by Davig and Leeper (2007) which allows indeterminacy to be a state-dependent phenomenon. Thus, we can investigate whether the price puzzle is present at regimes where there is violation of the Taylor principle. Our results show that the price puzzle is present only in the high volatility regime (i.e. indeterminate regime) and is driven by a combination of an omitted variable problem and of the Choleski identification approach. Once we augment the mispecified VAR model with an appropriate proxy of the expected inflation and impose model consistent restrictions, the price puzzle disappears in the low volatility (i.e. determinate) regime

.

References

1. Benati, L., 2008. “The Great Moderation in the United Kingdom”, Journal of Money Credit and Banking, vol. 40, pp. 121-147.
2. Benati, L. and Surico P., 2009. "VAR Analysis and the Great Moderation," American Economic Review, vol. 99(4), pp. 1636-52
3. Canova, F., 2006. "You can use VARs for structural analyses. A comment to VARs and the great moderation". mimeo, Universitat Pompeu Fabra.
4. Canova, F. and Pina A., 2005. Monetary policy misspecification in VAR models. In New Trend in Macroeconomics (ed. C. Diebolt and C. Kyrtsou). Springer.
5. Canova, F. and De Nicolo G., 2002. "Monetary disturbances matter for business fluctuations in the G-7", Journal of Monetary Economics, vol. 49, pp. 1131-1159.
6. Carlstrom, C., Fuest, T., and Paustian M. (2009), "Monetary Policy Shocks, Choleski identification, and DNK models", Journal of Monetary Economics, vol. 56, pp. 1014-1021.
7. Castelnuovo, E. and Surico P., 2010. Monetary policy, inflation expectations, and the price puzzle. The Economic Journal. 120(549), pp. 1262--1283.
8. Davig, T. and Leeper, M. (2007), "Generalizing Taylor Principle", American Economic Review, Vol. 97(3), pp. 607-635.
9. Farmer, E. Waggoner, D. and Zha, T. (2011), "Minimal State Variable Solutions to Markov Switching Rational Expectation Models", Journal of Economic Dynamic and Control, vol. 35, pp. 2150-2166.
10. Sims, C., 1992. "Interpreting the macroeconomic time series facts: the effects of monetary policy". European Economic Review. vol. 36, pp. 975-1000.

Figures

Figure 1: Impulse-responses of UK inflation based on trivariate and quadravariate MRS VAR – identification using the Choleski method

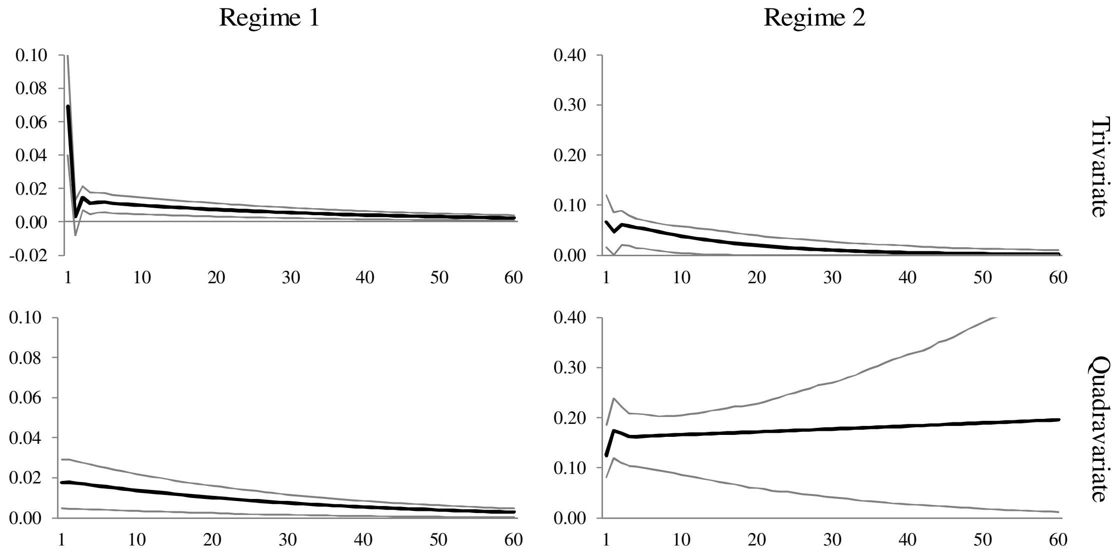

Figure 2: Impulse-responses of UK inflation based on trivariate and quadravariate MRS VAR – identification using the sign restrictions method

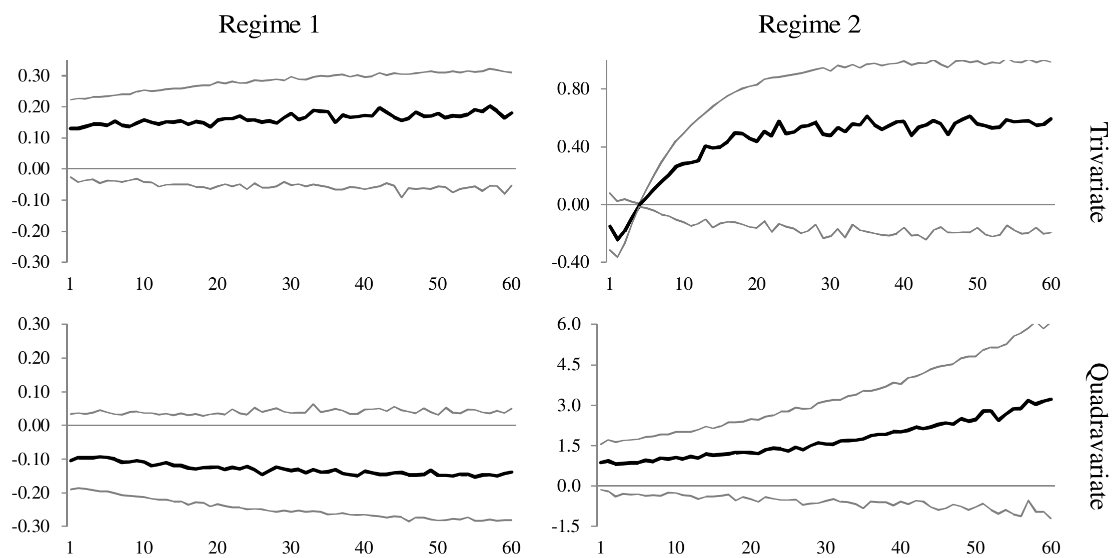

Figure 3: Filtered probabilities