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North American trade and US monetary policy☆,☆☆

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ABSTRACT

This paper investigates how an increase in the United States Federal Fund rate affects the United States economy and how the effects are transmitted to the Canadian economy using the factor-augmented VAR (FAVAR) approach of Stock and Watson (2005) and Bernanke et al. (2005). A distinguishing feature of our model is the disaggregation of the traded goods sector where imports and exports are disaggregated into 12 and 13 industries, respectively. Extra information is provided on the domestic and international transmission mechanisms between the two countries. The factor-augmented VAR method allows impulse response functions to be generated for all the variables in the data set and so is able to provide a comprehensive description of the domestic and international transmission mechanisms between the United States and Canada.

1. Introduction

What are the dynamic effects of US monetary policy shocks throughout the US and the Canadian economy? This question is answered by applying factor-augmented VAR methodology — based on the Stock and Watson (1998, 2002) two-step principal component approach[1] — of Bernanke et al. (2005) and Stock and Watson (2005) to a large data set which takes into account the traded goods sector, where exports and imports are disaggregated into 12 and 13 industries, respectively.[2]

The great appeal of using FAVAR models to study monetary policy transmission mechanisms is that they can, in line with the current practice of monetary authorities, who tend to monitor a large number of economic time series before setting monetary policy, potentially employ thousands of data series in the model. Lagana' and Sgro (2011) have investigated the effect of a rise in the US personal income tax rate on the US and Canada using disaggregated traded good sector data on imports and exports. This paper is an extension of that analysis to monetary policy shocks.

Employing FAVAR models has at least two advantages over traditional VARs.[3] First, the fact that the VAR information set is likely to be smaller than that used by policy-makers may imply that the VAR model is miss-specified. If the model suffers from omitted variable bias it implies that policy shocks cannot be fully recovered from VAR innovations and so may produce erroneous results. The "price puzzle" discovered by Sims (1992) is only one example of the serious consequences of a miss-specified VAR model.[4] Second, impulse responses can only be routinely generated for the variables included in the model, and constitute only a subset of the variables of interest to economists and policy-makers.[5]

Our approach is to use principal components analysis to calculate the factors that summarize the most relevant information contained in the series. It should be stressed that the number of factors will be much smaller than the number of variables in the data set. As a result,

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[1] Factor models have been applied to both non-stationary (Dees et al., 2007; Laganà, 2009; Pesaran and Smith, 2006) and stationary variables (Bernanke et al., 2005; Laganà and Mountford, 2005; Stock and Watson, 2005).

[2] The few papers that have investigated international trade spill-overs from monetary policy shocks have not had access to disaggregated trade data on the main imports into Canada from the United States and the main exports from Canada to the United States that we use in the present paper (see Humtaz and Surico, 2009).

[3] These models were first introduced by Christopher Sims in 1980 (Sims, 1980). Bernanke and Blinder (1992) and Sims (1992) were the first to use these models to identify and estimate the effect of monetary policy on macroeconomic variables. Eichenbaum and Evans (1995) and Grilli and Roubini (1996) identified the effects of domestic and foreign monetary policy shocks using VARs. See also Christiano et al. (2000) for a survey.

[4] Sims (1992) was the first to note the conventional finding in the VAR literature, that a monetary policy contraction produces a slight increase rather than a decrease in inflation and might be due to the imperfectly controlling information the central bank may have about future inflation.

[5] Due to the high degree of freedom costs in the estimation, VARs typically include fewer than 10 variables. Exceptions are the Bayesian VAR models, which can include up to 20 variables (e.g., Leeper et al., 1996).

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the amount of information which can be handled by the model increases dramatically, hence the chance of under-specifying the econometric model used to assess the effect of policy shocks is significantly reduced.[6]

The results show that the factor-augmented VAR model generates a reasonable response to the domestic and international transmission mechanisms of United States changes in monetary policy where, following a rise in the United States Federal Fund rate, United States investment and production, inflation and the share price fall. On the other hand, the response of the Canadian economy is mixed. Canadian industrial production, construction and the share price fall, the exchange rate on the US $ to national currency unit (Canadian $) appreciates, while unemployment rises. Imports into Canada from the United States generally increase, while mixed evidence is found on exports from Canada to the United States. Some of these results are in line with standard theory when one considers that the United States is a large open economy whilst Canada is an adjacent, "small", open economy, and that the trading relations between the two countries are extensive and strong, especially after the signing of NAFTA on 2 January 1988 and its coming into effect on 1 January 1989.

However, the extra information generated by the factor-augmented VAR also unearths other identification issues. In particular, following a rise in the US interest rates the US real effective exchange rate depreciates.

There are two important points here. First, Bernanke et al. (2005) method in identifying a monetary policy shock using a Cholesky decomposition of the variance covariance matrix is followed. However, as stressed by Bernanke et al. (2005), factor models can be used with a variety of identification methods and techniques designed to overcome identification difficulties.[7] Second, these counter-intuitive responses are only evident because of the factor model's ability to generate impulse responses for a large number of variables. Thus, the new "puzzling" responses are evidence of the extra information generated by factor-augmented VARs.

This paper is organized as follows. Section 2 describes the econometric framework, Section 3 describes the data, and Section 4 reports the econometric results obtained from the models presented in Section 2.

2. The model

This section discusses the statistical model, which motivates the inclusion of estimated factors into a VAR. The main characteristic of dynamic factor models is that they are able to summarize an enormous amount of information in a few estimated factors. Adding these factors to a VAR. therefore, offers a possible solution to the VAR's limited information problem.

Following Stock and Watson (2005), the VAR form of the dynamic factor model can be written as:

$$\begin{bmatrix} F_t \\ X_t \end{bmatrix} = \begin{bmatrix} \Phi(L) & 0 \\ \Lambda\Phi(L) & D(L) \end{bmatrix} \begin{bmatrix} F_{t-1} \\ X_{t-1} \end{bmatrix} + \varepsilon_t \tag{1}$$

where X_t denotes a large $(n\times 1)$ information matrix which contains hundreds of stationary economic time series, and F_t a small $(n\times 1)$ vector of unobservable factors which can summarize most of the information contained in X_t. Λ is a $(n\times r)$ matrix, with the coefficients of λ_i (L) on the *i*th row; Φ (L) is a diagonal lag polynomial matrix made of the Γ_t coefficients. The error term is defined as follows:

$$\varepsilon_t = \begin{bmatrix} I \\ \Lambda \end{bmatrix} G\eta_t + \begin{bmatrix} 0 \\ v_t \end{bmatrix}.$$

The crucial point of this factor-augmented VAR model (Eq. (1)) is that the amount of information that can be handled by the model changes dramatically $(r \ll n)$. The above vector equation will be estimated using the two-step procedure of Stock and Watson (2005).[8]

3. Data transformation

The data set used to estimate the factors is a balanced panel that contains 131 monthly time series for the United States and Canada from 1982 (1) to 2005 (1). The series were chosen from DataStream using the following categories: employment; output; consumer and retail confidence; prices; money; interest rates; stock prices and exchange rates. For Canada, additional categories on orders; composite leading indicators; fixed capital; balance of payment; credit and debit were included. The authors obtained an additional category, the main imports into Canada from the United States, and the main exports out of Canada to the United States from Canada Statistics. As in the literature, monthly figures were used because they are more likely to capture the effects of any monetary policy change. The sample size was determined by the trade data, which were only available for the period 1982–2005. As a measure of shock, a 1 standard deviation increase in the US Federal Fund rate was used.

Appendix A lists the data series included in the dataset. The model outlined in Section 2 assumes that X_t is a matrix of I (0) underlying macroeconomic variables, so the 131 series were subjected to four preliminary steps: possible transformation by taking logarithms, possible differencing, possible seasonal adjustment, and screening for outliers. The decision to take logarithms or to first difference the series was based on data inspection and formal unit root tests. Most series were transformed in logarithm and differenced. Specific transformations and the list of series is given in Appendix A (seasonal adjustment should be performed only when there is a clear statistical evidence and economic interpretation of the seasonal/calendar effects. Most series included in our sample of data are seasonally adjusted by the US and Canada statistical agencies). After the transformations, all series were standardized to have sample mean zero and unit variance.

[6] The possibility of including potentially thousands of data series in the statistical model brings to the fore the issue of the optimal design of the data set. Which series should be included and which excluded from the data set? It is not always the case that more data are better. As Boivin and Ng (2006) show, the addition of data series can reduce forecasting performance when the idiosyncratic errors in data series are cross-correlated.

[7] Although the use of the Cholesky decomposition is a standard assumption, its appropriateness is regularly questioned in the literature (see Uhlig (2005) for a recent example and Christiano et al. (2000) for an excellent survey of the literature). Thus, it is important to stress that many other identification schemes are available in the VAR literature (see, for example, Ahmadi and Uhlig, 2009; Bernanke and Mihov, 1998; Leeper et al., 1996; Stock and Watson, 2005; Uhlig, 2005), which may be more appropriate for identifying monetary policy in the US. However, this paper attempts to highlight the contributions of factor models to the analysis of US monetary policy and employing a particular identification scheme would tend to obscure the role played by factor augmentation in the analysis. Thus, we follow Bernanke et al. (2005) in using a Cholesky identification.

[8] The system, like standard VARs, requires an identifying assumption to recover the policy shock. This paper follows Bernanke et al. (2005) in assuming the Cholesky decomposition in which the policy variable, in our case the US Federal Fund rate, is ordered last and assumes that the X_t matrix can be partitioned into three blocks: a slow-series, the shock, and a fast-moving series[7]. The slow-moving variables are those predetermined as of the current period, such as real variables, whereas, the fast-moving variables are those highly sensitive to contemporaneous economic news or shocks, such as prices and financial assets. The slow-series shocks can affect all variables, a shock from monetary policy can affect only itself and the fast-moving variables, shocks in the fast-moving variables can only affect fast variables.