Fiscal Policy and Asset Prices in a Dynamic Factor Model with Cointegrated Factors

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Introduction

- Existing studies on fiscal policy and asset prices: Afonso and Sousa (2011); Agnello and Sousa(2013) in a Structural VAR Model (SVAR).

- Limitations of SVAR model:

  1. Measurement error and variable omission problem affects transmission of shocks.

  2. Non-invertibility problem, SVAR innovations may not span the space of the structural shocks.

Motivation of Dynamic Factor Model

- Dynamic factor model (DFM) overcomes the problems inherent in VAR [Bernanke and Kuttner (2005); Forni and Gambetti (2010); Nakamura and Steinsson 2018)]
- Large datasets in DFM spans the space of structural shocks and resolves the dimensionality problem in SVAR model.
- DFM allows computation of Impulse Response Functions (IRFs) of several variables without dimensionality problems.

Contribution

- This is the first paper to estimate the effect of fiscal policy on asset prices in Structural Dynamic Factor Model (SDFM).
- In addition, I combine cointegration with dynamic factor model to estimate the response of asset prices to government spending shocks.

Research Question

- How do stock prices and housing prices respond to government spending shock?
- Does government spending shock show persistent effects?
- How significant is government spending in explaining the forecast error variance of variables in the model?

Brief Literature Review

- **Fiscal policy and Asset prices using VAR Model**

  1. Afonso and Sousa (2011): Effects of fiscal policy on asset markets using SVAR.
  2. Agnello and Sousa (2013): Fiscal policy and asset prices in a panel VAR model.

- **Dynamic Factor Model**

  1. Barigozzi, Lippi and Luciani (2021): Effects of oil price shock on US economy with cointegrated factors.
  2. Laumer (2020):Government spending and heterogenous Consumption in a Factor-Augmented VAR (FAVAR) model.
  3. Stock and Watson (2016): Effect of Oil price shock on US Economy.
  4. Alessi and Kerssenfischer (2019). The response of asset prices to monetary policy shocks.

Data

- The dataset consist of 207 quarterly observations representing the US economy.
- The time series variables ranges from real activity variables, prices, productivity and earnings, interest rates and spreads, money and credit, asset variables, and variables representing international activity.
- Sample period: 1985Q1-2021Q4. I choose 1985 as starting point because of structural break during the great moderation.
- No transformation for $I(1)$ variables but for $I(2)$ variables, I take first differences.

Model Specification

Dynamic Factor Model (DFM)

Following Stock and Watson (2016) and Barogozzi et al.,(2021), each observable variable in the $N \times 1$ dimension of $\mathbf{X_t}$, is decomposed into common component and idiosyncratic components:

$$\mathbf{X_t} = \mathbf{\Lambda F_t} + \xi_\mathbf{t}, \tag{1}$$

$$\mathbf{A}(L)\mathbf{F_t} = \eta_\mathbf{t}, \qquad \mathbf{A}(L) = \mathbf{I} - \mathbf{A_1}L - ... - \mathbf{A_p}L^p, \tag{2}$$

$$\eta_\mathbf{t} = \mathbf{H}\epsilon_\mathbf{t}, \tag{3}$$

- $\xi_\mathbf{t} \sim N(0, \Psi)$ and $\eta_\mathbf{t} \sim N(0, \mathbf{\Sigma}_\eta)$
- $\mathbf{F_t} = (f_{1t}, \dots, f_{rt})'$ is an $r \times 1$ vector of unobservable factors,
- $\mathbf{\Lambda} = (\lambda_1', \dots, \lambda_N')'$, is $N \times r$ matrix of factor loadings,
- $\eta_\mathbf{t} = (\eta_{1t}, \dots, \eta_{rt})'$ is $r \times 1$ vector of uncorrelated factor innovation,
- $\eta_\mathbf{t}$ and $\xi_\mathbf{t}$ are uncorrelated at all leads and lags.

Model Estimation

Identification of Government Spending Factor

- The ordering of the variables in $\mathbf{X_t}$ is specified below:

$$\begin{pmatrix} G_t \\ \mathbf{X_{2:n,t}} \end{pmatrix} = \begin{pmatrix} \Lambda_1 \\ \mathbf{\Lambda_{2:n}} \end{pmatrix} \begin{pmatrix} F_t^G \\ \mathbf{F_{2:r,t}} \end{pmatrix} + \begin{pmatrix} \xi_{1t} \\ \xi_{\mathbf{2:n,t}} \end{pmatrix}$$

- I estimate the factor loadings by applying the "named factor" normalization restriction by Stock and Watson (2016) specified as:

$$\mathbf{\Lambda^{NF}} = \begin{bmatrix} \Lambda_1 \\ \Lambda_{2:n}^{NF} \end{bmatrix}$$

where $\Lambda_1 = (1 \quad 0 \ldots 0)$

- Estimation of factors and their loadings are extracted using principal components analysis.

Model Estimation

Identification of Shocks and Estimation of IRFs

- Equation (3) becomes

$$\eta_{\mathrm{t}} = \mathbf{H}\begin{pmatrix} \epsilon_{1t} \\ \tilde{\eta}_{\bullet t} \end{pmatrix} = \begin{bmatrix} H_1 & H_\bullet \end{bmatrix}\begin{pmatrix} \epsilon_{1t} \\ \tilde{\eta}_{\bullet t} \end{pmatrix} \tag{4}$$

- Combining unit effect normalization and named factor normalization, eqn (5) can be written as:

$$\begin{pmatrix} \eta_t^{G_t} \\ \eta_{\bullet t} \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ H_{21} & H_{\bullet t} \end{pmatrix}\begin{pmatrix} \epsilon_t^{g_t} \\ \tilde{\eta}_{\bullet t} \end{pmatrix} \tag{5}$$

  with unit effect normalization imposed on the coefficients on the diagonal of **H**.

Model Estimation

- The estimated IRF of shock j on variable i at time k defined as :

$$\widehat{\phi}^{\text{VAR}}_{i1,k} = \widehat{\boldsymbol{\lambda}}'_i \left[\widehat{\mathbf{A}_k}^{\text{VAR}} \right]^{-1} \widehat{\mathbf{h}}_1, \tag{6}$$

where $\widehat{\boldsymbol{\lambda}}'_i$ represents the i-th row of $\widehat{\boldsymbol{\Lambda}}$, $\quad \widehat{\mathbf{h}}_1$ is the first column of $\widehat{\mathbf{H}}$ and $\widehat{\mathbf{A}}^{\text{VAR}}_k$ is the VAR estimate of $\mathbf{A}(L)$.

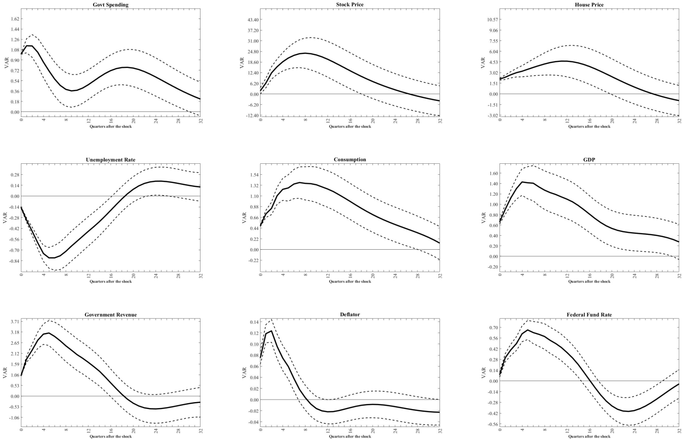
Results

Table: Importance of Common Factors for Selected Variables

	R^2 of Number of factors			
Series	Factor 1	Factor 2	Factor 4	Factor 7
Real GDP	0.68	0.71	0.76	0.81
Consumption	0.52	0.57	0.61	0.68
Investment	0.45	0.49	0.52	0.54
Government Spending	**1.0**	0.87	0.84	0.89
Tax Revenue	0.45	0.44	0.47	0.51
Unemployment Rate	0.70	0.78	0.83	0.85
Employment Nonfarm	0.73	0.85	0.86	0.82
Labor productivity	0.38	0.35	0.38	0.50
Housing starts	0.08	0.27	0.53	0.60
Fed Funds	0.02	0.21	0.33	0.48
S&P 500	0.06	0.30	0.47	0.68
House Price	0.17	0.19	0.46	0.54
GDP Deflator	0.25	0.08	0.11	0.15

Impulse Response of Government Spending Shock

Figure: IRFs of government spending shock on selected variables (1985Q1-2021Q4).



Results

- Both stock price and house price responded positively to government spending shock.
- Intuition: expansionary fiscal policy leads to increase in economic activity which increase demand for financial assets, hence a rise in asset prices.
- The result implies that government spending shock does not depress stock and housing market.
- My result is different from Afonso and Sousa (2011) and Agnello and Sousa (2013): difference due to estimation method.
- The effect of government spending shock on house price and stock price dies slowly.

Variance Decomposition Analysis

Table: Forecast Error Variance Decomposition for Selected Variables

Variable	Contribution
GDP	0.70
Consumption	0.35
Investment	0.56
Employment	0.64
Unemployment rate	0.44
Government Spending	0.75
Tax Revenue	0.28
Fed funds rate	0.23
Hours Worked	0.62
GDP Deflator	0.30
S&P 500	0.32
House Price	0.43

Conclusion

- Positive government spending shock has a positive effect on stock prices and house prices.
- The result implies that government spending does not depress both stock and housing markets as suggested by Agnello and Sousa (2013).
- The effect of government spending shock on house price and stock price dies slowly.