Financial stability, monetary stability and growth: A panel VAR analysis

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Abstract: This paper employs a panel vector autoregressive model (PVAR), to investigate the relationship among financial stress, inflation and growth in nineteen advanced countries over the period 1999-2016. To measure financial stress, we construct a financial stress index (FSI) that provides a signal of financial stress. We apply the PVAR approach along with panel impulse response functions, variance decomposition, and Granger causality tests to FSI data, on economic monetary stability, economic growth, housing markets and government policies. The analysis shows negative responses of the macroeconomic variables to financial stress shocks.

Keywords: Impulse Responses; Granger Causality; Government Deficit; House Prices; Financial Stress Index.

JEL: C32; C43; F30; G15

1. Introduction

The impact of macroeconomic factors on finance is well researched in the past and in the past as well as the channels the channels that lead to financial imbalances. However, after the global financial crisis of 2007, the interest of scholars has concentrated on the impact of financial cycles on the real economy, sparking the debate on whether there is such an influence. Previous studies have demonstrated that credit plays a key role in the transmission of financial distress to the broader economy. Several studies indicate that the credit channel is the main channel of transmission of financial distress (Jacobson et al., 2005; Gilchrist et al., 2009; Carlson et al., 2011). Empirical findings highlight credit growth as predictor of financial stress in economies.

From a theoretical perspective, scholars argue that monetary policy impacts the real economy through the financial accelerator mechanism (Kiyotaki and Moore, 1997; Bernanke et al., 1999). Recent theoretical developments move in the direction of incorporating the financial sector into a macroeconomic framework, thus relating financial frictions to economic activity (Cúrdia and Woodford, 2009; Gertler and Karadi, 2011; Gertler and Kiyotaki, 2010). There is limited research on the relationship between financial stability and growth (Cevik et al., 2013; Hakkio and Keeton, 2009; Hatzius et al., 2010; Mallick and Sousa, 2013). Hatzius et al. (2010) controlling for growth and inflation, and with the use of a financial soundness indicator, examine the predictive power of financial conditions on future economic activity. Mittnik and Semmler (2013) argue that in times of severe financial stress, large negative shocks to financial-stress have sizeable positive effects on real activity. Afonso et al. (2017) find that a financial stress shock has a negative effect on output and worsens the fiscal situation. Creel et al. (2015), using a panel GMM approach, find supportive evidence that financial instability has a negative effect on economic growth.

Another strand of the literature investigates linkages between financial stability and monetary stability. Schwartz (1995) finds that achieving price stability over the medium term is sufficient to prevent financial crises. Borio and Lowe (2002) argue that there is the possibility of financial instability even in conditions of low inflation and growth when there is a combination of supply shocks and asset price booms with overoptimistic assessments of risk. De Graeve et al. (2008) find evidence of a tradeoff between monetary stability and financial stability and suggest that an unexpected tightening of monetary policy increases the mean probability of distress. Thus, a key challenge for central banks is to maintain both monetary and financial stability simultaneously. Blot et al. (2015) however, examining the relationship between monetary stability and financial stability do not find supportive evidence.

Housing sector and its relationship to financial stability have received limited attention so far. Zhu (2005) argues that property prices through the banking channel and their profitability have important implications for financial stability. Helbling (2005) contends that housing price bubbles are coincided with sharp slowdowns in economic activity and with outright recessions. Goodhart and Hofmann (2008), in a panel VAR analysis, find a multidirectional link between house prices and the macroeconomy. Misina and Tkacz (2008) find that real estate prices are important predictors of financial stress. Reinhart and Rogoff (2009a) find that banking crisis episodes are usually related with a housing bust. Vašíček et al. (2017), use house prices to test the predictive power for financial stress using an FSI for 25 OECD countries.

Finally, we examine government deficit as another factor that might lead to severe economic/financial disturbances as in the recent example of Greece. Reinhart and Rogoff (2009b) argue that global economic factors, including commodity prices and center country interest rates, precipitate sovereign debt crises. They also posit that global debt crises are frequently emitted from the center through commodity prices, capital flows, interest rates, and shocks to investor confidence. Fischer (1993) finds that growth is negatively associated with inflation, large budget deficits and distorted foreign exchange markets. Reinhart and Rogoff (2010) argue that there is an association between high debt-to-GDP ratios with low real GDP growth rates. Das et al. (2010) examine the channels and the linkages of public debt to financial stability. They argue that poor debt management can raise sovereign risks deteriorating financial stability via a feedback loop. Taylor et al. (2012) examine the linkages between primary deficits, interest rates and economic growth. They find that low GDP growth rates are the cause of high debt-to-GDP ratios. Corsetti et al. (2013) examine how the sovereign risk channel affects macroeconomic dynamics and stabilization policy. They argue that the risk channel can become a critical determinant of macroeconomic outcomes in case of an environment that the monetary policy is constrained. Proaño et al. (2014) examining the relationship between growth, the level of debt, and the stress level, find that debt impairs economic growth in European Monetary Union during times of high financial stress.

In this paper, we examine the transmission of macroeconomic shock on financial stability and vice-versa using the PVAR model developed by Love and Zicchino (2006). The model allows for fixed effects across countries and to our knowledge the application of this procedure to financial stability has not been implemented before. Panel VAR methods have been used from several scholars (Galariotis et al., 2016; Georgoutsos and Moratis, 2017; Grossmann et al., 2014; Jawadi et al., 2016; Lof and Malinen, 2014). Georgoutsos and Moratis (2017) examine the default risk transmission at the bank and sovereign level. Lof and Malinen (2014) study the relationship between sovereign debt and economic growth. Jawadi et al. (2016) use a panel VAR to examine fiscal and monetary policy shocks. We use a panel data set of 19 OECD advanced countries for a time period that includes the last seventeen years.

The remainder of this paper is structured as follows: Section 2 presents the construction of the FSI and our dataset. Section 3 describes the PVAR framework. Section 4 presents the results of the empirical analyses. Finally, we conclude in Section 5.

2. Data

In this paper, we examine financial stress innovations on several macroeconomic variables. Illing and Liu (2006 p. 253), in a seminal work on financial index construction, define financial stress "as a continuous variable with a spectrum of values, where extreme values are called a crisis. "Different FSIs and methods to construct one exist in the literature (Hanschel and Monnin, 2005; Illing and Liu, 2006; Van den End, 2006; Hakkio and Keeton, 2009; Cardarelli et al., 2011; Vermeulen et al., 2015; Carlson et al., 2012; Hollo et al., 2012). For the purpose of this paper, we use similar methods to Cardarelli et al. (2011) to construct the FSI. The FSI is constructed by the equal variance-weighted average of 6 variables[1]:

i. the banking beta (the 12-month rolling beta), where r represents the month over month market returns computed over a 12-month rolling window. A beta greater than 1 represents a riskier banking sector in line with the CAPM.

$$\beta_{i,t} = \frac{\text{cov}(r_{i,t}^{M}, r_{i,t}^{B})}{\text{var}\,(\text{M}_{i,t})}, \tag{1}$$

ii. the inverted term spread, measured as the difference between the short-term rate and long-term yields on government-issued securities.

iii. stock market returns, measured as the inverted month over month change in the stock index.

iv. stock market volatility, estimated by a GARCH(1,1) model using month over month returns.

v. a measure of sovereign risk measured as the difference between the long-term interest rate - US long-term interest rate, and,

vi. the foreign exchange market estimated by a GARCH(1,1) model using month over month returns.

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[1] Following Vermeulen et al., 2015 we did not included TED spread in our stress index.

The FSI is given by adding the 6 standardized variables and if is greater than 0, it indicates Stress while if it is lower than 0, indicates stability:

$$FSI_{i,t} = beta + inverterted\ term\ spread + stock\ market\ returns + stock\ market\ volatility + sovereign\ debt\ spreads + excange\ market\ volatility_{i,t} \quad (2)$$

Our data contain the constructed FSI for 19 OECD advanced countries. The summary statistics of the input data, spanning the period from the end of 1999 to 2016 are presented in Table 1. On average, Italy and Spain indicate the highest financial stress levels, followed by France. The Levin, Lin, Chu (LLC) unit root test for panel data indicates the stationary of the series. In Panel C, we observe that FSI and GDP have a significant negative correlation coefficient of -0.24, while FSI and CPI have a significant positive correlation coefficient of 0.15.

Insert Table 1 about here

The FSI thus captures the major episodes of financial distress during the last two decades, with higher values indicating more stressful periods. In Fig. 1 we plot the financial stress indices for every country together with the GDP growth and CPI Change. From the plot, we distinguish one period of increased financial stress, for all countries in 2008 during the global financial crisis. US reaches a maximum of financial stress in March 2008. Several other countries financials distress picked during 2008 e.g. Canada, Netherlands, UK. In the case of Greece, FSI has a maximum at 2.51 in February 2010 during its sovereign debt crisis.

Insert Fig. 1 about here
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3. Methodology

This paper is built on the PVAR framework as an attempt to examine the dynamic relationship among financial stability, monetary stability and growth. Using the VAR methodology, we can treat our variables of interests as endogenous and therefore examine the effects of financial stress on financial stability and growth, and also the reverse effects. Following Love and Zicchino, (2006), we exploit a panel VAR generalized method of moments (GMM) estimator to explore stress dynamics and macro variables of the 19 OECD advanced countries. Our model can be written as:

$$y_{it} = \Gamma_0 + \Gamma_1 Z_{it-1} + f_i + d_t + e_{it}, \quad (3)$$

where $y_{it}=(y_1,\ldots,y_{N,t})'$ is a vector of three variables: GDP (Real GDP growth), CPI (CPI Change) and FSI; f_i denotes fixed effects; d_t denotes the forward mean-differencing; e_{it} is a vector of independently and identically distributed errors. Data were time demeaned and forward mean-differenced, using the Helmert procedure and following Arellano and Bover, (1995) as fixed effects are usually correlated with the regressors. Model 1 was estimated using GMM-style instruments as proposed by Holtz-Eakin et al. (1988). First, we present the results of the PVAR and then we proceed to Granger causality Wald tests for each equation of the underlying PVAR model, testing the hypothesis that all coefficients on the lag of variable m are jointly zero in the equation for variable n., Finally we present the impulse response functions (IRFs) using Monte Carlo (MC) simulations for the confidence intervals and following Cholesky identification and the forecast-error variance decompositions (FEVDs).

4. Empirical results

First, we test for the stability of our PVAR checking whether all eigenvalues lie inside the inner circle. Usually variables that are introduced first in VAR models are assumed to be the most exogenous and affect subsequent variables both contemporaneously and with a lag, whereas variables that are ordered later are less exogenous and affect previous variables only with a lag. Following these general directions, we introduce macro-economic variables first in the system and estimate our baseline model: GDP→CPI→FSI. Next, we introduce our augmented model of five variables including a measure of government deficit (deficit/surplus, DEF) and a measure of the real estate markets (house prices, HP): GDP→DEF→HP→CPI→FSI.

4.1 PVAR results

Primary, we present the results from the estimated PVAR(2) and the GMM coefficients. From Table 2, we observe that GDP growth has a negative effect on FSI concurrently and after a lag, while has an effect on CPI only after a lag. Taking FSI as the dependent variable, we observe that most of the GMM coefficients of CPI and GDP growth are significant.

4.2 Granger-causality

Next, we examine the cross-country Granger causation of financial stress. In Table 4, we report the Chi-square Wald statistics for the null hypothesis that the FSI does not Granger-cause CPI or GDP growth and vice versa. The final row reports the joint probability of all lagged variables in the equation, in which we test the null hypothesis that all lags of all variables can be excluded from each equation in the VAR system. We can characterize Granger causalities from FSI to GDP growth and from CPI to GDP growth as bidirectional. However, Granger causation from FSI to CPI found to be unidirectional. In that case, we argue that the causality runs one way only—from financial stress to inflation. The joint significance Chi-square statistics in the last row indicate all variables are Granger-caused by all the lagged variables.

4.3 Panel impulse response functions

The same ordering used in the PVAR was used in the estimation of the IRFs and FEVDs. Fig. 2, plots the responses to a one standard deviation shock for a 10 quarters period. GDP growth responds negatively and significantly to a shock of the FSI. Our findings are in line to other scholars that examine the relationship of financial stress and growth (Apostolakis and Papadopoulos, 2015; Bloom, 2009; Cevik et al., 2013; Creel et al., 2015; Hakkio and Keeton, 2009; Mallick and Sousa, 2013). FSI responds negatively in the first lags but not significantly to a shock of the GDP growth and responds positively to an inflation shock. That means that a positive shock in the general level of prices increase financial stress in the short term. Turning now to inflation responses from a GDP growth shock or a FSI shock, we observe a positive and significant impact from a GDP growth shock, while inflation responds negatively but not significant to a shock of the FSI. Finally, GDP growth responds negatively to an inflation shock, in line with the findings of Apostolakis and Papadopoulos (2015).

Insert Fig. 2 about here

4.4 Panel variance decompositions

Table 4 reports the FEVDs of the baseline PVAR model after 10 and 20 periods. We observe that the CPI explains about 14% of the total variance in GDP, while GDP growth and FSI explain about 25% and about 28% of the total variance of CPI, respectively. GDP growth has the largest explanatory power for the financial stress, explaining about 14% indicating a rather large influence. CPI explains only a small portion of the variance of the FSI (2%).

4.5 Augmented PVAR model including house prices and government deficit

Tables 5, 6 and 7 show the results of the PVAR analysis with 5 variables. Table 6 shows that there is a bidirectional relationship between FSI and house prices. Table 7 indicates that house prices can explain about 10% of the variance of the FSI while deficit can explain only

1%. About 10% of the variation of GDP growth is explained by the macro-variables. Financial stress and GDP growth explain a large portion of the variation of the inflation. Variation in house prices is explained by deficit (33%) and GDP growth (18%). In Fig. 2 we illustrate the impulse responses of the augmented model: GDP→DEF→HP→CPI→FSI. The response of GDP growth to FSI shocks remain negative and significant as in our three-variable model. Afonso et al. (2017) find that a financial stress shock has a negative effect on output and worsens the fiscal situation. Additionally, we observe no significant response from financial stress to a positive growth shock. A positive shock to the FSI has a negative, but small effect, on house prices. A shock on house prices increases significantly financial stress for the first periods. A larger negative response is observed to deficit from a positive shock of the FSI.

Furthermore, we observe that a positive impact on house prices increases GDP growth. This outcome is in line with the findings of Goodhart and Hofmann (2008). Notably, the impulse-response function of GDP growth on deficit shows that when there is a positive shock to GDP growth, deficit shows a strong positive response for the first 2 periods (bottom row). Reversely, the response of GDP growth in a deficit shock, although it is positive in the short run, before becomes negative, is not significant. Our findings are in contrast to Taylor et al. (2012) who find a negative response of real primary deficit to a shock in GDP growth. Proaño et al. (2014) find that financial stress affects the relationship between debt and economic growth via its impact on risk premia, in particular bond spreads. Debt impairs economic growth primarily during times of high financial stress. Furthermore, Lof and Malinen (2014) find a significant negative effect of growth on debt, but the reverse effect of debt on growth, is not significant. A positive shock to deficit is translated into a positive response from the CPI. Examining emerging market economies, Jawadi et al. (2016) show that an unexpected fiscal policy expansion has a has a positive effect on output and has a persistent and positive effect on the price level.

Insert Fig. 3 about here

4.6 Robustness tests

As a robustness test, first we use an alternative PVAR model, and the least squares dummy variable estimator as described by Cagala and Glogowsky (2015). In Fig. 1 in the Appendix B we provide the IRFs using this approach. Results are similar except the response of FSI in a growth shock (bottom left) which is now positive and significant after a lag. Furthermore, responses of FSI and CPI to CPI and GDP growth shocks respectively, have become non-significant. Secondly, we conduct sensitivity analyses with respect to different Cholesky orderings and also, we construct and examine cumulative impulse response functions. More volatile variables are usually put at the end of the model as it is expected to affect all other variables contemporaneously, while they affected by all other variables with a lag. As GDP and deficit are expected to affect all other variables contemporaneously, while they are affected by all other by a lag can be found at the beginning of the system, while FSI can be always found at the end of the Cholesky ordering as it is expected to react contemporaneously to all other variables in the system but affect the other variables with a lag. The following models were estimated:

i. GDP→DEF→CPI→HP→FSI,
ii. DEF→GDP→HP→CPI→FSI,
iii. DEF→GDP→CPI→HP→FSI.

Appendix B provides the IRFs of different ordering of the five variable PVAR model. The IRFs are similar to the initial ordering and we can argue that our findings are resistant to the different variable orderings. Finally, in Fig. 4 we present the cumulative IRFs for the baseline model and in Fig. 5 for our augmented model. The results verify our previous findings: GDP growth leads to a higher level of inflation. CPI leads to higher financial stress but lower GDP growth, while FSI leads to lower inflation and GDP growth. In addition, we observe no significant response from FSI to a GDP growth shock. In Fig. 5, we observe that a shock on house prices has a positive and significant impact on financial stress, while a financial shock has a negative impact to deficit and house prices.

Insert Figs. 4 and 5 about here
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5. Conclusions

This paper examines the macro-financial stress relationship by applying a PVAR approach for 19 advanced countries and constructing IRFs, over the period 1999–2016. To our knowledge, this is the first paper that adopts a PVAR framework, to study the relationship between financial stability monetary stability and growth. The results reveal, that a positive shock to financial stress results in negative impact in all macro-economic variables: First and foremost, has a negative impact on growth and also negative for inflation. House prices and deficit responses are also negative. Financial stress is positively influenced by inflation shock and increases in house prices. In contrast, a positive economic shock or an increase on the deficit do not influence financial stress. Analyses of variance decomposition and Granger causality further support our findings of the relationship between financial stress and macro-economic variables. We find that growth, deficit, house prices and inflation explain about 30% of the variation of financial stress. Monitoring risk stemming from potential house bubbles is important for the resiliency of the financial system. Overall, our findings provide new insights about the importance of financial stability in the context of macro-prudential policy and regulation. In this light, it is important policy makers and central bankers to develop a macroprudential monitoring framework and tools for examining financial stability and soundness. Future research should study the relationship between financial stress and macroeconomic variables, focusing on the potential differences between developed and developing countries.

References

Afonso, A., Baxa, J., Slavík, M., 2017. Fiscal developments and financial stress: a threshold VAR analysis. Empir. Econ. 1–29. https://doi.org/10.1007/s00181-016-1210-5

Apostolakis, G., Papadopoulos, A.P., 2015. Financial stress spillovers across the banking, securities and foreign exchange markets. J. Financ. Stab. 19, 1–21. https://doi.org/10.1016/j.jfs.2015.05.003

Arellano, M., Bover, O., 1995. Another look at the instrumental variable estimation of error-components models. J. Econom. 68, 29–51.

Bernanke, B.S., Gertler, M., Gilchrist, S., 1999. The financial accelerator in a quantitative business cycle framework, in: Taylor, J.B., Woodford, M. (Eds.), Handbook of Macroeconomics. Elsevier, pp. 1341–1393.

Bloom, N., 2009. The impact of uncertainty shocks. Econometrica 77, 623–685. https://doi.org/10.3982/ECTA6248

Blot, C., Creel, J., Hubert, P., Labondance, F., Saraceno, F., 2015. Assessing the link between price and financial stability. J. Financ. Stab. 16, 71–88. https://doi.org/10.1016/j.jfs.2014.12.003

Borio, C., Lowe, P., 2002. Asset prices, financial and monetary stability: exploring the nexus (BIS Working Paper No. No 114). Bank for International Settlements.

Cagala, T., Glogowsky, U., 2015. XTVAR: Stata module to compute panel vector autoregression, Statistical Software Components.

Cardarelli, R., Elekdag, S., Lall, S., 2011. Financial stress and economic contractions. J. Financ. Stab. 7, 78–97. https://doi.org/10.1016/j.jfs.2010.01.005

Carlson, M., Lewis, K., Nelson, W., 2012. Using Policy Intervention to Identify Financial Stress (SSRN Scholarly Paper No. ID 1991854). Social Science Research Network, Rochester, NY.

Carlson, M.A., King, T., Lewis, K., 2011. Distress in the financial sector and economic activity. BE J. Econ. Anal. Policy 11. https://doi.org/10.2202/1935-1682.2697

Cevik, E.I., Dibooglu, S., Kutan, A.M., 2013. Measuring financial stress in transition economies. J. Financ. Stab. 9, 597–611. https://doi.org/10.1016/j.jfs.2012.10.001

Corsetti, G., Kuester, K., Meier, A., Müller, G.J., 2013. Sovereign Risk, Fiscal Policy, and Macroeconomic Stability. Econ. J. 123, F99–F132. https://doi.org/10.1111/ecoj.12013

Creel, J., Hubert, P., Labondance, F., 2015. Financial stability and economic performance. Econ. Model., Special Issue on Current Challenges on Macroeconomic Analysis and International Finance Modelling 48, 25–40. https://doi.org/10.1016/j.econmod.2014.10.025

Cúrdia, V., Woodford, M., 2009. Credit frictions and optimal monetary policy (BIS Working Paper No. 278). Bank for International Settlements.

Das, U.S., Papapioannou, M., Pedras, G., Ahmed, F., Surti, J., 2010. Managing public debt and its financial stability implications. Sover. DEBT Financ. CRISIS 357.

De Graeve, F., Kick, T., Koetter, M., 2008. Monetary policy and financial (in)stability: an integrated micro-macro approach. J. Financ. Stab. 4, 205–231.

Fischer, S., 1993. The role of macroeconomic factors in growth. J. Monet. Econ. 32, 485–512. https://doi.org/10.1016/0304-3932(93)90027-D

Galariotis, E.C., Makrichoriti, P., Spyrou, S., 2016. Sovereign CDS spread determinants and spill-over effects during financial crisis: A panel VAR approach. J. Financ. Stab. 26, 62–77. https://doi.org/10.1016/j.jfs.2016.08.005

Georgoutsos, D., Moratis, G., 2017. Bank-sovereign contagion in the Eurozone: A panel VAR Approach. J. Int. Financ. Mark. Inst. Money 48, 146–159. https://doi.org/10.1016/j.intfin.2017.01.004

Gertler, M., Karadi, P., 2011. A model of unconventional monetary policy. J. Monet. Econ., Carnegie-Rochester Conference Series on Public Policy: The Future of Central Banking April 16-17, 2010 58, 17–34. https://doi.org/10.1016/j.jmoneco.2010.10.004

Gertler, M., Kiyotaki, N., 2010. Chapter 11 - financial intermediation and credit policy in business cycle analysis, in: Benjamin M. Friedman and Michael Woodford (Ed.), Handbook of Monetary Economics. Elsevier, pp. 547–599.

Gilchrist, S., Yankov, V., Zakrajšek, E., 2009. Credit market shocks and economic fluctuations: Evidence from corporate bond and stock markets. J. Monet. Econ. 56, 471–493. https://doi.org/10.1016/j.jmoneco.2009.03.017

Goodhart, C., Hofmann, B., 2008. House prices, money, credit, and the macroeconomy. Oxf. Rev. Econ. Policy 24, 180–205. https://doi.org/10.1093/oxrep/grn009

Grossmann, A., Love, I., Orlov, A.G., 2014. The dynamics of exchange rate volatility: A panel VAR approach. J. Int. Financ. Mark. Inst. Money 33, 1–27. https://doi.org/10.1016/j.intfin.2014.07.008

Hakkio, C.S., Keeton, W.R., 2009. Financial stress: what is it, how can it be measured, and why does it matter? Econ. Rev. 5–50.

Hanschel, E., Monnin, P., 2005. Measuring and forecasting stress in the banking sector: evidence from Switzerland (BIS Papers chapters). Bank for International Settlements.

Hatzius, J., Hooper, P., Mishkin, F.S., Schoenholtz, K.L., Watson, M.W., 2010. Financial Conditions Indexes: A Fresh Look after the Financial Crisis (Working Paper No. 16150). National Bureau of Economic Research. https://doi.org/10.3386/w16150

Helbling, T.F., 2005. Housing price bubbles - a tale based on housing price booms and busts, in: BIS Papers Chapters. Bank for International Settlements, pp. 30–41.

Hollo, D., Kremer, M., Lo Duca, M., 2012. CISS - A Composite Indicator of Systemic Stress in the Financial System (SSRN Scholarly Paper No. ID 2018792). Social Science Research Network, Rochester, NY.

Holtz-Eakin, D., Newey, W., Rosen, H.S., 1988. Estimating vector autoregressions with panel data. Econom. J. Econom. Soc. 1371–1395.

Illing, M., Liu, Y., 2006. Measuring financial stress in a developed country: An application to Canada. J. Financ. Stab. 2, 243–265.

Jacobson, T., Lindé, J., Roszbach, K., 2005. Exploring interactions between real activity and the financial stance. J. Financ. Stab. 1, 308–341. https://doi.org/10.1016/j.jfs.2005.02.011

Jawadi, F., Mallick, S.K., Sousa, R.M., 2016. Fiscal and monetary policies in the BRICS: A panel VAR approach. Econ. Model. 58, 535–542. https://doi.org/10.1016/j.econmod.2015.06.001

Kiyotaki, N., Moore, J., 1997. Credit cycles. J. Polit. Econ. 105, 211–48.

Lof, M., Malinen, T., 2014. Does sovereign debt weaken economic growth? A panel VAR analysis. Econ. Lett. 122, 403–407. https://doi.org/10.1016/j.econlet.2013.12.037

Love, I., Zicchino, L., 2006. Financial development and dynamic investment behavior: Evidence from panel VAR. Q. Rev. Econ. Finance 46, 190–210. https://doi.org/10.1016/j.qref.2005.11.007

Mallick, S.K., Sousa, R.M., 2013. The real effects of financial stress in the Eurozone. Int. Rev. Financ. Anal. 30, 1–17. https://doi.org/10.1016/j.irfa.2013.05.003

Misina, M., Tkacz, G., 2008. Credit, asset prices, and financial stress in Canada (No. Vol. 5 No. 4). Bank of Canada Working Paper.

Mittnik, S., Semmler, W., 2013. The real consequences of financial stress. J. Econ. Dyn. Control 37, 1479–1499.

Proaño, C.R., Schoder, C., Semmler, W., 2014. Financial stress, sovereign debt and economic activity in industrialized countries: Evidence from dynamic threshold regressions. J. Int. Money Finance 45, 17–37.
Reinhart, C.M., Rogoff, K.S., 2010. Growth in a Time of Debt. Am. Econ. Rev. 100, 573–578. https://doi.org/10.1257/aer.100.2.573
Reinhart, C.M., Rogoff, K.S., 2009a. The Aftermath of Financial Crises. Am. Econ. Rev. 99, 466–472. https://doi.org/10.1257/aer.99.2.466
Reinhart, C.M., Rogoff, K.S., 2009b. This Time Is Different: Eight Centuries of Financial Folly. Princeton University Press, Princeton, New Jersey.
Schwartz, A.J., 1995. Why financial stability depends on price stability. Econ. Aff. 15, 21–25. https://doi.org/10.1111/j.1468-0270.1995.tb00493.x
Taylor, L., Proaño, C.R., de Carvalho, L., Barbosa, N., 2012. Fiscal deficits, economic growth and government debt in the USA. Camb. J. Econ. 36, 189–204. https://doi.org/10.1093/cje/ber041
Van den End, J.W., 2006. Indicator and boundaries of financial stability (DNB Working Paper No. 097). Netherlands Central Bank, Research Department.
Vašíček, B., Žigraiová, D., Hoeberichts, M., Vermeulen, R., Šmídková, K., de Haan, J., 2017. Leading indicators of financial stress: New evidence. J. Financ. Stab. 28, 240–257. https://doi.org/10.1016/j.jfs.2016.05.005
Vermeulen, R., Hoeberichts, M., Vašíček, B., Žigraiová, D., Šmídková, K., Haan, J. de, 2015. Financial Stress Indices and Financial Crises. Open Econ. Rev. 26, 383–406. https://doi.org/10.1007/s11079-015-9348-x
Zhu, H., 2005. The importance of property markets for monetary policy and financial stability, in: BIS Papers Chapters. Bank for International Settlements, pp. 9–29.

Tables

Tables

Table 1

Descriptive statistics: advanced countries

Panel A N=72	Mean	Median	MAX	MIN	Std.	Mean	Median	Max	Min	Std.	Mean	Median	MAX	MIN	Std.
	FSI					**CPI**					**GDP**				
AS	-0.186	-0.548	11.528	-3.0734	2.29802	1.853972	1.772833	3.772333	0.202667	0.875792	1.6431	1.6505	5.57	-5.842	1.976094
AU	-0.487	-0.759	10.318	-3.3555	2.20889	2.713037	2.613833	6.096333	1.051667	1.094287	3.0339	2.876	5.167	1.158	0.983906
BG	-0.369	-1.081	7.1665	-4.2711	2.45773	1.937514	1.913667	5.693333	-1.14133	1.216017	1.6684	1.6035	5.121	-3.811	1.669722
CN	-0.639	-1.123	11.439	-4.3384	2.53761	1.917537	1.9275	4.478667	-0.81867	0.876593	2.3172	2.4755	5.892	-4.048	1.843587
DK	-0.777	-1.171	5.8629	-4.7618	2.27457	1.840093	2.0855	4.209667	0.117	0.937295	1.2457	1.468	4.732	-6.168	2.123439
ES	-1.238	-1.634	3.0275	-3.6286	1.66877	2.220343	2.645833	4.922	-1.113	1.589416	1.929	3.081	5.586	-4.263	2.684996
FR	-1.094	-1.496	4.5033	-3.8324	1.76741	1.389356	1.633167	3.289667	-0.402	0.849332	1.4165	1.322	4.439	-3.824	1.555222
GER	0.2962	-0.333	8.2702	-3.1577	2.31778	1.378968	1.387333	3.118667	-0.20667	0.744946	1.3636	1.6095	5.569	-6.926	2.31334
GR	-0.385	-0.382	2.5128	-3.2221	1.36229	2.167181	2.822167	5.55	-2.44733	2.055831	0.3327	0.8435	6.778	-10.277	4.66284
IR	-0.57	-1.293	8.652	-3.4491	2.55677	2.055935	2.292833	6.675	-6.06367	2.620584	5.324	5.385	27.717	-9.055	6.598652
IT	-1.462	-1.653	3.3221	-5.1878	1.7596	1.838986	2.139	3.967	-0.431	1.061835	0.3823	0.8695	4.19	-7.209	2.239414
JP	0.2107	-0.312	10.699	-3.3176	2.58863	-0.02283	-0.20333	3.606	-2.17233	1.038817	0.8429	1.07	5.527	-8.67	2.223669
NL	0.311	-0.602	11.209	-4.6259	2.9525	1.882222	1.837333	4.402333	-0.00933	0.994615	1.6013	1.803	5.661	-4.52	2.122766
NW	-0.089	-0.456	12.935	-4.171	2.7408	2.085069	2.056667	4.856	-1.299	1.089211	1.7202	1.8365	5.393	-1.567	1.666516
PT	-0.499	-0.694	4.0452	-3.1014	1.83494	2.071343	2.419833	4.748	-1.404	1.496686	0.6968	1.2695	4.809	-4.466	2.282493
SD	-0.065	-0.304	5.6287	-3.4654	1.83883	1.169963	1.038167	4.424	-1.127	1.157613	2.4732	2.992	7.872	-6.301	2.706271
SW	-0.02	-0.564	7.2556	-2.8198	2.0704	0.48775	0.469833	3.003333	-1.39133	0.920821	1.8763	1.9805	4.63	-3.185	1.705113
UK	-0.706	-1.214	8.7131	-4.2246	2.40782	1.951569	1.713333	4.848667	-0.052	1.153338	1.9318	2.194	4.906	-5.922	1.96749
US	-0.034	-0.545	11.084	-4.286	2.74659	2.180787	2.079667	5.253	-1.607	1.25477	2.1035	2.277	5.266	-4.062	1.810935

Panel B												
	Mean	Median	Max	Min	Std.	N	Mean	Median	Max	Min	Std.	N
	DEF						**HP**					
AS	-0.05646	0.059833	5.294333	-3.852	1.21783	52	0.008841	0.008326	0.08284	-0.07483	0.024321	67
AU	-0.98636	-0.65383	7.763	-7.93633	3.03832	72	0.018678	0.018943	0.059506	-0.02222	0.019817	72
BG	NA	NA	NA	NA	NA	0	0.008631	0.009304	0.035654	-0.02385	0.013308	47
CN	-0.09948	0.008833	2.139	-4.85067	1.235289	72	0.016746	0.016504	0.061637	-0.03446	0.018397	72
DK	0.06563	0.028333	3.041667	-3.258	1.182537	72	0.010697	0.01153	0.077626	-0.07787	0.026184	72
ES	-0.17164	0.364833	10.26333	-10.2097	3.78227	52	0.010467	0.012213	0.065068	-0.05195	0.027672	72
FR	-0.17511	0.008667	11.92867	-10.5	3.866514	72	0.012486	0.010595	0.052279	-0.03726	0.019527	72
GER	0.258176	0.8835	12.77233	-14.899	4.925162	72	0.003247	0.001398	0.02224	-0.01022	0.007384	72
GR	-0.05328	-0.01933	6.988333	-6.298	1.630064	72	-0.00965	-0.01174	0.041988	-0.03951	0.017836	43
IR	-0.00669	0.075	0.995	-1.84967	0.493769	72	0.008151	0.01253	0.097731	-0.07775	0.037643	72
IT	-0.04936	-0.1455	11.83267	-15.4547	5.701025	72	0.005053	0.005437	0.057372	-0.02207	0.013306	72
JP	0.30995	3.186333	26.11633	-45.531	13.4552	43	-0.00482	-0.00757	0.027407	-0.01868	0.009924	72
NL	0.033471	0.0465	4.004	-7.452	1.606759	68	0.008254	0.008745	0.052992	-0.03889	0.017758	72
NW	-0.06375	0.021333	4.108	-6.79833	1.786578	72	0.018055	0.019423	0.080997	-0.0704	0.02791	72
PT	-0.02223	0.018167	1.923333	-2.097	0.597187	72	0.000213	0.000795	0.037446	-0.03192	0.015991	35
SD	0.044009	0.198167	5.016333	-6.67433	1.94668	72	0.018406	0.019079	0.061293	-0.05187	0.017753	72
SW	0.021972	-0.00717	0.635667	-0.53967	0.280575	72	0.007682	0.007602	0.02569	-0.01025	0.006772	72
UK	-0.33398	-0.01467	8.696667	-13.2437	3.681925	72	0.015298	0.018297	0.082	-0.06616	0.025713	72
US	-2.94444	0.224833	71.97267	-110.597	29.28226	72	0.009837	0.015788	0.041659	-0.05137	0.021817	72

Panel B: Panel data descriptive					
	FSI	CPI	GDP	DEF	HP
Mean	-0.411	1.7431	1.7843	-0.2527	0.00942
Median	-0.811	1.7893	1.906	0.05333	0.00874
Max	12.935	6.675	27.717	71.9727	0.09773
Min	-5.188	-6.064	-10.28	-110.6	-0.07787
Std. Dev.	2.3073	1.4252	2.8628	7.97651	0.02212
Skewness	1.6823	-0.245	1.0567	-3.4851	-0.09406
Kurtosis	7.9049	4.2899	18.667	63.4139	4.31852
JB	2016.541***	108.5279***	14246.28***	188465.3***	94.01567***
LLC	-12.4079***	-3.65513***	-5.91240***	-13.1835***	-5.84545***
N	1368	1368	1368	1223	1272
Panel C: Pairwise correlations among variables	1	2	3	4	5
FSI	1				
CPI	0.14333***	1			
GDP	-0.24329***	0.10241***	1		
DEF	-0.16682***	0.05910**	0.18201***	1	
HP	-0.28362***	0.04940*	0.38994***	0.09591***	1

Note: J-B denotes the Jarque-Bera test for normality. LLC is the panel unit root test (with just a constant using AIC to select the lag length and Newey-West automatic bandwidth selection and Bartlett kernel) of Levin, Lin and Chu (2002), Ho: Panels contain unit roots vs. Ha: Panels are stationary. *** denotes significance at the 1% level. ** denotes significance at the 5% level.

Table 2

PVAR (2) coefficient estimates.

Dependent variable	GDP	CPI	FSI
GDP (1)	0.9078***	0.0521***	-0.0793***
	(20.3150)	(3.8067)	(-2.9741)
GDP (2)	-0.0654	-0.0192	0.0619**
	(-1.3885)	(-1.4808)	(2.4341)
CPI (1)	-0.0840	1.1815***	0.4958***
	(-0.8846)	(30.9535)	(6.0965)
CPI (2)	-0.1843***	-0.3268***	-0.5130***
	(-2.6380)	(-9.0485)	(-6.3024)
FSI (1)	-0.0749***	-0.0039	0.8013***
	(-3.0657)	(-0.2746)	(20.1501)
FSI (2)	-0.0741***	0.0050	-0.0615*
	(-3.1194)	(0.4114)	(-1.8021)

Note: No. of obs. = 1311, No. of panels = 19, Instruments: l(1/4). Robust standard errors, Z stats in parentheses. The VAR model estimated 2 lags according to MBIC. *** denotes significance at the 1% level. ** denotes significance at the 5% level. * denotes significance at the 10% level.

Table 3

Granger causality tests among the advanced countries

	FSI	CPI	GDP
FSI		0.155	40.620***
CPI	44.769***		17.863***
GDP	9.047**	25.019***	
All	47.056***	25.669***	81.777***

Note: The tests are based on the PVAR(2) model. Entries in the table are chi-square statistics for the null hypothesis that the excluded variable does not Granger-cause Equation variable vs the alternative hypothesis that the excluded variable Granger-causes Equation variable. *** denotes significance at the 1% level. ** denotes significance at the 5% level. * denotes significance at the 10% level.

Table 4

Forecast-error variance decomposition (FEVD).

Response variable & Forecast horizon	Impulse variable		
	GDP	CPI	FSI
GDP			
10	0.6323	0.2373	0.1304
20	0.6063	0.2549	0.1387
CPI			
10	0.1403	0.8463	0.0134
20	0.1443	0.8302	0.0255
FSI			
10	0.0029	0.0767	0.9204
20	0.0043	0.0790	0.9167

*** denotes significance at the 1% level. ** denotes significance at the 5% level. * denotes significance at the 10% level.

Table 5

PVAR (1) estimates

VARIABLES	GDP	DEF	HP	CPI	FSI
GDP	0.7150***	0.2371***	0.0004*	0.0159*	-0.0129
	(20.3570)	(4.0316)	(1.9140)	(1.7649)	(-0.6760)
DEF	0.0073*	0.5081***	-0.0001**	0.0102***	0.0034
	(1.8396)	(6.8000)	(-2.1457)	(4.2280)	(0.6437)
HP	37.2332***	-0.0848	0.6276***	7.2232***	13.0846***
	(11.7641)	(-0.0137)	(16.0910)	(6.3049)	(5.0680)
CPI	-0.3275***	0.2610*	0.0007	0.8369***	0.0595
	(-5.3635)	(1.7750)	(1.3526)	(35.2268)	(1.2780)
FSI	-0.1301***	-0.1766*	-0.0016***	0.0116	0.8111***
	(-5.3783)	(-1.6757)	(-5.3601)	(1.1494)	(22.6450)
Observations	1,121	1,121	1,121	1,121	1,121

Note: No. of obs. = 1.121, No. of panels = 19, Instruments: l(1/4). Robust standard errors, Z stat in parentheses. The VAR model estimated 1 lag according to MBIC. *** denotes significance at the 1% level. ** denotes significance at the 5% level. * denotes significance at the 10% level.

Table 6

Forecast-error variance decomposition (FEVD)

Response variable & Forecast horizon	GDP	DEF	HP	CPI	FSI
GDP					
10	0.4979	0.0158	0.1793	0.1289	0.1781
20	0.4852	0.0173	0.1779	0.1274	0.1922
def					
10	0.0282	0.6082	0.3313	0.0216	0.0106
20	0.0286	0.6005	0.3352	0.0250	0.0108
HP					
10	0.0298	0.0071	0.8610	0.0113	0.0908
20	0.0315	0.0073	0.8521	0.0115	0.0977
CPI					
10	0.0390	0.0347	0.0283	0.8976	0.0005
20	0.0389	0.0348	0.0311	0.8948	0.0005
FSI					
10	0.0061	0.0082	0.0177	0.0828	0.8853
20	0.0060	0.0090	0.0177	0.0876	0.8797

*** denotes significance at the 1% level. ** denotes significance at the 5% level. * denotes significance at the 10% level.

Table 7

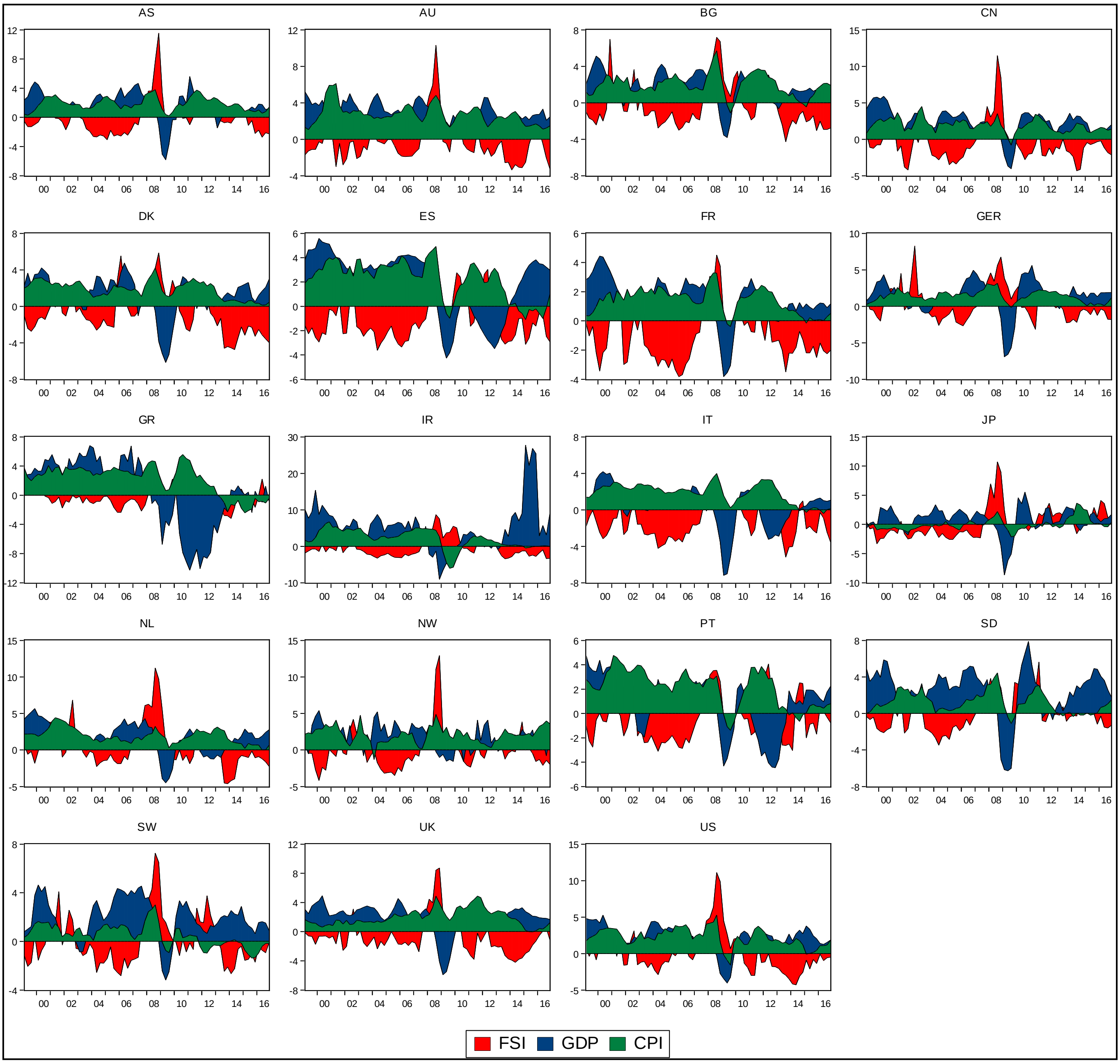
Granger causality tests among the advanced countries.

Lags (1)	GDP	DEF	HP	CPI	FSI
GDP		16.254***	3.663*	3.115*	0.457
DEF	3.384*		4.604**	17.876***	0.414
HP	138.393***	0		39.751***	25.684***
CPI	28.768***	3.151*	1.829		1.633
FSI	28.926***	2.808*	28.73***	1.321	
All	271.364***	28.825***	38.871***	70.823***	30.367***

Note: The tests are based on the PVAR(1) model. Entries in the table are chi-square statistics for the null hypothesis that the excluded variable does not Granger-cause Equation variable vs the alternative hypothesis that the excluded variable Granger-causes Equation variable. *** denotes significance at the 1% level. ** denotes significance at the 5% level. * denotes significance at the 10% level.

Figures

Fig. 2 FSI, GDP, and CPI



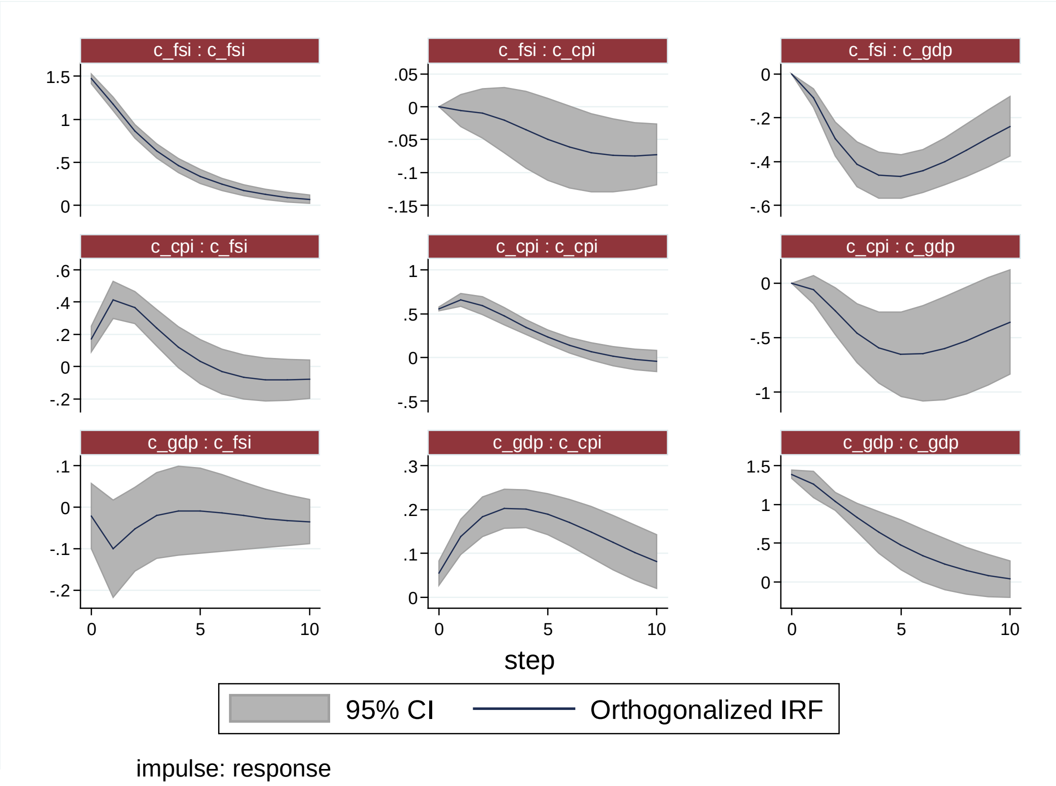


Fig. 3. IRFs of shocks, baseline model.
Note: Impulse: Response, PVAR(2), error bands were drawn from 500 MC repetitions.

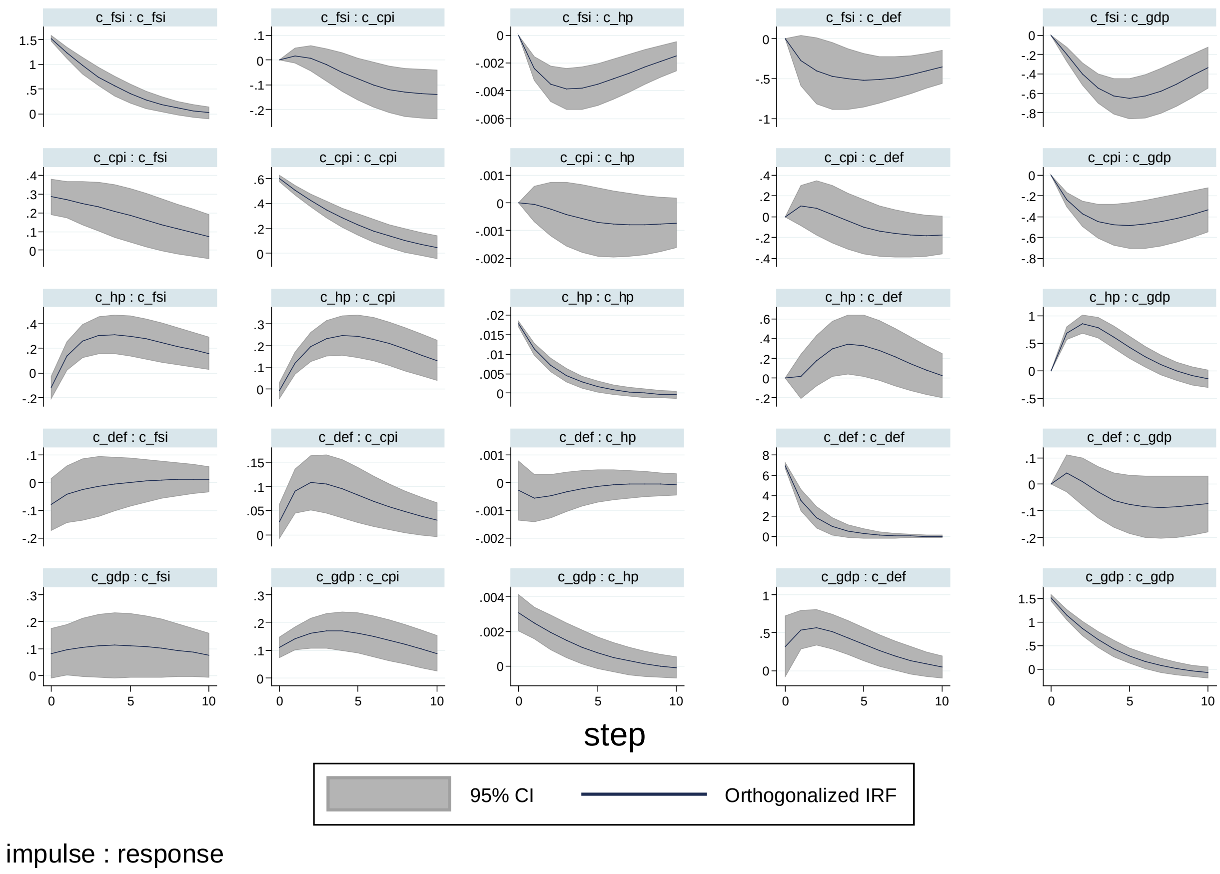


Fig. 4. IRFs of shocks, 5 variables model.
Note: VAR(1), error bands were drawn from 500 repetitions.

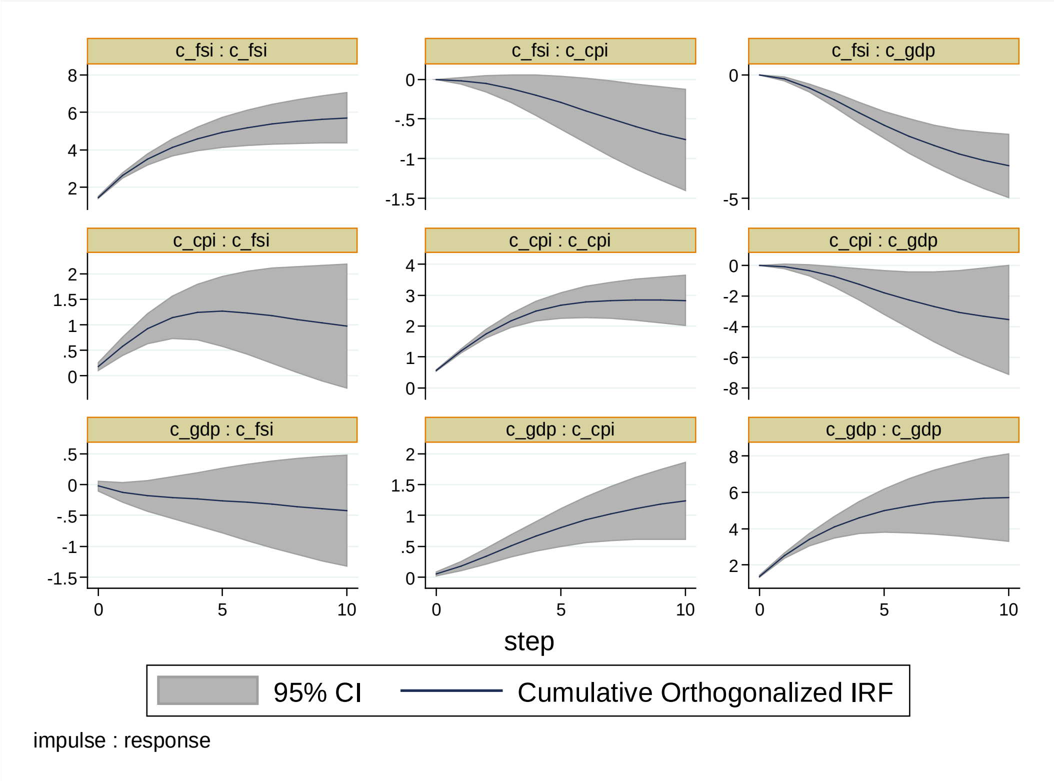


Fig. 5. Accumulated IRFs of shocks.
Note: VAR(2), error bands were drawn from 500 repetitions.

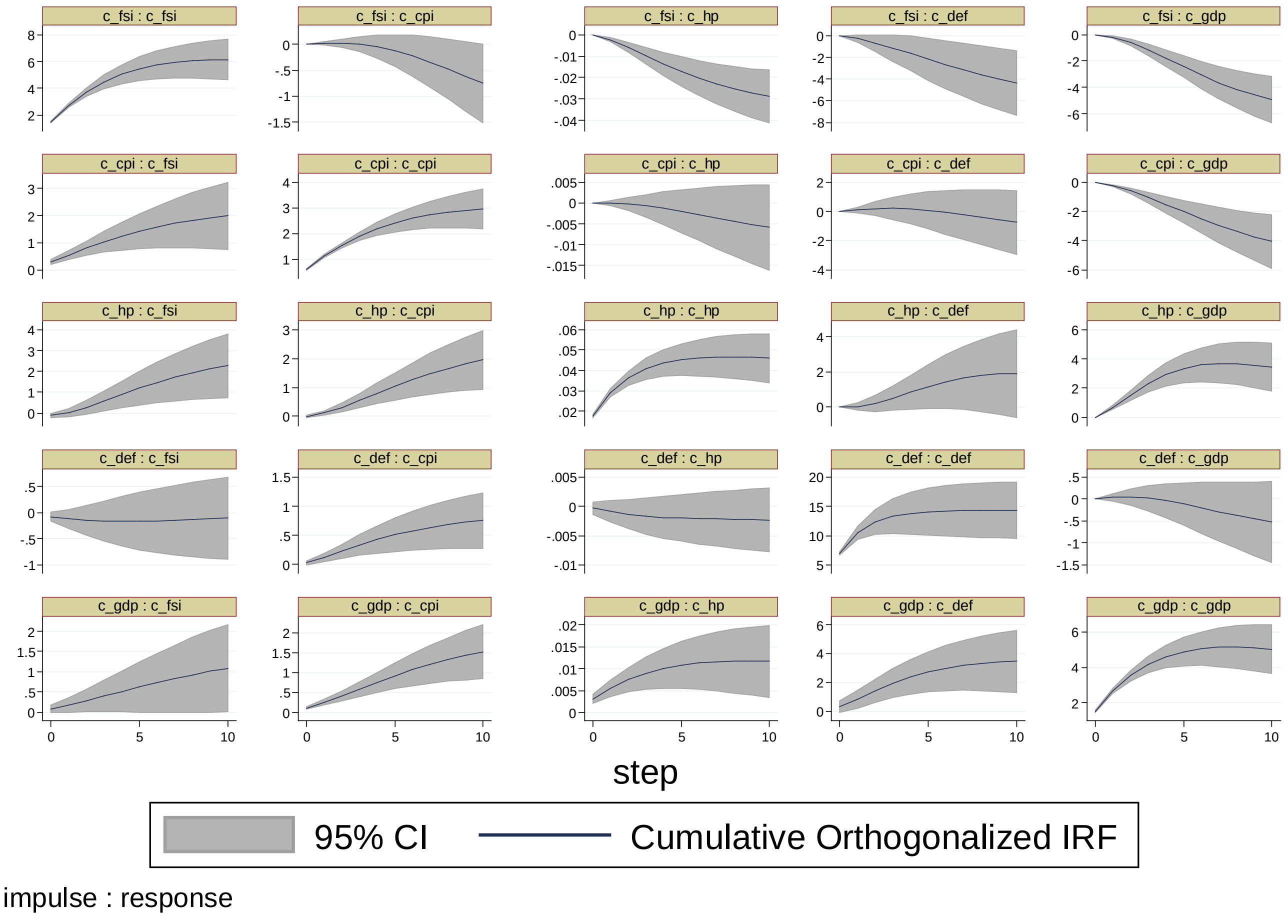


Fig. 6. Accumulated IRFs of shocks, 5 variables model.
Note: VAR(1), error bands were drawn from 500 repetitions.

Appendix A: Data Description

A) FSI components

Component	Calculation	Source
Banking beta (CAPM)	$B_{it} = {cov(r_{it}^{M}, r_{it}^{B})}/{\sigma_{i,M}^{2}}$	DataStream
Inverted term spread	The government short-term rate minus government long-term rate	DataStream and OECD
Sovereign risk	Long-term interest rate - US long-term interest rate (0 for the US)	DataStream and OECD
Stock market returns	The inverted month-over-month change in the stock index	DataStream
Stock market volatility	GARCH (1.1)	DataStream
Exchange market volatility	GARCH (1.1)	BIS

Note: Monthly series**.** The aggregate FSI is compiled by standardized and summing the six components: FSI_t = Banking beta + Inverted term spread + Sovereign risk+ Stock market returns + Stock market volatility + Exchange market volatility.

B) Description of the time series used in the second part of the paper

Series	Frequency	Source	Description
GDP	Q	DataStream	Real gross domestic product, % YoY, Standardized
CPI	M	DataStream	Consumer price index, % YoY, Standardized
House prices	Q	BIS, DataStream	Residential Property Prices; Long Series, NSA &OE Residential Property Prices: All Dwellings, % MoM
Govt. debt	M	DataStream	Central Government Deficit/Surplus, CHG YoY, Standardized, CURN

Appendix B: Robustness tests

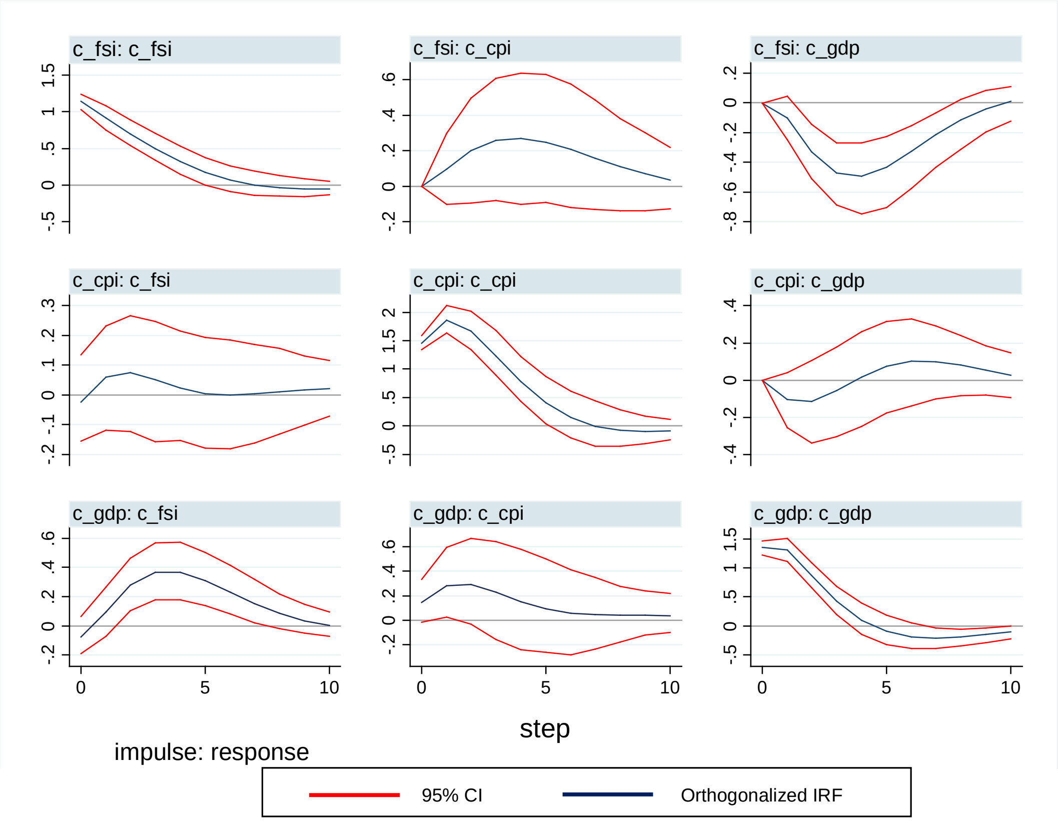


Fig. 7 Orthogonalized IRFs of shocks, using the least squares dummy variable estimator.
Note: VAR(2), error bands were drawn from 500 repetitions. 95% confidence intervals.

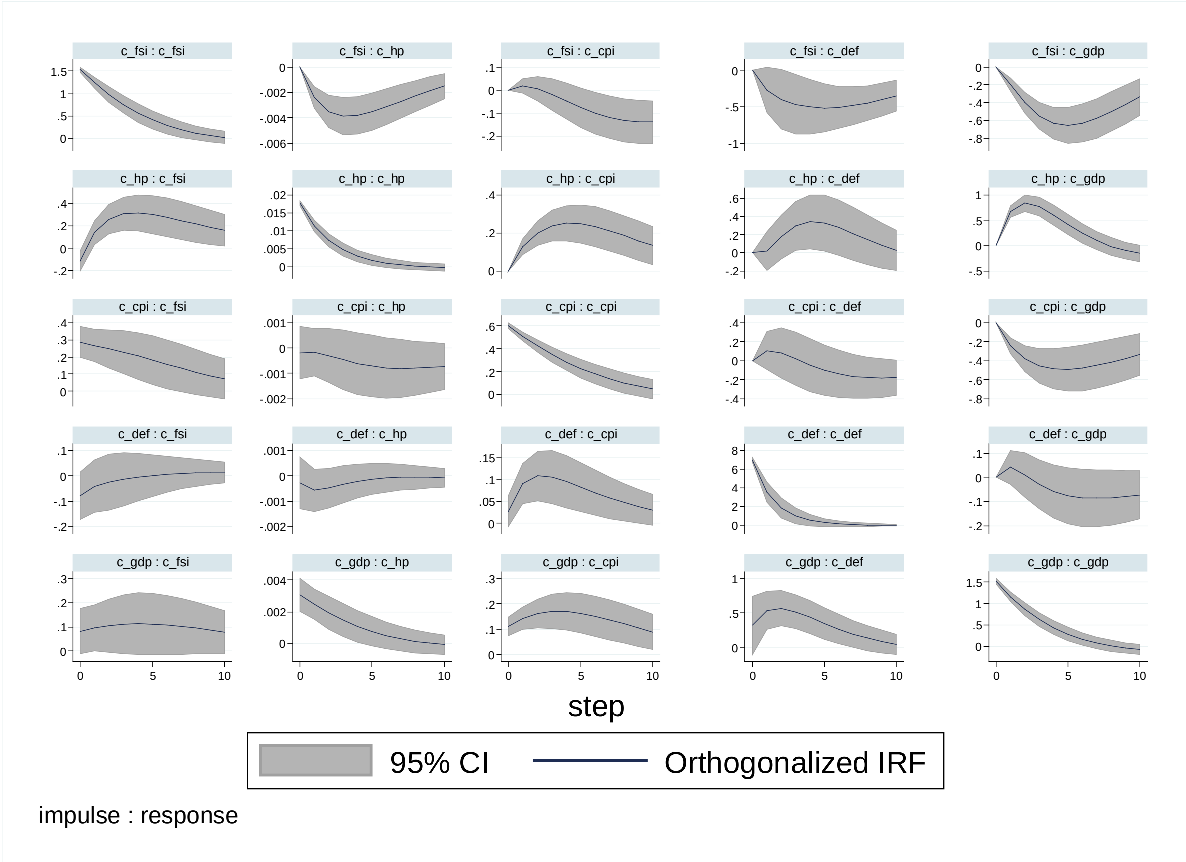


Fig. 8. Different Cholesky ordering: GDP→DEF→CPI→HP→FSI
Note: VAR(1), error bands were drawn from 500 repetitions.

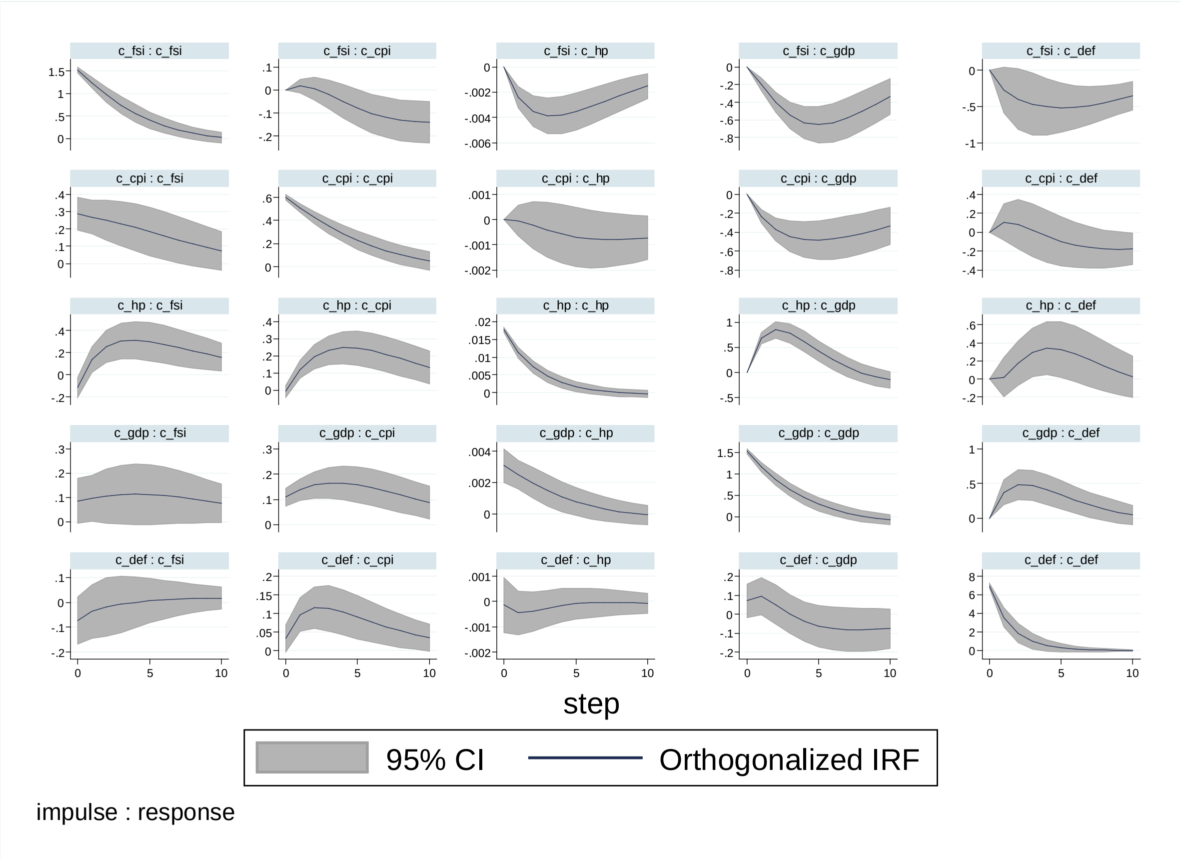


Fig. 9. Different Cholesky ordering: DEF→GDP→HP→CPI→FSI
Note: VAR(1), error bands were drawn from 500 repetitions.

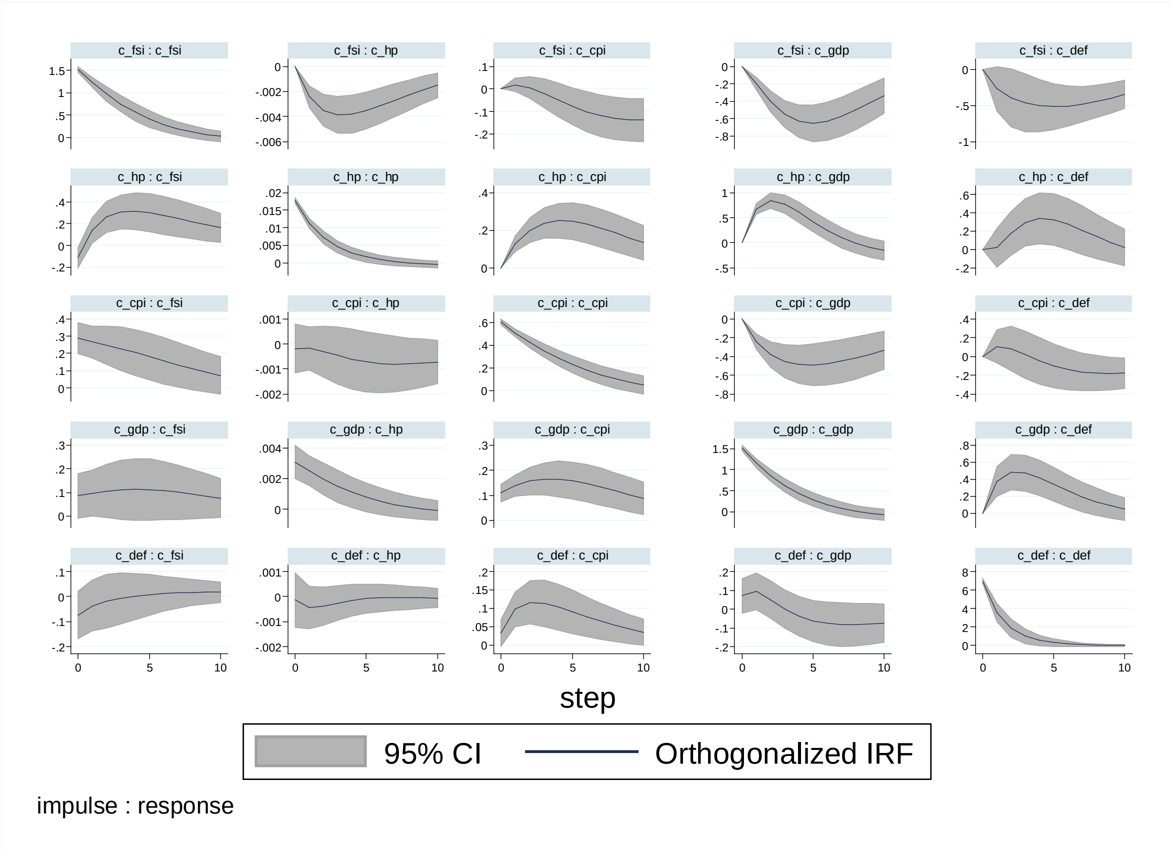


Fig. 10. Different Cholesky ordering: DEF→GDP→CPI→HP→FSI
Note: VAR(1), error bands were drawn from 500 repetitions.