Financial frictions and global spillovers*

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Abstract

We investigate whether changes in risk premia associated with frictions in U.S. financial markets play a role in global economic contractions. American economic activity is modeled jointly with the G6 economies using a two-region threshold vector autoregression (TVAR). This model captures regime-dependent dynamics in the presence of financial frictions, measured by a corporate bond risk premium. Transition from a state characterized by unconstrained financial intermediation to a regime in which borrowers face stringent credit constraints arises endogenously in this framework. Our results reveal an international dimension of the financial accelerator mechanism: financial frictions give rise to an amplification of risk premium shocks, and facilitate their transmission across the globe.

JEL classification: C32; C34; E32; G01; F44

Keywords: Financial frictions; Global recession; Nonlinear dynamics; Spillover

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1 Introduction

The risk-bearing capacity of the financial sector is procyclical over the business cycle, and it has the potential to amplify economic fluctuations. For example, a rise in risk aversion during the 2007-08 financial crisis provoked a credit crunch and the most severe recession since World War II in the United States. The crisis was borne out of losses on asset-backed securities, which increased uncertainty about collateral values in money markets and generated high risk aversion throughout the U.S. financial system. In response, bank balance sheets contracted through asset fire-sales, and this deleveraging process was exacerbated by frictions in financial intermediation. Financial frictions weighed on the interbank market, as banks hoarded liquidity instead of lending to each other. Amidst tightening borrowing conditions credit-constrained firms were forced to postpone or cancel investment projects, leading to a collapse of aggregate economic activity. The crisis quickly spread across borders, ultimately dragging down the entire global economy.

The interplay between the financial sector and the real economy is well understood from a theoretical perspective. Bernanke and Gertler (1989, 1990), Kiyotaki and Moore (1997), and Bernanke et al. (1999) have shown that financial frictions amplify the magnitude and persistence of business cycle fluctuations. Financial frictions may arise from collateral constraints or information asymmetries which introduce a wedge between the cost of external funds available to firms and the opportunity cost of internal funds. A rise in the premium on external finance weakens firm balance sheets by worsening their borrowing conditions. A decline in corporate net worth, in turn, commands a higher premium, generating an adverse feedback loop between firm balance sheets and business cycles, known as the financial accelerator mechanism.

The 2007-08 financial crisis had a significant international dimension, which suggests that financial shocks may have an impact beyond the country of origin.[1] Krugman (2008) describes an "international finance multiplier" by which deteriorating economic conditions are transmitted across borders through their effects on the balance sheets of internationally operating financial institutions. If financial intermediaries are borrowing-constrained, a fall in asset values in one country can lead to balance sheet contraction in other countries, triggering a vicious cycle of balance sheet deterioration and asset fire-sales across countries. This deleveraging spiral results in a magnification of the initial shock and a synchronized worldwide decline in real economic activity. Comprehensive

[1] Several international crisis transmission channels have been documented in the literature, for example, cross-border holdings of asset-backed collateralized debt obligations and bank credit default swaps, balance-sheet rebalancing by globalized banking conglomerates, and the collapse of global trade. See, e.g., Longstaff (2010), Bems et al. (2011), Bagliano and Morana (2012), Cettorelli and Goldberg (2012), Eichengreen et al. (2012), Giannetti and Laeven (2012), De Haas and Van Horen (2013), and Kalemli-Ozcan et al. (2013).

theoretical models that feature similar mechanisms have been developed by Devereux and Yetman (2010, 2011), Olivero (2010), Kollmann et al. (2011), and Dedola and Lombardo (2012).

Thus far, there is only limited empirical evidence on global financial spillovers in the presence of financial frictions.[2] Hence, the purpose of this paper is to study the international transmission of U.S. risk premium shocks while accounting for financial frictions. We model American economic activity jointly with the G6 economies (Canada, France, Germany, Italy, Japan, and the United Kingdom) using a two-region threshold vector autoregression (TVAR). This model captures regime-dependent dynamics conditional on the extent of frictions among lenders and borrowers in U.S. financial markets. A central question addressed in this framework is whether financial frictions amplify the effect of risk premium shocks on the global economy.

We gauge financial frictions by the degree of risk aversion in the U.S. corporate bond market. The Excess Bond Premium (EBP) proposed by Gilchrist and Zakrajsek (2012) is used as a comprehensive proxy for risk aversion. The EBP reflects systematic deviations in the pricing of U.S. corporate bonds relative to the expected default risk of the underlying issuers. In particular, the EBP measures a premium demanded by investors for bearing exposure to credit risk across the entire maturity spectrum (from 1- to 30-years) and the range of credit quality (from D to AAA) in the corporate bond market, beyond the compensation for the usual counter-cyclical movements in expected corporate default.[3] A rise in the EBP reflects a reduction in creditors' risk tolerance, which raises the cost of external finance and constrains access to credit in the U.S. economy. In the TVAR model, the economy is said to shift from a risk-tolerant state characterized by normal credit supply conditions to a risk-averse regime marked by tight credit conditions whenever the EBP exceeds an estimated threshold value. This nonlinearity gives rise to a financial accelerator mechanism in our model.

There is ample evidence for a financial accelerator in the U.S. economy. For example, Carlstrom and Fuerst (1997), Bernanke et al. (1999), and Christiansen and Dib (2008) show that financial frictions amplify U.S. business cycles in dynamic stochastic general

[2] Helbling et al. (2011) and Bagliano and Morana (2012) assess the effects of U.S. financial shocks on the global economy. Nevertheless, they do not explicitly model the amplification and feedback implied by financial frictions.

[3] Gilchrist and Zakrajsek (2012) construct a composite credit spread index as an arithmetic average of credit spreads on senior unsecured corporate bonds issued by 1,112 nonfinancial firms. For each firm, the credit spread for a corporate bond of a given maturity is obtained as the difference between the corporate bond yield and the yield of a corresponding synthetic risk-free security from the Treasury yield curve. Gilchrist and Zakrajsek (2012) decompose the credit spread index using a Black-Scholes-Merton option-pricing model estimated under a risk-neutrality assumption. This model removes (i.) the systematic counter-cyclical movements in firm-specific distance-to-default, (ii.) the level, slope and curvature of the Treasury yield curve, and (iii.) the realized volatility of ten-year Treasury bonds. The EBP is the residual component unexplained by these factors.

equilibrium (DSGE) models. From an empirical perspective, Bernanke et al. (1996) show that economic downturns have a larger impact on borrowers who suffer from financial frictions due to high agency costs, in line with their related theoretical work (see Bernanke and Gertler, 1989, 1990; Bernanke et al., 1996). Similarly, Meisenzahl (2014) finds that agency problems between borrowers and lenders constrain small businesses' access to credit, thereby stalling the recovery from the Great Recession. Even though a financial accelerator is often embedded in structural macroeconomic models, most empirical studies resort to models that do not account for the amplification and feedback loops implied by the theoretical literature. An important exception is offered by Balke (2000), who employs a TVAR model to study the relationship between credit and the macroeconomy. The TVAR model represents an empirical counterpart of the nonlinear DSGE models with occasionally binding credit constraints proposed by Mendoza (2010) and Bianchi and Mendoza (2010).

Traditionally, the literature has been primarily concerned with the transmission of fundamental macroeconomic shocks in the presence of financial frictions. However, more recently the focus has shifted towards assessing the relative importance of shocks originating in the financial sector. For instance, Nolan and Thoenissen (2009) show that shocks to the external finance premium lead business cycle fluctuations. Moreover, Meeks (2012) finds that credit shocks account for a considerable amount – around one fifth – of economic fluctuations. Finally, Helbling et al. (2011) show that credit market shocks can be propagated across borders.

Our empirical results suggest that the transmission of risk premium shocks depends crucially on the extent of financial frictions. An unexpected rise in the EBP has an insignificant effect on both the U.S. and the global economy in a state characterized by high risk tolerance, when credit is abundant. On the contrary, EBP shocks lead to a significant contraction of industrial production, consumer prices, and short-term interest rates in the U.S. and worldwide in periods of elevated risk aversion, when credit constraints are binding. Moreover, we find that international stock prices significantly drop and the effective USD exchange rate appreciates in response to a rise in the EBP, which corroborates the role of international financial markets in transmitting the shock. Thus, financial frictions induce an amplification of risk premium shocks and facilitate their global spillover, which reveals an international dimension of the U.S. financial accelerator mechanism.

The remainder of the paper is organized as follows. We describe our econometric approach in section 2. Section 3 offers a brief description of the data, and it outlines our empirical results. Finally, section 4 summarizes our findings and concludes the paper.

2 Methodology

2.1 The threshold vector autoregressive model

In this section we present our two-region TVAR model for the U.S. and the rest of the world (RoW). We proxy RoW variables by weighted averages of the six major industrialized economies (Canada, France, Germany, Italy, Japan, and the United Kingdom). Let $Z_t = (q_t^*,\, \pi_t^*,\, q_t,\, \pi_t,\, i_t^*,\, i_t)$ represent a dynamic system of macroeconomic variables that comprises the growth rate of industrial production in the RoW (q_t^*), the rate of consumer price inflation in the RoW (π_t^*), the growth rate of industrial production in the U.S. (q_t), the rate of consumer price inflation in the U.S. (π_t), the nominal short-term interest rate in the RoW (i_t^*), and the nominal U.S. federal funds rate (i_t). We augment this system with the EBP (rp_t) obtained from Gilchrist and Zakrajsek (2012), which reflects the extent of financial frictions in the United States.

We model the 7-dimensional vector $Y_t = (Z_t', rp_t)$ using a TVAR which captures nonlinear dynamics conditional on the degree of risk aversion in the U.S. financial system. The model in its structural form is given by:

$$Y_t = \begin{cases} \mathrm{A}^1 Y_t + \Theta^1(L)Y_t + \varepsilon_t^1 & \text{if} \quad rp_{t-d} < \gamma, \\ \mathrm{A}^2 Y_t + \Theta^2(L)Y_t + \varepsilon_t^2 & \text{if} \quad rp_{t-d} \geq \gamma, \end{cases} \tag{1}$$

for $t \in \{1, ..., T\}$, where rp_{t-d} acts as a threshold variable with delay d. The (7×7) parameter matrices A^1 and A^2 reflect the contemporaneous relationships between the endogenous variables contained in Y_t, while the (7×7) lag polynomial matrices $\Theta^1(L) = \Theta_1^1 L^1 + ... + \Theta_p^1 L^p$ and $\Theta^2(L) = \Theta_1^2 L^1 + ... + \Theta_p^2 L^p$ describe their dynamic interaction. The (7×1) vectors of orthogonal shocks ε_t^1 and ε_t^2 are normally distributed with zero mean and regime-dependent positive definite covariance matrices $\Sigma_\varepsilon^1 = E(\varepsilon_t^1 \varepsilon_t^{1\prime})$ and $\Sigma_\varepsilon^2 = E(\varepsilon_t^2 \varepsilon_t^{2\prime})$.

The global economy can either reside in a state of unconstrained financial intermediation characterized by high risk tolerance ($rp_{t-d} < \gamma$), or in a risk-averse regime, in which borrowers face more stringent credit constraints ($rp_{t-d} \geq \gamma$). Transition between regimes arises whenever rp_{t-d} crosses an estimated threshold value γ. The contemporaneous and dynamic transmission as well as the volatility of shocks can vary across these two regimes. Since rp_t is an endogenous variable in the system, it can act as an amplifier of shocks hitting the economy.

The reduced form of the TVAR model is given by:

$$Y_t = \begin{cases} \Phi^1(L)Y_t + u_t^1 & \text{if} \quad rp_{t-d} < \gamma, \\ \Phi^2(L)Y_t + u_t^2 & \text{if} \quad rp_{t-d} \geq \gamma, \end{cases} \tag{2}$$

where $\Phi^1(L) = (I - A^1)^{-1}\Theta^1(L)$ and $\Phi^2(L) = (I - A^2)^{-1}\Theta^2(L)$ are p-order lag-polynomial matrices of the reduced form coefficients (where $p \in \mathbb{N}$), and where $u_t^1 \sim (0, \Sigma_u^1)$ and $u_t^2 \sim (0, \Sigma_u^2)$ are (7×1) vectors of reduced form Gaussian white noise forecast errors, with $\Sigma_u^1 = E(u_t^1 u_t^{1'})$ and $\Sigma_u^2 = E(u_t^2 u_t^{2'})$ positive definite. The reduced form parameters are estimated using the maximum likelihood estimator (MLE) described in Galvao (2006). This entails computing the constrained MLE for $\Phi^1(L)$, $\Phi^2(L)$, Σ_u^1, and Σ_u^2, holding d and γ fixed. For a given delay d and threshold value γ, the MLE are the OLS estimators given by:

$$\begin{bmatrix} \Phi_1^1 \\ \Phi_2^1 \\ \vdots \\ \Phi_p^1 \end{bmatrix}' = \left(\left(\begin{bmatrix} Y_{t-1} \\ Y_{t-2} \\ \vdots \\ Y_{t-p} \end{bmatrix}' D^1 \right)' \left(\begin{bmatrix} Y_{t-1} \\ Y_{t-2} \\ \vdots \\ Y_{t-p} \end{bmatrix}' D^1 \right) \right)^{-1} \left(\begin{bmatrix} Y_{t-1} \\ Y_{t-2} \\ \vdots \\ Y_{t-p} \end{bmatrix}' D^1 \right)' Y_t$$

and

$$\begin{bmatrix} \Phi_1^2 \\ \Phi_2^2 \\ \vdots \\ \Phi_p^2 \end{bmatrix}' = \left(\left(\begin{bmatrix} Y_{t-1} \\ Y_{t-2} \\ \vdots \\ Y_{t-p} \end{bmatrix}' D^2 \right)' \left(\begin{bmatrix} Y_{t-1} \\ Y_{t-2} \\ \vdots \\ Y_{t-p} \end{bmatrix}' D^2 \right) \right)^{-1} \left(\begin{bmatrix} Y_{t-1} \\ Y_{t-2} \\ \vdots \\ Y_{t-p} \end{bmatrix}' D^2 \right)' Y_t,$$

where $D^1 = I(rp_{t-d} < \gamma)$ and $D^2 = I(rp_{t-d} \geq \gamma)$ are indicator functions. The estimated residuals are obtained as: $\hat{u}_t^1 = Y_t D_t^1 - ([Y_{t-1}^{'}, Y_{t-2}^{'}, ..., Y_{t-p}^{'}]D_t^1)[\hat{\Phi^1}_1, \hat{\Phi^1}_2, ..., \hat{\Phi^1}_p]$ and $\hat{u}_t^2 = Y_t D_t^2 - ([Y_{t-1}^{'}, Y_{t-2}^{'}, ..., Y_{t-p}^{'}]D_t^2)[\hat{\Phi^2}_1, \hat{\Phi^2}_2, ..., \hat{\Phi^2}_p]$. Finally, the MLEs for the covariance matrices are $\hat{\Sigma}_u^1 = 1/T^1 \sum_{t=1}^{T^1} \hat{u}_t^1 \hat{u}_t^{1'}$and $\hat{\Sigma}_u^2 = 1/T^2 \sum_{t=1}^{T^2} \hat{u}_t^2 \hat{u}_t^{2'}$, where $T^1 + T^2 = T$.

The model is estimated for all possible values of d and γ on an equally spaced grid of rp_{t-d}. The MLE for $\hat{d}$ and $\hat{\gamma}$ are then obtained by solving the following optimization problem:

$$(\hat{\gamma}, \hat{d}) = \min_{\substack{\gamma_L \leq \gamma \leq \gamma_U \\ 1 \leq d \leq d_{max}}} \left(\frac{T^1}{2} \log(|\Sigma_u^1|) + \frac{T^2}{2} \log(|\Sigma_u^2|), \right).$$

where γ_L is the 15%th percentile and γ_U is the 85% percentile of the empirical distribution of rp_{t-d}. Hence, following Balke (2000), we restrict the search region such that at least 15% of the observations (plus the number of parameters) are in each regime.

2.2 Testing for threshold behavior

In order to choose between a linear and a threshold VAR model, we use the bounded supWald and bounded supLM statistics, following Altissimo and Corradi (2002), Galvao (2006), and Artis et al. (2007). The threshold γ is not identified and constitutes a nuisance parameter under the null hypothesis of a linear VAR model. However, the bounded supWald and supLM statistics provide consistent model selection criteria when a nuisance parameter is present only under the nonlinear alternative.

The bounded supWald (BW) statistic is given by:

$$\mathrm{BW} = \frac{1}{2\log(\log(T))}\left(\sup_{\gamma_L \leq \gamma \leq \gamma_U} T\left(\frac{SSR^{lin} - SSR^{nlin}(\gamma)}{SSR^{nlin}(\gamma)}\right)\right)^{\frac{1}{2}},$$

and bounded supLM statistic (BLM) is given by:

$$\mathrm{BLM} = \frac{1}{2\log(\log(T))}\left(\sup_{\gamma_L \leq \gamma \leq \gamma_U} T\left(\frac{SSR^{lin} - SSR^{nlin}(\gamma)}{SSR^{lin}}\right)\right)^{\frac{1}{2}}.$$

SSR^{lin} is the the sum of squared residuals under the linear VAR null, and $SSR^{nlin}(.)$ is the sum of squared residuals under the TVAR alternative hypothesis. The statistics BW and BLM provide the asymptotic bounds on the supremum of the Wald and LM statistics computed over a grid $\gamma_L \leq \gamma \leq \gamma_U$ of possible values for the threshold γ. The TVAR model is chosen over the linear VAR if BW > 1 and, similarly, if BLM > 1. This model selection rule ensures that type I and type II errors are asymptotically zero.

2.3 Identification of risk premium shocks

Identification of risk premium shocks is achieved by imposing orthogonality restrictions on the contemporaneous relationships A^1 and A^2. In particular, the risk premium shock is recovered by a Cholesky decomposition of the regime-specific reduced-form covariance matrices Σ_u^1 and Σ_u^2. The reduced form covariance matrices can be decomposed as $\Sigma_u^1 = (\mathrm{A}^1)^{-1}\Sigma_\varepsilon^1(\mathrm{A}^1)^{-1'}$ and $\Sigma_u^2 = (\mathrm{A}^2)^{-1}\Sigma_\varepsilon^2(\mathrm{A}^2)^{-1'}$, from which the regime-specific structural shocks can be recovered as $\varepsilon_t^1 = \mathrm{A}^1 u_t^1$ and $\varepsilon_t^2 = \mathrm{A}^2 u_t^2$. We impose the following recursive ordering of the shock vector: $\varepsilon_t^s = [\varepsilon_{q^*,t}^s, \varepsilon_{\pi^*,t}^s, \varepsilon_{q,t}^s, \varepsilon_{\pi,t}^s, \varepsilon_{i^*,t}^s, \varepsilon_{i,t}^s, \varepsilon_{rp,t}^s]$, where $s = 1, 2$.

Instead of interpreting the entire vector of orthogonal shocks from a structural perspective, we attach an economic interpretation solely to the U.S. risk premium shock, and we remain agnostic regarding the identity of the remaining shocks. By ordering the EBP last, our identifying assumption entails that risk aversion in the U.S. financial sector responds without delay to all macroeconomic and policy shocks hitting the global econ-

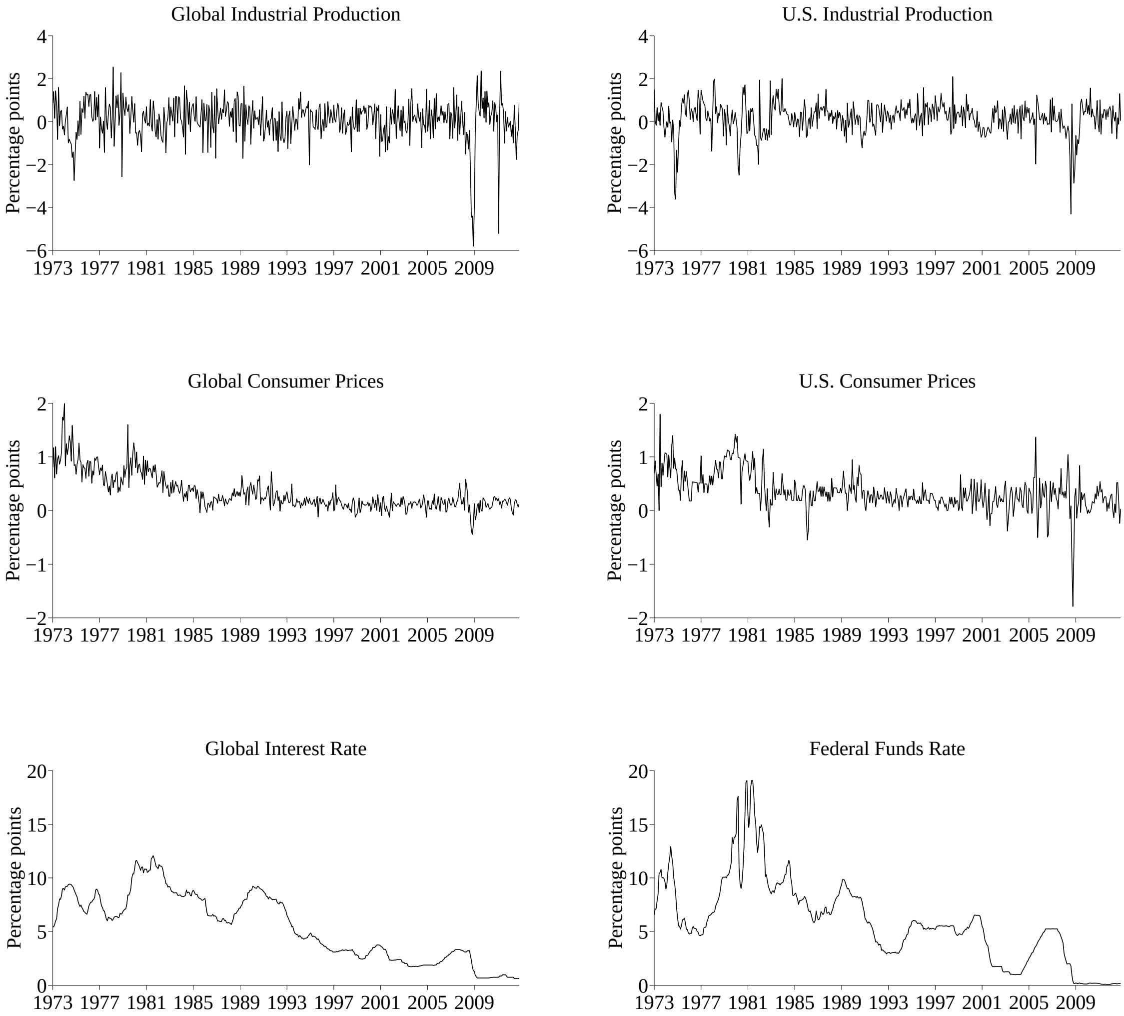

Figure 1: Macroeconomic variables

Note: Macroeconomic variables for the U.S. and the RoW. RoW variables are constructed as averages of the G6 economies (Canada, France, Germany, Italy, Japan, and the U.K.) weighted by PPP-adjusted annual real GDP. Sample: January 1973 - December 2012.

omy. This assumption acknowledges the high-frequency nature of financial markets, in line with the standard approach in VARs with financial variables (see also Gilchrist and Zakrajsek, 2011, 2012). Our recursive order also implies that the U.S. economy reacts contemporaneously to macroeconomic shocks originating in the RoW. Furthermore, this ordering is in line with the standard assumption that real economic activity reacts with a delay to changes in nominal interest rates and to shocks hitting the financial sector, while interest rates can respond within the month to macroeconomic disturbances (see, e.g., Christiano et al., 1996).

3 Empirical results

3.1 Data

We use monthly data between January 1973 and December 2012. Time series for the U.S. are obtained from the Federal Reserve Bank of St. Louis and from Gilchrist and Zakrajsek (2012).[4] RoW variables are proxied by weighted averages of time series for Canada, France, Germany, Italy, Japan, and the United Kingdom. We use industrial production data for the G6 obtained from the OECD and CPI data from the IMF International Financial Statistics. For each country, the nominal monetary policy rate is used. The weights reflect the average overall size of the economy over the estimation period, and they are based on PPP-adjusted annual real GDP from the Penn World Tables.

Figure 1 depicts the 6 macroeconomic variables used in our analysis. The high co-movement between the U.S. economy and the major industrialized economies is already apparent from a visual inspection of the time series plots.

3.2 Financial regimes

We estimate a TVAR model with 4 lags selected using the Akaike information criterion (AIC) proposed by Tsay (1998) and the bias-corrected AIC proposed by Wong and Li (1998). Table 1 shows the BW and BLM statistics that guide our model selection between a constant-parameter linear VAR against the threshold-VAR alternative. The table shows the test statistics for each individual equation in the TVAR and for p=1, 2, 3, and 4 lags. Recall that the TVAR model is preferred over the linear VAR if the statistic exceeds unity, which would indicate that financial frictions give rise to significant nonlinearities. The equation-wise supremum statistics speak unequivocally in favor of the nonlinear model.

The estimated threshold value is $\hat{\gamma} = -0.0012$ percentage points with a delay of $\hat{d} = 1$ month. The fact that $\hat{\gamma}$ is almost zero lends a natural interpretation to the identified regimes in terms of risk tolerance (negative values of EBP) vs. risk aversion (positive EBP). Figure 2 illustrates the lagged EBP (solid line) together with the estimated threshold (dashed line). The shaded areas correspond to periods when the EBP resides above the threshold. At a first glance, five major episodes of distress in U.S. banking and credit markets stand out. The first corresponds to the mid-1970s, and coincides with the collapse of the Bretton Woods system, the 1973 oil embargo, and the associated stock market crash of 1973-74. The second turbulent period concurs with the second oil crisis

[4]The data of Gilchrist and Zakrajsek (2012) was retrieved from the *American Economic Association* webpage at: `http://www.aeaweb.org/articles.php?doi=10.1257/aer.102.4.1692`, and we are grateful to Simon Gilchrist and Egon Zakrajsek for kindly supplying the extended time series that span the January 1973 - December 2012 period.

Statistic(p)	q_t^*	π_t^*	q_t	π_t	i_t^*	i_t	rp_t
BW(1)	2.63	2.22	2.45	2.24	1.80	3.02	3.22
BLM(1)	2.57	2.18	2.40	2.21	1.78	2.93	3.11
BW(2)	2.73	2.50	2.59	3.36	2.37	4.79	3.72
BLM(2)	2.66	2.44	2.53	3.24	2.32	4.45	3.56
BW(3)	3.81	3.13	3.18	3.76	2.89	5.09	4.31
BLM(3)	3.63	3.03	3.08	3.58	2.81	4.68	4.05
BW(4)	4.21	3.34	4.00	4.27	4.67	4.83	4.95
BLM(4)	3.97	3.22	3.80	4.02	4.35	4.48	4.58

Table 1: Model selection

Note: The table shows the BW and BLM statistics for each individual equation in the TVAR with p=1, 2, 3, and 4 lags. The TVAR model is chosen over the linear VAR if BW $>$ 1 and, similarly, if BLM $>$ 1.
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in 1979, the deep recession of 1980-82, and the great disinflation under the Volcker Fed. The banking crises of the 1980s (including the savings and loan crisis, the mutual savings bank crisis, and the Latin American debt crises) represent the third period of elevated risk aversion.[5] Fourth, the U.S. economy was characterized by tight credit supply conditions at the wake of the new millennium, around the Enron, Y2K, and 9/11 debacles, and the burst of the dotcom bubble. Finally, credit constraints were evidently binding between 2007-09, during the global credit crunch.

3.3 Structural analysis

In this section, we investigate the effects of U.S. financial risk premium shocks on the global economy. Figure 3 shows the impulse response functions (IRFs) to a risk premium shock from a baseline linear VAR model over 24 months (without financial frictions) together with 90% bootstrap confidence bands. Following a shock to the U.S. risk premium, the financial sector responds with an immediate jump in risk aversion; the shock dies out after about 1.5 years. Industrial production and consumer prices decline significantly in response to the financial shock, which suggests that firms and households respond to tightening borrowing conditions by embarking on a protracted process of deleveraging. At the same time, the monetary policy instrument falls by about 100 basis points. Remarkably, the global economy reacts to the deterioration of U.S. financial conditions in a significant fashion. Global production as well as interest rates contract in tandem with the U.S. economy. Hence, already within a simple linear VAR model we find evidence for

[5] A historical account of the 1980s crises can be found in Federal Deposit Insurance Corporation (1997).

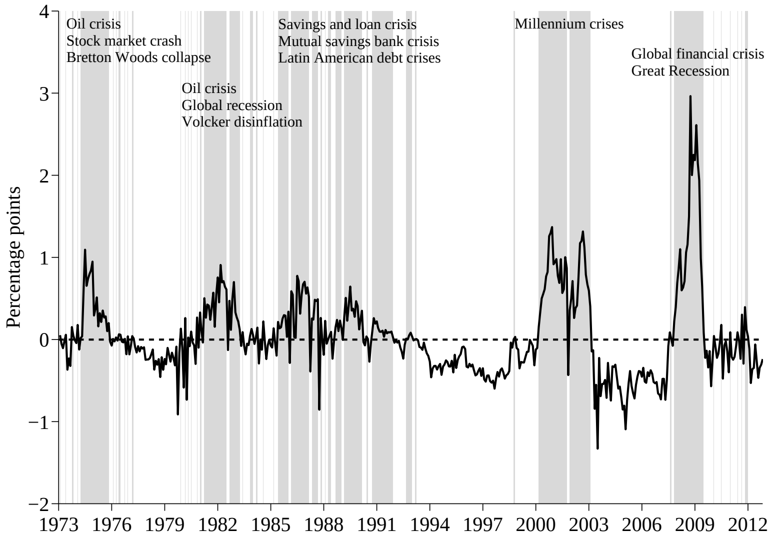


Figure 2: Excess bond premium and financial regimes

Note: The solid line depicts the lagged excess bond premium and the dashed line corresponds to the estimated threshold value ($\hat{\gamma} = -0.0012$). Risk-averse periods are shaded in grey. Sample: January 1973 - December 2012.

international spillovers.

To capture potential asymmetries across regimes, we calculate regime-dependent IRFs following Ehrmann et al. (2003) and Candelon and Lieb (2013). The regime-dependent IRF describes the dynamic effects of the identified structural shocks *within* each regime, under the assumption that the economy resides in the same regime for the entire duration of the response. Hence, it amounts to a linear IRF conditional on a given regime. This approach yields orthogonal shocks recovered through our structural identification scheme, which constitutes an important advantage compared to the generalized IRFs occasionally used in the literature. Figure 4 shows the regime-dependent IRFs based on a one-percentage-point rise in the EBP from the TVAR model. Solid lines are the IRFs in the risk-averse regime with shaded areas representing bootstrapped 90% confidence bands based on 5000 draws, while dotted lines are the IRFs in the risk-tolerant regime with dashed lines representing 90% confidence bands. To facilitate the comparison of impulse response functions across models, the vertical axis spans the same range as the linear IRFs depicted in Figure 3. Upon distinguishing between normal and tight financial conditions, we find a strong asymmetry in the strength of the responses across the two regimes. A shock to the risk premium has essentially no consequences when credit is abundantly available in the economy. Hence, the financial system absorbs the risk premium shock in the risk-tolerant regime, and there are no consequences for the macroeconomy.

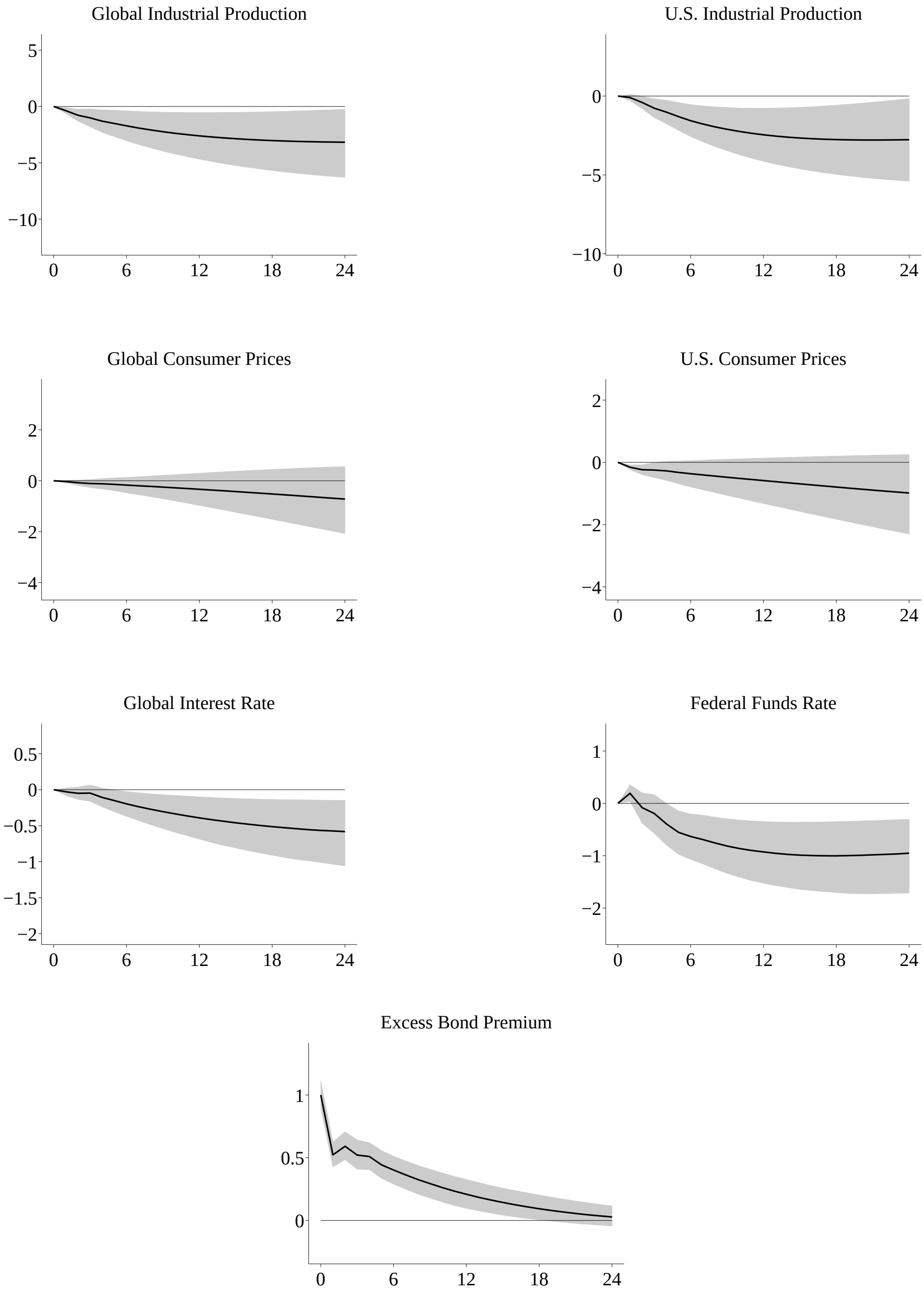


Figure 3: Impulse responses to an excess bond premium shock (linear VAR)

Note: Impulse responses to a one-percentage-point rise in the EBP from a linear VAR model over 24 months. The impulse responses of output growth and inflation were accumulated. The shaded areas represent bootstrapped 90% confidence bands based on 5000 draws.

On the contrary, a rise in the risk premium can be detrimental for the real economy under stringent credit conditions. In particular, a risk premium shock provokes a significant global contraction in times of tight credit conditions, while central banks embark on an aggressive expansionary policy route worldwide. Due to the interconnectedness of the U.S. economy with the rest of the world, tightening borrowing conditions and the associated recession in the U.S. generate worldwide repercussions.

3.4 International transmission channels

Our baseline results suggest that financial frictions facilitate the global spillover of financial disturbances. In this section, we investigate the role of international financial markets in spreading the financial shock across the globe. A careful explanation of this effect would require modeling all potential international transmission channels by means of a large-scale multi-country structural model, which is beyond the scope of this paper. However, the rise in financial sector globalization observed since the early 1980s, as documented by, e.g., Kose et al. (2009), Goldberg (2009), Forbes (2010), and Gourinchas et al. (2012), offers some clues as to what may have contributed to this spillover phenomenon. In general, cross-country financial integration is beneficial, as it enables economies to internationally diversify their income portfolios. However, financial interdependence comes at the price that shocks can be easily transmitted across countries in times of crisis (see, e.g., Longstaff, 2010; Ehrmann et al., 2011; Eichengreen et al., 2012; Metiu, 2012).

A potentially important transmission channel is provided by the balance-sheet rebalancing behavior of globally active institutional investors and financial intermediaries. In the presence of financial frictions, country-specific shocks can trigger international balance-sheet deterioration and asset fire-sales, which may result in a magnification of the initial shock and a correlated downturn of real economic activity across countries (see, e.g., Krugman, 2008; Devereux and Yetman, 2010, 2011; Olivero, 2010; Kollmann et al., 2011; Dedola and Lombardo, 2012). Empirical support for this transmission channel has been provided by Cettorelli and Goldberg (2012), Giannetti and Laeven (2012), De Haas and Van Horen (2013) and Kalemli-Ozcan et al. (2013).

To assess the importance of international financial markets in propagating U.S. risk premium shocks, we augment our baseline specification with foreign exchange returns and international equity returns. We use the nominal effective exchange rate (NEER) index of the U.S. with respect to its 15 main trading partners obtained from the Bank for International Settlements, and we use the weighted average of MSCI stock market indices for the G6 economies. Figure 5 shows the regime-dependent IRFs to a rise in the risk premium from the augmented TVAR model. The estimated effects closely resemble the ones from our baseline model, which confirms the robustness of our earlier results.

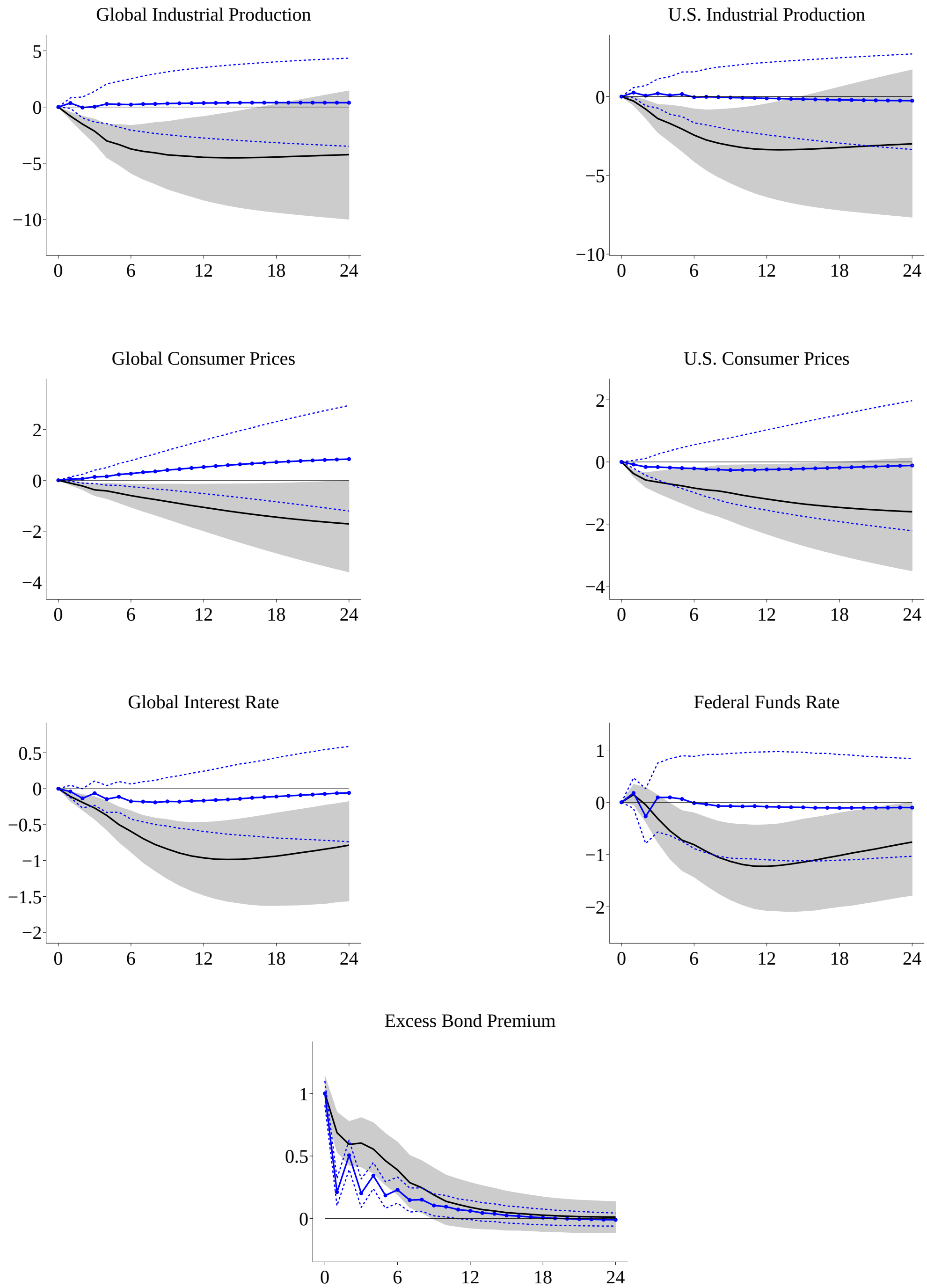


Figure 4: Impulse responses to an excess bond premium shock (TVAR)

Note: Impulse responses to a one-percentage-point rise in the EBP from a nonlinear TVAR model over 24 months. The impulse responses of output growth and inflation were accumulated. The solid lines (dotted lines) are the IRFs in the risk-averse (risk-tolerant) regime with shaded areas (dashed lines) representing bootstrapped 90% confidence bands based on 5000 draws.

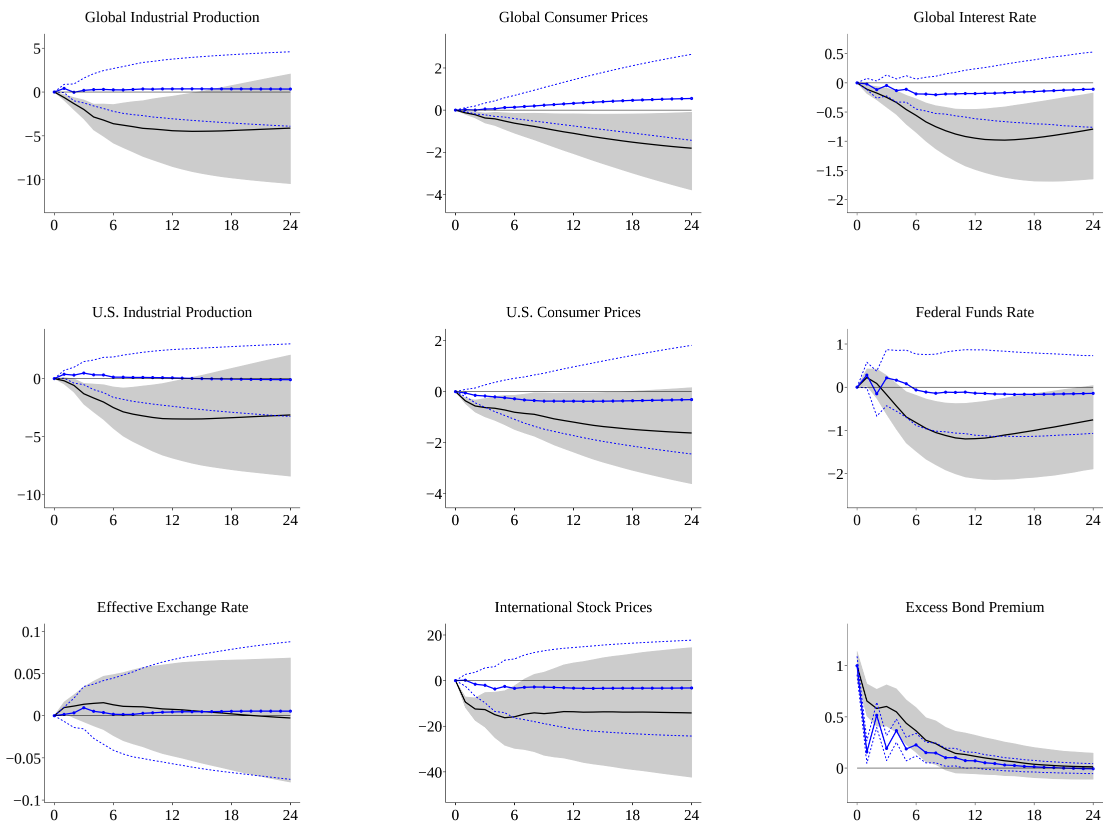


Figure 5: International transmission channels

Note: Impulse responses to a one-percentage-point rise in the EBP from a TVAR model augmented with foreign exchange returns and international stock prices. The impulse responses of output growth, inflation, and international stock returns were accumulated. The solid lines (dotted lines) are the IRFs in the risk averse (risk tolerant) regime with shaded areas (dashed lines) representing bootstrapped 90% confidence bands based on 5000 draws.

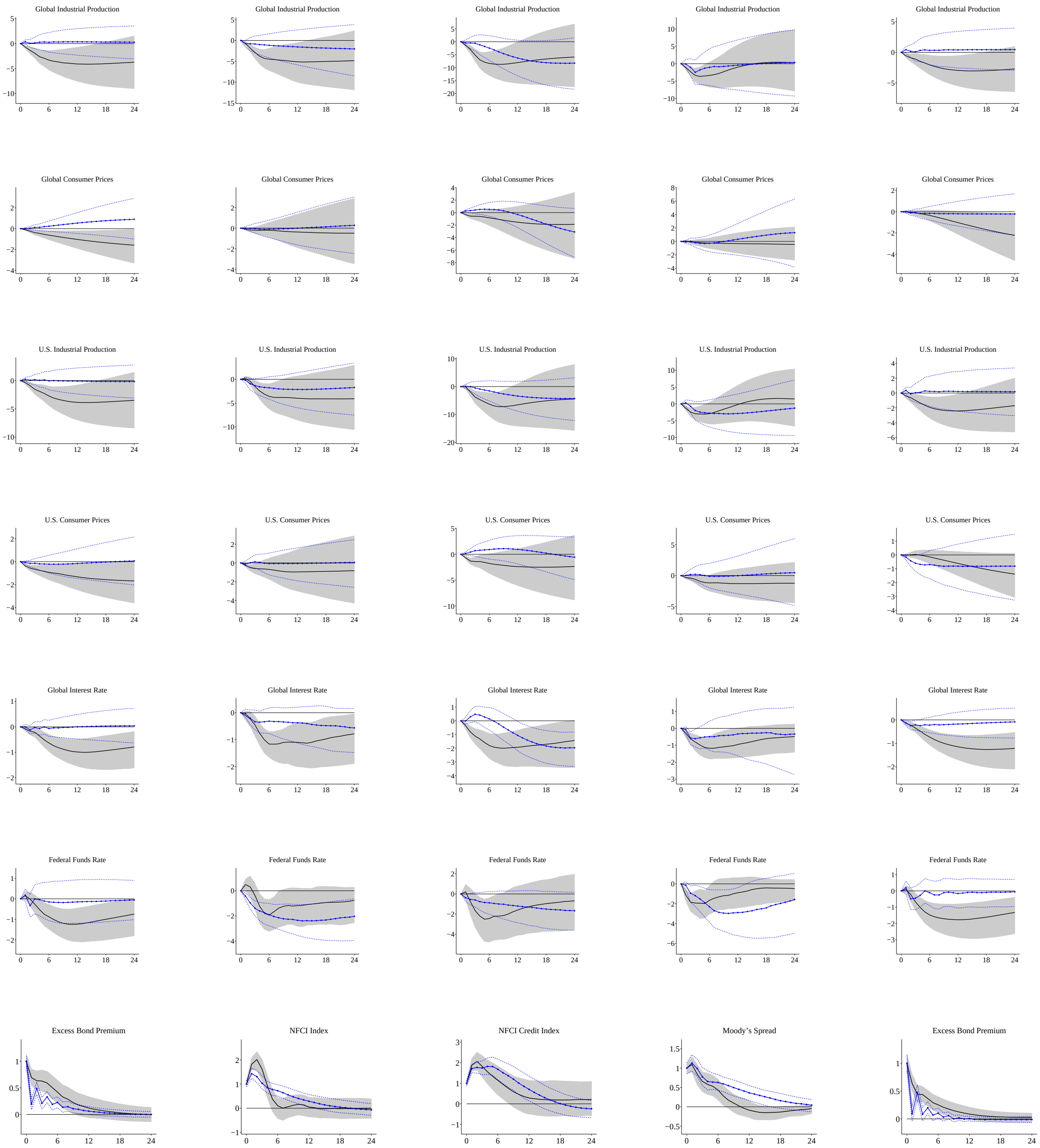
Regarding the transmission channels, international financial markets do not respond to the shock in the risk-tolerant regime. However, in times of elevated risk aversion, the EBP shock leads to a significant, albeit short-lived, appreciation of the USD, and a substantial and statistically significant decline in international equity prices. These findings lend empirical support to the international finance multiplier by which a fall in asset prices provokes a vicious cycle of balance sheet deterioration and asset fire-sales across countries, that results in a magnification of the initial shock and a synchronized worldwide decline in real economic activity.

3.5 Robustness

In this section, we verify the robustness of our findings against variations of the baseline model specification. First, we consider an alternative weighting scheme of G6 variables based on bilateral financial positions with respect to the U.S. economy. Second, we assess three alternative proxies for financial frictions: the National Financial Conditions Index (NFCI) of the Chicago Fed, the NFCI credit subindex, and the Moody's Baa-Aaa long-term bond yield spread. Third, we investigate whether our results remain unchanged when the recent global financial crisis is removed from the sample.

The first column of Figure 6 depicts the IRFs to a rise in the EBP when financial weights for the G6 variables. Following Imbs (2004), financial weights are constructed as $w_i = |(NFA_i/GDP_i) - (NFA_{US}/GDP_{US})$, using the data from Lane and Milesi-Ferretti (2007). NFA_i denotes the net foreign asset position in country i. The weight w_i will take high values for countries that have diverging external positions with respect to the U.S., as such countries are more likely to lend and borrow from the U.S. according to Imbs (2004). We normalize the weights to sum to 1. The second column of Figure 6 shows the the IRFs to a financial shock using the NFCI index of the Chicago Fed, while the third column of the figure shows the IRFs when using the NFCI credit subindex, and the fourth column shows the IRFs when using the Moody's long-term bond spread. Figure 7 shows the regimes estimated using these three alternative proxies for risk aversion in U.S. financial markets. The three variables yield chronologies of tight credit in the U.S. economy similar to the regimes identified using the EBP. The final column of Figure 6 presents the IRFs to an EBP shock from the TVAR model estimated until December 2006.

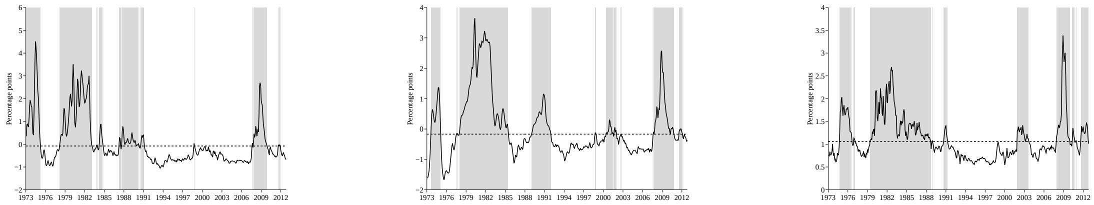
Our main findings remain unchanged in that an unexpected rise in U.S. risk premia triggers a significant contraction of production, prices and interest rates in the U.S. as well as across the globe in periods when financial constraints are binding. Meanwhile, the responses are subdued and predominantly insignificant in periods when borrowing is relatively cheap in U.S. financial markets. This asymmetry prevails across all model



Financial weights | NFCI | NFCI Credit | Moody's spread | w/o GFC

Figure 6: Robustness checks

Note: Bla.



NFCI | NFCI Credit | Moody's spread

Figure 7: Financial risk indicators and financial regimes

Note: The solid line depicts the NFCI index (left panel)/ NFCI credit subindex (middle panel)/ and the Moody's Baa-Aaa spread (right panel), and the dashed line corresponds to the estimated threshold value. Risk-averse periods are shaded in grey. Sample: January 1973 - December 2012.

specifications.

4 Conclusion

The consensus view in macroeconomic theory holds that financial frictions – e.g., collateral constraints and information asymmetries – can amplify business cycle fluctuations. Financial accelerator effects may operate within as well as across economies. Although financial frictions are often embedded in structural macroeconomic models, most empirical studies on macro-financial linkages resort to linear models that do not account for the amplification mechanisms implied by the theoretical literature. There is an equally limited empirical literature that investigates the relation between credit markets and global spillovers. This paper aims to fill these gaps.

We investigate whether financial frictions in the United States play a role in worldwide economic contractions. We model economic activity in the U.S. jointly with the G6 economies using a threshold vector autoregressive model. This model captures regime-dependent dynamics in the presence of financial frictions. Transition from a state characterized by unconstrained financial intermediation to a regime in which constraints are binding arises endogenously in this framework. In our model, financial frictions are captured by a corporate credit risk premium proposed by Gilchrist and Zakrajsek (2012). This premium reflects systematic deviations in the pricing of U.S. corporate bonds relative to the expected default risk of the underlying issuers, it thus provides a useful gauge of credit supply conditions in the U.S. economy.

Using the excess bond premium as an endogenous threshold variable, we identify five prolonged periods of distress in U.S. banking and credit markets. We detect three tight credit episodes that coincide with the banking crises of the 1970s and 1980s. The

U.S. economy was also characterized by tight credit market conditions in the early 2000s, around the Enron, Y2K, and 9/11 debacles and following the burst of the dotcom bubble. Finally, the episode between 2007-09 is identified as the most recent credit crunch.

We assess the regime-specific dynamics of the model in response to financial disturbances by regime-dependent impulse response functions. Upon distinguishing between normal and tight credit regimes, we uncover a strong asymmetry in the strength of the responses across the two regimes: an unexpected rise in U.S. risk premia triggers a significant contraction in the global economy when borrowing constraints are binding, while the financial sector absorbs the risk premium shock in the risk-tolerant regime, and there are no aggregate economic consequences. Our results reveal an international dimension of the U.S. financial accelerator mechanism in that financial frictions give rise to an amplification of financial shocks originating in the U.S., and facilitate their spillover to the global economy in times of tight credit market conditions. These results draw attention to the negative externalities imposed on the global economy via frictions in financial intermediation in the United States.

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