Are the Effects of a US Financial Shock on non-US Countries Asymmetric?

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Abstract

In the past few decades, US financial markets have experienced a high degree of financial integration with non-US countries. I examine whether US financial shocks affect non-US economies, especially focusing on potential asymmetric effects. US financial shocks are identified from a model that allows the asymmetric effects of US financial market disturbances following a recent paper (Barnichon, Matthes, and Ziegenbein (2020)). Using Smooth Local Projection, I find that US financial shocks lead to asymmetric effects in a majority of G7 countries (Canada, Germany, France, the UK and Italy): an adverse US financial shock, i.e., tightening of financial conditions, generates a significant decline in the countries' output and the movements are similar

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across the countries, while a favorable US financial shock, i.e., easing of financial conditions, generates no statistically significant responses. The asymmetry also exists in short-term interest rates and share prices indices.

JEL: C14, C32, E32, E44, F44

1 Introduction

In the global economy, there has been a remarkable increase in financial interdependencies between the US and other countries. For example, statistics on both inflow and outflow of foreign direct investment in US reveal a large and fast-growing financial connectedness of US financial market with other countries. Previous literature discussing US financial disturbances has focused on the impacts in the domestic economy. For instance, Gilchrist, Yankov, and Zakrajšek (2009), Gilchrist and Zakrajšek (2012) (hereafter GZ), and Barnichon, Matthes, and Ziegenbein (2020) (hereafter BMZ) show that disruptions in US credit market result in a protracted decrease in US economic activities.

Since the recent global crisis, some papers have examined the importance of the financial crisis in a global context. Most advanced economies have experienced large and long-term effects of financial market disruptions on a global level (e.g., Ball (2014), Romer and Romer (2017)). Specifically, Romer and Romer (2017) introduce a new measure capturing the intensity of post-war financial crises in 24 OECD countries and find significant loss of outputs following a severe financial distress. Ball (2014) also examines 23 OECD countries to estimate the damages in potential output in each country using the OECD Economic Outlook and finds long-term losses from the Great Recession in most countries.

BMZ estimate the possibly asymmetric effects of US financial shock on the US economy. They show that an adverse financial shock (tightening of financial conditions) has large and long-lived effect whereas a favorable financial shock (easing of financial conditions) has little effect on output. Their motivation stems from addressing limitations from two leading strands of the literature that estimate the effects of financial strains on economic activity. Romer and Romer (2017) employ narrative accounts which cannot identify the causal effects of financial shocks on economic activity, but implicitly incorporate asymmetric effects of the shock by focusing only on negative financial developments. On the other hand, GZ (2012) use a structural VAR which does not allow for potential asymmetric effects of financial shocks on economic activity, but can identify the causal effects. BMZ exploit a nonlinear Vector Moving-Average (VMA) model to take into account both the casual effects and the possible asymmetric effects of US financial shocks.

Given the high degree of US financial market integration with many countries, a natural question is: To what extent does a US financial disruption affect non-US economies? Moreover, it is worth exploring whether asymmetries exist here too. To focus on the possible asymmetric effects of US financial shocks on other countries' economic activities, I build on but depart from BMZ by using their estimated shocks in an international context. To the best of my knowledge, this paper is the first to directly investigate the effects of US financial shocks on other major economies, especially focusing on the *asymmetric* effects using empirical model that estimates nonlinearly.

I proceed in two steps. First, I extract US financial shocks following the spirit of BMZ. The main part of the identification strategy is to isolate shocks to the Excess Bond Premium (EBP), popularized by GZ (2012), that are orthogonal to the current state of macro variables. Details are provided in Section 2. Second, I use the Smooth Local Projection (SLP), proposed by Barnichon and Brownlees (2019), to examine the possible asymmetric effects of US financial shocks on non-US G7 countries excluding Japan[1] (hereafter G5) and three additional countries, South Korea, Brazil and Mexico, that are the top-ranked US trade partners. The SLP approach approximates impulse response coefficients using a linear combination of B-splines basis functions, the parameters of which are estimated by generalized ridge estimation (see Barnichon and Brownlees (2019) for details). SLP offers a number of benefits over the standard LP introduced by Jordà (2005). First, SLP can notably increase estimation precision while preserving the flexibility of the standard LP. Also, SLP provides more regular (i.e., less erratic) impulse responses than standard LP.

My findings suggest the existence of asymmetric effects of US financial shocks on G5 countries. An adverse US financial shock brings negative effects, i.e. drops IP growth on impact for more than a year, on the economic activities of Canada, Germany, France, the UK and Italy. However, a favorable US financial shock has less effect on output of these countries. In addition, the countries exhibiting the asymmetric dynamics behave similarly from impact up to nearly 18 months to an

[1] The reason for excluding Japan is that the country has experienced exceptional economic conditions than other G7 countries: such as having zero lower bound for very long periods and suffering from the "Lost Decade".

adverse US financial shock. I explore two more variables, short-term interest rates and a domestic share prices index, which also show asymmetry between the responses of a negative US financial shock and the responses of a positive US financial shock.

The rest of the paper is structured as follows. Section 2 provides the empirical model and the shock identification method. Section 3 presents the evidence of asymmetric effects of US financial shocks on non-US countries. Section 4 concludes.

2 Empirical model specification

To detect whether impacts of US financial shocks in a global context are asymmetric, it is necessary to first extract nonlinearly identified US financial shocks. In this section, I review the main concepts of the empirical methodology used in BMZ to identify the shock: (i) nonlinear VMA model to allow both the causal and the possible asymmetric effects of the shocks, and (ii) FAIR to estimate the VMA model. For details, readers may refer to BMZ (2020) or Barnichon and Matthes (2018).

2.1 Nonlinear VMA model and FAIR

Let $\boldsymbol{y}_t$ be a vector of stationary macroeconomic variables. A VMA with asymmetry is described by

$$\boldsymbol{y}_t = \boldsymbol{\mu} + \sum_{j=0}^{K} \boldsymbol{\Psi}_j(\boldsymbol{\varepsilon}_{t-j})\boldsymbol{\varepsilon}_{t-j}, \tag{1}$$

where $\boldsymbol{\mu}$ is a vector of intercept, K the number of lags,[2] either finite or infinite, $\boldsymbol{\varepsilon}_t$ a vector of structural shocks ($E(\boldsymbol{\epsilon_t}) = 0$ and $E(\boldsymbol{\epsilon_t}\boldsymbol{\epsilon_t}') = I$, Gaussian innovations), and $\boldsymbol{\Psi}_j(\boldsymbol{\varepsilon}_{t-j})$ the impact matrix coefficients depending on the value (e.g., sign) of the structural shocks, i.e., the impulse response function of a negative shock may differ from that of a positive shock.

To estimate a VMA model, it is common to use a VAR model which then requires inversion to obtain MA representation. However, if the true model is nonlinear, the existence of a VAR representation does not necessarily hold, since inverting (1) is impossible in general (Barnichon and Matthes (2018)). Thus, BMZ directly estimate the VMA model (1), i.e., directly estimate the impulse response functions, by employing Functional Approximations of Impulse Responses (FAIR). FAIR is a method of approximating impulse responses with a few number of basis functions. Using FAIR allows to address an issue of large dimensionality of parameters which occurs when estimating the full MA model.[3]

To illustrate the nonlinear VMA model with FAIR in detail, let ε^i_{t-j} be a structural shock of interest and rewrite (1) as

$$\boldsymbol{y}_t = \boldsymbol{\mu} + \sum_{j=0}^{K}[\boldsymbol{\Psi}_j^+(\boldsymbol{\varepsilon}_{t-j} \odot \mathbf{1}_{\varepsilon^i_{t-j}>0}) + \boldsymbol{\Psi}_j^-(\boldsymbol{\varepsilon}_{t-j} \odot \mathbf{1}_{\varepsilon^i_{t-j}\leq 0})] \tag{2}$$

with $\boldsymbol{\Psi}_j^+$ and $\boldsymbol{\Psi}_j^-$ the impact matrices for positive and negative shocks of interest, respectively, and $\odot$ indicating element-wise multiplication. Then, using a FAIR

[2] Because the variables are stationary, the lag length K can be truncated at some large enough horizon. Here, I use $K = 120$ following BMZ.

[3] Unlike estimating the full MA model, FAIR is all about estimating $\{a, b, c\}$ in equation (3) and constants.

method, each element of matrix $\mathbf{\Psi}_j^+$, say $\psi^+(j)$, can be approximated with a sum of basis functions. Here, Gaussian basis functions are chosen because typical impulse response patterns can be captured with one or two Gaussian functions: a monotonic or hump-shaped IRF with one Gaussian function and oscillating IRF with two Gaussian functions (see Barnichon and Matthes (2018)). Specifically, using two Gaussian basis functions as in BMZ (2020), $\psi^+(j)$ can be written as

$$\psi^+(j) = \sum_{n=1}^{2} a_n^+ e^{-(\frac{j-b_n^+}{c_n^+})^2}, \quad \forall j > 0 \tag{3}$$

with contemporaneous impact matrix, $\psi^+(0)$, left unrestricted for flexibility and to allow imposing short-run restrictions into FAIR. Similar expression holds for $\mathbf{\Psi}_j^-$ and $\psi^-(j)$.

2.2 Shock identification

To identify US financial shock, the Excess Bond Premium (EBP), popularized by GZ (2012), is used as a financial variable. According to GZ, the EBP denotes deviations in the pricing of US corporate bonds relative to the expected default risk of the issuer. It captures additional compensation demanded - beyond expected default risk - by investors for bearing corporate credit risk. GZ document that, as corporate bond market is dominated by (highly leveraged) investors, fluctuations in corporate credit spreads may represent shifting risk attitudes of these investors. Thus, an increase in EBP reflects reduction in their effective risk-bearing capacity and thus a contraction in the supply of credit. All told, innovations to the EBP can be interpreted as a credit supply shock and will be referred to as “financial shocks”.

BMZ follow GZ identification scheme which imposes a recursive ordering between macroeconomic variables and financial variables: $\boldsymbol{y}_t$ includes monthly data of (i) log-difference of industrial production (IP), (ii) log-difference of the CPI, (iii) EBP, and (iv) effective federal funds rate (FFR). The recursive identification implies that the economic variables do not react on impact to the financial shock. However, BMZ do not impose a recursive ordering between EBP and FFR, a strong assumption made in GZ that monetary policy shocks do not affect the EBP on impact. Instead, they add external information[4] related to the monetary policy shock in the model (1) to separately identify each of the financial shock and the monetary shock.

The model (1) is estimated using Bayesian methods with a Multiple-block MH algorithm. I skip the details here as it is documented in the online appendix of BMZ (2020).

3 Asymmetric effects of US financial shock on non-US economies

In this section, I treat the nonlinearly identified shocks in Section 2 as observable and employ Smooth Local Projection (SLP) to estimate the possible asymmetric impulse responses of non-US economic variables to US financial shocks. The shocks

[4]Without imposing a recursive assumption between EBP and FFR, additional information is needed to identify each financial and monetary policy shock. A measurement equation using external proxy variable for the monetary policy shock (Romer and Romer (2004)) is added. This setup originates from Caldara and Herbst (2019).

are monthly frequency covering the period from 1973 to 2016.[5] For the country selection, I consider non-US G7 countries other than Japan (G5 henceforth), i.e., Canada (CAN), France (FRA), Germany (DEU), the UK (GBR) and Italy (ITA), as they are large open economies with ranked highly among the trading partners of the US. Besides these countries, three additional countries that are non-G7 but are ranked within top 10 trading partners with the US, which are South Korea (KOR), Mexico (MEX) and Brazil (BRA), are considered. As a natural starting point, my primary interest is to measure the behavior of real economic activity (industrial production) in each country to the shocks. I also estimate the impulse responses of two additional variables, short-term interest rates and share prices index. All foreign variables are monthly data from the OECD database.

3.1 Evidence from VMA-Smooth Local Projection (VMA-SLP)

Denoting s_t the variable of interest for each country, the impulse responses can be estimated from the following VMA-SLP model (4): denote the extracted financial shocks in the VMA model as $\{\hat{\varepsilon}_t\}$

$$s_{t+h} = \alpha_h + \beta_h^+(\hat{\varepsilon}_t \cdot 1_{\hat{\varepsilon}_t > 0}) + \beta_h^-(\hat{\varepsilon}_t \cdot 1_{\hat{\varepsilon}_t \leq 0}) + \gamma^{'} x_t + u_{t+h}, \quad h \leq 60 \tag{4}$$

[5] Since the extended Romer and Romer (2004) monetary policy instrument is available up to 2007 by Wieland and Yang (2020), I first consider the 1973-2007 sample period by including the FFR in the model. However, BMZ find that the results are robust to excluding the FFR in the model, so I extend the sample period to 2016 by dropping the FFR and use this period as a benchmark. Results for the 1973-2007 sample period, which also provide robustness checks by excluding the 2008 crisis, are presented in the Appendix.

where β_h^+ and β_h^- are the coefficients of interest capturing the impulse responses to a positive or negative financial shock, respectively, at horizon h, and x_t includes 12 lags of the left-hand side variable. SLP approximates the impulse response coefficients using a sum of B-splines basis functions which the parameters are estimated by generalized ridge estimation.[6]

In the main text, I show the impulse responses of the G5 countries and the results for the rest of the countries are reported in the Appendix. First, Figure 1 shows the estimated impulse responses of US IP to US financial shocks in thick blue line along with shaded area covering 68% and 90% confidence bands calculated using Newey-West estimator as proposed in Barnichon and Brownlees (2019). For an easy comparison of the asymmetry, the impulse responses to a favorable shock are multiplied by -1. As in BMZ (2020), US financial shocks have asymmetric effects on US output. To be specific, the impulse responses to an adverse shock and a favorable shock show different dynamic patterns in terms of both economically and statistically significance.[7] As reported in the left panel, an adverse shock reduces IP growth on impact and the effect persists for more than a year with its peak occurring after nearly 10 months. On the other hand, a favorable shock has less or no statistically significant effect on IP growth.

[6]Refer to Barnichon and Brownlees (2019) Section 2 for detailed descriptions.

[7]If there is no asymmetry, the responses to a negative shock and a positive shock are the same.

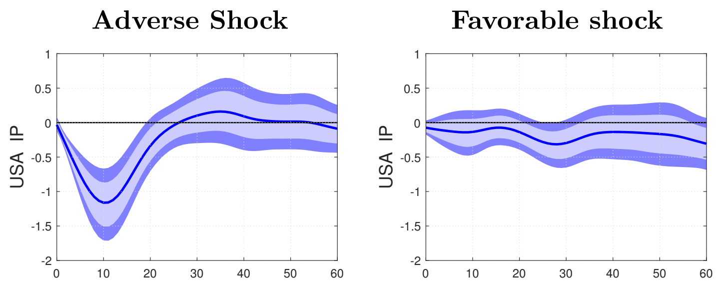

Figure 1: Impulse responses of US IP growth to an adverse US financial shock (left panel) and a favorable US financial shock (right panel). Blue thick line shows impulse response coefficient estimates from SLP and shaded areas represent 68% and 90% confidence bands. For the sake of easy comparison, the impulse responses in the right panel are multiplied by -1.

Now, Figure 2 plots impulse responses of IP growth of the G5 countries that show (similar) asymmetric effects to US financial shocks as exhibited in Figure 1. An adverse US financial shock results in significant decline in output in each of the G5 countries (Canada, Germany, France, the UK and Italy). The movements and magnitudes of the responses of IP growth following a negative US financial shock in these countries are similar to those in the US until about 20 months after the shock. On the other hand, a favorable US financial shock has little effect on the countries' output as the confidence bands include zeros, with the exception of a few horizons in Canada, Germany and France. The findings indicate that an adverse US financial shock matters more than a favorable US financial shock to the G5 economies, similar to the US. The impulse responses of the rest of the countries (South Korea, Brazil and Mexico) reported in Figure 5 in the Appendix present either (almost) symmetric or not statistically significant effects except Brazil.[8]

I provide two robustness checks in the Appendix focusing only on the G5 coun-

[8]Brazil also shows a decrease in IP growth to an adverse US financial shock, but the effect is weaker than that of the G5 countries.

tries: the results are robust to (i) a specification from GZ (2012), i.e., financial shocks identified from a VAR, as reported in Figure A.1,[9] and (ii) the 1973-2007 sample period excluding the global financial crisis as reported in Figure A.2.[10]

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[9]The asymmetry effects are not as clear as in the benchmark specification, but are still detected in the US and the G5 countries (especially focusing on the 68% confidence bands for the UK and Italy) except Germany.

[10]The asymmetric dynamics are broadly similar to the benchmark results except in the US, Canada and Germany, which show increase in IP growth about two to three years after a favorable shock. Remember that the impulse responses following a favorable shock are multiplied by -1.

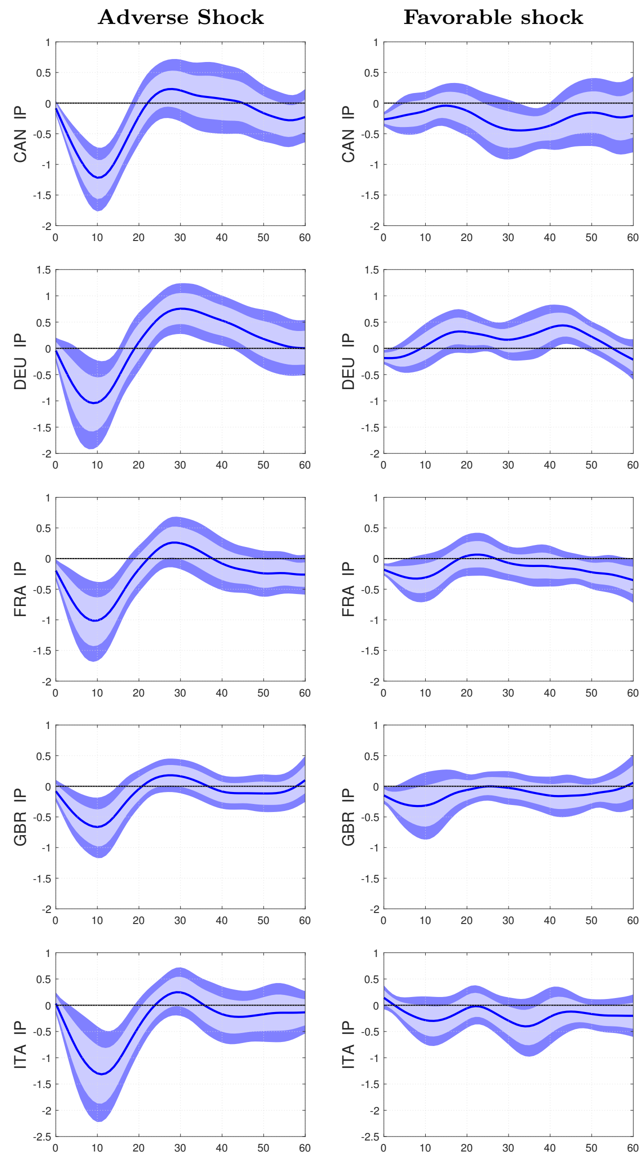

Figure 2: Impulse responses of IP growth of the G5 countries to an adverse US financial shock (left panel) and a favorable US financial shock (right panel). Blue thick line shows impulse response coefficient estimates from SLP and shaded areas represent 68% and 90% confidence bands. For the sake of easy comparison, the impulse responses in the right panel are multiplied by -1.

To see how dynamics of each country in Figure 2 to an adverse US financial shock are correlated with those of the US, I calculate correlation coefficients between

US IP responses and each of the G5 countries' responses to an adverse US financial shock.[11] Since the responses are statistically significant for all the countries until approximately 20 months after the shock, I first calculate the correlations using only 20 horizons which the results are reported in the second row of Table 1. The values indicate large comovements between the US and each country, which implies synchronization in the dynamics across countries. I also calculate the correlations using the whole 60 horizons, although the latter part of the responses are no longer significant for some countries. The results are reported in the last row of Table 1. The correlations are still high but slightly decreased (except Germany) compared to those considering only 20 horizons.

$\text{corr}(USA_{t+h}, x_{t+h})$	*CAN*	*DEU*	*FRA*	*GBR*	*ITA*
$h \leq 20$	0.9892	0.8788	0.9268	0.9305	0.9929
$h \leq 60$	0.9571	0.9290	0.9075	0.8992	0.9619

Table 1: Correlations of IP growth responses to an adverse US financial shock

Next, I estimate the impulse responses of two additional variables, short-term interest rate and share prices index. For the short-term interest rate, I choose government bond rate because it provides longer data periods than the central bank policy rate for some countries, such as South Korea and Mexico. Figure 3 presents the effects of US financial shocks on the short-term interest rate of the US and the G5 countries. First, looking at the responses from the US (reported in the first row), the short-term interest rate following an adverse financial shock drops[12] for more

[11]The correlations are calculated using the values from blue thick lines (i.e., estimated impulse response coefficients from SLP) to an adverse shock.

[12]One could conjecture that when the economy is sluggish, as shown in Figure 2 that the IP growth

than four years, while the effects to a favorable shock are less or not statistically significant. Among the G5 countries, Canada and Germany show the asymmetry as displayed in the second and third row: drop in the short-term interest rate to an adverse shock is significant whereas the responses generated from a favorable shock is not statistically significant. Also, France and the UK appear to have the asymmetry as well, even though focusing on the 68% confidence band. The impulse responses of South Korea and Mexico are exhibited in Figure 6, with South Korea showing the asymmetry.[13]

The responses of the share prices indices to US financial shocks are depicted in Figure 4. First, an adverse US financial shock appears to have negative effects on the share prices index of the US and the G5 countries. Moreover, the dynamics, especially persistence of the effects, are similar across the countries. However, as shown in the right panel, a favorable US financial shock has no statistically significant effects on each country. The impulse responses of South Korea, Brazil and Mexico are displayed in Figure 7 in the Appendix. The three countries exhibit either (almost) symmetric or less statistically significant effects. As robustness checks, I carry out the same analysis (focusing on the G5 countries) with the 1973-2007 data period, and the results are shown in the Appendix Figure A.3[14] for the short-term interest rates and Figure A.4 for the share prices indices.

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declines to an adverse US financial shock, investors' demand for safe assets (e.g., government bonds) increases which leads to lower government bond rate.

[13]The data is not available for Brazil.

[14]Although the asymmetry between adverse and favorable shock is most distinct in the US, it is still detected in Canada and Germany as displayed in the second and third row. For the rest of the G5 countries, the movements of the short-term interest rates are either not significant to an adverse shock or somewhat symmetric between the left and the right panel.

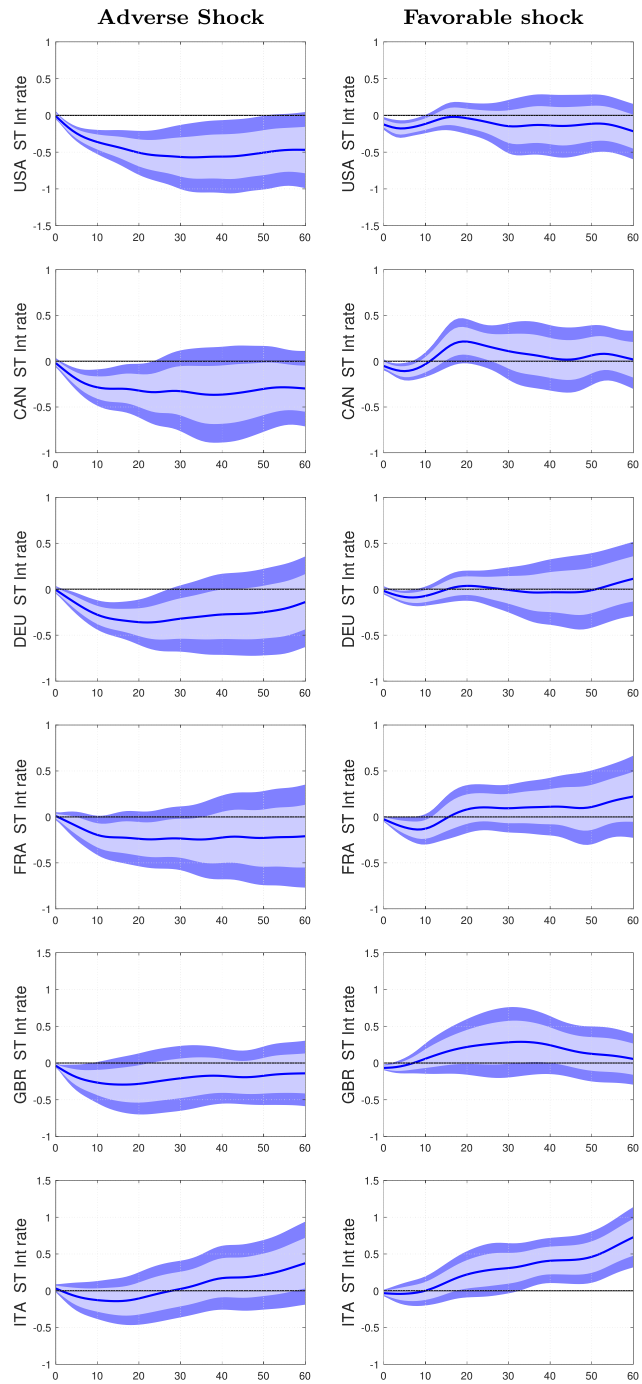

Figure 3: Impulse responses of short-term interest rates of the US and the G5 countries to an adverse US financial shock (left panel) and a favorable US financial shock (right panel). Blue thick line shows impulse response coefficient estimates from SLP and shaded areas represent 68% and 90% confidence bands. For the sake of easy comparison, the impulse responses in the right panel are multiplied by -1.

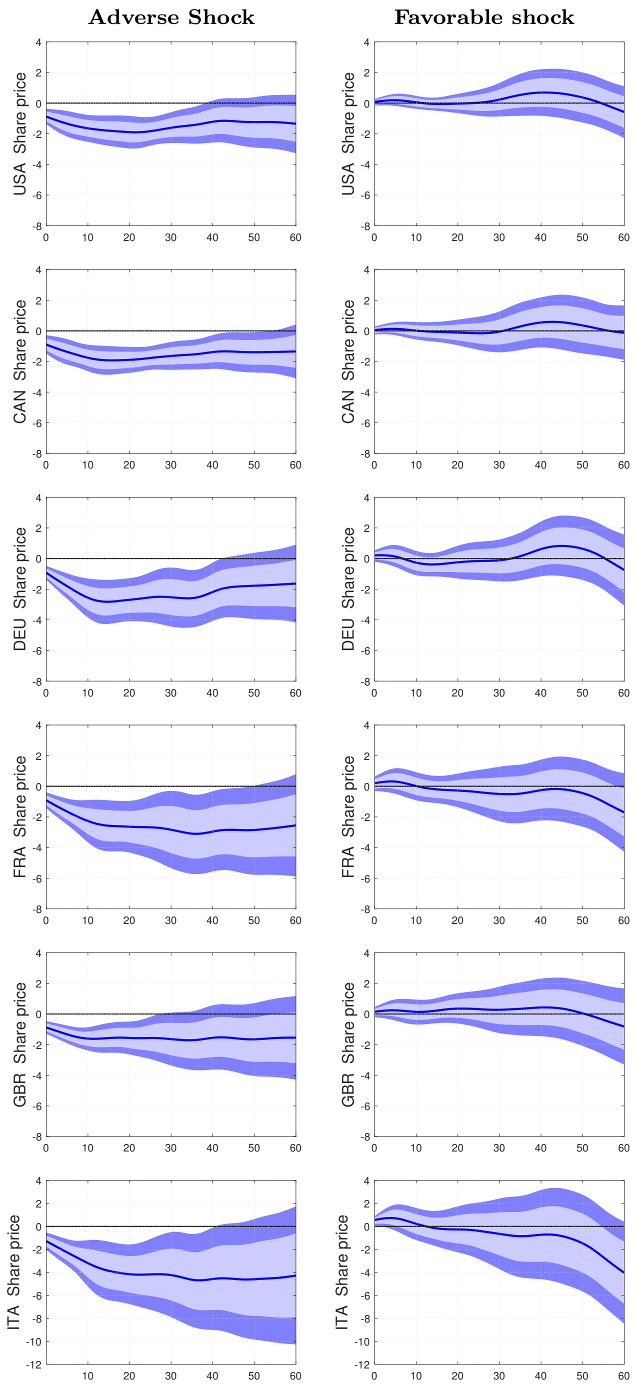

Figure 4: Impulse responses of share prices index of the US and the G5 countries to an adverse US financial shock (left panel) and a favorable US financial shock (right panel). Blue thick line shows impulse response coefficient estimates from SLP and shaded areas represent 68% and 90% confidence bands. For the sake of easy comparison, the impulse responses in the right panel are multiplied by -1.

4 Conclusion

This paper studies the existence of possibly asymmetric effects of US financial shocks on major developed countries (Canada, Germany, France, Italy and the UK) and three additional countries (South Korea, Mexico and Brazil) having large trading ties with the US. The US structural shocks are identified following the procedure of BMZ (2020) which uses a Vector Moving-Average (VMA), that allows nonlinear effects of US financial market disruptions. Then I treat the extracted financial shocks as observable and feed them into Smooth Local Projection (SLP) to estimate the possibly asymmetric dynamics of output, short-term interest rate and share prices index of each foreign country. The results indicate that an adverse US financial shock matters more than a favorable shock for most major economies, i.e., Canada, Germany, France, the UK and Italy. They show significant contractions in the economic variables following an adverse US financial shock, which is not detected with a favorable financial shock.

In this research, I focused on providing empirical evidences of asymmetric effects of US financial shocks on non-US countries, especially G5 countries. Moreover, as I showed in Section 3.1, the impulse response dynamics of IP growth and share prices index of the G5 countries to an adverse US financial shock display similar trends with those of the US. These findings echo a recent paper (Perri and Quadrini (2018)) which explores a high degree of international synchronization of real and financial activities of G7 countries and asymmetry dynamics of real economic variables between credit booms (generating sluggish growth) and credit busts (generating strong contraction). Also, they suggest that as financial markets are globally integrated, crises become less frequent, which increases the leverage and results in large contractions in the economic activities. Their findings are proposed by a theoretical model that emphasizes the role of financial frictions, especially driven by global liquidity shortage raised by pessimistic self-fulfilling expectations, in a two-country setting.

In line with the idea of Perri and Quadrini (2018), to understand the underlying mechanisms that explain the asymmetric effects of US financial shocks studied in this paper, a potential direction for the future research could be estimating macroeconomic model with financial frictions in an international context.

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Appendix

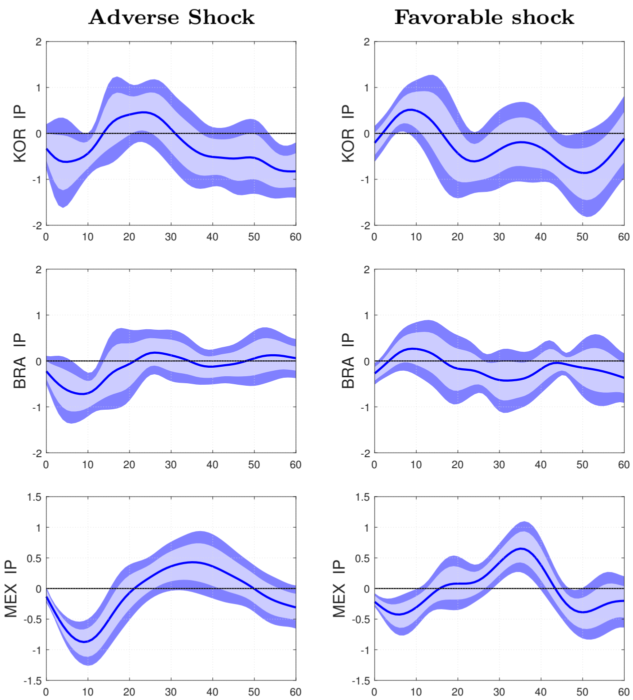

Figure 5: Impulse responses of IP growth of South Korea, Brazil and Mexico to an adverse US financial shock (left panel) and a favorable US financial shock (right panel). Blue thick line shows impulse response coefficient estimates from SLP and shaded areas represent 68% and 90% confidence bands. For the sake of easy comparison, the impulse responses in the right panel are multiplied by -1.

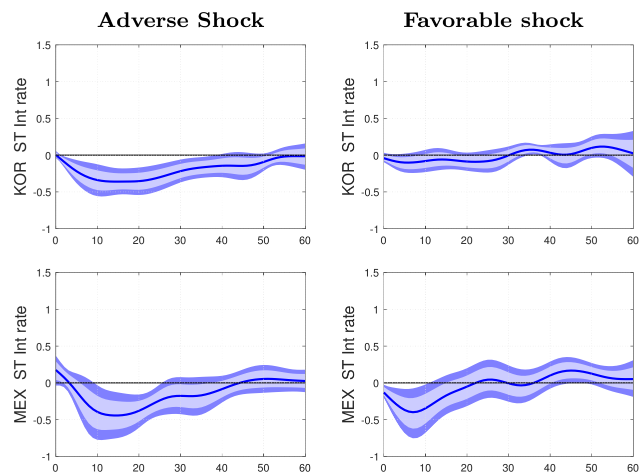

Figure 6: Impulse responses of short-term interest rate of South Korea and Mexico (data is not available for Brazil) to an adverse US financial shock (left panel) and a favorable US financial shock (right panel). Blue thick line shows impulse response coefficient estimates from SLP and shaded areas represent 68% and 90% confidence bands. For the sake of easy comparison, the impulse responses in the right panel are multiplied by -1.

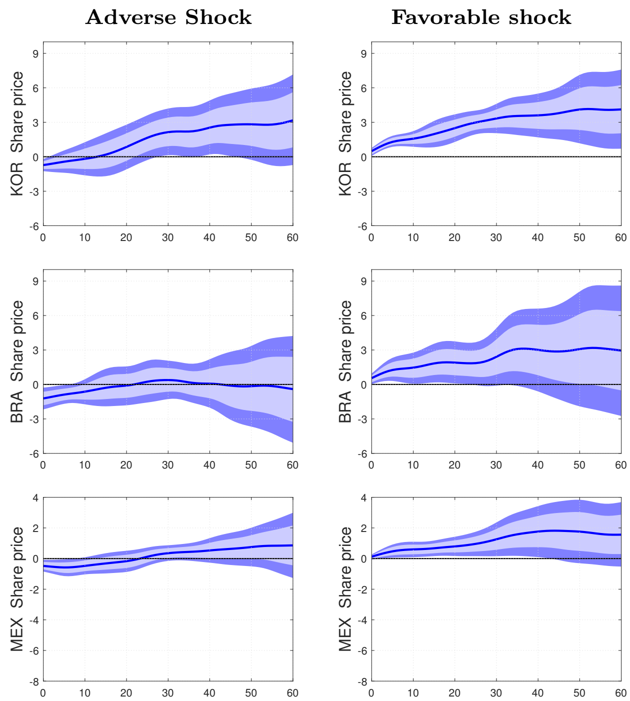

Figure 7: Impulse responses of share prices index of South Korea, Brazil and Mexico to an adverse US financial shock (left panel) and a favorable US financial shock (right panel). Blue thick line shows impulse response coefficient estimates from SLP and shaded areas represent 68% and 90% confidence bands. For the sake of easy comparison, the impulse responses in the right panel are multiplied by -1.

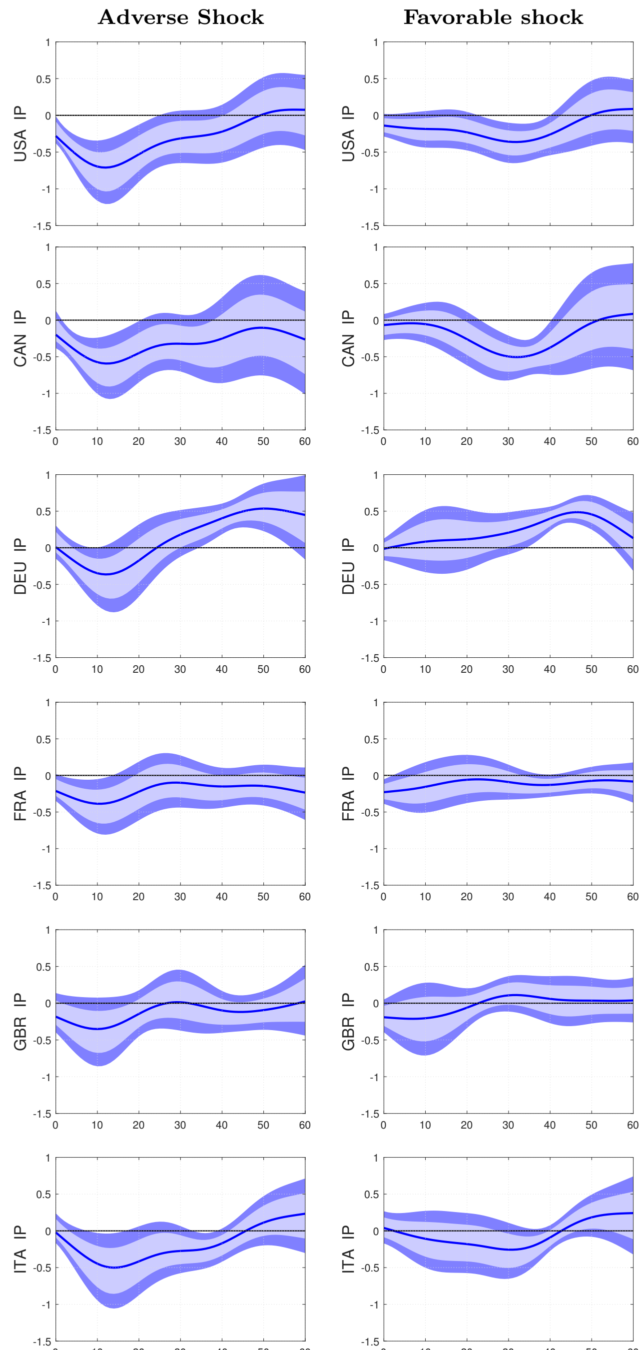

Figure A.1: GZ specification - Robustness check. Impulse responses of IP growth of the US and the G5 countries to an adverse US financial shock (left panel) and a favorable US financial shock (right panel). Blue thick line shows impulse response coefficient estimates from SLP and shaded areas represent 68% and 90% confidence bands. For the sake of easy comparison, the impulse responses in the right panel are multiplied by -1.

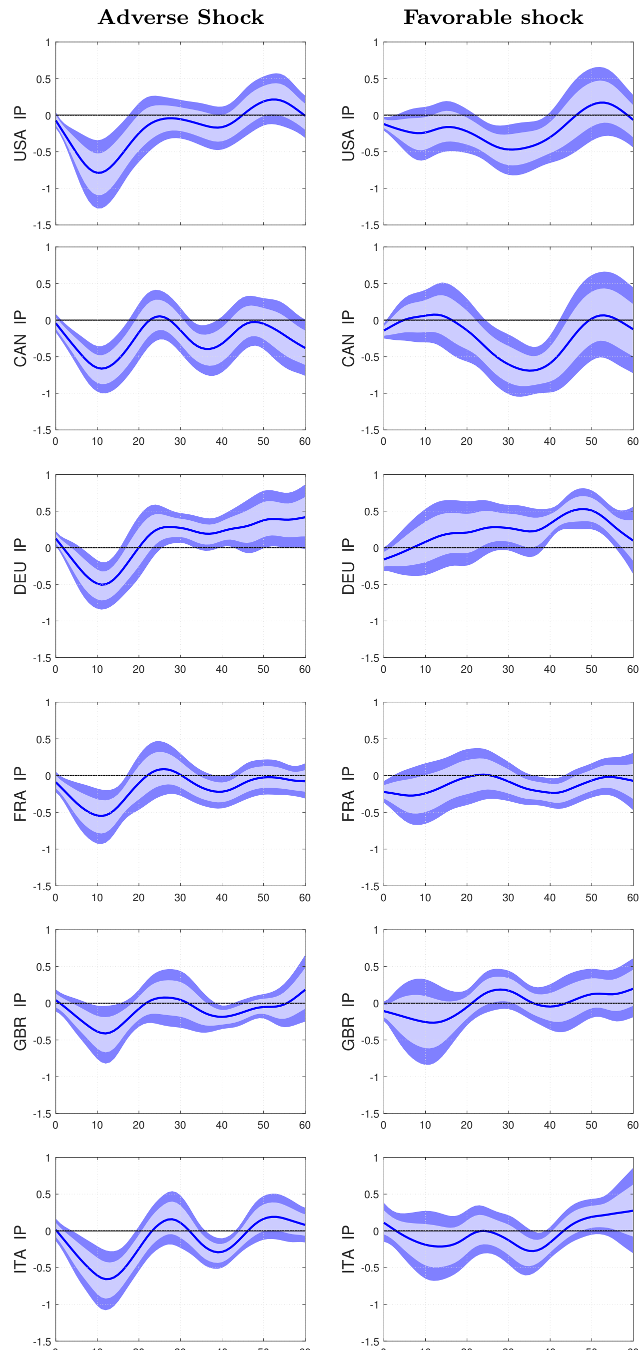

Figure A.2: Sample period excluding the 2008 crisis (1973-2007) - Robustness check. Impulse responses of IP growth of the US and the G5 countries to an adverse US financial shock (left panel) and a favorable US financial shock (right panel). Blue thick line shows impulse response coefficient estimates from SLP and shaded areas represent 68% and 90% confidence bands. For the sake of easy comparison, the impulse responses in the right panel are multiplied by -1.

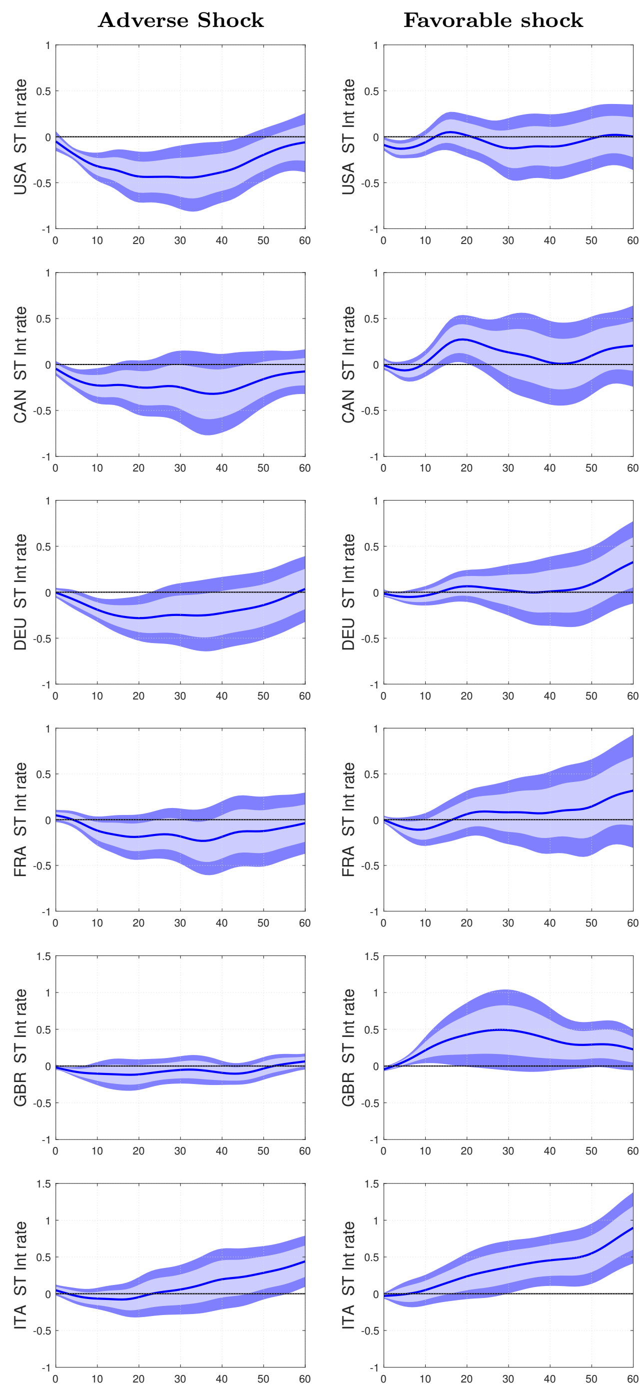

Figure A.3: Sample period excluding the 2008 crisis (1973-2007) - Robustness check. Impulse responses of short-term interest rates of the US and the G5 countries to an adverse shock (left panel) and a favorable shock (right panel). Blue thick line shows coefficient estimates from SLP and shaded areas represent 68% and 90% confidence bands. For the sake of easy comparison, the impulse responses in the right panel are multiplied by -1.

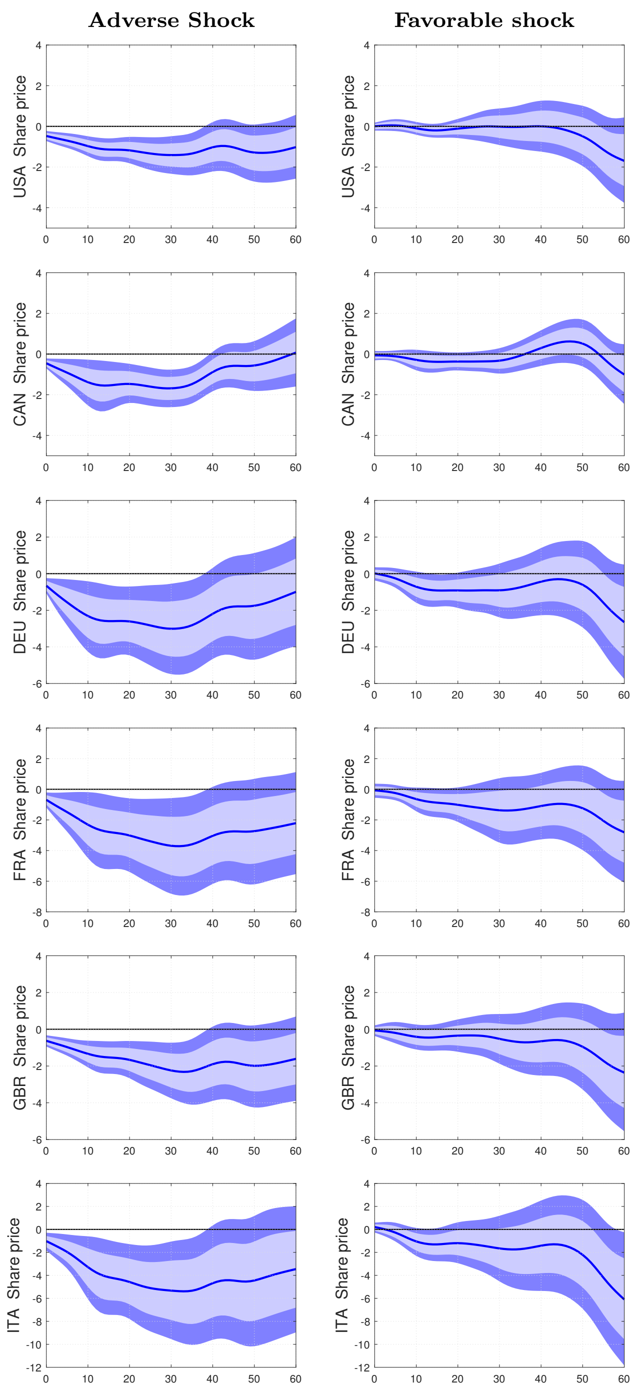

Figure A.4: Sample period excluding the 2008 crisis (1973-2007) - Robustness check. Impulse responses of share prices index of the US and the G5 countries to an adverse shock (left panel) and a favorable shock (right panel). Blue thick line shows coefficient estimates from SLP and shaded areas represent 68% and 90% confidence bands. For the sake of easy comparison, the impulse responses in the right panel are multiplied by -1