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Essays on Financial Globalisation

Author:
Lorenz EMTER

Supervisor:
Agustín BÉNÉTRIX

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Declaration of Authorship

I, Lorenz EMTER, declare that this thesis titled, "Essays on Financial Globalisation", submitted to Trinity College Dublin for the degree of Doctor in Philosophy (Ph.D.), has not been submitted as an exercise for a degree at this or any other university. I confirm that I was the lead author for each of the co-authored chapters in the thesis. All research contained herein is entirely my and my co-authors' work.

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"The genie unleashed by a half century of global financial development cannot be stuffed back in its bottle. So the best governments can do is to undertake effective domestic regulation while cooperating on their common challenges from financial globalization [...]."

Obstfeld (2021)

Summary

This dissertation is a collection of three essays on financial globalisation. As argued in Obstfeld (2021), the rapid growth of international financial capital markets in recent decades provided benefits in the form of international risk sharing, capital transfer, and liquidity provision. At the same time, national policy makers might find it harder to reach domestic policy objectives since international financial markets span beyond the reach of any one national sovereignty, particularly in the areas of financial stability and international taxation. A common theme running through the essays in this dissertation is the importance of global factors shaping national macro-financial outcomes with a focus on policy options for domestic policy makers which can tame the ramifications of financial globalisation.

Chapter 2, co-authored with Johannes Beutel, Norbert Metiu, Esteban Prieto, and Yves Schueler, studies the international transmission of shocks to global financial conditions on macroeconomic tail risks in advanced and emerging economies. The chapter shows that contractionary financial and monetary policy shocks originating in the U.S. cause elevated downside risks to output growth around the world. By tightening financial conditions globally, these shocks affect the left tail of the conditional output growth distribution disproportionately. This effect is particularly pronounced for countries with less flexible exchange rate arrangements, higher foreign currency exposures, and higher levels of private sector leverage. This suggests that policymakers face a trilemma, in which the exchange rate regime and macroprudential policies matter for downside risks to growth.

Chapter 3 extends the literature on extreme episodes in international capital flows. Using a quarterly panel of 98 advanced as well as emerging and developing countries from 1990 to 2018 the chapter shows that domestic variables are significantly related to the probability of incurring sharp reversals in capital inflows controlling for global push factors. In particular, negative growth shocks combined with high levels of leverage in the domestic private sector are a significant determinant of sudden stops. This is in line with real business cycle models including an occasionally binding credit constraint and income trend shocks. By limiting excessive credit growth, countercyclical macroprudential policy could, hence, also serve

to reduce the susceptibility of capital inflows to sudden stops.

Chapter 4, co-authored with Agustín Bénétrix and Martin Schmitz, examines the impact of automatic exchange of information (AEOI) treaties between tax authorities on cross-border investment positions in tax haven countries. Employing a confidential sectoral breakdown of data on bilateral bank deposits, we find that the AEOI significantly reduced cross-border deposits in tax havens, in particular by households. Moreover, the portfolio and direct investment assets of tax haven entities in non-haven countries fell significantly after AEOI introduction, indicating a reduction of round-tripping investments. However, we also document evidence of deposit shifting by the household sector to haven countries not participating in the AEOI and, moreover, observe larger foreign direct investment positions and non-bank financial institutions' deposits between tax haven countries, suggesting an increased use of shell companies since AEOI introduction. Hence, the chapter highlights the importance and effectiveness of multilateral policy making in order to curb one particular challenge posed by financial globalisation in the form of tax evasion, while highlighting some of the remaining challenges for policymakers.

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Chapter 1

General Introduction

This dissertation is a collection of three essays on financial globalisation. As argued in Obstfeld (2021), the rapid growth of international financial capital markets in recent decades provided benefits in the form of international risk sharing, capital transfer, and liquidity provision. At the same time, national policy makers might find it harder to reach domestic policy objectives since international financial markets span beyond the reach of any one national sovereignty, particularly in the areas of financial stability and international taxation. Building on this important observation, a common theme running through the essays in this dissertation is the importance of global factors shaping national macro-financial outcomes with a focus on policy options for domestic policy makers which can tame some of the negative ramifications of financial globalisation.

The first two chapters add new perspectives to the long-standing discussion about international economic policy dependence and the impact of increasing international financial integration (see, e.g., Mundell (1960), Fleming (1962), Obstfeld, Shambaugh, and Taylor (2005), Rey (2015)). The classical trilemma of international macroeconomics refers to countries' inability of pursuing a fixed exchange rate, free capital mobility and an independent monetary policy at the same time. Rey (2015) suggests that the scale of financial integration in recent decades has turned this trilemma into a dilemma, i.e., an 'irreconcilable duo' of free capital flows and independent monetary policy, irrespective of the exchange rate regime. She underpins this suggestion by empirical evidence that cross-country heterogeneity in the degree of co-movement of capital flows and asset prices with the global financial cycle is independent of the exchange rate regime.

Chapter 2, co-authored with Johannes Beutel, Norbert Metiu, Esteban Prieto, and Yves Schueler, presents an analysis of the effects shocks to global financial conditions can have on real economic output. Since the global financial crisis, policymakers have become increasingly concerned with the risk of large negative output growth realizations. In turn, a rapidly growing body of research on downside risks to growth has emerged (e.g., Adrian, Boyarchenko, and Giannone 2019; Aikman, Bridges, Hoke, O'Neill, and Raja 2019; and Prasad et al. 2019). This literature emphasizes that tight domestic financial conditions increase macroeconomic tail risks. As also discussed to some extend in Chapter 3, domestic financial conditions in many countries are to a substantial degree determined by global forces, in part due to financial globalisation. Notions such as the "global financial cycle" and "global liquidity" capture the idea that financial conditions in center countries transmit to countries around the world (e.g., Bank for International Settlements 2011; Rey 2015; Eickmeier, Gambacorta, and Hofmann 2014; and Miranda-Agrippino and Rey 2020).

In this Chapter, we connect the discussion on downside risks to growth with the discussion on the global financial cycle. Specifically, we explore the impact of shocks to global financial conditions on the conditional distribution of GDP growth around the world. We show that U.S. financial and monetary policy shocks disproportionally affect downside risks to growth in other countries. More precisely, the Chapter extends the literature by providing answers to the following questions: (i) How do U.S. financial and monetary policy shocks affect downside risks to growth around the world? (ii) Which country characteristics increase the vulnerability to such shocks? We address these questions using a Bayesian quantile VAR estimated on a panel of macroeconomic and financial data from 44 advanced and emerging countries. We study U.S. financial and monetary policy shocks because of the United States' pivotal role in the global financial system.

Three novel results emerge. First, we find that U.S. financial shocks increase downside risks to growth around the world by tightening financial conditions globally. On average across the countries in our sample, the aggregate effect of the shock after four quarters is four times stronger at the lower tail than at the median of conditional GDP growth. The impact at the upper tail is positive and far less pronounced.

Hence, in response to the shock, the conditional distribution of GDP growth in virtually all considered countries changes its shape and becomes more negatively skewed as disproportionately more mass shifts to the lower tail.

Second, we find evidence that several country characteristics significantly matter for the international transmission U.S financial shocks *at the lower tail* of the conditional GDP growth distribution. *At the median*, these characteristics – if at all – only weakly matter. Specifically, we do not find a statistically significant difference in the median GDP growth responses to U.S. financial shocks between countries with fixed versus floating exchange rates, with more or less foreign currency exposure, or with more or less leveraged private households. In contrast, we find that these country characteristics significantly matter at the lower tail of the GDP growth distribution. Downside risks to growth increase particularly strongly for countries with fixed exchange rates, higher foreign currency exposure, and higher levels of leverage of domestic households.

Third, the results for U.S. monetary policy shocks are similar to those for U.S. financial shocks. Consistent with U.S. monetary policy impacting global financial conditions, we find that U.S. monetary policy shocks have stronger effects at the lower tails of GDP growth abroad compared to the effect on the median or upper tail. Turning to country characteristics, we find that the exchange rate regime matters for international spillovers of U.S. monetary policy shocks at the lower tail of GDP growth, but not at its median.

The results presented in this Chapter suggest that considering the effect of U.S. shocks on macroeconomic *tail* risks may help to reconcile the somewhat puzzling observations found at the conditional median. First of all, we find that fixed exchange rates do seem to increase a country's vulnerability to large downturns in GDP triggered by U.S. financial or monetary policy shocks. Similarly, the finding that downside risks to growth are larger for countries with higher foreign currency exposure suggests a potential role for capital controls or other policies limiting the extent of foreign currency exposure. Moreover, our evidence shows that the risk of large output declines is indeed lower in countries with stricter limits on private household sector leverage, even after controlling for exchange rate regime and foreign currency exposure. While the effect of country characteristics need not be causal, our findings

suggest that, at least potentially, policies that limit the amount of private household leverage could mitigate the risk of large economic downturns.

Chapter 3 studies one important mechanism through which shocks to global financial conditions can be transmitted across countries, i.e. sharp reversals in capital inflows. These so called sudden stops are associated with dire economic outcomes. They have been shown to go hand in hand with sharp current account adjustments and real exchange rate depreciations which regularly result in financial instability and significant output losses, as well as increasing unemployment. The potential reasons behind such sudden stops are still subject to debate in the literature. The global financial crisis (GFC) has drawn attention to global push factors such as changes in global risk aversion, which are outside the control of domestic policy makers in countries experiencing sudden stops. However, more recent literature has shown that since the GFC, extreme capital flow movements have become less correlated with these so called push factors and that, in fact, global, regional and domestic variables previously used in the literature are less able to explain large movements in international capital flows (Forbes & Warnock, 2021).

Chapter 3 extends the analysis of sudden stop episodes to the post-crisis period and to a larger set of countries than previously analysed in the literature. Using this extensive dataset, domestic variables are found to be significantly related to the probability of incurring sharp reversals in gross capital inflows. In particular, negative growth shocks combined with high levels of leverage in the domestic private sector are found to be a significant determinant of sudden stops. More precisely, I find that, at elevated levels of leverage in the domestic economy, a one standard deviation growth shock increases the probability of incurring a sudden stop by substantially more than when leverage is at its median or lower. This holds when global and contagion factors are accounted for. The result is also robust to including other potential domestic drivers of sudden stops like the fiscal balance, government debt levels, financial openness and exchange rate regime measures, the stock of reserve assets, as well as to excluding the GFC from the sample.

Chapter 3 therefore provides empirical evidence in support of theoretical work stressing the importance of domestic variables in determining sudden stop episodes complementing the recent empirical literature which found a predominant role for

global factors. The evidence found in this Chapter is consistent with recent additions to the theoretical literature on real business cycle models with occasionally binding collateral constraints (Akıncı & Chahrour, 2018; Flemming, L'Huillier, & Piguillem, 2019; Seoane & Yurdagul, 2019). In these models expected income gains in the future, either through an observable component in productivity or persistent shocks to trend income growth, lead agents to increase leverage, not internalizing externalities on aggregate debt in the economy. Hence, when the expected productivity gains are not actually realised or an unforeseen negative shock hits the economy, the constraint is more likely to bind. Therefore, sudden stops in capital inflows should be more likely for economies with high levels of leverage which exhibit a negative growth shock, precisely as found in this Chapter. By limiting excessive credit growth, countercyclical macroprudential policy could, hence, also serve to reduce the susceptibility of capital inflows to sudden stops.

Chapter 4, co-authored with Agustìn Bènètrix and Martin Schmitz, analyses another adverse consequence of financial globalisation, i.e. the fact that it may facilitate tax evasion by individuals. Financial globalization, together with advances in information technology, increases the ease with which capital can be moved across jurisdictions. Individual motivations for doing so can be manifold but for national governments opening up capital accounts comes with one important adverse consequence – it also becomes easier for tax evaders to move funds offshore to so called tax havens. Tax havens are generally thought of as countries that harbour wealth from non-residents seeking to hide ownership of these funds in order to avoid tax payments in their country of residence. Such international tax evasion by households does not only reduce tax revenues and the effective taxation of the rich, it can also have an eroding effect on trust in state institutions, particularly the tax system (Menkhoff & Miethe, 2019). Chapter 4 provides an analysis of the effectiveness of one of the most recent tools governments deployed in a multilateral effort to fight tax evasion, i.e. the automatic exchange of information (AEOI) on account holders.

The empirical analysis in Chapter 4 employs confidential data on deposits held in tax haven jurisdictions from the BIS locational banking statistics combined with

information on the timing of entering AEOI treaties, i.e. the OECD Common Reporting Standard (CRS) and the US Foreign Account Tax Compliance Act (FATCA), to assess the impact of these latest efforts to reign in offshore tax evasion. Using data until 2019Q4, including the breakdown by counterparty sector isolating household deposits, we can illuminate some hitherto open questions. First, we investigate whether it is actually deposits by households which are affected by the treaties. Hence, we can overcome a key limitation of the existing literature which were based on deposits by the entire non-bank sector (i.e. including non-bank financial institutions, non-financial corporations, governments, and households). Moreover, we assess the longer-term effects of the AEOIs. In addition, Chapter 4 also extends the literature by analysing the effect of AEOI treaties on other financial instruments beyond deposits, i.e. foreign direct investment and portfolio investment which have hitherto gone unexplored.

The findings presented in Chapter 4 suggest that the (threat of) automatic information exchange significantly reduced cross-border deposits by households in tax havens, while deposits of non-bank financial institutions (NBFIs) and non-financial corporations (NFCs) from non-haven residents in tax havens were unaffected. More precisely, we find that bilateral household deposits from non-haven countries in haven banks decrease by 28.5 percent upon signature of the AEOI legislation, while the effect on deposits by the broader non-bank sector is found to be only 12.5 percent. Moreover, we do find the impact of the AEOI to be persistent, suggesting that the AEOI is more effective than earlier initiatives. However, the more granular breakdown of our data allows us to document evidence of deposit shifting by the household sector, in line with evidence found for earlier information on demand treaties. This suggests that the AEOI is more effective than earlier initiatives in that it is more persistent but remains incomplete as long as non-participating haven countries allow households to simply shift deposits.

We furthermore document a significantly negative effect of AEOI on portfolio investment assets reported by tax havens residents vis-à-vis non-haven residents, in line with the results in Heckemeyer and Hemmerich (2020). Similarly, the FDI liability positions of non-havens vis-à-vis havens decline significantly after joining

the AEOI. We interpret this as evidence indicating a reduction of round-tripped investment from non-havens through havens. Moreover, we observe that non-havens report decreasing FDI asset positions in tax havens after joining the AEOI, suggesting that part of these assets were related to corporate structures with a tax-evading purpose.

However, we also find some evidence of negative side effects of the AEOI. In particular, banks in haven countries report increasing deposits from NBFIs resident in other tax havens after AEOI announcement. We interpret this as evidence that networks of shell companies used to obfuscate ultimate beneficiaries of account holders might have become more elaborate. This is corroborated by the finding that signing up to the AEOI framework is associated with a positive effect on FDI assets between tax havens. Hence, future policy initiatives should be aimed at increasing transparency regarding ultimate ownership of investments by looking-through corporate structures.

Finally, Chapter 5 provides a summary of the overall findings and offers some general conclusions and policy recommendations, as well as some suggestions for future research.

Chapter 2

The Global Financial Cycle and Macroeconomic Tail Risks

2.1 Introduction

Since the global financial crisis, policymakers have become increasingly concerned with the risk of large negative output growth realizations. In turn, a rapidly growing body of research on downside risks to growth has emerged (e.g., Adrian et al. 2019, Aikman et al. 2019, and Prasad et al. 2019). This literature emphasizes that tight domestic financial conditions increase macroeconomic tail risks. However, domestic financial conditions are to a substantial degree determined by global forces. Notions such as the "global financial cycle" and "global liquidity" capture the idea that financial conditions in center countries transmit to countries around the world (e.g., Bank for International Settlements 2011, Rey 2015, Eickmeier et al. 2014, and Miranda-Agrippino and Rey 2020).

In this chapter, we connect the discussion on downside risks to growth with the discussion on the global financial cycle. Specifically, we explore the impact of shocks to global financial conditions on the conditional distribution of GDP growth around the world. We show that U.S. financial and monetary policy shocks affect financial conditions and downside risks to growth in other countries. This *international* transmission of macroeconomic *tail* risks has thus far not been explored in the literature. To the best of our knowledge, we are the first to provide answers to the following questions: (i) How do U.S. financial and monetary policy shocks affect downside risks to growth around the world? (ii) Which country characteristics increase the

vulnerability to such shocks?

We address these questions using a Bayesian quantile VAR estimated on a panel of macroeconomic and financial data from 44 advanced and emerging countries. This approach extends the Bayesian quantile VAR developed by Schüler (2020) to a multi-country setting. We study U.S. financial and monetary policy shocks because of the United States' pivotal role in the global financial system. The U.S. dollar plays an important role as funding currency for international financial intermediaries and as a currency of denomination for portfolios worldwide. Consequently, U.S. financial conditions are an essential factor for the global financial cycle and financial conditions around the world (see, e.g., Miranda-Agrippino & Rey, 2020). We use the excess bond premium (EBP) developed by Gilchrist and Zakrajsek (2012) as a proxy for U.S. financial conditions (see also Metiu, Hilberg, and Grill (2016), Born and Enders (2019)). The EBP measures "variation in the average price of bearing exposure to U.S. corporate credit risk, above and beyond the compensation for expected defaults" (Gilchrist and Zakrajsek 2012, p. 1700). In addition, we connect to a recent literature highlighting U.S. monetary policy as an important driver of the global financial cycle and the international transmission of U.S. monetary policy through financial markets (e.g. Rey (2015), Bruno and Shin (2015), and Miranda-Agrippino and Rey (2020)). Building on this literature, we use the approach by Miranda-Agrippino and Ricco (2021) to extract informationally-robust monetary policy shocks.

Three results emerge. First, we find that U.S. financial shocks increase downside risks to growth around the world by tightening financial conditions globally. The aggregate effect of the shock after four quarters is four times stronger at the lower tail than at the median of conditional GDP growth. The impact at the upper tail is positive and far less pronounced. Hence, in response to the shock, the conditional distribution of GDP growth in virtually all considered countries changes its shape and becomes more negatively skewed as the lower tail widens.

Second, we find evidence that several country characteristics significantly matter for the international transmission U.S financial shocks *at the lower tail* of the conditional GDP growth distribution. *At the median* (and at the mean), these characteristics – if at all – only weakly matter. Specifically, we do not find a statistically significant difference in the median GDP growth responses to U.S. financial shocks

between countries with fixed versus floating exchange rates, with more or less foreign currency exposure, or with more or less leveraged private households. In contrast, we find that these country characteristics significantly matter at the lower tail of the GDP growth distribution. Downside risks to growth increase particularly strongly for countries with fixed exchange rates, higher foreign currency exposure, and higher levels of leverage of domestic households.

Third, the results for U.S. monetary policy shocks are similar to those for U.S. financial shocks. Consistent with U.S. monetary policy impacting global financial conditions, we find that U.S. monetary policy shocks have stronger effects at the lower tails of GDP growth abroad compared to the effect on the median or upper tail. Turning to country characteristics, we find that the exchange rate regime matters for international spillovers of U.S. monetary policy shocks at the lower tail of GDP growth, but not at its median.

These findings add a new perspective to a long-standing discussion about international economic policy dependence (see, e.g., Mundell (1960), Fleming (1962), Obstfeld et al. (2005)), and, more recently, about the impact of increasing international financial integration (see, e.g., Rey 2015). The classical trilemma of international macroeconomics refers to countries' inability of pursuing a fixed exchange rate, free capital mobility and an independent monetary policy at the same time. Rey (2015) suggests that the scale of financial integration in recent decades has turned this trilemma into a dilemma, i.e., an 'irreconcilable duo' of free capital flows and independent monetary policy, irrespective of the exchange rate regime. She underpins this suggestion by empirical evidence that cross-country heterogeneity in the degree of co-movement of capital flows and asset prices with the global financial cycle is independent of the exchange rate regime. Dedola, Rivolta, and Stracca (2017) show that in addition to the exchange rate regime, trade and financial openness and U.S. dollar exposure can also *not* explain the cross-country heterogeneity in output responses to US monetary policy shocks.

Our results suggest that considering the effect of U.S. shocks on macroeconomic *tail* risks may help to reconcile the somewhat puzzling observations found at the conditional mean or median. First of all, we find that fixed exchange rates do seem

to increase a country's vulnerability to large downturns in GDP triggered by U.S. financial or monetary policy shocks. The classical trilemma may still exist, and it may help to explain episodes such as the Asian financial crisis of 1997 in which stable exchange rates together with independent monetary policy and free capital mobility had contributed to large capital inflows followed by a sudden stop, that led to a financial crisis and a large decline in GDP growth (see, e.g., Obstfeld et al. (2005)). Similarly, the finding that downside risks to growth are larger for countries with higher foreign currency exposure fits the Asian experience, and it suggests a potential role for capital controls or other policies limiting the extent of foreign currency exposure.

Our findings also speak to the global financial crisis of 2008 in which, despite flexible exchange rates, a tightening of global financial conditions reversed a surge in asset prices and credit flows, causing deep economic downturns in many advanced economies. Against this backdrop, Rey (2015) argues that policymakers should respond to international financial integration by using macroprudential regulation and other financial policies in order to mitigate negative consequences of cycles in global financial conditions. Her rationale is that while the global financial cycle is outside of the control of (most) individual countries, countries can use financial policies to break the transmission channel arising from excessive credit growth and leverage. Our evidence shows that the risk of large output declines is indeed lower in countries with stricter limits on private household sector leverage, even after controlling for exchange rate regime and foreign currency exposure. While the effect of country characteristics need not be causal, our findings suggest that, at least potentially, policies that limit the amount of private household leverage could mitigate the risk of large economic downturns.

The chapter proceeds as follows. In Section 2.2, we provide a brief overview of the related literature. In Section 2.3, we introduce the Bayesian panel quantile VAR model and describe the data, as well as our strategy to identify shocks to U.S. financial conditions. In Section 2.4, we present and discuss the empirical results before Section 2.5 concludes.

2.2 Related Literature

We contribute to the literature on downside risks to growth and to the literature on the international transmission of U.S. shocks. We connect these two strands, as the international transmission of shocks adds a new perspective to the former literature, while the effect of shocks on different parts of the conditional growth distribution is a new aspect to the latter.

The literature on downside risks to growth studies the relationship between domestic financial conditions and the conditional distribution of macroeconomic variables. In pioneering work, Cecchetti (2006) and Cecchetti and Li (2008) apply quantile regression techniques developed by Koenker and Bassett (1978) to analyze the impact of equity and house price booms on tail risks to output and inflation. In a seminal paper, Adrian et al. (2019) show that the conditional distribution of U.S. GDP growth varies with U.S. financial conditions. They document that downside risks to growth increase following a tightening in financial conditions. Adrian, Grinberg, Liang, and Malik (2018) argue that this relation inverts for longer forecast horizons, implying a trade-off between loose financial conditions today and higher downside risk to growth in the medium term. Aikman et al. (2019) apply the method of Adrian et al. (2019) to a panel of advanced economies. They show that credit and property price booms as well as current account deficits predict increased downside risks to growth. Higher bank capitalization has a mitigating effect. Our chapter adds to a recent strand of this literature that seeks to go from reduced form models to an empirical modelling of the underlying structural shocks that drive downside risks. For instance, Loria, Matthes, and Zhang (2019) add to Adrian et al. (2019) by combining quantile regressions with local projection regressions to study the effect of structural shocks on U.S. macroeconomic tail risk. Chavleishvili and Manganelli (2019) show that shocks to domestic financial conditions impact the lower tail of domestic industrial production. In contrast to the empirical approach in Loria et al. (2019), we can also provide scenario analysis, which can further increase our understanding of the impact of the shock by studying different conditional paths for the variable of interest. Moreover, instead of relying on a two step procedure, we can estimate the effect on various quantiles in one step, therefore reducing one source of estimation

uncertainty. Compared to the frequentist approach proposed by Chavleishvili and Manganelli (2019), the Bayesian approach in Schüler (2020) allows us to model more variables at the same time. Hence, we can estimate the system of equations jointly instead of estimating equation by equation as in Chavleishvili and Manganelli (2019), therefore likely capturing estimation uncertainty in a more efficient way.

The literature on the international transmission of U.S. shocks has developed several strands. One closely related strand studies the international transmission of U.S. financial shocks. Fink and Schüler (2015) analyzes the transmission of shocks to U.S. financial conditions to emerging economies. They find that shocks to U.S. financial conditions transmit mainly through financial rather than trade linkages. Eickmeier and Ng (2015) use global VAR methods and sign restrictions to study the international transmission of U.S. financial shocks and find evidence for global spillovers. Metiu et al. (2016) find that the global impact of U.S. financial shocks varies with the tightness of U.S. financial conditions. Cesa-Bianchi, Ferrero, and Rebucci (2018) study how reduced form shocks to the leverage of U.S. brokers and dealers transmit across borders. They find some evidence that house prices in countries with higher maximum LTV ratios and a larger share of foreign currency denominated credit react stronger to these reduced form shocks. The evidence is weaker for consumption and exchange rates.

Another closely related strand of this literature studies the international transmission of U.S. monetary policy shocks. For instance, Miranda-Agrippino and Rey (2020) show that U.S. monetary policy shocks affect global financial conditions by inducing a deleveraging of global financial intermediaries, a decline of cross-border credit flows and a tightening of domestic financial conditions around the world. Habib and Venditti (2019) suggest that U.S. monetary policy affects global financial conditions indirectly through the pricing of risk rather than through changes in quantities. Degasperi, Hong, and Ricco (2020) find differential effects of contractionary and expansionary U.S. monetary policy shocks on certain international macroeconomic outcomes.

2.3 Methodology

2.3.1 Bayesian Quantile VAR

For any given country, we estimate a separate Bayesian quantile VAR, using the methodology developed by Schüler (2020). Let $\mathbf{y}_t = (y_{1t}, y_{2t}, \ldots, y_{nt})'$ denote a vector of n endogenous random variables with $t = 1, \ldots, T$. Country subscripts are omitted in order to simplify notation. For fixed quantile values $\boldsymbol{\tau} = (\tau_1, \tau_2, \ldots, \tau_n)'$, the reduced form Bayesian quantile VAR model can be written as:

$$\mathbf{y}_t = \boldsymbol{\nu}_{\boldsymbol{\tau}} + \sum_{i=1}^{p} \mathbf{A}_{i|\boldsymbol{\tau}} \mathbf{y}_{t-i} + \mathbf{v}_{t|\boldsymbol{\tau}}, \tag{2.1}$$

where $\boldsymbol{\nu}_{\boldsymbol{\tau}}$ is a vector of intercepts, $\mathbf{A}_{i|\boldsymbol{\tau}}$ denotes the $n \times n$ matrix of lagged coefficients, and $\mathbf{v}_{t|\boldsymbol{\tau}} = (v_{1t|\tau_1}, v_{2t|\tau_2}, \ldots, v_{nt|\tau_n})'$ is a vector of error terms. It is assumed that $Q_{\tau_j}(v_{jt|\tau_j}|\mathcal{F}_{t-1}) = 0$, where $j \in \{1, \ldots, n\}$. Q_{τ_j} refers to the τ_j-th quantile of $v_{jt|\tau_j}$ conditional on $\mathcal{F}_{t-1}$, which is the information set including information up to time period $t-1$.

As an illustration, let $n = 2$ and $p = 1$. Given $\boldsymbol{\tau} = (\tau_1, \tau_2)'$, Equation (2.1) can be explicitly written as

$$\begin{pmatrix} y_{1t} \\ y_{2t} \end{pmatrix} = \begin{pmatrix} \nu_{1|\tau_1} \\ \nu_{2|\tau_2} \end{pmatrix} + \begin{pmatrix} a_{11,1|\tau_1} & a_{12,1|\tau_1} \\ a_{21,1|\tau_2} & a_{22,1|\tau_2} \end{pmatrix} \begin{pmatrix} y_{1,t-1} \\ y_{2,t-1} \end{pmatrix} + \begin{pmatrix} v_{1t|\tau_1} \\ v_{2t|\tau_2} \end{pmatrix}, \tag{2.2}$$

where the value for τ_1 may differ from the value of τ_2. Given the assumption on $\mathbf{v}_{t|\boldsymbol{\tau}}$, the conditional quantile of y_{1t} is given by
$Q_{\tau_1}(y_{1t}|\mathcal{F}_{t-1}) = \nu_{1|\tau_1} + a_{11,1|\tau_1} y_{1,t-1} + a_{12,1|\tau_1} y_{2,t-1}$. Put differently, the quantile VAR describes the evolution of the conditional quantiles of endogenous variables, where, for each endogenous variable, a specific quantile value is assumed, such as τ_1 for y_{1t}.

Since different sets of values for $\boldsymbol{\tau}$ can be assumed, the quantile VAR lends itself to scenario analysis. We describe this next.

2.3.2 Pseudo-Structural Analysis

Unlike in the context of traditional VARs, the covariance matrix of the reduced-form residuals does not provide an adequate starting point for structural analysis in the

quantile VAR framework. This is because the residual covariance matrix summarizes the common fluctuations of residuals around means and not quantiles.

The common fluctuation of residuals around quantiles can instead be captured by a co-exceedance measure in the spirit of Blomqvist, 1950 and Koenker and Bassett, 1990:

$$\mathbf{\Omega}_{\boldsymbol{\tau}} = (\omega_{jk}) \equiv \frac{\mathrm{E}[\psi_{\tau_j}(v_{jt|\tau_j})\psi_{\tau_k}(v_{kt|\tau_k})]}{f_{v_{jt|\tau_j}}(0) f_{v_{kt|\tau_k}}(0)}, \tag{2.3}$$

where $\psi_{\tau_j}(v_{jt|\tau_j}) \equiv \tau_j - 1(v_{jt|\tau_j} < 0)$, with 1 being the indicator function and $j, k \in \{1, \ldots, n\}$. Furthermore, $f_{v_{jt|\tau_j}}(0)$ denotes the probability density function of $v_{jt|\tau_j}$ evaluated at 0. The product of $\psi_{\tau_j}(v_{jt|\tau_j})$ and $\psi_{\tau_k}(v_{kt|\tau_k})$ measures the strength with which the two error terms jointly exceed their respective quantiles contemporaneously. Therefore, we need to transform the error terms before being able to perform structural analysis similar to traditional VARs. This is the reason why we call it pseudo-structural analysis.

Specifically, analogous to traditional VAR analyses, Equation (2.3) allows for the identification of pseudo-structural shocks $\boldsymbol{\varepsilon}_{t|\boldsymbol{\tau}} = (\varepsilon_{1t|\boldsymbol{\tau}}, \ldots, \varepsilon_{nt|\boldsymbol{\tau}})'$, where each $\varepsilon_{jt|\boldsymbol{\tau}}$ depends on the full vector of fixed quantiles $\boldsymbol{\tau}$. The Cholesky decomposition $\mathbf{\Omega}_{\boldsymbol{\tau}} = P_{\boldsymbol{\tau}} P_{\boldsymbol{\tau}}'$ yields

$$\boldsymbol{\varepsilon}_{t|\boldsymbol{\tau}} = P_{\boldsymbol{\tau}}^{-1} \widetilde{\psi}_{\boldsymbol{\tau}}(\mathbf{v}_{t|\boldsymbol{\tau}}), \tag{2.4}$$

where $\widetilde{\psi}_{\boldsymbol{\tau}}(\mathbf{v}_t) = (\psi_{\tau_1}(v_{1t|\tau_1})/f_{v_{1t|\tau_1}}(0), \ldots, \psi_{\tau_n}(v_{nt|\tau_n})/f_{v_{nt|\tau_n}}(0))'$. By construction, the pseudo-structural shocks have mean zero and unit variance. Most importantly, they are uncorrelated with each other. They differ to usual structural shocks because the indicator function transforms the innovations into a dichotomous time series. Here, only the exceedances, i.e., the innovations that exceed the respective quantiles (for instance, the 10% quantile) receive a large weight. Therefore, away from the median, the exceedances are the strongest shocks.[1]

The effects of pseudo-structural shocks are estimated using a pseudo quantile impulse response function (PQIRF) in the spirit of Gallant, Rossi, and Tauchen (1993) and Koop, Pesaran, and Potter (1996):

$$\mathrm{PQIRF}_{\boldsymbol{\tau}}(h, \varepsilon_{jt|\boldsymbol{\tau}}, \mathcal{F}_{t-1}) = \breve{Q}_{\boldsymbol{\tau}}(\mathbf{y}_{t+h}|\varepsilon_{jt|\boldsymbol{\tau}}, \mathcal{F}_{t-1}) - Q_{\boldsymbol{\tau}}(\mathbf{y}_{t+h}|\mathcal{F}_{t-1}), \tag{2.5}$$

[1] At the median, the weights are equal for shocks that exceed the median in both directions.

which allows to infer on the marginal impact of shock j on the system. That is, a baseline scenario $Q_{\boldsymbol{\tau}}(\mathbf{y}_{t+h}|\mathcal{F}_{t-1})$ is subtracted from a shock scenario $\breve{Q}_{\boldsymbol{\tau}}(\mathbf{y}_{t+h}|\varepsilon_{jt|\boldsymbol{\tau}}, \mathcal{F}_{t-1})$, where

$$\breve{Q}_{\boldsymbol{\tau}}(\mathbf{y}_t|\varepsilon_{jt|\boldsymbol{\tau}}, \mathcal{F}_{t-1}) \equiv \boldsymbol{\nu}_{\boldsymbol{\tau}} + \sum_{i=1}^{p} \mathbf{A}_{i|\boldsymbol{\tau}} \mathbf{y}_{t-i} + P_{\boldsymbol{\tau}} \begin{pmatrix} \vdots \\ \varepsilon_{jt|\boldsymbol{\tau}} \\ \vdots \end{pmatrix}. \tag{2.6}$$

For example, assume that the Bayesian quantile VAR model has one lag ($p = 1$), the first shock is set to $\varepsilon_{1t|\boldsymbol{\tau}} = \delta$, and all other shocks are zero. The PQIRF at different horizons, h, is then given by:

$$\text{PQIRF}_{\boldsymbol{\tau}}(h, \varepsilon_{1t|\boldsymbol{\tau}} = \delta, \mathcal{F}_{t-1}) \equiv \mathbf{A}_{1|\boldsymbol{\tau}}^{h} P_{\boldsymbol{\tau}} \begin{pmatrix} \delta \\ 0 \\ \vdots \\ 0 \end{pmatrix} \tag{2.7}$$

As pointed out by Chavleishvili and Manganelli, 2019, standard impulse responses measure the impact of a structural shock on the conditional expectation of the conditional expectations of future values of the endogenous variables. In contrast, PQIRF measures the impact of a structural shock on the conditional quantile of the conditional quantiles of future values of the endogenous variables.

Put differently, PQIRF measures the deviation of conditional quantiles of the endogenous variables in response to a shock and how this deviation of the conditional quantiles leads to deviations of future conditional quantiles. This intertemporal dependence can be seen by considering the term $\breve{Q}_{\boldsymbol{\tau}}(\mathbf{y}_{t+1}|\varepsilon_{jt|\boldsymbol{\tau}}, \mathcal{F}_{t-1}) = \boldsymbol{\nu}_{\boldsymbol{\tau}} + \mathbf{A}_{1|\boldsymbol{\tau}} \breve{Q}_{\boldsymbol{\tau}}(\mathbf{y}_t|\varepsilon_{jt|\boldsymbol{\tau}}, \mathcal{F}_{t-1}) + \sum_{i=2}^{p} \mathbf{A}_{i|\boldsymbol{\tau}} \mathbf{y}_{t-i}$. It illustrates that conditional quantiles in $t+1$ depend recursively on the history of past conditional quantiles.

Therefore, for a fixed set of values of $\boldsymbol{\tau}$, the PQIRF describes the evolution of the conditional quantiles of the endogenous variables in response to a shock. In this sense, $\boldsymbol{\tau}$ defines a specific scenario. For instance, one might be interested in studying the evolution of the conditional lower tail of one variable in response to a shock. Another option would be to define a change in the quantile values, taking place some time after a shock. For example, $\boldsymbol{\tau}$ may be assumed for some initial period after a shock and $\boldsymbol{\tau}^*$ thereafter.

In this chapter, we consider both approaches. For one, we fix τ for the entire horizon of the PQIRF analysis. For another, as a robustness check, we change the values of τ some periods after the shock.

Since we are specifically interested in the evolution of the conditional quantiles of GDP growth, we consider different quantile values for this variable. In the first (benchmark) scenario, we analyse the evolution of the 10%, 50%, and 90% quantiles, respectively; leaving the quantile values for the other endogenous variables at the 50% quantile. In the second (robustness) scenario, we assume that two periods (half a year) after a shock, the quantile value for GDP growth switches from 10% (90%) to 50%, mimicking a fast return of the economy to a median state.[2]

2.3.3 Bayesian Estimation

The quantile VAR model is estimated using Bayesian methods. We estimate the coefficient matrix (for fixed quantile values) by drawing from a multivariate Laplace distribution using a Metropolis-within-Gibbs sampler with uninformative priors. The priors are

$$\boldsymbol{\alpha} \sim \mathcal{N}(\mathbf{0}, \mathbf{I}_{n(pn+1)} \cdot 10) \qquad \text{and} \qquad \boldsymbol{\Sigma} \sim \mathcal{IW}(n, \mathbf{I}_n),$$

with $\boldsymbol{\alpha}$ being the column vector $\text{vec}(\mathbf{A})$ and $\mathbf{A} = (\boldsymbol{\nu}, \mathbf{A}_1, \ldots, \mathbf{A}_p)'$. For further details, see Schüler (2020).

The benchmark model is estimated with two lags. We specify the model parsimoniously because we use non-informative prior information. The Metropolis-within-Gibbs sampler takes 10,000 draws and discards the first 5,000 draws as burn-in draws. We check trace plots and the quantile conditions on the error terms to assure the convergence of the sampler.

2.3.4 Multi-Country Analysis

We apply the Bayesian quantile VAR to a multi-country setting. For any given country and set of quantile values, we estimate a separate Bayesian quantile VAR and compute the corresponding country-specific PQIRFs of conditional GDP growth.

[2]For the 10% quantile, the lower tail, this is actually a very conservative assumption, since the average duration of U.S. contractions past World War II is around 10 months ($>$ 3 quarters, see NBER recession periods). For the sample period of this chapter, i.e. 1980-2018, the average duration is around 11 months.

We then obtain the median group estimate of the PQIRF by computing the point-for-point median across country-specific PQIRFs. As Degasperi et al. (2020), we opt for the median because it is more robust to the impact of potential outliers. However, we obtain similar results when using the mean instead of the median to aggregate across countries, as in, e.g., Pesaran and Smith (1995), Gambacorta, Hofmann, and Peersman (2014), and Cesa-Bianchi et al. (2018). We report one-standard-deviation bands that reflect the variation across countries around the median group estimator.

2.3.5 Data

Our dataset consists of an unbalanced quarterly panel of 44 advanced economies (AE) and emerging market economies (EMEs) for the period between 1980:Q1 and 2018:Q4.[3] We obtain EBP data from the Board of Governors of the Federal Reserve System.[4] Seasonally adjusted real GDP series are obtained from the OECD. Where not available from the OECD, data from the IMF International Financial Statistics (IFS) are used. CPI data are obtained from the IMF. If seasonally adjusted series are not available for either of those variables, seasonality is removed using the U.S. Census Bureau's X-13 seasonal adjustment procedure. Data on interest rates are taken from Eurostat, OECD, and IMF IFS, extended by data collected in Emter, Schmitz, and Tirpák (2019).

2.4 Results

2.4.1 Contribution of U.S. Shocks to the Global Financial Cycle

We start our analysis by highlighting that U.S. financial shocks and U.S. monetary policy shocks are important drivers of the global financial cycle. For this purpose, we analyse the forecast error variance shares attributable to these two shocks estimated within a standard VAR model.

[3]The 44 countries in our dataset are: AUS, AUT, BEL, CAN, CHE, CHL, CHN, COL, CZE, DEU, DNK, ESP, EST, FIN, FRA, GBR, GRC, HKG, HUN, IDN, IRL, ISL, ISR, ITA, JPN, KOR, LTU, LUX, LVA, MEX, MYS, NLD, NOR, NZL, PHL, POL, PRT, RUS, SGP, SVK, SVN, SWE, THA, ZAF.

[4]See: https://www.federalreserve.gov/econresdata/notes/feds-notes/2016/updating-the-recession-risk-and-the-excess-bond-premium-20161006.html.

Specifically, we estimate a VAR for quarterly data that includes the following endogenous variables: a U.S. monetary policy shock series derived from a high-frequency instrument that accounts for informational rigidities (see Miranda-Agrippino & Ricco, 2021)[5]; the U.S. EBP developed by Gilchrist and Zakrajsek (2012); U.S. GDP growth; U.S. CPI inflation; the U.S. federal funds rate; and a composite measure of the global financial cycle constructed by Miranda-Agrippino and Rey (2020). The VAR is estimated for the period between 1991:Q1 and 2009:Q4, as the monetary policy shock series is available for this period. Financial and monetary policy shocks are identified using a Cholesky decomposition.

Figure 2.1 shows the forecast error variance share of the global financial cycle explained by U.S. financial and monetary policy shocks. We find that U.S. financial shocks account for more than 28 percent of variation in the global financial cycle four quarters after the shock. U.S. monetary policy shocks explain around 12 percent at this horizon. Thus, the two shocks jointly explain around 40% of the variation in the global financial cycle, motivating our focus on U.S. financial conditions and monetary policy as potentially important sources of downside risks to growth across the globe.[6]

2.4.2 International Transmission of Financial Shocks

In this section, we study the international transmission of U.S. financial shocks to macroeconomic tail risks. We estimate impulse responses of the conditional quantiles of GDP growth in country j to a shock to the U.S. EBP using the multi-country Bayesian quantile VAR approach described in Section 3. For each country, the quantile VAR includes four endogenous variables in the following order: the U.S. EBP; the log-difference of real GDP of country j; the log-difference of CPI of country j; and the short-term interest rate of country j. We estimate the multi-country Bayesian quantile VAR for the period between 1980:Q1 and 2018:Q4. Following Cesa-Bianchi et al. (2018), our baseline specification assumes that U.S. financial conditions may

[5]We estimate a VAR for U.S. data using the baseline model specification of Miranda-Agrippino and Ricco (2021) that includes the EBP, and we extract the realized monetary policy shock sequence from the VAR using an instrumental variables approach. The realized shock sequence constitutes the U.S. monetary policy shock series used in our analysis.

[6]Similar results are obtained when decomposing the forecast error variance of the global stock market factor by Habib and Venditti (2019).

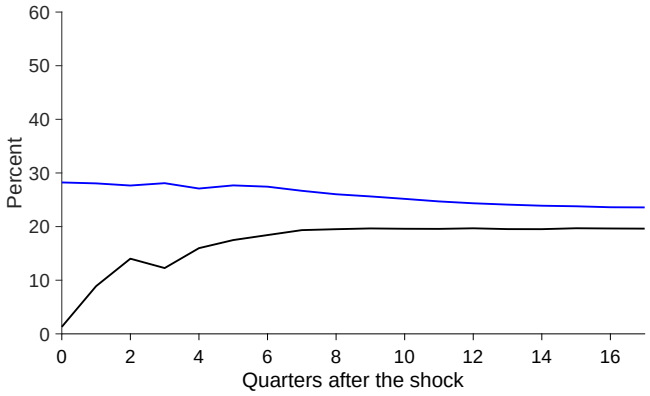


FIGURE 2.1: Forecast error variance decomposition of the global financial cycle

Note: The figure depicts the forecast error variance share (in percent) of the global financial cycle explained by U.S. financial shocks (blue solid line) and U.S. monetary policy shocks (black solid line), obtained from a VAR with four lags. The VAR contains, in this particular order, a U.S. monetary policy shock series proposed by Miranda-Agrippino and Ricco (2021), the EBP by Gilchrist and Zakrajsek (2012), U.S. GDP growth, U.S. CPI inflation, the U.S. federal funds rate, and the composite measure for the global financial cycle constructed by Miranda-Agrippino and Rey (2020). The shocks are identified using a Cholesky decomposition.

contemporaneously affect macroeconomic outcomes in individual countries, while conditions in other countries may affect the U.S. EBP only with a lag of one quarter. This identifying restriction is implemented by ordering the EBP before the country-specific variables, and then applying a Cholesky decomposition of the co-exceedance measure in Equation (2.3).

Figure 2.2 displays the international response of GDP growth at the median, the 10% quantile, and the 90% quantile of the GDP growth distribution following an unexpected tightening in U.S. financial conditions, associated with an orthogonal one-standard-deviation increase in the EBP. We report the cross-country median group estimates of the PQIRF of GDP growth, together with one-standard-deviation bands that reflect heterogeneity in the estimated impulse responses across countries.

An unexpected tightening in U.S. financial conditions leads to a significant reduction in GDP growth across countries at the conditional median (black solid line). The impact at the median are in line with the effects at the mean obtained from a standard VAR (see Figure 2.A.3 in the Appendix). The impact of a U.S. financial conditions shock at the upper tail (90% quantile) of GDP growth is positive and far less pronounced than the impact of a shock at the median (blue solid line). By contrast, the impact of a shock at the lower tail (10% quantile) is substantially stronger than at the median (red solid line). At the four quarter horizon the effect at the

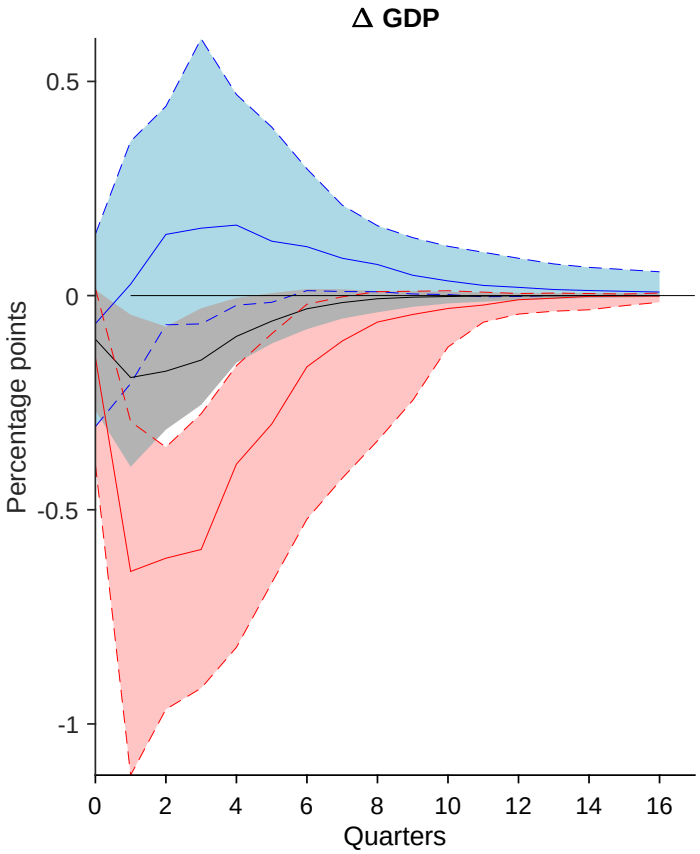


FIGURE 2.2: The international transmission of a shock to U.S. financial conditions

Note: The figure depicts the median group estimate of the panel quantile impulse response function (PQIRF) with conditional GDP growth at the median (black solid line), the estimated PQIRF with conditional GDP growth at its 10% quantile (red solid line), and the estimated PQIRF with conditional GDP growth at its 90% quantile (blue solid line). Shaded areas correspond to one standard deviation around the median group estimates, indicating heterogeneity in the estimated impulse responses across countries.

lower tail is roughly four times stronger than at the median. Figure 2.A.2 in the Appendix depicts the pseudo forecast error variance share of the conditional 10%, 50%, and 90% quantile of GDP growth attributed to a U.S. financial conditions shock. At business cycle frequencies, the shock explains more than three times as much of the variation in GDP growth at the 10% quantile than at the median or the 90% quantile.

The shaded areas in Figure 2.2 convey considerable cross-country heterogeneity. The individual impulse response functions for each country are shown in Figure 2.A.1 in the appendix, along with posterior 68% probability bands obtained from Bayesian estimation. Consistent with Figure 2.2, the individual impulse responses

display substantial heterogeneity across countries. Nevertheless, the quantile impulse responses for each country can be fairly precisely estimated. For the overwhelming majority of countries and time horizons the probability bands of the different quantiles do not overlap, indicating that the dynamics at the different conditional quantiles significantly differ. This means that conditional distribution of GDP growth is changing in response to a shock.

The asymmetric effects of a shock to U.S. financial conditions on GDP growth hold in a variety of robustness checks, reported in Figure 2.A.4 in the appendix. First, we obtain virtually identical impulse responses when using the recursive quantile VAR model suggested by Chavleishvili and Manganelli (2019) instead of the Bayesian quantile VAR model by Schüler (2020).[7] Second, the results are robust to varying the composition of our sample. More specifically, the results hold for a smaller sample of countries for which we have data starting before 1990, alleviating concerns that imprecise estimates of the tails of the distribution for countries with relatively short country-specific time series are driving our results.[8] Moreover, the results hold when we use a balanced panel starting in 1996:Q1. Third, using the Chicago Fed's National Financial Conditions Index (NFCI) as a measure for U.S. financial conditions instead of the EBP leads to the same result. Fourth, our results also hold when using PPP-GDP weighted median group estimates. Fifth, the results are nearly identical to the baseline findings when amending the Bayesian quantile VAR with a U.S. block consisting of GDP growth, CPI inflation, and the federal funds rate, ordered above the EBP in order to remove any remaining confounding factors from other U.S. shocks from the EBP. Sixth, the results are robust to ordering the EBP last in the system. Seventh, the results are robust to conducting a scenario analysis, for which we consider the conditional 10% (90%) quantile of GDP growth only up to two quarters after the shock and the 50% quantile thereafter. We use this scenario to formulate a lower bound of the impact of a shock on the tails (see discussion in

[7] Chavleishvili and Manganelli (2019) propose to estimate a recursive quantile VAR model for structural shock identification. That is, the authors propose to explicitly model the contemporaneous relation between the endogenous variables. In contrast to this chapter's approach, the model proposed by Chavleishvili and Manganelli (2019) does not require the estimation of the co-exeedance measure. However, Chavleishvili and Manganelli (2019) estimate the VAR equation by equation. Therefore, the two frameworks differ, for instance, in their way to identify structural shocks.

[8] The smaller, but still representative, sample consists of 17 countries, namely AUS, CAN, CHE, DEU, FRA, GBR, ITA, JPN, KOR, MEX, NOR, NZL, PHL, SGP, SWE, THA, and ZAF.

Section 2.3.2).

Are there country characteristics which increase the vulnerability to downside risks from U.S. financial shocks? In order to address this question, we relate the size of individual countries' GDP growth responses to several country characteristics in a cross-sectional regression framework. Our dependent variables are: the cumulated impact of the U.S. financial shock on conditional GDP growth over the first four quarters estimated at the median of the GDP growth distribution; the cumulated impact of the shock estimated at the 10% quantile; and the difference between the cumulated impact at the 10% quantile and the median. Based on the previous literature, we consider the following country characteristics: the degree of *de facto* financial openness following Lane and Milesi-Ferretti (2007); the flexibility of the exchange rate regime according to the classification by Ilzetzki, Reinhart, and Rogoff (2019), in which countries with more freely floating currencies are assigned higher values; the level of leverage in the private household sector, measured by home-ownership-weighted maximum loan-to-value (LTV) ratios following Cesa-Bianchi et al. (2018)[9]; financial market development according to the IMF financial market development index; and the extent of foreign currency exposure, measured as cross-border bank claims in foreign currency over total cross-border bank claims following Cesa-Bianchi et al. (2018).[10] All variables enter the following regressions as time averages over the BQVAR model's sample period to the extent there is data available.

Our baseline OLS regression estimates are shown in the first column of Table 2.1. At the 10% quantile of GDP growth, we find that countries with a relatively more flexible exchange rate regime exhibit a significantly more moderate (i.e., less negative) tail response of GDP growth to a U.S. financial shock. A higher share of debt denominated in foreign currency is associated with a stronger (i.e., more negative) tail response. The home-ownership-weighted maximum LTV ratio – a key determinant of domestic leverage (Cesa-Bianchi et al., 2018) – is associated with a stronger

[9]Maximum LTV ratios are obtained from Alam et al. (2019) and home ownership rates are obtained from the Housing Finance Information Network.

[10]More precisely, the numbers on FX exposures are taken from Fig. 2 in Cesa-Bianchi et al. (2018) and cross-checked with values reported in Bénétrix, Gautam, Juvenal, and Schmitz (2019). The numbers in Cesa-Bianchi et al. (2018) are based on "[...] cross-border bank claims in foreign currency over total cross-border bank claims." Where cross-border bank claims refer to "[...] foreign claims (all instruments, in all currencies) of all BIS reporting banks vis-à-vis all sectors." The correlation between this FX measure and the one in Bénétrix et al. (2019) is 0.9. We use the numbers in Cesa-Bianchi et al. (2018) to maximise our country sample.

GDP response, implying that economies with higher structural levels of leverage are more sensitive to a shock to U.S. financial conditions. By contrast, higher financial openness *per se* does not significantly increase vulnerability to U.S. financial shocks.

Jointly, the considered country characteristics explain a sizable share of the cross-country variation in the GDP growth responses at the lower tail ($R^2 = .46$). The regression results remain intact when potential outliers are excluded, and when we control for direct links to the U.S. via trade and financial channels (columns (2) to (5)). Strikingly, the considered country characteristics are not significantly associated with the heterogeneity in GDP growth responses at the median (see Table 2.1, middle panel). A similar result is obtained for the 90% quantile (which is therefore not included in the table).

To further test the robustness of the results of the GDP growth responses at the lower tail, we run additional specifications, as depicted in Table 2.A.1 in the appendix. First, we test alternative measures of financial openness. Columns (1) and (2) show that the results are robust to using a de jure measure of financial openness (Chinn & Ito, 2008) and a measure based on by cross-border banking claims to GDP. Second, the results are robust to excluding financial centres as defined by Lane and Milesi-Ferretti (2018).[11] Third, the results for the exchange rate regime and the foreign currency exposure hold when we include the share of countries' non-US trade invoiced in US dollar measured according to Boz et al. (2020), even though our country sample is reduced to 36 in this case. This increases the standard error on the home-ownership-weighted maximum LTV ratio and renders it insignificant but the coefficient estimate remains unchanged (Column 4). Fourth, we test an alternative definition of the the exchange rate regime variables for euro area members. The classification in Ilzetzki et al. (2019) classifies the euro area as a system of fixed exchange rates. However, since we are considering financial shocks originating from the U.S., exchange rate flexibility vis-à-vis the US dollar might be more key for the transmission of the shock. Since the euro is freely floating towards the dollar but the size of the exchange rate adjustment following the shock might be subject to an individual country's weight in the euro area aggregate, we re-code the exchange

[11] The financial openness variable becomes statistically significant in this specification, which might highlight the fact that financial centres have very high gross foreign asset and liability positions that are often not not related to the domestic sector to a substantial degree.

TABLE 2.1: Explaining GDP responses to U.S. financial shocks

	(1)	(2)	(3)	(4)	(5)
VARIABLES	IRF GDP (10% quantile)				
Financial openness (de facto)	-0.001	-0.008	-0.001	-0.001	-0.001
	(0.006)	(0.056)	(0.006)	(0.006)	(0.006)
Exchange rate regime	0.158***	0.091**	0.159***	0.166***	0.161***
	(0.048)	(0.039)	(0.052)	(0.051)	(0.053)
Maximum LTV x home ownership	-0.032**	-0.024**	-0.032**	-0.035**	-0.034**
	(0.015)	(0.010)	(0.015)	(0.015)	(0.016)
Financial market development	-0.014	-0.010	-0.014	-0.014	-0.015
	(0.017)	(0.014)	(0.017)	(0.017)	(0.017)
Foreign currency exposure	-0.054***	-0.037**	-0.054***	-0.053***	-0.054***
	(0.018)	(0.014)	(0.018)	(0.018)	(0.018)
US financial links			-0.002		0.012
			(0.020)		(0.029)
US trade links				-0.007	-0.013
				(0.013)	(0.019)
Constant	0.770	0.361	0.795	0.977	0.976
	(1.783)	(1.287)	(1.828)	(1.841)	(1.862)
Observations	44	40	44	44	44
R-squared	0.45	0.39	0.45	0.46	0.46
VARIABLES	IRF GDP (50% quantile)				
Financial openness (de facto)	-0.002	-0.071**	-0.002	-0.002	-0.002
	(0.002)	(0.028)	(0.003)	(0.003)	(0.002)
Exchange rate regime	0.030	0.003	0.029	0.036*	0.030
	(0.020)	(0.019)	(0.022)	(0.021)	(0.022)
Maximum LTV x home ownership	-0.009	-0.009*	-0.009	-0.011*	-0.010
	(0.006)	(0.005)	(0.006)	(0.006)	(0.006)
Financial market development	-0.001	0.006	-0.001	-0.001	-0.001
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Foreign currency exposure	-0.007	-0.001	-0.007	-0.006	-0.007
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
US financial links			0.001		0.013
			(0.008)		(0.012)
US trade links				-0.005	-0.011
				(0.005)	(0.008)
Constant	-0.077	-0.178	-0.087	0.069	0.067
	(0.746)	(0.629)	(0.765)	(0.765)	(0.764)
Observations	44	40	44	44	44
R-squared	0.19	0.29	0.19	0.21	0.23

Note: Table shows the results of regressing the 4 quarter sum of different GDP responses (10% quantile, median, and 10% minus median) on country characteristics. For details on the variables, see Section 4.2. Columns report (2) sample excluding IE, LV, LT, LU; (3) including US financial links; (4) US trade links; (5) both US linkages. Robust standard errors in parentheses. Stars indicate the usual levels of significance (*** $p<0.01$, ** $p<0.05$, * $p<0.1$). LTV denotes loan to value. For details on the variables, see Section 4.2.

rate regime as fully flexible for the country with the highest GDP weight (in PPP terms) and decreasing in flexibility with decreasing weight in aggregate GDP. The results we obtain for this exchange rate variable are very similar to the ones in our baseline specification (Column 5). Fifth, and finally, we show in Column 6 that our baseline results are robust to using the GDP responses obtained from alternative scenario analysis in which we assume that two periods (half a year) after a shock, the quantile value for GDP growth switches from 10% to 50%, as described in Section 2.3.2.

We conclude that a country's vulnerability in terms of large GDP contractions arising from U.S. financial shocks is particularly strong for countries with high foreign currency liability exposures, high levels of household sector leverage, and less flexible exchange rate arrangements, irrespective of their levels of financial openness and development. These results are consistent with, e.g., Berkmen, Gelos, Rennhack, and Walsh (2012), who find that the global financial crisis had a particularly detrimental effect on output in countries with high levels of leverage in the domestic financial system, while exchange rate flexibility helped to cushion the impact.

2.4.3 International Transmission of Monetary Policy Shocks

A number of recent studies have investigated the international transmission of U.S. monetary policy through financial markets and have highlighted U.S. monetary policy as an important driver of the global financial cycle (see, e.g., Rey 2015; Bruno and Shin 2015; and Miranda-Agrippino and Rey 2020). In this section, we contribute to this literature by examining the international transmission of U.S. monetary shocks to the conditional distribution of GDP growth in other countries.

To that end, we add to each country-specific quantile VAR the U.S. monetary policy shock series derived from the high-frequency instrument proposed by Miranda-Agrippino and Ricco (2021) as described above. Plagborg-Møller and Wolf (2021) show that a recursive VAR with an externally identified shock series provides valid structural estimation, as long as the shock measure is ordered first. Since the U.S. monetary policy shock series is an exogenous shock sequence, we order it above the EBP and the country-specific block comprised of the log-difference of real GDP,

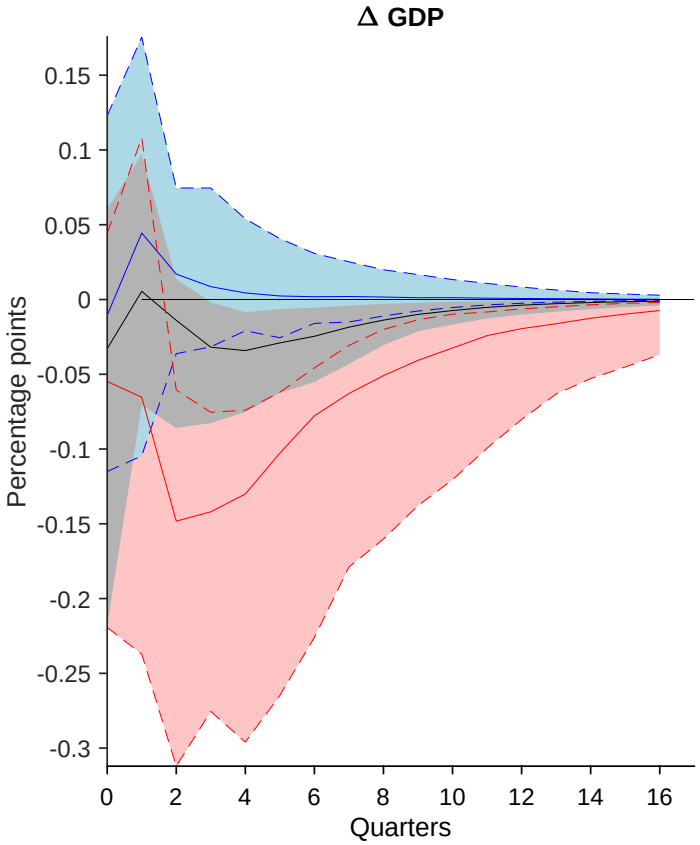


FIGURE 2.3: The international transmission of a U.S. monetary policy shock

Note: The figure depicts the median group estimate of the panel quantile impulse response function (PQIRF) with conditional GDP growth at the median (black solid line), the estimated PQIRF with conditional GDP growth at its 10% quantile (red solid line), and the estimated PQIRF with conditional GDP growth at its 90% quantile (blue solid line). Shaded areas correspond to one standard deviation around the median group estimates, indicating heterogeneity in the estimated impulse responses across countries.

the log-difference of CPI, and the short-term interest rate. Pseudo quantile impulse responses are then computed by applying a Cholesky decomposition of the co-exceedance measure as described in Section 2.3.

Figure 2.3 depicts the international response of GDP growth at the median, the 10% quantile, and the 90% quantile of the GDP growth distribution following an unanticipated tightening in U.S. monetary policy. The shock leads to a significant reduction in GDP growth across countries at the conditional median. Consistent with the results for U.S. financial shocks, the impact of the shock at the lower tail (10% quantile) of conditional GDP growth is substantially stronger than the effect at the median or the upper tail (90% quantile). Our estimates thus indicate that an unexpected monetary policy tightening in the U.S. leads to an increase in downside risks to growth around the world. Again, the baseline estimates are subjected to several robustness checks which confirm that U.S. monetary policy has stronger effects on the lower tail of the conditional GDP growth distribution (see Figure 2.A.5 in the Appendix). In particular, estimates yield identical conclusions upon using the recursive quantile VAR model proposed by Chavleishvili and Manganelli (2019), a balanced panel starting in 1996:Q1, and the PPP-GDP weighted median group estimator, as well as an alternative scenario analysis, in which conditional 10% (90%) quantile of GDP growth returns to the 50% quantile two quarters after the shock.[12]

We now turn to the question of whether the vulnerability to downside risks from U.S. monetary policy shocks varies systematically across countries. Estimates from a regression of the size of individual countries' GDP growth responses on country characteristics are shown in Table 2.2. We find that in countries with relatively more flexible exchange rates the lower tail of the GDP growth distribution responds less (i.e., becomes less negative) following a U.S. monetary policy shock. This finding is robust across different specifications. We do not find a systematic relation between cross-country variation in the responses of the lower tail of GDP growth and any of the other country characteristics. Additionally, mirroring the regression results for U.S. financial shocks, we do not find any robust relation between country characteristics and the response of GDP growth at the median of the distribution. This finding

[12]Varying the variable ordering or purging the U.S. monetary policy shock series again from U.S. variables is redundant because it is an exogenous shock sequence extracted from an identified VAR model. Therefore, we do not conduct such robustness checks.

TABLE 2.2: Explaining GDP responses to U.S. monetary policy shocks

	(1)	(3)	(3)	(4)	(5)
VARIABLES	IRF GDP (10% quantile)				
Financial openness (de facto)	0.001	0.063*	0.001	0.001	0.001
	(0.003)	(0.037)	(0.003)	(0.003)	(0.003)
Exchange rate regime	0.073***	0.072***	0.058**	0.070***	0.059**
	(0.024)	(0.026)	(0.026)	(0.026)	(0.026)
Maximum LTV x home ownership	-0.001	0.002	0.002	-0.001	0.001
	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)
Financial market development	0.006	-0.001	0.006	0.006	0.006
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Foreign currency exposure	-0.014	-0.012	-0.015	-0.014	-0.015*
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
US financial links			0.016		0.026*
			(0.010)		(0.014)
US trade links				0.002	-0.010
				(0.007)	(0.009)
Constant	-0.916	-0.942	-1.131	-0.987	-0.991
	(0.909)	(0.841)	(0.903)	(0.940)	(0.912)
Observations	44	40	44	44	44
R-squared	0.35	0.27	0.39	0.35	0.40
VARIABLES	IRF GDP (50% quantile)				
Financial openness (de facto)	-0.001	-0.012	-0.001	-0.001	-0.001
	(0.001)	(0.016)	(0.001)	(0.001)	(0.001)
Exchange rate regime	0.020*	0.011	0.015	0.020*	0.016
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Maximum LTV x home ownership	-0.006*	-0.005	-0.005	-0.006	-0.005
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Financial market development	-0.001	-0.001	-0.001	-0.001	-0.002
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Foreign currency exposure	-0.007*	-0.004	-0.007*	-0.007	-0.007*
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
US financial links			0.005		0.010
			(0.004)		(0.006)
US trade links				0.000	-0.004
				(0.003)	(0.004)
Constant	0.344	0.312	0.274	0.333	0.332
	(0.396)	(0.375)	(0.399)	(0.410)	(0.403)
Observations	44	40	44	44	44
R-squared	0.29	0.18	0.31	0.29	0.33

Note: Table shows the results of regressing the 4 quarter sum of different GDP responses to a 1 standard deviation U.S. monetary policy shock (10% quantile, median, and 10% minus median) on country characteristics. For details on the variables, see Section 4.2. Columns report (2) sample excluding IE, LV, LT, LU; (3) including US financial links; (4) US trade links; (5) both US linkages. Robust standard errors in parentheses. Stars indicate the usual levels of significance (*** $p<0.01$, ** $p<0.05$, * $p<0.1$). LTV denotes loan to value. For details on the variables, see Section 4.2.

may explain why studies that study the international transmission of U.S. monetary policy shocks at the mean of the GDP growth distribution by using standard VAR models do not find "clear-cut systematic relation[s] [...] between country responses and likely relevant country characteristics" (see Dedola et al., 2017, page S24). We show that this result is robust to the same additional robustness checks as discussed in Section 2.4 in the lower panel of Table 2.A.1 in the appendix.

2.5 Conclusion

We study the international transmission of U.S. financial and monetary policy shocks to macroeconomic tail risks. We thereby connect the literature on downside risks to growth with the literature on the global financial cycle. We show that U.S. financial and monetary policy shocks are important structural drivers of GDP tail risk in both advanced and emerging economies. The effect of a shock to U.S. financial conditions is approximately four times stronger at the lower tail of the conditional GDP growth distribution in individual countries than the effect at the median. Similar results are obtained for the effect of U.S. monetary policy shocks on international downside risks to GDP growth.

We find that the strength of the GDP growth response systematically varies with certain country characteristics at the lower tail of the conditional GDP growth distribution but not at the mean or median. Policymakers concerned with the possibility of large negative output growth realizations should thus pay particular attention to policy choices that expose their economies to elevated GDP tail risks arising from external shocks. Specifically, countries with high foreign currency liability exposures, high levels of household sector leverage, and less flexible exchange rates are particularly vulnerable to downside risks to growth arising from U.S. financial shocks. This finding helps to reconcile the evidence from the impulse response analysis with the role played by the domestic exchange rate regime and private sector leverage during historical crisis episodes, such as the 1997-98 Asian financial crisis and the 2007-08 global financial crisis. In addition, our results indicate that countries with less flexible exchange rates are relatively more vulnerable to GDP tail risks arising from U.S. monetary policy shocks. The exchange rate regime thus matters for the

risk of large economic downturns arising from both financial and monetary policy spillovers, creating a trilemma in macroeconomic tail risk.

Appendix

2.A Additional Figures and Tables

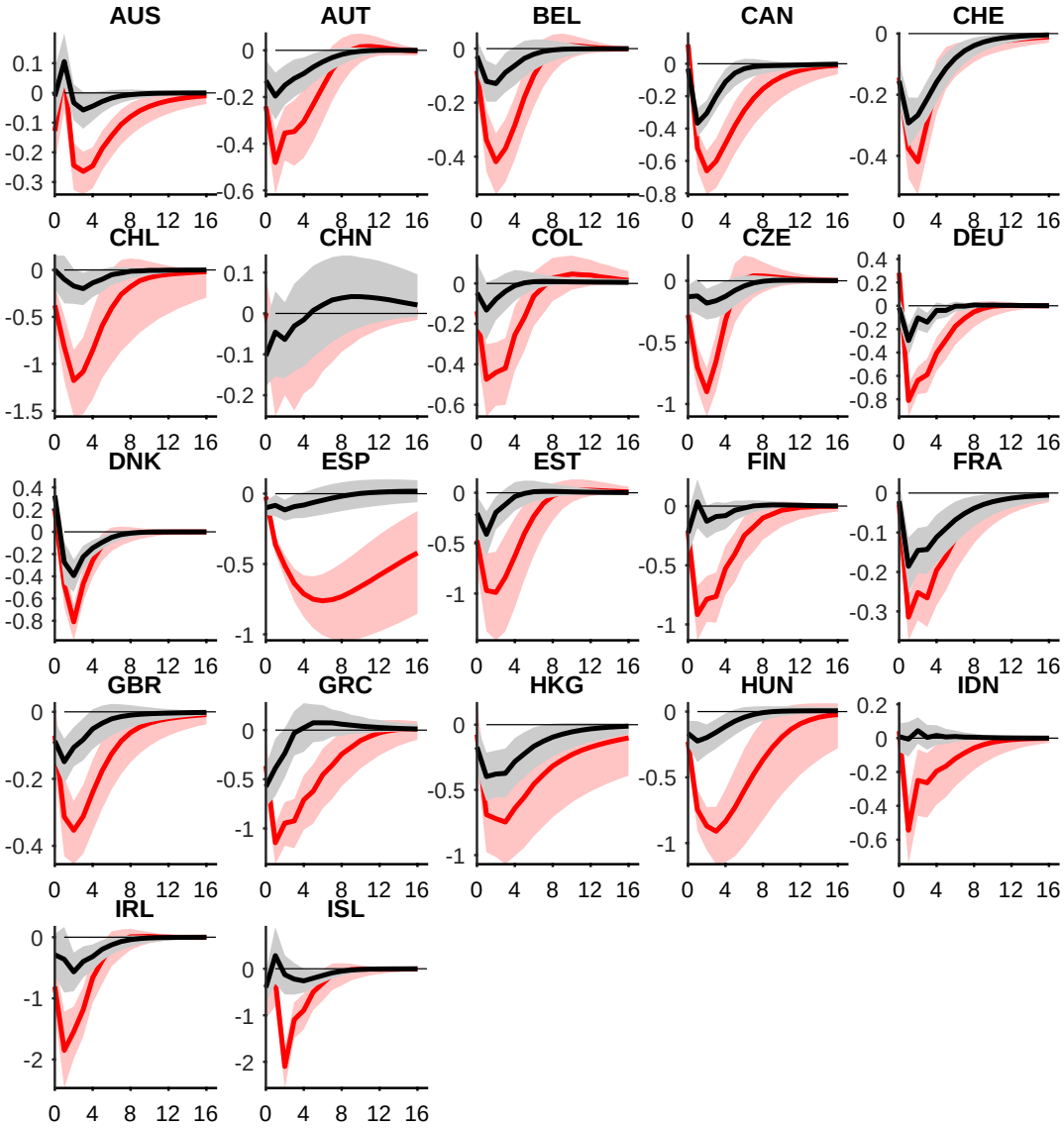


FIGURE 2.A.1: Individual-country pseudo quantile impulse responses

Note: Median of the posterior estimate of PQIRFs (solid lines) with posterior 68% probability bands (shaded areas). The black lines represent the PQIRFs with conditional GDP growth at the median, and the red lines are the PQIRFs with conditional GDP growth at its 10% quantile. The x-axis shows quarters after the shock. Shocks are scaled to one standard deviation of the unconditional EBP.

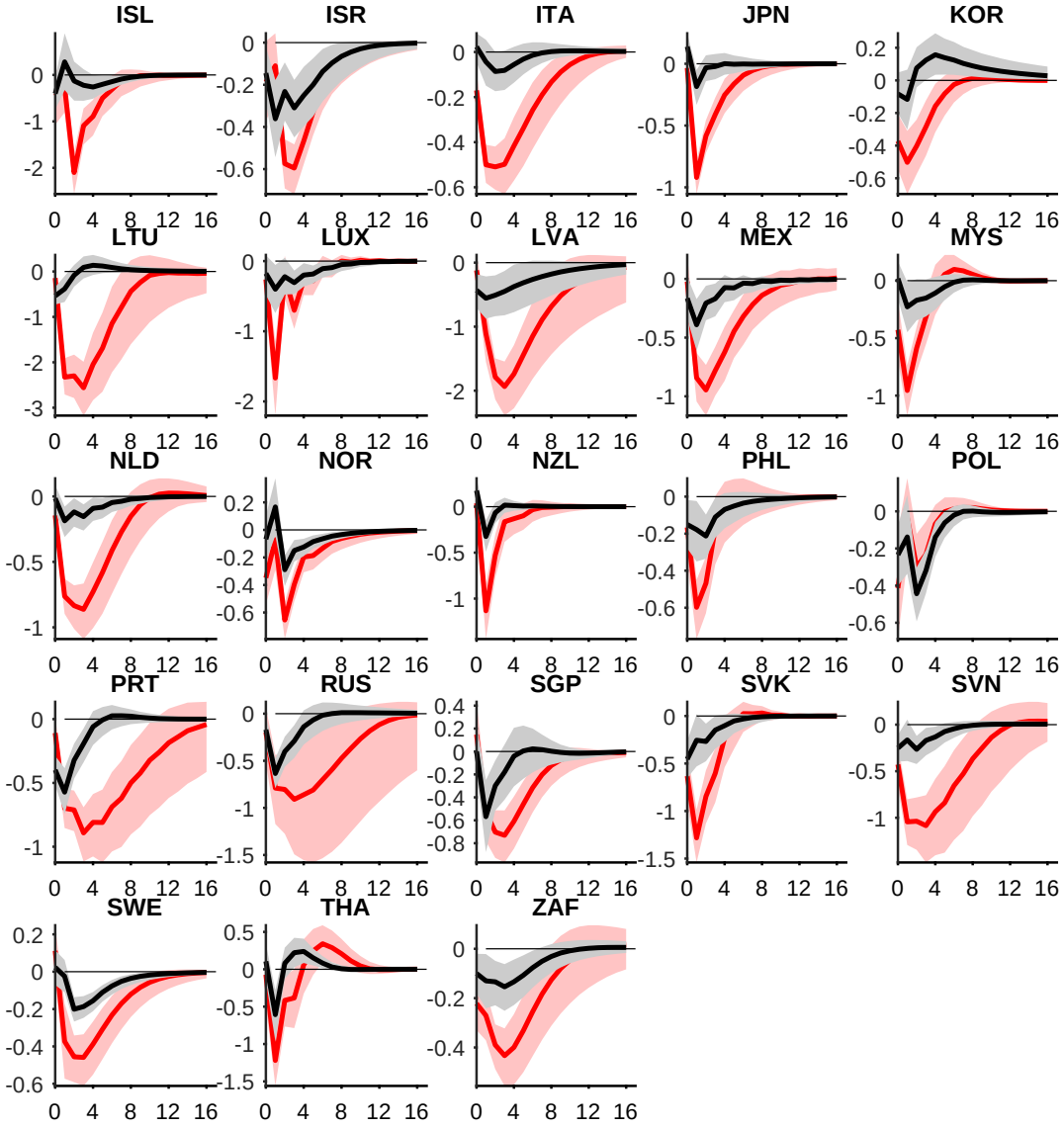


FIGURE 2.A.1: Individual-country pseudo quantile impulse responses (cont.)

Note: Median of the posterior estimate of PQIRFs (solid lines) with posterior 68% probability bands (shaded areas). The black lines represent the PQIRFs with conditional GDP growth at the median, and the red lines are the PQIRFs with conditional GDP growth at its 10% quantile. The x-axis shows quarters after the shock. Shocks are scaled to one standard deviation of the unconditional EBP.

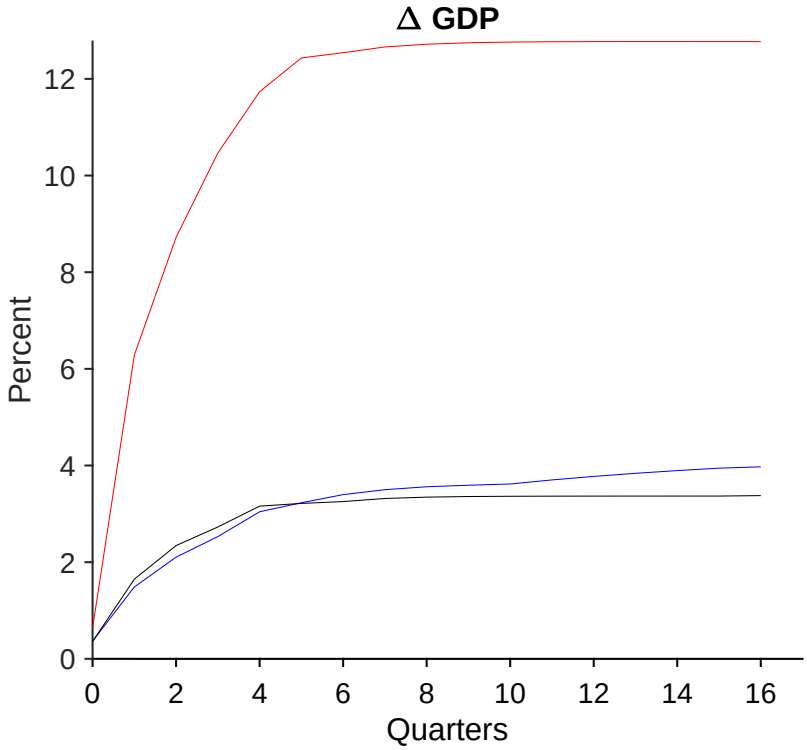


FIGURE 2.A.2: FEVD of ΔGDP obtained from the baseline BQVAR

Note: Median group estimate of the forecast error variance decomposition (FEVD) due to a one standard deviation increase in the EBP obtained from the baseline Bayesian quantile VAR model. The black line depicts FEVD with ΔGDP at the median, the blue line shows the FEVD with ΔGDP at the 90% quantile, and the red line is the FEVD with ΔGDP at the 10% quantile.

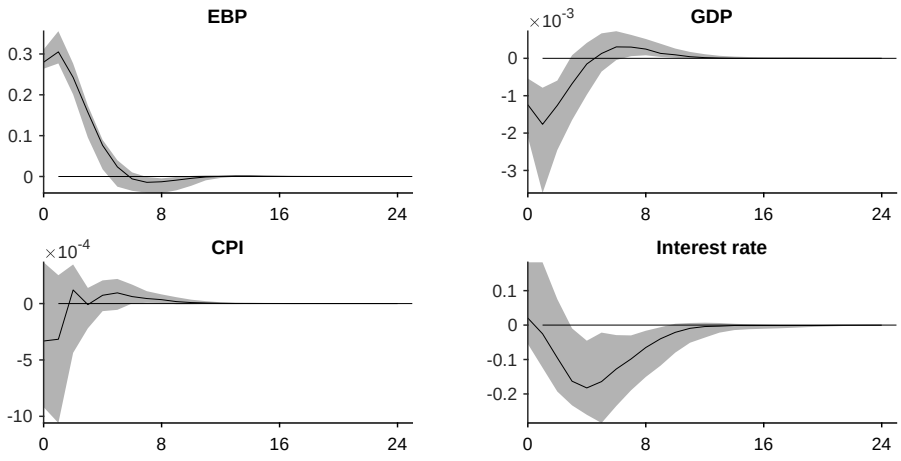


FIGURE 2.A.3: Impulse responses to an EBP shock estimated from a standard VAR

Note: The solid lines are the (cross-country) median group estimates of the mean IRF obtained from a standard VAR following a tightening of U.S. financial conditions scaled to one standard deviation of the unconditional EBP. Shaded areas represent one standard deviation around the median group estimator, indicating heterogeneity in responses across countries.

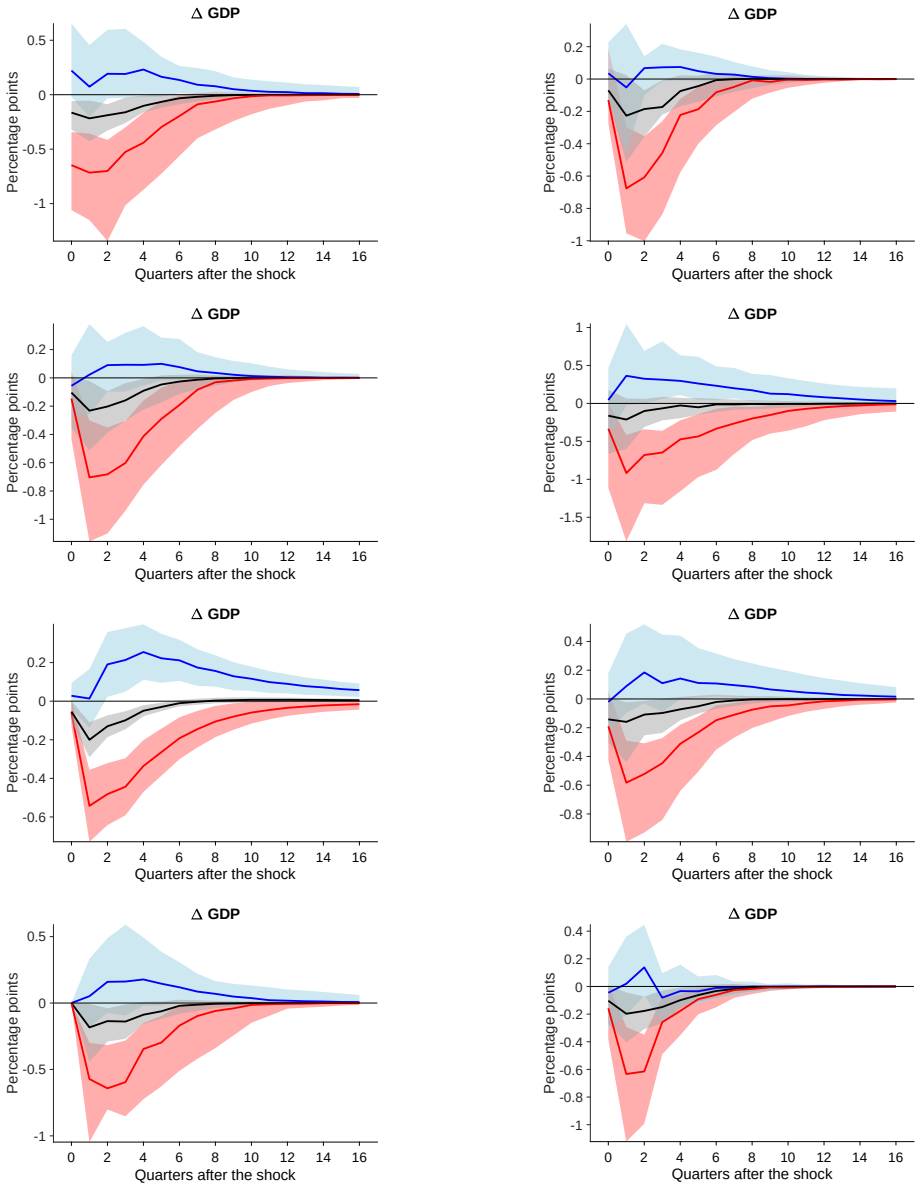


FIGURE 2.A.4: Robustness checks - U.S. financial shock

Note: The figure depicts the median group estimate of the panel quantile impulse response function (PQIRF) with conditional GDP growth at the median (black solid line), the estimated PQIRF with conditional GDP growth at its 10% quantile (red solid line), and the estimated PQIRF with conditional GDP growth at its 90% quantile (blue solid line). Shaded areas correspond to one standard deviation around the median group estimates, indicating heterogeneity in the estimated impulse responses across countries. Results are shown for (top left to bottom right): a recursive quantile VAR following Chavleishvili and Manganelli (2019) (Panel 1); a sub-sample of countries with time series data starting before 1990 (Panel 2); a balanced panel starting in 1996:Q1 (Panel 3); NFCI instead of EBP (Panel 4); PPP-GDP weighted median group estimator (Panel 5); a quantile VAR augmented with U.S. GDP growth, U.S. inflation, and the U.S. short-term interest rate (Panel 6); and the EBP ordered last (Panel 7); and a scenario analysis in which two quarters after the shock, the quantile value for GDP growth switches from 10% (90%) to 50% (Panel 8).

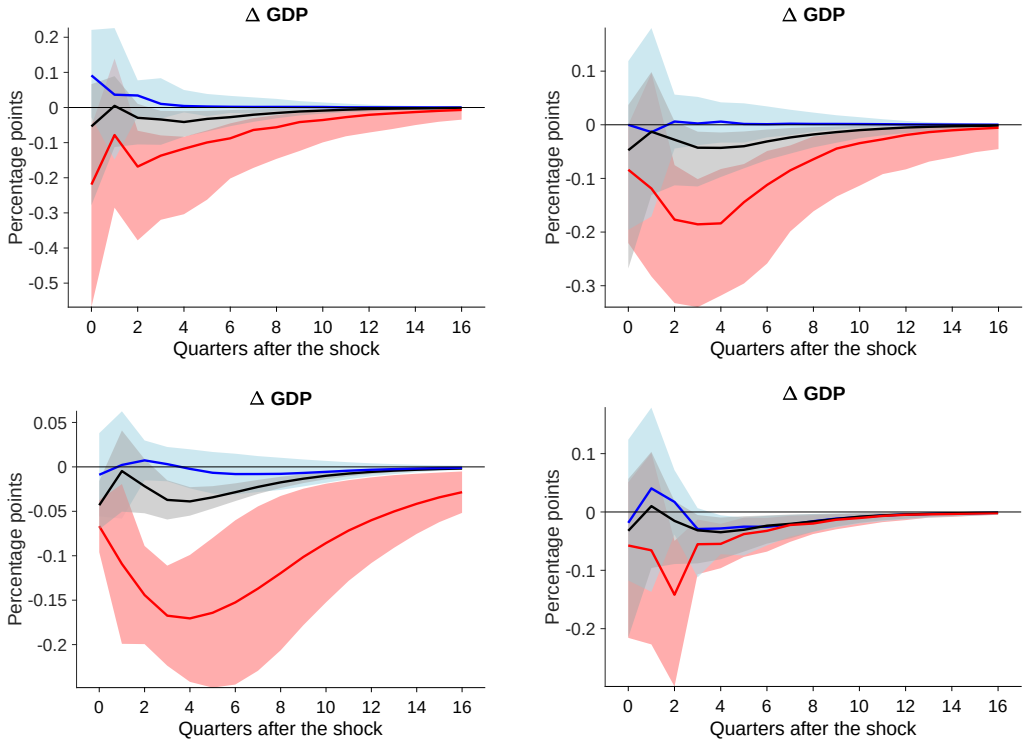


FIGURE 2.A.5: Robustness checks - U.S. monetary policy shock

Note: The figure depicts the median group estimate of the panel quantile impulse response function (PQIRF) with conditional GDP growth at the median (black solid line), the estimated PQIRF with conditional GDP growth at its 10% quantile (red solid line), and the estimated PQIRF with conditional GDP growth at its 90% quantile (blue solid line). Shaded areas correspond to one standard deviation around the median group estimates, indicating heterogeneity in the estimated impulse responses across countries. Results are shown for (top left to bottom right): a recursive quantile VAR following Chavleishvili and Manganelli (2019) (Panel 1); a balanced panel starting in 1996:Q1 (Panel 2); and the PPP-GDP weighted median group estimator (Panel 3); and a scenario analysis in which two quarters after the shock, the quantile value for GDP growth switches from 10% (90%) to 50% (Panel 4).

TABLE 2.A.1: Explaining GDP tail responses by country characteristics - additional robustness checks

	GDP responses to U.S. financial shocks (10% quantile)					
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES						
Financial openness	-1.328	-0.050	-0.163**	-0.003	-0.000	-0.004
	(0.839)	(0.041)	(0.076)	(0.007)	(0.005)	(0.004)
Exchange rate regime	0.124**	0.143**	0.101*	0.184**	0.135***	0.128***
	(0.051)	(0.055)	(0.053)	(0.089)	(0.045)	(0.047)
Maximum LTV x home ownership	-0.027**	-0.029***	-0.023**	-0.024	-0.024**	-0.024***
	(0.010)	(0.010)	(0.010)	(0.022)	(0.010)	(0.008)
Financial market development	0.015	0.010	0.015	0.009	0.008	0.005
	(0.014)	(0.011)	(0.012)	(0.024)	(0.013)	(0.012)
Foreign currency exposure	-0.021***	-0.019**	-0.036**	-0.022*	-0.013*	-0.015**
	(0.008)	(0.008)	(0.016)	(0.011)	(0.007)	(0.006)
USD trade share				-0.005		
				(0.010)		
Constant	0.231	-0.588	-1.893*	-0.844	-1.170	-0.395
	(1.195)	(1.169)	(0.978)	(2.663)	(1.240)	(0.979)
Observations	44	44	37	36	44	44
R-squared	0.48	0.44	0.57	0.48	0.47	0.47

	GDP responses to U.S. monetary policy shocks (10% quantile)					
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES						
Financial openness	-0.571	0.039	-0.027	0.005**	0.004*	0.003
	(0.365)	(0.031)	(0.042)	(0.002)	(0.002)	(0.002)
Exchange rate regime	0.052*	0.073**	0.082**	0.080**	0.056***	0.064**
	(0.027)	(0.030)	(0.031)	(0.036)	(0.020)	(0.026)
Maximum LTV x home ownership	-0.001	-0.003	0.001	0.000	-0.000	-0.002
	(0.006)	(0.006)	(0.005)	(0.007)	(0.006)	(0.006)
Financial market development	0.015**	0.009	0.011*	0.001	0.011*	0.006
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Foreign currency exposure	-0.005	-0.006	-0.007*	-0.013**	-0.002	-0.006
	(0.005)	(0.005)	(0.004)	(0.005)	(0.004)	(0.004)
USD trade share				0.007		
				(0.007)		
Constant	-0.822	-0.919	-1.176*	-0.656	-1.326*	-0.695
	(0.753)	(0.682)	(0.622)	(0.763)	(0.707)	(0.645)
Observations	44	44	37	36	44	44
R-squared	0.39	0.36	0.41	0.45	0.36	0.34

Note: results of regressing the 4 quarter sum of different GDP growth (at 10% quantile) responses to a 1 standard deviation U.S. financial (panel 1) or monetary policy shock (panel 2) on country characteristics. Columns report alternative specification with (1) de jure measure of financial openness (Chinn & Ito, 2008); (2) financial openness measured by cross-border banking claims/GDP; (3) exclude financial centres as defined by Lane and Milesi-Ferretti (2018) (BEL, CHE, GBR, HKG, IRL, LUX, NLD, SGP); (4) including the share of countries' non-US trade invoiced in US dollar (Boz et al., 2020); (5) exchange rate regime adjusted for EA members according to GDP PPP weight; (6) GDP response from alternative scenario analysis. Stars indicate the usual levels of significance (*** $p<0.01$, ** $p<0.05$, * $p<0.1$). LTV denotes loan to value.

Chapter 3

Leverage Cycles, Growth Shocks, and Sudden Stops in Capital Inflows

3.1 Introduction

Are countries prey to the tides of global capital movements or can domestic policies tame some of the adverse consequences of financial globalisation?[1] This question has been subject to debates by academics and policymakers and there is no clear consensus. It is particularly important to understand whether sharp reversals in capital inflows, so called sudden stops, can be avoided by domestic policymakers because of the dire economic outcomes they are associated with. In particular, sudden stops have been shown to go hand in hand with abrupt current account adjustments and real exchange rate depreciations which regularly result in financial instability and significant output losses, as well as increasing unemployment (Calvo, 1998; Calvo, Izquierdo, & Mejia, 2004; Calvo, Izquierdo, & Mejía, 2008; Cavallo, Powell, Pedemonte, & Tavella, 2015; Romelli, Terra, & Vasconcelos, 2018; Rothenberg & Warnock, 2011).

Starting with Calvo, Leiderman, and Reinhart (1993) the empirical literature on the drivers of international capital flows distinguishes global 'push' factors from

[1] This chapter is a slightly revised version of the Working Paper version published as Central Bank of Ireland Research Technical Paper Vol. 2020, No. 6, and Trinity Economic Papers No. 1120. It is currently under review at the *Journal of International Money and Finance*.

country-specific 'pull' factors.[2] In this framework, push factors are usually understood to entail common factors, i.e. monetary and fiscal policies, as well as risk aversion in core advanced economies, which are outside the control of individual recipient country policymakers. Conversely, pull factors are borrowing-country specific economic and policy characteristics. Forbes and Warnock (2012) conclude that most factors related to capital flow volatility are indeed global factors outside the control of most countries' domestic policy space. For portfolio flows, Fratzscher (2012) finds that "push" factors were the main drivers of capital flows during the global financial crisis (GFC). However, institutional quality and country risk together with the strength of macroeconomic fundamentals are found to explain a large share of the heterogeneity of capital flows during the GFC. More recent work by, e.g. Cerutti, Claessens, and Rose (2019) suggests that merely a quarter of the variation in capital flows is driven by global factors leaving the rest to be explained by other causes. In fact, Forbes and Warnock (2021) find that, since the GFC, the link between global push factors and extreme capital flow movements has weakened and these episodes have become more idiosyncratic. The focus on global factors that emerged in the literature after the GFC is also somewhat at odds with real business cycle (RBC) models explaining sudden stops by a combination of high leverage and adverse productivity shocks in the domestic economy triggering occasionally binding credit constraints (Akıncı & Chahrour, 2018; Flemming et al., 2019; Mendoza, 2010; Seoane & Yurdagul, 2019).

This chapter sheds new light on the role of domestic factors as drivers of sudden stops by combining analysis of these sharp reversals in gross capital inflows with novel data on domestic economic developments in a large sample of countries. More specifically, we combine Balance of Payments (BOP) data from the IMF with the recently published dataset by Kose, Kurlat, Ohnsorge, and Sugawara (2017) providing broad country coverage for debt sustainability indicators to construct a quarterly panel of 98 advanced (AE) as well as emerging and developing (EMDE) countries (31 AEs and 67 EMDEs) for the period 1990 to 2017. Further combining these data with global drivers of capital flows identified in the literature (Forbes & Warnock, 2012; Habib & Venditti, 2019), as well as with additional domestic controls, this chapter

[2] See Kaminsky (2019) for a recent survey of the literature on international capital flows.

extends the analysis of sudden stop episodes to the post-crisis period and to a larger set of countries than previously analysed in the literature.

Employing this novel and extensive dataset in a complementary logarithmic regression framework, domestic variables are found to be significantly related to the probability of incurring sharp reversals in gross capital inflows. In particular, negative growth shocks combined with high levels of leverage in the domestic private sector are found to be a significant determinant of sudden stops. This is in line with recent theoretical postulations by Akıncı and Chahrour (2018) and Flemming et al. (2019), and Seoane and Yurdagul (2019), as well as the empirical literature on debt cycles and crises (Gourinchas & Obstfeld, 2012; Schularick & Taylor, 2012). More precisely, I find that, at elevated levels of leverage in the domestic economy, a one standard deviation growth shock increases the probability of incurring a sudden stop by 3.5 percentage points. This is equivalent to a 36 percent increase in the unconditional probability of 9.7 percent and 60 percent larger than the effect of a one standard deviation shock in global risk aversion, measured by the VIX index of implied volatility on US equity options.

This chapter is related to a wide range of literature on international capital flows. First, and most directly, it contributes to the empirical analysis of sudden stops.[3] Prior to the GFC, the empirical literature on sudden stops focused on domestic factors to explain the incidence of sudden stops finding some evidence for the role of debt and openness (Calvo et al., 2004). The GFC spawned a renewed interest in capital flow volatility and the most influential studies point out two important short-comings of the previous literature. First, the focus on net inflows does not allow to differentiate between actions of foreign and domestic investors (Broner, Didier, Erce, & Schmukler, 2013; Forbes & Warnock, 2012; Milesi-Ferretti & Tille, 2011;

[3]The concept of sudden stops in capital inflows was first introduced in the theoretical contribution by Calvo (1998).

Rothenberg & Warnock, 2011).[4] Second, global factors play a significant role in explaining the occurrence of sudden stops in gross capital inflows.[5] In fact, Forbes and Warnock (2012) conclude that most domestic factors only have a limited correlation with capital flow volatility and that capital controls do not seem to shield an economy against capital flow waves.[6] Lo Duca (2012) shows that domestic factors actually gain importance in periods of heightened global market tensions but that when global market tensions become extreme they can induce panics which render regional developments insignificant. In a recent study on sudden stops of international fund flows, Li, de Haan, and Scholtens (2019) show that global, contagion, and domestic factors are all related to the likelihood of sudden stops. Everett and Galstyan (2020) show that domestic factors are equally important to push factors in source countries in the context of bank portfolio holdings. Forbes and Warnock (2021) show that, since the GFC, extreme capital flow movements have become less correlated with global push factors such as changes in global risk aversion. In fact, global, regional and domestic variables previously used in the literature are found to be less able to explain large movements in international capital flows such as sudden stops in the extended post-GFC sample period. This chapter adds to the literature by showing that domestic leverage cycles combined with negative growth shocks are significantly associated with the probability of incurring sudden stops in overall gross capital inflows. This holds when global and contagion factors are accounted for. The result is also robust to including other potential domestic drivers of sudden stops like the fiscal balance and government debt levels, as well as financial openness, the stock of reserve assets, and the exchange rate regime. It is also robust to excluding the GFC from the sample.

Second, this chapter therefore provides empirical evidence in support of theoretical work stressing the importance of domestic variables in determining sudden

[4]Cavallo et al. (2015) find that sudden stops in gross capital inflows can be detrimental to GDP growth even when they are not associated with stops in net inflows. The authors disaggregate sudden stops by dissecting gross capital flows by functional instrument category and show that some types of flows are more disruptive than others. In particular, they find that sudden stops which combine falls in net flows and those that are driven by abrupt reductions in other investment inflows are indeed the most disruptive because they are associated with larger declines in GDP.

[5]See, for example, Rey (2015), Rey (2016), Cerutti et al. (2019), McQuade and Schmitz (2019) for a discussion of global factors as determinants of international capital flows.

[6]Forbes and Warnock (2014) show that these results also hold for episodes disaggregated into debt and equity led episodes showing that most episodes of extreme capital flow movements are debt-led.

stop episodes complementing the recent empirical literature which found a predominant role for global factors.[7] Akıncı and Chahrour (2018), Flemming et al. (2019), and Seoane and Yurdagul (2019) develop real business cycle models with occasionally binding collateral constraints based on Garcia-Cicco, Pancrazi, and Uribe (2010) and Mendoza (2010). In these models expected income gains in the future, either through an observable component in productivity or persistent shocks to trend income growth, lead households to increase leverage, not internalizing externalities on aggregate debt in the economy. Hence, when the expected productivity gains are not actually realised or an unforeseen negative shock hits the economy, the constraint is more likely to bind. Therefore, sudden stops in capital inflows should be more likely for economies with high levels of leverage which exhibit a negative growth shock, precisely as found in this chapter.

This chapter is structured as follows. Section 3.2 describes the main data source for gross capital inflows, discusses the methodology used to identify sudden stop episodes, and presents some stylised facts on these sharp reversals in capital inflows. Subsequently, the role of domestic leverage and productivity shocks as determinants of sudden stops are discussed in Section 3.3 deriving hypotheses which are tested using the methodology outlined in Section 3.4. The results are discussed in Section 3.5 and buffeted with robustness checks and extensions in Section 3.6 before Section 3.7 concludes.

3.2 Sudden Stops in Capital Inflows

As mentioned above, the distinction of international capital flows into flows by foreign and domestic investors has been shown to be crucial in order to gain a more nuanced understanding of capital flow volatility.[8] For example, Broner et al. (2013) show that gross in- and outflows are positively correlated and procyclical, i.e. domestic agents invest abroad when foreigners invest in a country, and more so during

[7] Theoretical contributions on the role of push factors include Bacchetta, Tille, and Van Wincoop (2012), Gourio, Siemer, and Verdelhan (2013), Bruno and Shin (2015) on risk, Giannetti (2007), Brunnermeier (2009), and Calvo (2012) on liquidity/credit, as well as Dedola and Lombardo (2012) and Devereux and Yetman (2010) on leverage.

[8] It should be noted that in the balance of payments the distinction between gross inflow or gross outflow depends on the residency of the asset. More specifically, net foreign purchases of domestic assets refer to gross capital inflows. Conversely, net purchases of foreign assets by domestic investors are gross outflows (Forbes & Warnock, 2012).

expansions. Moreover, Forbes and Warnock (2012) show that using gross instead of net flows yields fundamentally different results regarding drivers of extreme capital flow episodes. Eichengreen and Gupta (2016) show that decreases in investment by non-residents is typically behind sudden stops in net inflows since residents' stabilizing reaction, i.e. a reduction in gross outflows, is not sufficient to offset the reduction in gross inflows. I follow this literature and focus on sharp reversals in gross capital inflows.

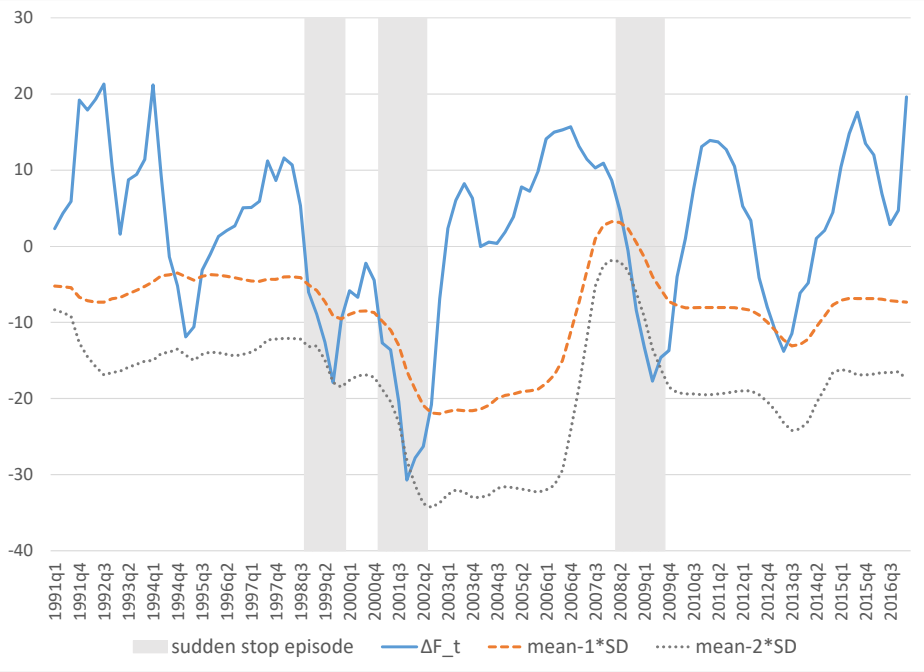


FIGURE 3.1: Identifying sudden stops for Argentina

Note: Note: ΔF_t denotes the year on year change in four quarter moving sums of gross capital inflows in USD billion. A sudden stop is defined as a period in which ΔF_t falls 1 standard deviation (SD) below its 5 year moving average and 2 SD below its mean for at least 1 quarter. The episode ends when ΔF_t recovers to above 1 SD below the mean (Forbes & Warnock, 2012).

Data on gross capital inflows are gathered from the IMF's quarterly International Financial Statistics (IFS).[9] In accordance with BPM6 standards these inflows are recorded by national agencies on a residency principle and reported to the IMF. Gross capital inflows denote net occurrence of financial liabilities, i.e. gross liability flows net of repayments. Hence, these inflows are usually interpreted as net

[9]Note that inflows reported in the IMF IFS exclude exceptional financing.

purchases of domestic assets by foreign agents. Inflows are reported by functional category, i.e. foreign direct investment (FDI), portfolio equity investment (PE), portfolio debt investment (PD), as well as other investment (OI). I construct a measure of capital inflows by summing flows reported in the individual categories.[10]

Following Forbes and Warnock (2012), I define sudden stops in capital inflows as follows. Let F_t denote the four-quarter rolling sum of capital inflows into a particular country in quarter t. Then ΔF_t is the year on year change in this smoothed measure of quarterly inflows, i.e.

$$F_t = \sum_{i=0}^{3} GROSSINFLOW_{t-i}, \text{ with } t = 4, 5, ..., T \text{ and} \tag{3.1}$$

$$\Delta F_t = F_t - F_{t-4}, \text{ with } t = 8, 7, ..., T \tag{3.2}$$

A country is then defined to exhibit a sudden stop episode, $e_{it} = 1$, if ΔF_t falls one standard deviation below its moving historical mean provided it reaches two standard deviations below the mean at some point and the episode lasts longer than one quarter. The episode ends when gross inflows are no longer at least one standard deviation below the mean.[11] The moving mean and corresponding standard deviations are computed over five year windows.[12]

Figure 3.1 illustrates this definition for Argentina. The solid line is the year on year change in four quarter sums of gross capital inflows as defined in equation (1) and the dashed and dotted lines illustrate the thresholds for mean capital inflows being one or two standard deviations below the moving mean, respectively. According to the definition of sudden stops outlined above, three periods are identified as sudden stop episodes for Argentina between 1990 and 2017 and highlighted in shaded

[10] Inflows in financial derivatives are excluded from the analysis due to sparse reporting and relatively small size. Furthermore, I exclude countries with less than 10 years of consecutive data.

[11] While the definition by Forbes and Warnock (2012) is the most commonly used one, there are, of course, alternative definitions of sudden stop episodes. Cavallo et al. (2015) use the definition by (Calvo et al., 2004) and Forbes and Warnock (2012) but, i.a., distinguish sudden stop events by conditioning on extreme events simultaneously happening in gross outflows and net flows. Results for this alternative definition and for episodes in which the reduction in flows amounted to at least 5% of a recipient country's GDP are qualitatively similar (see Section 3.6.2 and Table 3.A.9).

[12] The results are robust to increasing (decreasing) the length of these windows to 6 (3) years. While the results also hold for further increasing the length of the window to, for example, 8 years, further decreasing the length substantially reduces number of sudden stop episodes identified by the procedure.

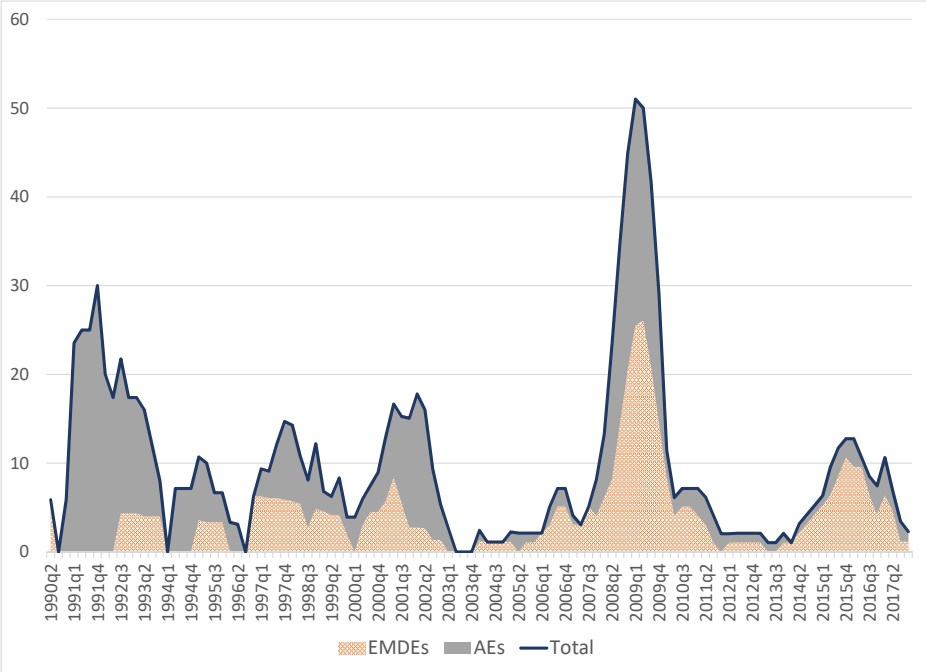


FIGURE 3.2: Percent of countries in a sudden stop episode

Note: sudden stop episodes defined according to Forbes and Warnock (2012). Countries grouped into advanced economies (AE) and emerging and developing economies according to IMF definition.

grey, i.e. 1998Q4 to 1999Q4, 2001Q1 to 2002Q2 (both during the Argentine Great Depression), and 2008Q3 to 2009Q4 (the GFC). Table 3.A.1 in the appendix lists all episodes identified using this definition of sudden stops for the sample used in the further analysis.

Figure 3.2 shows the percentage of countries in a sudden stop episode in a respective quarter over time. Generally, sudden stops tend to come in waves (Forbes & Warnock, 2012) with higher numbers of countries experiencing an episode simultaneously during periods of major economic crises such as the early 1990s recession, the Asian financial crisis, the dot-com bubble bust, as well as the GFC. While this highlights the potential role for global and contagion factors as determinants of sudden stop episodes, the fact that sudden stops are also identified outside of these major global crisis years suggests a role for domestic factors as well. It also becomes apparent that sudden stops are not purely a phenomenon observed in EMDEs but

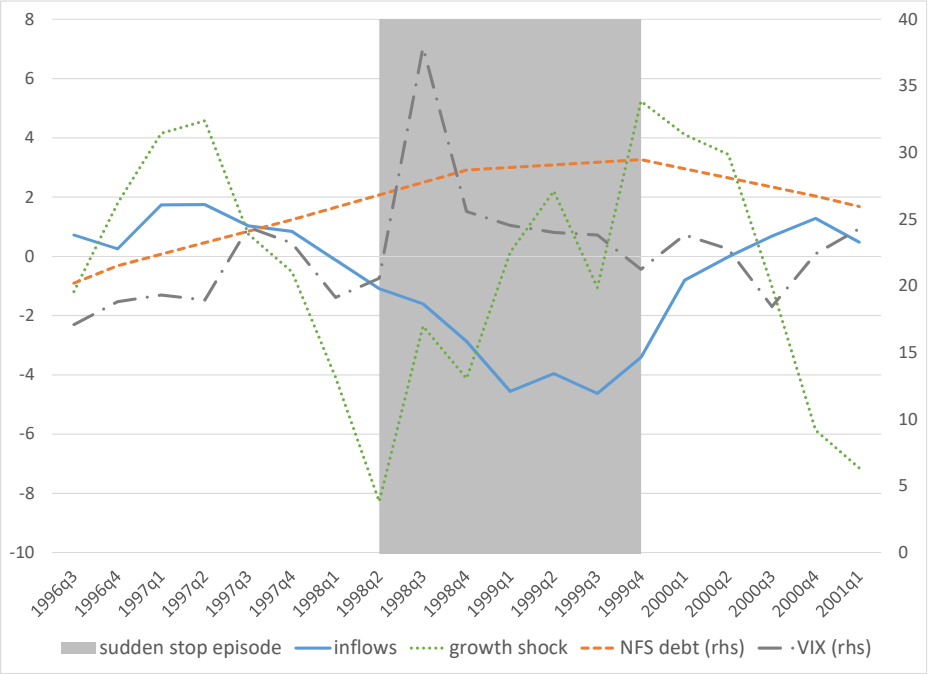


FIGURE 3.3: Leverage cycle, growth shock, and sudden stop in Peru

Note: the evolution of the year on year change in gross capital inflows, the stock of private non-financial sector credit to GDP (NFS debt), GDP growth deviations from trend (growth shock), and global risk aversion (VIX), around the sudden stop episode in Peru between 1998Q2 and 1999Q4 identified according to the definition by Forbes and Warnock (2012).

that they are also common in AEs.

Table 3.1 summarizes the incidence of sudden stop episodes during sub-periods and across AEs and EMDEs. The unconditional probability of observing a sudden stop episode in any given quarter throughout the sample is 9.7 percent. AEs exhibit sharp reversals of gross capital inflows relatively more often which reflects the higher volatility of gross flows in high-income countries documented in the literature (Broner et al., 2013), as well as the fact that the period during which sudden stops where most prevalent – the GFC – affected AEs more severely (Lane & Milesi-Ferretti, 2011). Sudden stops last for slightly more than 5 quarters on average. It is worth noting that not all sharp reversals in gross inflows coincide with sudden stops in net inflows (Cavallo et al., 2015). In fact, only around 53 percent of sudden stop episodes go hand in hand with sharp reversals in net inflows. However,

TABLE 3.1: Incidence of sudden stops in

	... gross inflows (% of total observations)			... net inflows (% of gross inflow stops)			... gross flows (decline > 5 % of GDP)		
	All countries	AEs	EMDEs	All countries	AEs	EMDEs	All countries	AEs	EMDEs
1990Q1 - 2018Q1	9.7	13.0	7.6	53.0	46.8	59.5	73.6	81.2	65.5
Pre-GFC	7.1	10.3	4.7	47.0	38.6	60.8	63.4	64.5	61.8
Post-GFC	9.7	11.5	8.8	54.8	51.4	57.2	81.2	97.1	70.1
GFC	36.0	57.4	25.4	63.2	55.4	72.0	80.7	92.6	67.4

Note: Global Financial Crisis (GFC) defined as period between 2008Q1 and 2009Q4. Country classification according to IMF.

the reductions in gross inflows typically make up sizeable fractions of GDP, especially for AEs but also for EMDEs. The fact that the share of episodes during which the decline in gross inflows exceeded 5 percent of GDP is significantly higher in the post-crisis period reflects the growing size of capital flows that went hand in hand with financial globalisation. Taken together Table 3.1 and Figure 3.2 illustrate that while sudden stop episodes have not become more prevalent over time, the size of the "turnaround", and the corresponding potential for adverse economic outcomes, has increased (Eichengreen & Gupta, 2016).

3.3 Potential Drivers of Sudden Stops

3.3.1 Leverage, Productivity Shocks, and Sudden Stops

Akıncı and Chahrour (2018) develop a small open economy RBC model with an occasionally binding collateral constraint showing that the probability of sudden stops increases when households receive good news about the domestic economy, i.e. expected productivity gains in the future. More precisely, the representative agent in Akıncı and Chahrour (2018) faces labour augmenting productivity shocks that are observed contemporaneously but don't affect productivity until some time in the future in addition to contemporaneous productivity shocks usually implemented into RBC models. These positive news shocks boost output contemporaneously since firms, which are fully owned by households, have the incentive to increase labour demand today for an expected future productivity increase because it is costly to adjust labour.[13] Therefore, anticipated productivity gains lead to a permanent but

[13] In short, Akıncı and Chahrour (2018) combine the open economy RBC model in Garcia-Cicco et al. (2010) with a collateral constraint as in Mendoza (2010) and augment it to include adjustment costs to both labour and debt, as well as gradual de-trending of labour in the utility function.

gradual increase in output incentivising households to borrow from abroad, bringing the economy closer to the borrowing constraint. When the expected productivity gains are not actually realised or an unforeseen negative productivity shock hits the economy, the constraint is therefore more likely to bind.[14] Seoane and Yurdagul (2019) and Flemming et al. (2019) show that a model with trend income shocks can generate similar dynamics of over-borrowing in the run up to sudden stops. Hence, sudden stops in capital inflows should be more likely for economies with high levels of leverage which exhibit a negative growth shock.

In order to test this hypothesis, I measure leverage in the economy using domestic credit to the private sector (share of GDP) taken from Kose et al. (2017) and growth shocks as deviations in quarterly real GDP growth from its four quarter growth trend based on data from the IMF's IFS database (Forbes & Warnock, 2012). While very simple, this definition of a growth shock has the advantage of being available for a wide set of countries. In addition, it is very closely correlated with a finer measure of growth shocks based on historical forecast data from the IMF WEO database constructed using the difference between realized growth rates and forecast growth rates for a respective period (Figure 3.A.1).[15]

3.3.2 Other Domestic Factors

Other country characteristics might also be related to the probability of experiencing a sudden stop. To control for other potential domestic drivers, I gather data on the fiscal balance measured in percent of GDP, the government debt to GDP ratio, as well as the sovereign rating of a particular country, all taken from Kose et al. (2017).[16] The prior is that unsustainable public finances might lead to sudden stops if investors lose confidence (Calvo et al., 2004). In addition, measures of financial openness are

[14] With a binding constraint, agents will lower debt and capital holdings (in domestic firms) simultaneously, which is how the model delivers the qualitative patterns surrounding sudden stop episodes, as defined by Akıncı and Chahrour (2018): (i) the cyclical component of GDP is at least one-and-a-quarter standard deviations below its trend level, (ii) the reversal in the trade balance-to-GDP ratio (which is equivalent to balance on foreign debt) is at least one-and-a-quarter standard deviations above average.

[15] In order to obtain quarterly frequency, quarter two values use the spring WEO forecast while quarter four values are based on the autumn forecast figures. The missing quarters are interpolated. Using this measure of growth shocks considerably reduces the country sample (to 69) but leaves results in tact (available upon request).

[16] The data in the Kose et al. (2017) database are at annual frequency and are linearly interpolated to quarterly frequency.

included to account for the fact that more financially open economies might, on the one hand, be more prone to exhibit sudden stops due to external shocks or domestic vulnerabilities (Eichengreen & Gupta, 2016). On the other hand, an open financial account might increase resilience due to a more diversified portfolio of creditors insulating the economy from idiosyncratic shocks to specific lenders (Edwards, 2004). I measure financial openness by total assets and liabilities over GDP (Lane & Milesi-Ferretti, 2007). It is important to note that more financially open economies tend to have higher levels of debt as shown in the pairwise correlations in Table 3.A.4. Finally, I also include GDP per capita from the IMF IFS as an additional control for the level of development.

3.3.3 Global and Contagion Factors

In order to control for the important role of global and contagion factors identified by (Forbes & Warnock, 2012), I include the same set of variables to capture them as used in the original study. Global factors include global risk captured by the Volatility Index (VIX) calculated by the Chicago Board Options Exchange, measures of global liquidity and interest rates, as well as global growth in real GDP, all based on data from the IMF IFS. The VIX is widely used in the literature to capture global uncertainty or risk aversion (e.g., Forbes and Warnock (2012), Fratzscher (2012), and McQuade and Schmitz (2019). Changes in global liquidity are captured by year-on-year growth in global money supply, i.e. the sum of M2 in the US, euro area, and Japan, as well as M4 in the UK.[17] Global interest rates are represented by the average rate on long-term government bonds in the US, euro area, and Japan. Global growth is measured by quarterly global growth in real economic activity.

Contagion is captured by the exposure-weighted average of rest-of-the-world episodes. Contagion may work through trade and financial channels (Born & Enders, 2019). Hence, episodes in other countries are weighted by country i's exports (relative to its total exports) to the trade partner country exhibiting a sudden stop episode in period t. Contagion through trade channels is then captured by the sum of episodes in trade partner countries weighted by their share in country i's exports.

[17] All converted into US dollars using exchange rate data from the IMF IFS.

Contagion through financial channels is measured in the same way using international bank claims as a proxy for financial ties. Bilateral trade data are from the IMF's Direction of Trade Statistics (DOTS) and banking exposures are from the BIS Locational Banking Statistics (LBS).[18] All variables used in the following regression analysis and their respective sources are summarized in Table 3.A.2 in the appendix.

Figure 3.3 serves as an illustration of how upswings in domestic leverage cycles combined with negative growth shocks can go hand in hand with sudden stops in gross capital inflows. It depicts the evolution of the year on year change in gross capital inflows (solid line), the stock of private non-financial sector credit to GDP (dashed line), as well as growth shocks (dotted line) around the sudden stop episode in Peru between 1998Q2 and 1999Q4. In the two years preceding the onset of the sudden stop episode private non-financial sector credit increased substantially from 20.2 to 26.8 percent of GDP. At the end of 1997 GDP growth began to fall below trend reaching its trough in 1998q2 simultaneous to the onset of the sudden stop episode. This suggests that the economy might indeed have reached a binding borrowing constraint due to a negative growth surprise as suggested by the mechanism laid out in Akıncı and Chahrour (2018). However, the episode also coincides with a spike in the VIX (dashed line with dots) which highlights the need for a more formal test of the various proposed determinants of sudden stops which is carried out in the regression analysis below.

3.4 Empirical Methodology

Following Forbes and Warnock (2012), I regress the dummy variable indicating whether a country is exhibiting a sudden stop episode at any given point in time between 1990Q1 and 2018Q1 on a set of global, contagion, and domestic variables.

[18] Note that financial links might be captured imperfectly since only 48 countries currently report to the BIS LBS. However, these include all major international banking centres such that contagion through international banks should be captured sufficiently well.

$$\begin{aligned} Prob(e_{it} = 1) = F(&\beta_1 Debt_{i,t-1} + \beta_2 GrowthShock_{i,t-1} \\ &+\beta_3 Debt_{i,t-1} * GrowthShock_{i,t-1} \\ &+\phi_{t-1}^{Domestic} B_D + \phi_{t-1}^{Contagion} B_C + \phi_{t-1}^{Global} B_G) \end{aligned} \tag{3.3}$$

As detailed in Section 3.3.1, sudden stops in capital inflows should be more likely for economies with high levels of leverage which exhibit a negative productivity shock according to Akıncı and Chahrour (2018). Hence, $Debt_{i,t-1}$ and $GrowthShock_{i,t-1}$ are the main variables of interest denoting domestic private sector indebtedness and the measure of growth shocks in country i, respectively. Because the theoretical models outlined above suggest that the aggregate collateral constraint should be more likely to bind for combinations of negative productivity shocks and high levels of aggregate debt, I expect a negative sign for β_3, i.e. on the interaction term between domestic private sector indebtedness and the measure of growth shocks.

To control for other drivers of sudden stops, sets of additional domestic factors, contagion factors, as well as global factors are included, summarized in the terms $\phi_{t-1}^{Domestic}$,$\phi_{t-1}^{Contagion}$, and ϕ_{t-1}^{Global}. As outlined in equation (3), all independent variables are lagged by one quarter. Because sudden stops are relatively rare events (almost 90 percent of the sample are zeros) I estimate equation (3) using the complementary logarithmic framework, again following Forbes and Warnock (2012).[19] The results are robust to using a logit or probit framework instead.

In the baseline estimations, I start with a relatively parsimonious set of explanatory variables. Besides the main variables of interest mentioned above I include a controls for financial openness, and GDP per capita, i.e. the domestic variables which showed the highest pairwise correlations with the main variables of interest (Table 3.A.4). In addition, I control for the level of government indebtedness. The other potential domestic drivers of sudden stops are included in robustness checks.[20] In addition to these domestic factors, I include measures of contagion and global factors as outlined above. This selection of explanatory variables leaves an unbalanced

[19] This framework assumes that sudden stop episodes follow an extreme value distribution with $F(.)$ being the according cumulative distribution function.

[20] See Table 3.A.8 and Section 3.6.1 for results including all domestic variables.

panel of 98 countries (31 AEs, 67 EMDEs). For these countries data is available for 62 countries before 2000 (24 AEs, 38 EMDEs) and the remaining countries enter the sample from 2000 onwards.[21]

3.5 Results

Table 3.1 shows the results of estimating equation 3.3. In general, domestic factors are revealed to be significantly associated with the occurrence of sudden stop episodes alongside contagion and global factors. In particular, higher levels of private sector indebtedness and negative growth shocks are found to be significantly positively related to the probability of incurring a sudden stop episode (column 1). The interaction term between domestic debt levels and growth shocks added in column 2 shows the expected sign indicating that sudden stops in capital inflows are indeed more likely for economies which exhibit a negative productivity shock when levels of leverage in the domestic economy are high.[22] This result is robust to the inclusion of country fixed effects in columns 3 and 4.[23] Moreover, the inclusion of the interaction term renders the coefficient on growth shocks insignificant implying that the shocks do not matter per se but combined with high levels of leverage they raise the probability of the economy hitting a binding borrowing constraint. In fact, the effect of growth shocks is found to be asymmetric since only negative growth shocks show a significant coefficient as documented in Table 3.A.5.

In line with Forbes and Warnock (2012), other domestic factors are found to be less robust in their predictive power regarding the occurrence of sharp reversals in gross capital inflows. While the ratio of government debt to GDP shows a positive sign, it does not reach conventional levels of significance in any of the specifications in Table 3.A.8. Higher de facto financial openness is associated with a lower likelihood of incurring a sudden stop in columns 1 and 2, this result seems to be driven by unobserved time invariant country characteristics since it becomes insignificant when country fixed effects are included. GDP per capita, which acts as a control for

[21] The results are robust to using the more balanced panel for 58 countries in Forbes and Warnock (2021).

[22] A similar interaction term of growth shocks with levels of government debt to GDP is not significant.

[23] Because these fixed effects become a perfect predictor of the probability of experiencing a sudden stop for countries which never experienced one, these countries drop out of the sample.

TABLE 3.1: Baseline results

VARIABLES	(1)	(2)	(3)	(4)
	Sudden stop indicator $(P(e_{it}=1))$			
Domestic				
Private sector credit	0.481***	0.352*	0.874**	0.743*
	(0.177)	(0.197)	(0.378)	(0.393)
Growth shock	-0.084***	-0.036	-0.085***	-0.032
	(0.021)	(0.030)	(0.024)	(0.033)
Private sector credit x Growth shock		-0.079**		-0.080**
		(0.032)		(0.040)
Government debt to GDP	-0.190	-0.194	-0.451	-0.436
	(0.205)	(0.209)	(0.502)	(0.503)
De facto fin. openness	-0.198**	-0.208**	0.062	0.054
	(0.100)	(0.104)	(0.252)	(0.254)
GDP p.c.	0.122	0.138	0.828***	0.839***
	(0.085)	(0.085)	(0.269)	(0.269)
Contagion				
Trade channel	0.478***	0.443***	0.590*	0.576*
	(0.130)	(0.134)	(0.342)	(0.334)
Financial channel	0.195	0.099	0.439	0.748
	(0.268)	(0.303)	(0.972)	(1.230)
Global				
VIX	0.022***	0.020***	0.025***	0.023***
	(0.006)	(0.006)	(0.006)	(0.006)
Liquidity growth	-0.025**	-0.022*	-0.027**	-0.024**
	(0.011)	(0.011)	(0.012)	(0.012)
Interest rates	0.154***	0.154***	0.386***	0.386***
	(0.055)	(0.055)	(0.102)	(0.100)
Growth	-0.216***	-0.212***	-0.217***	-0.210***
	(0.043)	(0.045)	(0.052)	(0.055)
Observations	7,478	7,478	6,727	6,727
of which sudden stops	726	726	726	726
Time period	1990q1-2018q1	1990q1-2018q1	1990q1-2018q1	1990q1-2018q1
Sample	All	All	All	All
Country FE	no	no	yes	yes
AUROC	0.752	0.754	0.816	0.816

Note: coefficient estimates of a complementary log-log estimation of equation 3.3. Sudden stop episodes, as well as global and contagion control variables are defined following Forbes and Warnock (2012). All explanatory variables are lagged by one quarter. Robust standard errors (clustered at the country-level) in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

the level of economic development in the regression, is found to be positively related to the incurrence of sudden stops reflecting the higher unconditional probability for AEs documented in Table 3.1.

Turning to contagion and global factors, Table 3.1 shows that sudden stops in capital inflows are more likely to happen when important trade partners also exhibit a sudden stop. Contagion does not seem to be a major factor with regard to financial channels. In addition, global factors are confirmed to be significant determinants of sharp reversals in gross capital inflows. In line with Forbes and Warnock (2012), I find that increases in global uncertainty, higher global interest rates, and lower

global growth momentum go hand in hand with an increased likelihood of sudden stops. In order to assess how well the selected variables explain the occurrence of sudden stops I follow the literature on (external) financial crises using the Area Under the Receiver Operating Characteristic (AUROC) (Catão & Milesi-Ferretti, 2014; Schularick & Taylor, 2012). The ROC plots the fraction of true positives that a given model signals against the fraction of false positives along all threshold settings determining when the estimated probability of a sudden stop would be interpreted as a signal for an impending sudden stop. The AUROC, in turn, provides a measure of the extent to which the model's signals outperform an uninformative "coin toss" (AUROC = 0.5). The selected explanatory variables provide relatively high AUROC values of 0.75 even without country fixed effects given the broad country sample. The inclusion of fixed effects increases the AUROC to 0.82. This implies that the selected variables exhibit predictive power that are in line with other models used in the literature. Schularick and Taylor (2012), for example, find values of 0.72 in their baseline specification.[24]

In order to assess the economic significance of the respective explanatory variables, Table 3.2 shows the marginal effects of the specification including fixed effects (Table 3.1, column 4) evaluated at different points in the distribution. The estimated marginal effects of the domestic variables are economically significant and similar in magnitude to those of the global factors. Columns 1 and 2 report the marginal effects evaluated at the 25 percentile and the mean of private sector credit, respectively. The marginal effects are not significantly different between these levels of leverage in the domestic economy. The estimates suggest that a one standard deviation growth shock increases the probability of incurring a sudden stop by 2 percentage points, which is equivalent to a 20.6 percent increase compared to the unconditional probability of 9.7 percent. By comparison, a one standard deviation increase in the VIX increases the predicted probability of a sudden stop by 1.1 percentage points, i.e. by 11.3 percent. As discussed above, the significance of the interaction term between domestic credit and growth shocks implies that the latter should matter more if an economy exhibits elevated levels of leverage. Column 3 reports estimates of the

[24] Probit estimations of the specifications in Table 3.1 yield pseudo R^2 values between 0.15 and 0.23.

marginal effects for levels of domestic private sector credit to GDP in the 75 percentile. As expected, the marginal effects of a negative growth shock are found to be higher. A one standard deviation growth shock increases the predicted probability of incurring a sudden stop by 3.5 percentage points or by 36 percent.,

Taken together the results suggest a decisive role of the level of leverage in the economy in determining the probability of incurring sudden stops because high levels of debt increase the adverse impact of negative productivity shocks. This is in line with the empirical and theoretical literature which suggests that leverage cycles are the most powerful predictors of sudden stops and financial crises (Akıncı & Chahrour, 2018; Gourinchas & Obstfeld, 2012; Schularick & Taylor, 2012).

3.6 Robustness and Extensions

3.6.1 Robustness

The robustness of the results presented in the previous section is assessed using a battery of sensitivity tests. First, a main endogeneity concern regarding the domestic variables is that a reversal in capital inflows and the accompanying reversals in the real exchange rate drive the slowdown in credit growth and the dismal growth performance rather than growth shocks and leverage increasing the likelihood of a sudden stop. To some extent this concern is already alleviated by the fact that the explanatory variables enter the regressions lagged by one period. However, since sudden stop periods span several quarters (by definition), including all quarters following the onset of a sudden stop might still give rise to erroneous conclusions regarding the direction of causality (Eichengreen & Gupta, 2016). Dropping all quarters following the onset of a sudden stop episode as suggested by Eichengreen and Gupta (2016) leaves the results intact with virtually unchanged coefficient estimates for the main variables of interest (Table 3.A.6).[25] Furthermore, including a lagged version of the dependent variable alongside several other additional explanatory variables leaves the coefficient on the interaction term between growth shocks and domestic credit unchanged and significant (Table 3.A.8, columns 3 and 4).[26]

[25] Notably, this exercise renders the coefficient on global growth insignificant.

[26] The coefficient estimate on the lagged dependent variable is positive and highly significant reflecting the fact that sudden stop episodes are persistent (by definition).

Second, the GFC period might be driving the results to a large extent, given that close to 30 percent of all sudden stop observations are from this period (Figure 3.2). Table 3.A.7 shows that the results are robust to excluding the GFC (2008-2009) from the sample. More specifically, the point estimates for the interaction between domestic leverage and growth shocks are virtually unchanged from the baseline estimates in Table 3.1 although the reduction of available sudden stop observations reduces the precision of the estimation slightly. Interestingly, the coefficient estimates on the global variables are reduced in size by excluding the GFC from the sample causing the global growth in liquidity to lose significance throughout and the VIX in some instances. Global growth and interest, however, remain highly significant.

Third, the relatively parsimonious selection of domestic variables might give rise to concerns that unobserved factors might be behind the results. However, the wide range of other additional explanatory factors considered in Table 3.A.8 are mostly insignificant.[27] Notable exceptions are the fiscal balance and changes in the sovereign rating which both exhibit a negative sign and statistical significance (columns 1 and 2). This implies that sudden stops might be preceded by widening fiscal deficits and downgrades of sovereign credit ratings. However, including the lagged dependent variable renders the coefficient on the fiscal balance insignificant highlighting the fact that governments might endogenously respond to sudden stops in capital inflows (columns 3 and 4). As an additional robustness check, a control for preceding surges in capital inflows is included to account for the possibility that sudden stops might simply be the result of large gross inflows in the past, which have also been shown to drive domestic credit growth (Lane & McQuade, 2014). A surge in capital inflows is defined symmetrically to a sudden stop (Forbes & Warnock, 2012) and enters the regression lagged by eight quarters.[28] The results depicted in columns (5) and (6) highlight that sudden stops are indeed often preceded by surges in capital

[27] Countries with a larger stock of reserves might increase investor confidence given their increased ability to withstand the impact of a sudden stop and might hence face a lower probability of sudden stops occurring in the first place (Eichengreen & Gupta, 2016). Quinn, Schindler, and Toyoda (2011) show that de facto and de jure measures of financial openness capture different facets of financial openness. Hence, I include the index developed by Chinn and Ito (2008) as a measure of de jure openness, as well as the de facto measure by Lane and Milesi-Ferretti (2007). The exchange rate regime is captured by the measure of Ilzetzki et al. (2019). Additional controls on reserve assets to GDP are based on IMF IFS data and fiscal variables are sourced from Kose et al. (2017).

[28] Specifications with alternative lag structures yield qualitatively similar results and leave the main results unchanged.

inflows as the coefficient is positive and highly significant. However, the coefficients on domestic growth shocks and their interactions with domestic leverage levels remain largely unchanged and significant. Finally, the specifications in columns (7) and (8) control for the Global Stock Market Factor (GSMF) developed by Habib and Venditti (2019) which has been shown to be tightly connected to a global cycle in capital flows.[29] This measure, which is also closely correlated with alternative measures of the global financial cycle (e.g. Miranda-Agrippino and Rey (2020) and Bonciani and Ricci (2020)), might therefore capture additional global drivers of sudden stops. In line with expectations, decreases in the GSMF, which reflect downturns in the global financial cycle, are indeed associated with a heightened probability of sudden stop episodes. Since the results for domestic growth shocks and their interactions with domestic leverage levels remain statistically significant in this specification as well, concerns that omitted factors, at the domestic or global level, might be driving the results are alleviated.[30]

Fourth, the results are robust to alternative definitions of sudden stop episodes (Table 3.A.9). Cavallo et al. (2015) show that sudden stops in gross capital inflows that coincide with stops in net inflows are particularly detrimental. Moreover, the authors note that, for example, some large gross inflows may represent an exchange of financial claims between residents and foreigners and generate offsetting gross outflows, which may in some cases be automatic. For example, a German resident may buy US bonds, a transaction which implies a gross outflow from Germany. This outflow could be paid by using the resident's existing stock of USD, which would reduce gross outflows from Germany by the same amount. Alternatively, the German resident could sell euros to a foreign bank in exchange for USD, resulting in an offsetting increase in gross inflows to Germany (Borio & Disyatat, 2011). "In both cases, there is an automatic offsetting and no change in net flows." (Cavallo et al., 2015, p. 49, fn. 3). Hence, financial transactions, particularly by large domestic entities, could be affecting both sides of a country's balance sheet at the same time.

[29] The GSMF is extracted as the common latent factor driving a panel of 63 country level stock market returns.

[30] In addition, the results hold when a variable capturing regional contagion is included, i.e. a dummy equal to one when a country in the same geographic region (using World Bank defined regions) is having an episode (Forbes & Warnock, 2012). The results are, furthermore, robust to a 95% winsorisation of the data which should mitigate the impact of extreme outliers.

While there would be no change in net flows, the underlying gross flows could be large and could be recorded as a sudden stop in gross inflows which might however not be relevant for economic developments in the country. Hence, I use an alternative definition of sudden stops in gross capital inflows which only considers those sudden stops in gross inflows which coincide with sudden stops in net inflows. This alternative definition leaves the main results unchanged (columns 3 and 4). In addition, statistical significance on the variable measuring contagion through the trade channel increases indicating that contagion might be more important for reversals in gross flows that also affect net flows. In order to restrict episodes to the most economically meaningful ones, columns 5 and 6 consider only those episodes were the reversal in flows exceeded 5% of GDP on average. This reduces the number of sudden stop quarters by 28 percent but leaves the results unchanged.

3.6.2 Extensions

Table 3.A.10 presents results for an extension of the previous analysis in which the sample is split into AEs and EMDEs and sudden stop episodes are separated into debt and equity led episodes. More precisely, a sudden stop is equity (debt) led when gross inflows were predominantly (i.e. > 50 percent) equity (debt) flows during the respective episode (Forbes & Warnock, 2014).[31] In line with Forbes and Warnock (2014), I find that the vast majority (75 percent) of sudden stop episodes is fuelled by debt, not equity flows. These tests reveal some interesting heterogeneity showing that growth shocks combined with high levels of leverage are predominantly a driver of sudden stops in EMDEs (columns 1 and 2). However, the combination of high indebtedness and negative growth surprises also holds considerable explanatory power for sudden stop episodes in AEs that are dominated by equity flows (column 5). Conversely, the interaction term is significant for episodes that are primarily driven by debt flows for EMDEs. This might be related to the fact that intermediation of debt flows by banks and other financial institutions in AEs might give rise to sudden stops that are unrelated to developments in the domestic economy for these countries.

[31] Equity inflows include FDI and portfolio equity flows while debt inflows include portfolio debt and other investment inflows.

Turning to other explanatory variables, it is noteworthy that the financial channel seems to be driving contagion effects for sudden stop episodes dominated by equity inflows (column 5). Since the sample of countries experiencing this type of sudden stops is predominantly made up of countries with a large and globally integrated financial sector, this is in line with theoretical results in, for example, Born and Enders (2019) who find that the financial channel dominated the trade channel in transmitting the GFC for countries with large financial centres. Furthermore, Table 3.A.10 highlights some interesting heterogeneity in the effect of global variables across types of episodes and countries. Global risk aversion, proxied by the VIX, is only significant for equity led episodes, suggesting that spikes in risk aversion of global investors predominantly correlate with retrenchments of equity investments. Debt led episodes, in comparison, seem to be more driven by developments in global liquidity and interest rates, which is in line with the findings of Bruno and Shin (2015) who highlight that global banks transfer liquidity from financial centre countries to regional banks world-wide.

3.7 Conclusion

This chapter provides a fresh look at the covariates of sudden stops in gross capital inflows by combining data on capital flows with a novel database by Kose et al. (2017) on domestic factors potentially driving sharp reversals in capital flows. Using a broader country sample than the previous literature, i.e. a quarterly panel of 98 advanced as well as emerging and developing countries from 1990 to 2018, this chapter shows that while global factors can be confirmed to be an important driver of episodes of sudden stops in gross capital inflows, domestic variables are also significantly related to the probability of incurring sharp reversals in capital inflows. The interaction between the level of leverage and negative growth shocks highlights the importance of domestic factors in determining sudden stops in gross capital inflows in line with predictions in real business cycle models with occasionally binding capital constraints and trend shocks (Akıncı & Chahrour, 2018; Flemming et al., 2019; Seoane & Yurdagul, 2019). The fact that leverage in the domestic economy tends to

amplify susceptibility to sudden stops in capital inflows has important policy implications. By limiting excessive credit growth, countercyclical macroprudential policy could also serve to reduce the susceptibility of capital inflows to sudden stops, in line with theoretical postulations by Flemming et al. (2019). Therefore, policymakers should make use of the macroprudential policy toolkit to "curtail the damaging extremes of domestic financial cycles" (Carney, 2019).

TABLE 3.2: Marginal effects

	(1)	(2)	(3)
	dP/dx with private sector credit at		
VARIABLES	p25	mean	p75
Domestic			
Private sector credit	0.038**	0.035***	0.064*
	(0.016)	(0.011)	(0.036)
Growth shock	-0.021***	-0.019***	-0.035***
	(0.006)	(0.006)	(0.011)
Government debt to GDP	-0.013	-0.012	-0.022
	(0.018)	(0.017)	(0.031)
De facto fin. openness	0.006	0.006	0.010
	(0.021)	(0.019)	(0.035)
GDP p.c.	0.103***	0.094***	0.173***
	(0.035)	(0.036)	(0.057)
Contagion			
Trade channel contagion	0.012*	0.011*	0.019*
	(0.007)	(0.006)	(0.012)
Financial channel contagion	0.002	0.002	0.004
	(0.007)	(0.007)	(0.012)
Global			
VIX	0.013***	0.011***	0.021***
	(0.004)	(0.003)	(0.007)
Liquidity growth	-0.007***	-0.007***	-0.012**
	(0.003)	(0.002)	(0.005)
Interest rates	0.058***	0.052***	0.096***
	(0.016)	(0.016)	(0.031)
Growth	-0.023***	-0.021***	-0.038***
	(0.005)	(0.006)	(0.009)
Observations	5,962	5,962	5,962
Time period	1990q1-2018q1	1990q1-2018q1	1990q1-2018q1
Sample	All	All	All
Country FE	yes	yes	yes

Note: marginal effects of the specification including fixed effects (Table 3.1, column 4) evaluated at different points in the distribution of private sector credit. All variables standardized around zero mean and standard deviation of 1. Robust standard errors (clustered at the country-level) in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Appendix

3.A Additional Figures and Tables

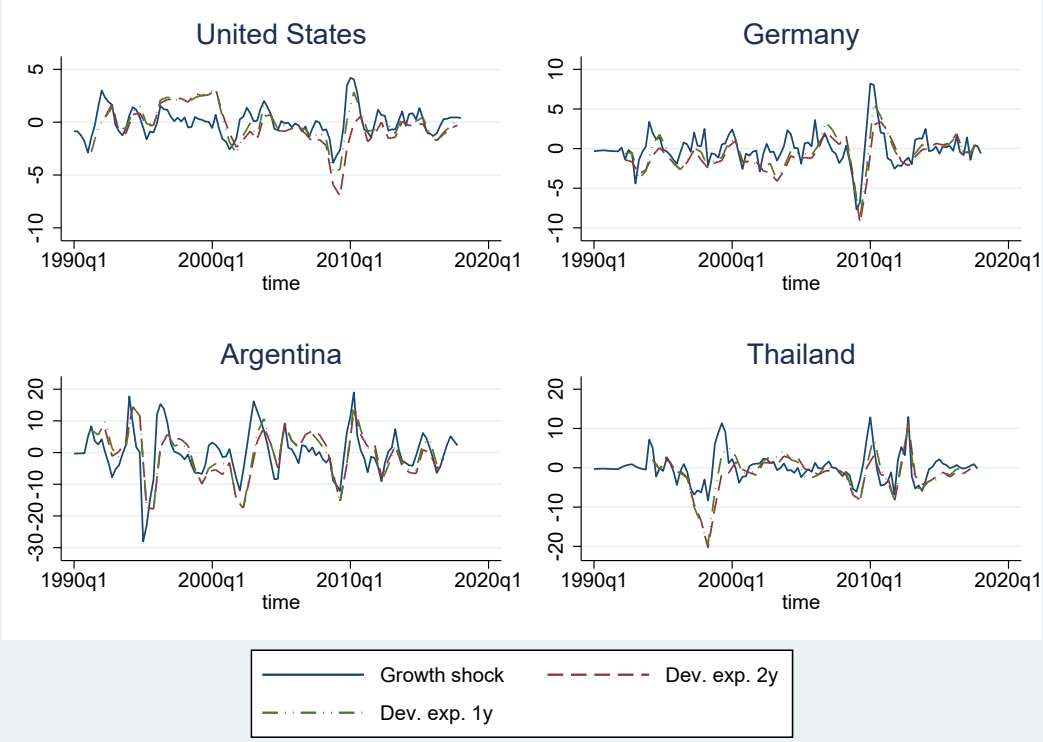


FIGURE 3.A.1: Measuring growth shocks

Note: comparison of the simple measure of growth shocks to two measures based on historical forecast data, one comparing realized growth rates in period t to the IMF WEO forecast for this period made one year (Dev exp. 1y) and the other one made two years (Dev exp. 2y) before period t.

TABLE 3.A.1: List of sudden stop episodes

Advanced Economies			**EMDEs**					
Country	Start	End	Country	Start	End	Country	Start	End
Australia	Q4-1997	Q4-1998	Argentina	Q4-1998	Q4-1999	Philippines	Q2-1992	Q3-1992
Australia	Q2-2005	Q4-2005	Argentina	Q1-2001	Q2-2002	Philippines	Q1-2008	Q1-2009
Belgium	Q4-2008	Q4-2009	Argentina	Q3-2008	Q4-2009	Poland	Q4-2008	Q3-2009
Canada	Q1-1991	Q1-1992	Armenia, Republic of	Q2-2010	Q2-2011	Romania	Q4-2008	Q1-2010
Canada	Q2-1995	Q2-1996	Azerbaijan, Republic of	Q2-2015	Q1-2016	Russian Federation	Q4-2008	Q4-2009
Canada	Q2-2008	Q2-2009	Belarus	Q1-2012	Q1-2013	Russian Federation	Q2-2014	Q2-2015
Cyprus	Q4-2009	Q3-2011	Bolivia	Q2-2000	Q3-2001	South Africa	Q1-1973	Q1-1974
Denmark	Q2-1992	Q2-1993	Bolivia	Q3-2006	Q2-2007	South Africa	Q1-1982	Q1-1983
Estonia	Q4-1998	Q3-1999	Bolivia	Q3-2014	Q3-2015	South Africa	Q2-1985	Q3-1986
Estonia	Q2-2008	Q4-2009	Brazil	Q3-2008	Q3-2009	South Africa	Q3-1998	Q3-1999
Estonia	Q2-2015	Q1-2016	Bulgaria	Q1-2009	Q2-2010	South Africa	Q3-2008	Q3-2009
Finland	Q2-1991	Q3-1992	Bulgaria	Q4-2015	Q1-2016	South Africa	Q3-2015	Q2-2016
Finland	Q2-2001	Q1-2002	Cambodia	Q1-2009	Q4-2009	Sri Lanka	Q4-1983	Q4-1984
Finland	Q2-2009	Q1-2010	Chile	Q2-2000	Q2-2001	Sri Lanka	Q1-2008	Q2-2009
Finland	Q4-2012	Q4-2013	Chile	Q2-2009	Q4-2009	Sri Lanka	Q4-2009	Q1-2010
France	Q1-1991	Q1-1992	Colombia	Q2-2008	Q2-2009	Sri Lanka	Q3-2010	Q4-2010
France	Q1-2002	Q4-2002	Colombia	Q3-2015	Q1-2016	Tajikistan	Q1-2009	Q3-2009
France	Q4-2007	Q3-2009	Costa Rica	Q1-2009	Q1-2010	Thailand	Q1-1992	Q1-1993
Germany	Q2-1994	Q1-1995	Costa Rica	Q3-2014	Q4-2015	Thailand	Q4-1996	Q2-1998
Germany	Q1-2001	Q2-2002	Croatia	Q3-2010	Q3-2011	Thailand	Q3-2008	Q2-2009
Germany	Q3-2008	Q4-2009	Czech Republic	Q2-2006	Q4-2006	Tonga	Q3-1989	Q3-1990
Greece	Q2-2006	Q4-2006	Czech Republic	Q1-2009	Q4-2009	Turkey	Q2-1994	Q2-1995
Greece	Q2-2010	Q3-2011	El Salvador	Q3-2004	Q1-2005	Turkey	Q2-2001	Q1-2002
Iceland	Q2-2001	Q2-2002	Ethiopia	Q3-2007	Q3-2008	Turkey	Q3-2007	Q4-2009
Iceland	Q2-2008	Q4-2009	Georgia	Q1-2009	Q1-2010	Uganda	Q3-2006	Q2-2007
Israel	Q1-2001	Q2-2002	Hungary	Q4-1996	Q2-1997	Ukraine	Q4-2008	Q1-2010
Israel	Q4-2007	Q2-2009	Hungary	Q1-2009	Q3-2010	Venezuela, Republica Bolivariana de	Q2-2006	Q4-2006
Israel	Q4-2011	Q3-2012	India	Q4-2015	Q1-2016			
Italy	Q4-1991	Q4-1993	Indonesia	Q4-2008	Q3-2009			
Italy	Q4-2000	Q3-2002	Indonesia	Q3-2015	Q1-2016			
Italy	Q4-2007	Q3-2009	Jordan	Q3-1992	Q4-1993			
Ireland	Q2-2008	Q3-2009	Jordan	Q3-2007	Q4-2008			
Japan	Q4-2008	Q4-2009	Kazakhstan	Q1-2008	Q1-2009			
Korea, Republic of	Q3-1997	Q4-1998	Kazakhstan	Q1-2015	Q1-2016			
Korea, Republic of	Q2-2008	Q3-2009	Lebanon	Q3-2010	Q2-2011			
Latvia	Q3-2008	Q1-2009	Lebanon	Q4-2015	Q1-2016			
Latvia	Q2-2015	Q1-2016	Lesotho	Q4-1991	Q2-1992			
Lithuania	Q4-1999	Q3-2001	Lesotho	Q3-1998	Q3-1999			
Lithuania	Q4-2008	Q1-2009	Lesotho	Q4-2010	Q1-2011			
Malta	Q3-2008	Q4-2009	Lesotho	Q2-2016	Q1-2017			
Netherlands	Q4-1990	Q1-1992	Macedonia, FYR	Q4-2006	Q3-2007			
Netherlands	Q1-2002	Q1-2003	Macedonia, FYR	Q4-2013	Q2-2014			
Netherlands	Q2-2008	Q4-2009	Malaysia	Q4-2005	Q3-2006			
New Zealand	Q3-2008	Q3-2009	Malaysia	Q3-2008	Q3-2009			
Norway	Q4-1997	Q1-1998	Mauritius	Q3-2008	Q2-2009			
Norway	Q3-2001	Q2-2002	Mexico	Q4-1994	Q4-1995			
Norway	Q1-2008	Q1-2010	Moldova	Q2-2009	Q2-2010			
Portugal	Q3-1992	Q3-1993	Moldova	Q4-2014	Q4-2015			
Portugal	Q4-2002	Q1-2003	Mongolia	Q2-2013	Q4-2014			
Portugal	Q1-2005	Q2-2005	Namibia	Q3-2007	Q4-2007			
Portugal	Q1-2011	Q4-2011	Nepal	Q4-1986	Q1-1987			
Slovenia	Q3-2008	Q4-2009	Nepal	Q2-1990	Q2-1991			
Spain	Q2-1994	Q2-1995	Nicaragua	Q3-2000	Q3-2001			
Spain	Q4-2001	Q3-2002	Pakistan	Q1-1995	Q4-1995			
Spain	Q4-2007	Q4-2009	Pakistan	Q3-1997	Q3-1999			
Sweden	Q1-1997	Q3-1997	Pakistan	Q2-2008	Q2-2009			
Sweden	Q4-2008	Q4-2009	Panama	Q4-2008	Q4-2009			
Sweden	Q1-2015	Q3-2015	Panama	Q1-2016	Q1-2017			
Switzerland	Q1-2008	Q1-2009	Panama	Q1-2016	Q1-2017			
United Kingdom	Q1-1991	Q2-1992	Peru	Q4-1983	Q3-1984			
United Kingdom	Q4-2001	Q3-2002	Peru	Q2-1998	Q4-1999			
United Kingdom	Q2-2008	Q3-2009	Peru	Q4-2008	Q3-2009			
United States	Q4-2001	Q3-2002	Philippines	Q4-1983	Q3-1984			
United States	Q1-2008	Q2-2009						

Note: Sudden stop episodes in gross capital inflows defined following Forbes and Warnock (2012) based on data from IMF IFS. Country classification according to IMF.

TABLE 3.A.2: Definition of variables and sources

Variable	Source	Comments
Sudden stop episode $e_{it} = 1$	Author's calculations based gross capital inflows data from quarterly IMF IFS and BOP statistics.	Episodes defined following Forbes and Warnock (2012).
Global risk (VIX)	Datastream	CBOE measure of 30 day expected volatility based on mid-quote prices of S&P 500 Index (call and put options)
Global liquidity	FRED, IMF IFS	Sum of (USD converted) M2 in the United States, Euro-zone, and Japan and M4 in the United Kingdom.
Global interest rates	IMF IFS	Average rate on long-term government bonds in the United States, core euro area, and Japan.
Global growth	IMF IFS	Year on year change in real global economic activity.
Financial links contagion	IMF BOP, IMF IFS, BIS LBS, author's calculations	Sudden stop episode in foreign countries weighted by bilateral banking links.
Trade links contagion	IMF BOP, IMF IFS, IMF DOTS, author's calculations	Sudden stop episode in foreign countries weighted by bilateral trade links.
Financial openness (de facto)	Lane and Milesi-Ferretti (2007).	Total assets and liabilities over GDP.
Financial openness (de jure)	Chinn and Ito (2008)	[0,1] closed to open. Based on information on cross-border financial transaction restrictions reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions.
Fiscal balance and government debt (percent of GDP)	Kose, Kurlat, Ohnsorge, and Sugawara (2017)	
Change in foreign currency long-term sovereign debt ratings Kose, Kurlat, Ohnsorge, and Sugawara (2017).	Kose, Kurlat, Ohnsorge, and Sugawara (2017), author's calculations	Q-o-q change in index ranging from 1 to 21 [best]. Domestic credit to private sector (percent of GDP)
Growth shock	IMF IFS, author's calculations	Deviations from four quarter growth trend
Exchange rate regime	Ilzetzki, Reinhart, and Rogoff (2019)	Index [1, 14], higher values indicate higher flexibility

TABLE 3.A.3: First observation for panel regression analysis

Advanced Economies			**Emerging Market Economies**		
First observation	Country	First observation	Country	First observation	Country
Jan-1990	United States	Q2-1990	Turkey	Q1-1999	Moldova
	United Kingdom		Argentina		Ukraine
	Denmark		Brazil		Cambodia
	France		Guatemala		Russian Federation
	Germany		Mexico	Q1-2000	Albania
	Italy		Bahamas, The		Kazakhstan
	Ireland		Jordan		Lesotho
	Netherlands		Bangladesh		Tonga
	Norway		Sri Lanka	Q1-2001	Colombia
	Sweden		India		El Salvador
	Canada		Indonesia		Myanmar
	Finland		Nepal		Vietnam
	Greece		Pakistan		Uganda
	Iceland		Philippines		Belarus
	Portugal		Thailand		Macedonia, FYR
	Spain		Ethiopia	Q1-2002	Georgia
	Israel		Seychelles	Q1-2003	Panama
	Korea, Republic of		Sudan		Cabo Verde
Q1-1994	Australia		Vanuatu		Mongolia
Q4-1997	Slovenia		Papua New Guinea	Q1-2004	Costa Rica
Q1-1998	Estonia	Q2-1991	Peru		Malaysia
	Lithuania	Q1-1993	Bolivia		Namibia
Q1-1999	Czech Republic	Q1-1995	Hungary		AzerbaiQ1, Republic of
	Slovak Republic	Q1-1996	Chile	Q1-2005	Paraguay
	Latvia		Romania		Uruguay
Q1-2000	Malta	Q1-1997	Nicaragua		Mauritius
	Singapore		Bulgaria		Fiji
Q1-2001	Japan	Q1-1998	Ecuador		Poland
Q1-2004	Switzerland		South Africa	Q1-2006	Belize
Q1-2005	New Zealand		Armenia, Republic of		Mozambique
Q1-2006	Cyprus		Croatia		Bosnia and Herzegovina
Q1-2007	Belgium	Q1-1999	Venezuela	Q1-2007	Lebanon
			Lao		Tajikistan
			Kyrgyz Republic		

Note: first observation entering the baseline regression analysis in table 3.1. Country classification according to IMF.

TABLE 3.A.4: First observation for panel regression analysis

	Private sector credit	Growth shock	Gov. debt to GDP	Fiscal balance	De facto fin. openness	De jure fin. openness	GDP p.c.	NFA/GDP	Reserve assets/GDP	Exchange rate regime
Growth shock	0.00									
Government debt to GDP	0.23	0.03								
Fiscal balance	0.10	0.00	-0.37							
De facto fin. openness	0.63	0.01	0.24	0.15						
De jure fin. openness	0.48	0.00	0.13	0.11	0.44					
GDP p.c.	0.77	-0.02	0.18	0.11	0.56	0.56				
NFA/GDP	0.09	0.01	-0.02	0.14	0.26	0.14	0.13			
Reserve assets/GDP	-0.07	0.01	0.10	0.11	0.21	-0.09	-0.11	0.11		
Exchange rate regime	0.02	-0.01	-0.07	0.09	-0.17	-0.15	0.01	0.08	0.07	
Sovereign rating change	-0.08	0.11	-0.11	0.11	-0.06	0.00	-0.04	0.04	0.03	0.02

Note: pairwise correlations between domestic variales.

TABLE 3.A.5: Negative and positive growth shocks

VARIABLES	(1)	(2)	(3)	(4)	(5)
	Sudden stop indicator ($P(e_{it}=1)$)				
Domestic					
Private sector credit	0.840**	0.604	0.883**	0.929**	0.650
	(0.384)	(0.406)	(0.395)	(0.391)	(0.396)
Growth shock (negative)	-0.097***	-0.033			-0.030
	(0.030)	(0.035)			(0.033)
Private sector credit x Growth shock (negative)		-0.109**			-0.099**
		(0.043)			(0.039)
Growth shock (positive)			-0.112**	-0.031	-0.029
			(0.055)	(0.089)	(0.078)
Private sector credit x Growth shock (positive)				-0.098	-0.031
				(0.084)	(0.060)
Government debt to GDP	-0.303	-0.326	-0.314	-0.301	-0.319
	(0.511)	(0.517)	(0.503)	(0.500)	(0.508)
De facto fin. openness	0.149	0.130	0.223	0.219	0.142
	(0.285)	(0.288)	(0.292)	(0.293)	(0.290)
GDP p.c.	1.498***	1.418***	1.559***	1.569***	1.397***
	(0.477)	(0.481)	(0.480)	(0.481)	(0.478)
Contagion					
Trade channel	0.634*	0.610*	0.659*	0.659*	0.614*
	(0.357)	(0.346)	(0.371)	(0.370)	(0.350)
Financial channel	0.438	0.755	0.353	0.413	0.791
	(1.030)	(1.276)	(0.934)	(0.993)	(1.262)
Global					
VIX	0.024***	0.022***	0.029***	0.029***	0.023***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Liquidity growth	-1.279*	-1.124*	-1.298**	-1.295**	-1.092*
	(0.664)	(0.662)	(0.650)	(0.652)	(0.654)
Interest rates	0.269**	0.278***	0.308***	0.310***	0.287***
	(0.105)	(0.103)	(0.099)	(0.099)	(0.101)
Growth	-0.219***	-0.209***	-0.235***	-0.234***	-0.202***
	(0.054)	(0.057)	(0.051)	(0.052)	(0.056)
Observations	6,727	6,727	6,727	6,727	6,727
of which sudden stops	726	726	726	726	726
Time period	1990q1-2018q1	1990q1-2018q1	1990q1-2018q1	1990q1-2018q1	1990q1-2018q1
Sample	All	All	All	All	All
Country FE	yes	yes	yes	yes	yes

Note: coefficient estimates of a complementary log-log estimation of 3.3. Sudden stop episodes, as well as global and contagion control variables are defined following Forbes and Warnock (2012). All explanatory variables are lagged by one quarter. Robust standard errors (clustered at the country-level) in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

TABLE 3.A.6: Only first quarter of sudden stop episode

VARIABLES	(1)	(2)	(3)	(4)
	Sudden stop indicator $(P(e_{it}=1))$			
Domestic				
Private sector credit	0.461***	0.396**	0.557	0.418
	(0.166)	(0.175)	(0.392)	(0.415)
Growth shock	-0.058*	-0.004	-0.063*	0.003
	(0.031)	(0.038)	(0.035)	(0.044)
Private sector credit x Growth shock		-0.087**		-0.094***
		(0.034)		(0.033)
Government debt to GDP	-0.115	-0.113	-0.275	-0.295
	(0.205)	(0.209)	(0.477)	(0.473)
De facto fin. openness	-0.140	-0.159	0.269	0.296
	(0.103)	(0.099)	(0.333)	(0.351)
GDP p.c.	0.021	0.032	0.848***	0.871***
	(0.071)	(0.070)	(0.264)	(0.267)
Contagion				
Trade channel	0.568***	0.563***	0.746	0.749
	(0.148)	(0.147)	(0.612)	(0.612)
Financial channel	0.009*	0.011	0.009	0.025**
	(0.005)	(0.007)	(0.009)	(0.013)
Global				
VIX	0.027***	0.025***	0.029***	0.029***
	(0.008)	(0.008)	(0.008)	(0.008)
Liquidity growth	-0.013	-0.012	-0.015	-0.014
	(0.026)	(0.026)	(0.026)	(0.026)
Interest rates	0.139***	0.139***	0.403***	0.409***
	(0.051)	(0.051)	(0.114)	(0.113)
Growth	-0.013	-0.005	-0.044	-0.034
	(0.060)	(0.061)	(0.077)	(0.078)
Observations	6,776	6,776	6,025	6,025
of which sudden stops	169	169	169	169
Time period	1990q1-2018q1	1990q1-2018q1	1990q1-2018q1	1990q1-2018q1
Sample	All	All	All	All
Country FE	no	no	yes	yes

Note: coefficient estimates of a complementary log-log estimation of 3.3. Sudden stop episodes, as well as global and contagion control variables are defined following Forbes and Warnock (2012). Only the first quarter of a sudden stop is included, all subsequent quarters are dropped. All explanatory variables are lagged by one quarter. Robust standard errors (clustered at the country-level) in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

TABLE 3.A.7: Excluding the Global Financial Crisis

VARIABLES	(1)	(2)	(3)	(4)
	Sudden stop indicator $(P(e_{it} = 1))$			
Domestic				
Private sector credit	0.395**	0.312	0.964**	0.856*
	(0.192)	(0.212)	(0.469)	(0.461)
Growth shock	-0.072***	-0.026	-0.064**	-0.022
	(0.023)	(0.033)	(0.025)	(0.032)
Private sector credit x Growth shock		-0.078*		-0.068*
		(0.041)		(0.041)
Government debt to GDP	-0.183	-0.166	-0.568	-0.540
	(0.240)	(0.240)	(0.563)	(0.556)
De facto fin. openness	-0.133	-0.140	0.061	0.075
	(0.109)	(0.110)	(0.313)	(0.308)
GDP p.c.	0.083	0.096	0.582*	0.601**
	(0.090)	(0.091)	(0.304)	(0.306)
Contagion				
Trade channel	0.688***	0.691***	1.021***	1.041***
	(0.220)	(0.224)	(0.302)	(0.304)
Financial channel	-0.002	-0.001	-0.008*	-0.007
	(0.005)	(0.005)	(0.004)	(0.006)
Global				
VIX	0.013*	0.012	0.016**	0.015**
	(0.008)	(0.008)	(0.007)	(0.007)
Liquidity growth	-0.006	-0.006	-0.017	-0.017
	(0.014)	(0.014)	(0.014)	(0.014)
Interest rates	0.165***	0.165***	0.373***	0.377***
	(0.061)	(0.061)	(0.119)	(0.117)
Growth	-0.206***	-0.200***	-0.191***	-0.183***
	(0.064)	(0.066)	(0.065)	(0.067)
Observations	6,995	6,995	6,239	6,239
of which sudden stops	530	530	530	530
Time period	1990q1-2018q1 excluding GFC (2008-2009)			
Sample	All	All	All	All
Country FE	no	no	yes	yes

Note: coefficient estimates of a complementary log-log estimation of 3.3 excluding the GFC. Sudden stop episodes, as well as global and contagion control variables are defined following Forbes and Warnock (2012). All explanatory variables are lagged by one quarter. Robust standard errors (clustered at the country-level) in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

TABLE 3.A.8: Additional explanatory variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Sudden stop indicator $(P(e_{it}=1))$							
Domestic								
Private sector credit	0.482	0.333	0.086	-0.034	0.459	0.238	0.388	0.186
	(0.514)	(0.495)	(0.303)	(0.306)	(0.441)	(0.438)	(0.456)	(0.457)
Growth shock	-0.083***	-0.033	-0.115***	-0.071**	-0.088***	-0.022	-0.089***	-0.027
	(0.025)	(0.035)	(0.022)	(0.029)	(0.026)	(0.037)	(0.025)	(0.040)
Private sector credit x Growth shock		-0.084**		-0.074**		-0.112**		-0.100**
		(0.043)		(0.034)		(0.046)		(0.047)
Government debt to GDP	-1.070	-1.074	-0.600	-0.651	-0.469	-0.451	-0.159	-0.140
	(0.728)	(0.730)	(0.389)	(0.407)	(0.677)	(0.673)	(0.678)	(0.675)
Fiscal balance	0.048*	0.047*	-0.034	-0.040	-0.032	-0.040	-0.066*	-0.071*
	(0.026)	(0.026)	(0.039)	(0.039)	(0.036)	(0.037)	(0.039)	(0.040)
De facto fin. openness	0.180	0.232	-0.082	-0.046	0.009	0.072	-0.094	-0.031
	(0.397)	(0.391)	(0.290)	(0.291)	(0.360)	(0.353)	(0.320)	(0.316)
De jure fin. openness	0.270	0.351	-0.096	-0.012	0.697	0.809	0.548	0.638
	(0.580)	(0.566)	(0.373)	(0.381)	(0.609)	(0.596)	(0.535)	(0.525)
GDP p.c.	0.562*	0.563*	0.764***	0.786***	0.465	0.465	1.109***	1.097***
	(0.314)	(0.317)	(0.240)	(0.241)	(0.339)	(0.342)	(0.349)	(0.355)
NFA/GDP	-0.029	-0.015	-0.027	-0.013	-0.024	-0.012	0.014	0.025
	(0.074)	(0.076)	(0.060)	(0.065)	(0.068)	(0.069)	(0.078)	(0.079)
Reserve assets/GDP	0.332	0.559	0.034	0.192	0.120	0.440	0.462	0.744
	(1.389)	(1.397)	(1.036)	(1.062)	(1.307)	(1.304)	(1.371)	(1.379)
Exchange rate regime	0.060	0.061	0.011	0.013	0.040	0.040	0.042	0.042
	(0.051)	(0.051)	(0.027)	(0.028)	(0.053)	(0.054)	(0.053)	(0.053)
Sovereign rating change	-0.535***	-0.521***	-0.550***	-0.544***	-0.495***	-0.474***	-0.510***	-0.491***
	(0.102)	(0.102)	(0.128)	(0.128)	(0.101)	(0.102)	(0.097)	(0.098)
Sudden stop t-1			3.640***	3.635***				
			(0.082)	(0.084)				
Surge t-8					0.653***	0.670***		
					(0.178)	(0.184)		
Contagion								
Trade channel	0.564**	0.581**	0.301*	0.314**	0.558**	0.575**	0.485**	0.502**
	(0.268)	(0.270)	(0.154)	(0.155)	(0.257)	(0.259)	(0.225)	(0.227)
Financial channel	0.073	0.065	0.013	0.009	0.072	0.065	0.071	0.067
	(0.050)	(0.048)	(0.024)	(0.024)	(0.051)	(0.048)	(0.052)	(0.049)
Global								
VIX	0.026***	0.025***	0.012*	0.011	0.024***	0.021***	0.035***	0.032***
	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)
Liquidity growth	-0.038***	-0.036***	-0.058***	-0.055***	-0.043***	-0.039***	-0.063***	-0.058***
	(0.012)	(0.012)	(0.016)	(0.016)	(0.012)	(0.012)	(0.014)	(0.014)
Interest rates	0.398***	0.410***	0.273***	0.285***	0.303***	0.311***	0.398***	0.405***
	(0.108)	(0.106)	(0.078)	(0.076)	(0.104)	(0.102)	(0.101)	(0.101)
Growth	-0.132**	-0.121**	0.042	0.047	-0.138**	-0.121**	-0.266***	-0.255***
	(0.054)	(0.057)	(0.049)	(0.049)	(0.057)	(0.061)	(0.066)	(0.068)
GSMF							-0.475***	-0.464***
							(0.107)	(0.103)
Observations	5,342	5,342	5,342	5,342	5,071	5,071	5,342	5,342
of which sudden stops	647	647	647	647	647	647	647	647
Time period	1990q1-2018q1	1990q1-2018q1	1990q1-2018q1	1990q1-2018q1	1990q1-2018q1	1990q1-2018q1	1990q1-2018q1	1990q1-2018q1
Sample	All	All	All	All	All	All	All	All
Country FE	yes	yes	yes	yes	yes	yes	yes	yes

Note: coefficient estimates of a complementary log-log estimation of 3.3. Sudden stop episodes, as well as global and contagion control variables are defined following Forbes and Warnock (2012). All explanatory variables are lagged by one quarter unless otherwise indicated. Columns (3) and (4) control for a lagged dependent variable. Surge t-8 in columns (5) and (6) denotes indicator variable for a surge in capital inflows (defined symmetrically to a sudden stop) lagged by 8 quarters. Columns (7) and (8) include the Global Stock Market Factor (GSMF) by Habib and Venditti (2019). Robust standard errors (clustered at the country-level) in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

TABLE 3.A.9: Alternative definitions of sudden stops

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Sudden stop in gross inflows		Sudden stop in net *and* gross inflows		Sudden stop in flows > 5% of GDP	
Domestic						
Private sector credit	0.874**	0.743*	1.166*	1.201	1.030**	0.880*
	(0.378)	(0.393)	(0.687)	(0.761)	(0.490)	(0.458)
Growth shock	-0.085***	-0.032	-0.082***	-0.029	-0.111***	-0.036
	(0.024)	(0.033)	(0.031)	(0.042)	(0.036)	(0.052)
Private sector credit x Growth shock		-0.080**		-0.100*		-0.101**
		(0.040)		(0.054)		(0.048)
Government debt to GDP	-0.451	-0.436	0.064	0.170	0.150	0.310
	(0.502)	(0.503)	(0.794)	(0.834)	(0.581)	(0.570)
De facto fin. openness	0.062	0.054	0.272	0.219	0.358	0.310
	(0.252)	(0.254)	(0.444)	(0.654)	(0.378)	(0.376)
GDP p.c.	0.828***	0.839***	0.948**	0.904*	0.889***	0.907**
	(0.269)	(0.269)	(0.468)	(0.466)	(0.322)	(0.357)
Contagion						
Trade channel	0.590*	0.576*	0.013**	0.012**	0.674	0.988*
	(0.342)	(0.334)	(0.005)	(0.005)	(0.428)	(0.591)
Financial channel	0.439	0.748	-0.018*	0.012	0.347	1.487
	(0.972)	(1.230)	(0.010)	(0.104)	(0.936)	(1.769)
Global						
VIX	0.025***	0.023***	0.034***	0.037***	0.028***	0.025***
	(0.006)	(0.006)	(0.009)	(0.008)	(0.007)	(0.008)
Liquidity growth	-0.027**	-0.024**	-0.021	-0.013	-0.040***	-0.031**
	(0.012)	(0.012)	(0.015)	(0.017)	(0.013)	(0.014)
Interest rates	0.386***	0.386***	0.540***	0.573***	0.432***	0.439***
	(0.102)	(0.100)	(0.178)	(0.183)	(0.129)	(0.128)
Growth	-0.217***	-0.210***	-0.143**	-0.102	-0.215***	-0.168**
	(0.052)	(0.055)	(0.068)	(0.080)	(0.068)	(0.080)
Observations	6,727	6,727	5,088	5,088	5,330	5,330
of which sudden stops	726	726	395	395	515	515
Time period	1990q1-2018q1	1990q1-2018q1	1990q1-2018q1	1990q1-2018q1	1990q1-2018q1	1990q1-2018q1
Sample	All	All	All	All	All	All
Country FE	yes	yes	yes	yes	yes	yes

Note: coefficient estimates of a complementary log-log estimation of equation 3.3. Sudden stop episodes defined following Forbes and Warnock (2012) in columns 1 and 2, restricted to sudden stop episodes in gross inflows which coincide with stops in net flows in columns 3 and 4, and restricted to episodes during which capital flows exceeded 5% of GDP on average in columns 5 and 6. Global and contagion control variables are defined following Forbes and Warnock (2012). All explanatory variables are lagged by one quarter. Robust standard errors (clustered at the country-level) in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

TABLE 3.A.10: Episodes split by type and country group

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Sudden stop indicator $(P(e_{it}=1))$							
	All inflows		equity led	debt led	equity led	debt led	equity led	debt led
Domestic								
Private sector credit	0.308	0.745***	0.442	0.301	0.094	0.352	1.215***	0.542
	(0.245)	(0.242)	(0.346)	(0.237)	(0.638)	(0.336)	(0.418)	(0.336)
Growth shock	-0.117*	-0.005	0.009	-0.059*	-0.016	-0.162**	-0.016	-0.012
	(0.066)	(0.034)	(0.033)	(0.033)	(0.088)	(0.065)	(0.035)	(0.040)
Private sector credit x Growth shock	-0.020	-0.144***	-0.117***	-0.030	-0.129*	0.046	-0.008	-0.140**
	(0.041)	(0.048)	(0.039)	(0.037)	(0.073)	(0.041)	(0.052)	(0.061)
Government debt to GDP	-0.219	0.073	-1.280**	0.082	-1.658**	0.244	-0.443	0.168
	(0.299)	(0.275)	(0.555)	(0.218)	(0.738)	(0.319)	(0.817)	(0.320)
De facto fin. openness	-0.053	-0.357**	-0.230	-0.179	-0.142	0.004	-0.372	-0.348**
	(0.142)	(0.142)	(0.179)	(0.139)	(0.250)	(0.198)	(0.318)	(0.168)
GDP p.c.	0.088	0.230**	-0.003	0.182	-0.220	0.266	0.114	0.250*
	(0.224)	(0.112)	(0.152)	(0.113)	(0.592)	(0.250)	(0.276)	(0.130)
Contagion								
Trade channel	0.357	0.409**	0.476***	0.421***	0.148	0.475**	0.569***	0.219
	(0.230)	(0.167)	(0.164)	(0.148)	(0.307)	(0.240)	(0.208)	(0.267)
Financial channel	0.663	-0.159	0.531	-0.845	2.490**	-1.440	-1.415	-0.042
	(0.967)	(0.463)	(0.444)	(0.960)	(1.003)	(1.459)	(1.978)	(0.471)
Global								
VIX	0.023***	0.024***	0.038***	0.012	0.013	0.026***	0.056***	0.008
	(0.009)	(0.008)	(0.011)	(0.008)	(0.020)	(0.010)	(0.012)	(0.011)
Global liquidity	-0.015	-0.024	0.007	-0.030***	0.021	-0.027*	-0.006	-0.029**
	(0.016)	(0.016)	(0.023)	(0.011)	(0.030)	(0.016)	(0.035)	(0.014)
Global interest rates	0.256***	0.091	0.048	0.182***	-0.063	0.363***	0.151	0.074
	(0.073)	(0.103)	(0.107)	(0.064)	(0.141)	(0.084)	(0.197)	(0.124)
Global growth	-0.239***	-0.178***	-0.055	-0.251***	-0.165	-0.247***	-0.014	-0.240***
	(0.080)	(0.055)	(0.074)	(0.051)	(0.102)	(0.086)	(0.107)	(0.065)
Observations	2,745	4,733	7,478	7,478	2,745	2,745	4,733	4,733
of which sudden stops	356	370	186	540	89	267	97	273
Time period	1990q1-2018q1	1990q1-2018q1	1990q1-2018q1	1990q1-2018q1	1990q1-2018q1	1990q1-2018q1	1990q1-2018q1	1990q1-2018q1
Sample	AE	EMDE	All	All	AE	AE	EMDE	EMDE
Country FE	no	no	no	no	no	no	no	no

Note: coefficient estimates of a complementary log-log estimation of 3.3. Sudden stop episodes, as well as global and contagion control variables are defined following Forbes and Warnock (2012). A sudden stop is equity (debt) led when gross inflows were predominantly (i.e. > 50 percent) equity (debt) flows during the respective episode (Forbes & Warnock, 2014). Robust standard errors (clustered at the country-level) in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Chapter 4

Automatic for the (tax) people: information sharing and cross-border investment in tax havens

4.1 Introduction

Tax havens are generally thought of as places that harbour assets from non-residents seeking to hide ownership of these assets in order to limit their tax liabilities in their country of residence. Such international tax evasion by individuals does not only reduce tax revenues and the effective taxation of the wealthy, it can also have an eroding effect on trust in state institutions, particularly the tax system (Menkhoff & Miethe, 2019). Tax evasion via offshore tax havens is therefore of great concern to policy makers. Recent media coverage of leaks of large datasets and other whistle-blower reports, the most prominent example being the Panama Papers in 2016 but also more recently the German government acquiring information on German citizens' wealth in Dubai, fuel this concern and highlight the ongoing relevance of tax evasion via tax havens as a significant problem.[1]

Johannesen and Zucman (2014) show that early efforts by G20 countries – in the form of tax information exchanges on request – to crack down on tax havens resulted

[1] https://www.tagesschau.de/wirtschaft/weltwirtschaft/scholz-daten-kauf-dubai-101.html [accessed 16.08.2021].

in a reallocation of deposits towards those tax havens which signed the least bilateral tax information exchange treaties. This highlighted that upon request information sharing between the tax authorities of two countries, while having some deterring effect, experienced limited success in containing overall tax evasion. Menkhoff and Miethe (2019) corroborate these findings adding that the effect of "information-on-request treaties" dissipates over time. The authors highlight this cannot be explained by deposit shifting alone and they do not find evidence of "transitioning into legality" which implies that tax evaders might try to put their funds into "new disguises that circumvent regulatory requirements" (Menkhoff & Miethe, 2019, p. 66).

Against this background, the OECD pursued a more comprehensive coverage of tax information treaties, including the automatic exchange of information (AEOI) facilitated by the Common Reporting Standard (CRS). These efforts, together with the adoption of the Foreign Account Tax Compliance Act (FATCA) by the United States Congress in 2010, resulted in 94 jurisdictions being committed to ensuring the effective automatic exchange of information with their respective relevant exchange partners by end 2019. This implies that the network of bilateral treaties has expanded significantly since the study of Johannesen and Zucman (2014) and the threat of enforcement has become arguably more credible since information is exchanged automatically between the tax authorities of the participating countries.

In this chapter we use confidential data on deposits held in tax haven jurisdictions from the BIS locational banking statistics combined with information on the timing of entering AEOI treaties to assess the impact of these latest efforts to reign in offshore tax evasion. Using data until 2019Q4, including the breakdown by counterparty sector isolating household deposits, we can illuminate some hitherto open questions. First, we investigate whether it is actually deposits by households which are affected by the treaties. Hence, we can overcome a key limitation of the existing literature which were based on deposits by the entire non-bank sector (i.e. including non-bank financial institutions, non-financial corporations, governments, and households). In order to assess the effect these studies had assumed that corporations were unaffected by tax information treaties and used rough estimates of the share of deposits belonging to households (Ahrens & Bothner, 2020; Johannesen & Zucman, 2014).

Second, we assess the longer-term effects of the AEOI. Menkhoff and Miethe (2019) find that the initial effect of the AEOI treaties is similar to earlier information-on-request treaties. Since their analysis only extends to the end of 2017 the authors note that they cannot assess the longer-term effects of the AEOIs "[...] due to their novelty and the resulting lack of observations". Ending their sample in 2017 as well, Casi, Spengel, and Stage (2020) and Ahrens and Bothner (2020) also investigate the short-term effect of AEOIs and find that they reduced non-bank cross-border deposits in tax havens.[2]

Third, this chapter also extends the literature by analysing the effect of AEOI treaties on other financial instruments beyond deposits, i.e. foreign direct investment and portfolio investment which have gone unexplored by the related literature. Due to the complexity of the global financial system, the AEOI treaties may affect other segments of international investment positions apart from bank deposits. Volumes of cross-border investment vis-à-vis other countries are disproportionately high in tax havens, also in other investment categories (Lane & Milesi-Ferretti, 2018). Moreover, anecdotal evidence suggests that tax evaders typically do not just park their wealth in tax havens in the form of bank deposits but also make use of shell companies and sham foundations to further invest these funds and obfuscate ownership.[3] In a similar vein, Heckemeyer and Hemmerich (2020) find that portfolio investment positions between tax haven and OECD countries were reduced by bilateral information upon request treaties between 2001 and 2014, suggesting that the threat of information exchange also reduced round-tripping of investment.[4]

Our findings suggest that the broader coverage of bilateral treaties and the threat of automatic information exchange significantly reduced cross-border deposits by

[2]Focusing exclusively on the OECD Common Reporting Standard (CRS) in the case of Casi et al. (2020).

[3]The case of Harald Joachim von der Goltz, a U.S. taxpayer who was sentenced to prison in September 2020 in the wake of the Panama Papers Investigation serves as a prime example. "[...] von der Goltz evaded his tax reporting obligations by setting up a series of shell companies and bank accounts, and hiding his beneficial ownership of the shell companies and bank accounts from the IRS. These shell companies and bank accounts made investments totaling tens of millions of dollars. [...] von der Goltz engaged the services of Mossack Fonseca [...] to create a sham foundation and shell companies formed under the laws of Panama and the British Virgin Islands to conceal from the IRS and others the ownership by von der Goltz of accounts established at overseas banks, as well as the income generated in those accounts." https://www.justice.gov/opa/pr/us-taxpayer-panama-papers-investigation-sentenced-prison [accessed 16.08.2021]

[4]Such round-tripping could happen via funds held by non-haven residents in havens which were subsequently reinvested in the non-haven country of residence.

households in tax havens. As a novelty to the literature we show that this is driven by households withdrawing deposits from tax havens, while deposits of non-bank financial institutions (NBFIs) and non-financial corporations (NFCs) in tax havens were unaffected. The impact of AEOIs uncovered in previous studies might therefore have been underestimated. We find that bilateral household deposits from non-haven countries in haven banks decrease by 28.5 percent upon signature of the AEOI legislation, while the effect on deposits by the broader non-bank sector is found to be only 12.5 percent, similar to the 11.5 percent effect found in Casi et al. (2020). Moreover, we do find the impact of the AEOI to be persistent, in contrast to results documented for earlier bilateral initiatives for information exchange on demand, as documented by Menkhoff and Miethe (2019). However, the more granular breakdown of our data allows us to document evidence of deposit shifting by the household sector, in line with Johannesen and Zucman (2014) for earlier treaties. This suggests that the AEOI is more effective than earlier initiatives in that it is more persistent but remains incomplete as long as non-participating haven countries allow households to simply shift deposits.

We furthermore document a significantly negative effect of AEOI on portfolio investment assets reported by tax havens residents vis-à-vis non-haven residents, in line with the results in Heckemeyer and Hemmerich (2020). Similarly, the FDI liability positions of non-havens vis-à-vis havens decline significantly after joining the AEOI which could be further evidence of a termination of round-tripping schemes. Moreover, we observe that non-havens report decreasing FDI asset positions in tax havens after joining the AEOI, suggesting that part of these assets were related to corporate structures with a tax-evading purpose.

However, we also find some evidence of negative side effects of the AEOI. In particular, banks in haven countries report increasing deposits from NBFIs resident in other tax havens after AEOI introduction. We interpret this as evidence that networks of shell companies used to obfuscate ultimate beneficiaries of account holders might have become more elaborate. This is corroborated by the finding that signing up to the AEOI framework is associated with a positive effect on FDI assets between tax havens. Hence, future policy initiatives should be aimed at increasing transparency regarding ultimate ownership of investments by looking-through corporate

structures.

In the remainder of the chapter we present the policy initiatives, data and some stylised facts in Section 4.2 and the econometric approach in Section 4.3. The results of the econometric analysis are presented and discussed in Section 4.4, before Section 4.5 concludes.

4.2 Policy Initiatives and Offshore Deposits

4.2.1 Global Policy Initiatives on Exchange of Information

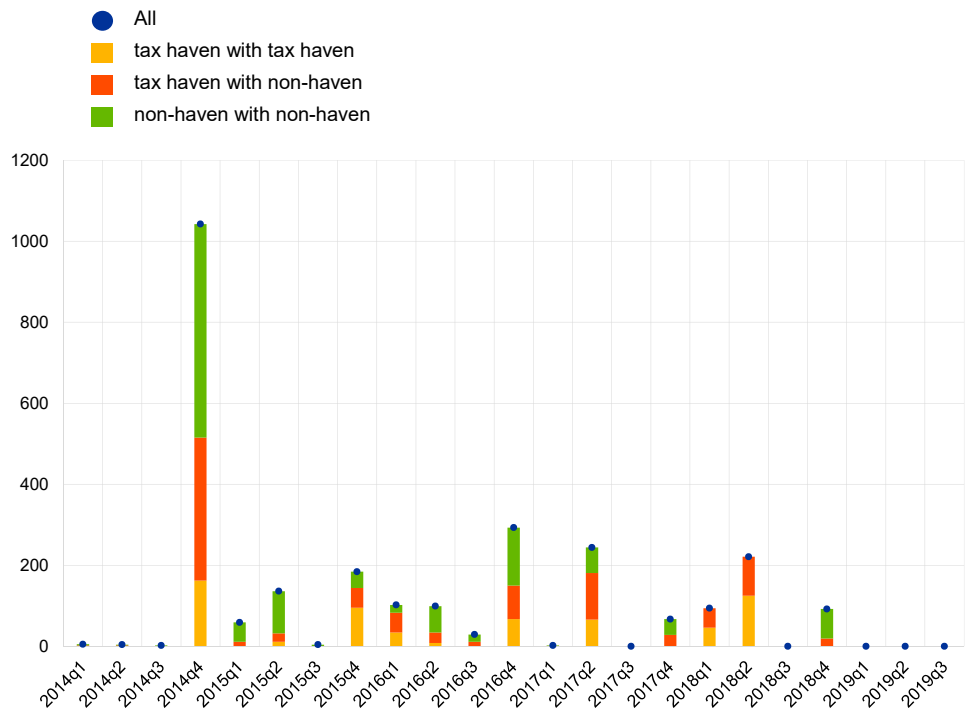
The global financial crisis led policy makers to put emphasis on the implementation of national and international tax transparency rules. This included a push to fight tax evasion arising from households' undeclared foreign assets. The OECD and the EU, in particular, wanted to achieve a model for cross-country exchanges of information between tax authorities. An earlier effort had been the EU's Savings Directive (and the related agreements with Switzerland and other countries) which started in 2005. While this exchange of information was automatic, it was limited in terms of country coverage and type of investment income (only related to interest income). In the OECD a first agreement in 2009 covered the information exchange on request (EOIR) to which more than 150 jurisdictions have committed since. The US adopted its US Foreign Account Tax Compliance Act (FATCA) in 2010. Within this framework the US has negotiated bilaterally with other countries bilateral intergovernmental agreements (IGAs) which provide for a reciprocal exchange of information on the financial income earned by their residents in the partner country.

In 2014, the Common Reporting Standard (CRS) on Automatic Exchange of Information (AEOI) was approved among the OECD countries. The AEOI commits the participating countries' authorities to collect information from their financial institutions on foreign residents' accounts and exchange this information automatically with the relevant participating countries on an annual basis. Our dataset on AEOIs is based on countries' individual dates at which they joined the OECD initiative. For a group of 56 early adopter countries, the starting date is October 2014, while for individual countries that joined later the date of adopting the respective national legislation (or when an official public commitment was made) is used. Hence, we

use the date individual countries sign the Multilateral Competent Authority Agreement (MCAA), thereby committing to introduce the CRS into national law. The (perceived) threat of being discovered by national tax authorities once the CRS becomes effective should motivate individuals to remove funds (or further obfuscate their ownership) from tax havens after they commit to the exchange of information and before it actually becomes effective.

Figure 4.1 shows the number of country-pairs available in the BIS LBS dataset starting to be covered by an AEOI treaty in a given quarter. While the bulk of new AEOI relationships was formed at the end of 2014, i.e. when the early adopters announced their participation, there is still considerable time variation during our sample period.

FIGURE 4.1: New automatic information exchange relationships over time



Note: Number of country-pairs in the BIS LBS becoming covered by an AEOI treaty in the respective quarter. Tax haven classification according to Johannesen and Zucman (2014).

As of the announcement date, automatic exchanges of information was theoretically possible with all other countries that had already joined the initiative. Hence, this possibility should trigger residents of AEOI countries with undeclared assets in the AEOI country to immediately withdraw these assets. In the same way, we use the signature dates for bilateral agreement of the United States related to the FATCA IGA. While the first bilateral treaties under FATCA where signed before the start of our sample period in 2014Q1, e.g. with Switzerland in 2013Q1, 13 of the tax havens in our sample signed bilateral treaties to automatically exchange information with the US during our sample period. For example, the Bahamas signed a treaty in 2014Q3. This means that while some of the effect of FATCA will be absorbed by the country-pair fixed effects for treaties signed before the start of our sample period, especially the effect of FATCA agreements signed after 2014 could still be captured by our setup. In robustness checks, we exclude the US as a saver country – and therefore FATCA agreements – from our sample and show that this does not materially affect our estimates of the effect of AEOI.

4.2.2 Data on Offshore Investment

Our main data source is the BIS Locational Banking Statistics (LBS) which detail the positions of banks resident in 44 reporting countries on counterparties located in over 200 countries. The data on these positions are collected according to national accounts and balance of payments principles. Hence, the compilation is based on the residence of entities and the data are not consolidated at the group level. In 2015, the BIS started to report a more detailed breakdown of cross-border positions by counterparty sector.[5]

These data, available from 2014 onward for most reporting countries, provide a more granular breakdown of the non-bank counterparty sector into financial institutions and non-financial counterparties. The latter includes non-financial corporations, households and governments.[6] The BIS LBS also breaks down banks'

[5] See Avdjiev, McGuire, and Wooldridge (2015) for details.

[6] The household sector refers collectively to households and non-profit institutions serving households.

positions by instrument. For our purposes, liabilities in the form of deposits are primarily of interest. The detailed breakdown by counterparty sector and instrument is only available in the confidential version of the LBS that we make use of.[7]

To distinguish tax haven countries from non-havens we use the list of tax havens in Johannesen and Zucman (2014) who include countries which have either strict bank secrecy laws, legal provisions restricting the access to bank information to domestic tax interest cases, or not having treaties for the exchange of information at all. The full list of tax havens can be found in appendix 4.A. Since these criteria are not stable across time and the appropriate list of tax haven countries is subject to debate, we test the robustness of our results using the alternative list employed by Casi et al. (2020).

TABLE 4.1: Share of liabilities vis-à-vis households

	Non-havens		Havens	
	HH/All	HH/NB	HH/All	HH/NB
Pre-AEOI	3.71	10.17	19.07	34.74
2Y post AEOI	3.26	10.74	18.19	34.72

Note: Share of cross-border liabilities vis-à-vis households (HH) in all instruments and sectors (All) and non-banks (NB) reported by banks resident in haven and non-haven countries in the last quarter before and 2 years after joining the AEOI framework, respectively. See table 4.A.1 for details on the country sample.

For 10 out of 18 tax havens covered by the definition of Johannesen and Zucman (2014) which report the detailed sectoral breakdown of their banks' liabilities in the BIS LBS, the share of HH deposits in banks' liabilities vis-à-vis the total non-bank sector was around 35 per cent during our sample period between 2014Q1 and 2019Q4 (Table 4.1). This is considerably higher than for the 13 non-haven countries which report the detailed breakdown where cross-border deposits by households account for only 10 percent. However, it is lower than 50 percent as ad-hoc assumed by Johannesen and Zucman (2014).[8]

As regards other financial instruments, i.e. bilateral foreign direct investment

[7] One caveat is that the confidential version of the LBS available to reporting central banks might provide only partial coverage for some country-pairs in case of strict confidentiality of certain observations.

[8] It is, of course, conceivable that the share of household deposits was indeed higher during the period that Johannesen and Zucman (2014) analyzed and has fallen as a consequence of earlier efforts to curb tax evasion.

and portfolio investment, we employ the International Monetary Fund's Coordinated Direct Investment Survey (CDIS) and Coordinated Portfolio Investment Survey (CPIS), respectively. These data are available for a wider set of countries than the BIS LBS. The full list of countries can be found in Table 4.A.2 in the appendix.

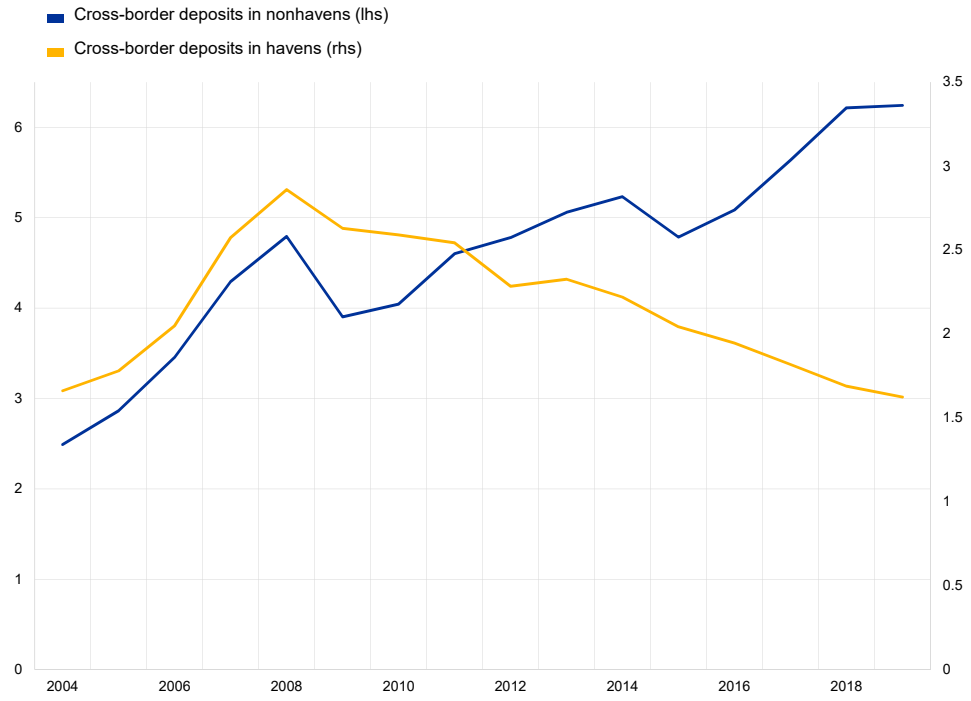
4.2.3 Tax Treaties and Offshore Deposits

Figure 4.2 shows the evolution of aggregate deposit liabilities of banks located in tax haven countries vis-à-vis non-banks abroad. Since the onset of the GFC these have decreased significantly, from 2.9 trillion USD in 2008 to 1.6 trillion USD in 2019. Conversely, cross-border deposits in non-haven countries recovered swiftly after the GFC and increased markedly, subsequently reaching 6.2 trillion in 2019 USD and thereby surpassing their pre-crisis peak of 4.8 trillion USD recorded in 2008. Focusing on the deposits held by non-haven residents during our sample period of 2014Q1 to 2019Q4, non-bank deposits in havens amounted to 1.2 trillion USD in the average year-quarter. By comparison, non-haven resident non-banks held USD 3.1 trillion in other non-haven countries during this period. The share of household deposits in total non-bank deposits of 34.7% reported above implies that non-haven resident households held approximately 416 billion USD in tax havens during the period we study.

Using the data on bilateral deposits, Figure 4.3 shows the evolution of non-haven deposits in haven and non-haven countries centered around the specific date the country pair joins the AEOI framework. While there was a clear parallel trend before joining the AEOI, deposits in haven countries from non-haven residents begin falling around the time both countries sign up for the AEOI framework. There is some evidence of anticipatory effects as the lines begin to diverge approximately one year prior to joining the AEOI. Hence, we show that our regression analysis is robust to accounting for such anticipation.

The substantial extent to which deposit have been withdrawn from tax haven countries between 2014 and 2018 can be grasped from Figure 4.4. While the average decrease in deposits in tax havens held by non-residents was 22 percent, this masks some heterogeneity across havens. Deposits held in the Cayman Islands and the Bahamas decreased by more than 60 percent, while they actually increased by 24

FIGURE 4.2: Non-bank cross-border deposits in haven and non-haven countries, 2004 -2019 (trillions USD)



Note: sum of yearly averages across individual reporting countries.

and 14 percent in Hong Kong and Malaysia, respectively, and stayed more or less unaffected like in Luxembourg or Bahrain.

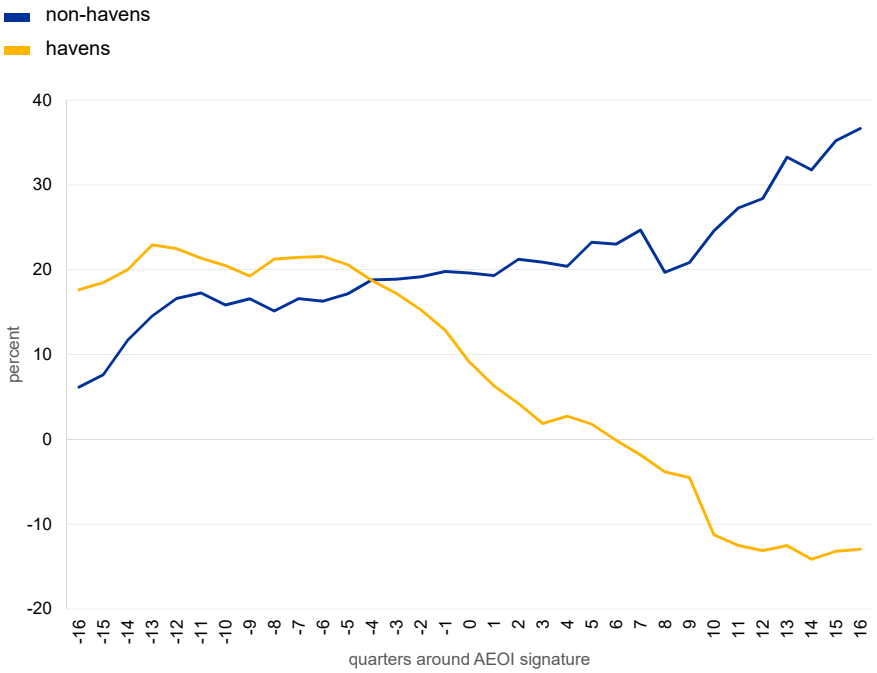
In summary, the graphical evidence suggests that the (threat of) automatic exchange of information was effective in reducing deposits in tax havens. To fully exploit the bilateral nature of our data and provide a precise estimate of the effect of AEOI treaties we turn to panel regression analysis in the following.

4.3 Empirical Strategy

4.3.1 Estimation Strategy for Deposits

We built on Johannesen and Zucman (2014) and run the following regression specification to test whether entering a bilateral automatic exchange relationship had a

FIGURE 4.3: Non-haven deposits in haven and non-haven countries around joining the AEOI



Note: Average deviation from country-pair long term mean (since 2000) in bilateral non-bank deposits. t=0 signature of AEOI.

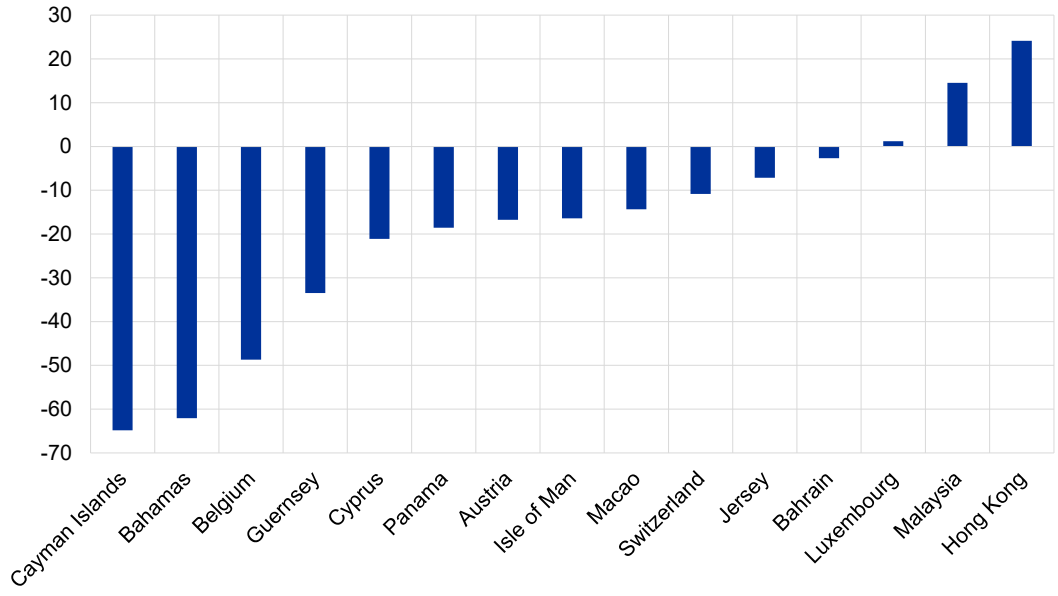
statistically significant impact on deposits held in tax haven countries:

$$ln(Dep_{ijt}) = \alpha + \beta * Sig_{ijt} + \gamma_{ij} + \theta_{jt} + \epsilon_{ijt} \tag{4.1}$$

Dep_{ijt} is the *log* of deposits in reporting country i from counterparty or "saver" country j. Sig_{ijt} is a dummy variable equal to one from quarter t in which both countries of a given country pair entered a bilateral exchange relationship (see Section 4.2.1 for further details).

Country-pair and saver country time fixed effects are denoted by γ_{ij} and θ_{jt}, respectively. Pair fixed effects control for time-invariant factors like distance and common language, while saver country time fixed effects control for unobserved developments specific to saver countries. To control for these developments is key

FIGURE 4.4: Deposit growth by tax haven, 2014 -2018 (percent)



since they might affect the supply of deposits in tax havens. For example, non-haven saver countries have started various domestic amnesties and voluntary disclosure programs during the period studied which could drive part of the reduction in cross-border deposits in haven countries depicted in Figure 4.2 (Menkhoff & Miethe, 2019). Standard errors are robust to autocorrelation and heteroscedasticity and clustered at the country-pair level. We use this empirical setup in all regressions we present and outline any changes to the specification in the text.[9]

We start our analysis in the first quarter of 2014. We control for the impact of previous treaties with the pair fixed effects γ_{ij}. Having said this, the effect of these treaties dissipated from 2010 onward as shown by Menkhoff and Miethe (2019).

The coefficient of interest in all our estimations is β. We expect β to be statistically different from zero and negative for deposits in tax havens from non-banks resident in non-haven countries. Since the information exchanged refers to individual account holders, we expect the effect of AEOI to be limited to household deposits.

[9]Note that this empirical framework differs from the case study design employed by Casi et al. (2020). We show that our results are robust to using the alternative specification in appendix 4.B.

Deposits from banks should not be affected (Menkhoff & Miethe, 2019). Deposits from NFCs and NBFIs could be affected negatively if they are related to tax evasion strategies through sham corporations and authorities are aware of the ultimate beneficiaries of the accounts. However, if evaders manage to successfully obfuscate their ownership these types of deposits might not be affected or even increase after AEOI introduction.[10] Hence, the sing of β is an empirical question in this case which we answer in our analysis.

4.3.2 Estimation Strategy for Portfolio Investment and FDI

We extend the analysis of the effect of AEOI to foreign portfolio and foreign direct investment (FDI) positions. Hence, Dep_{ijt} represents the log of portfolio and direct investment between country i and j, respectively in these estimation.

Since bilateral data on these alternative forms of bilateral investment positions are available at semi-annual and annual frequency only, respectively, we collapse Sig_{ijt} to the respective frequency. In order to still be able to compare investment positions in tax havens and non-havens before and after joining the AEOI framework, we start our sample period in 2013 for FDI.

We expect β to be negative and significant for equity portfolio investment assets reported by tax havens vis-à-vis non-havens. Since we focus on the effect of AEOI between countries i and j, this would be consistent with a reduction in round-tripping of assets by tax evaders in which they park deposits in tax havens which are then invested in their country of residence to earn capital income which is hidden from domestic tax authorities (Hanlon, Maydew, & Thornock, 2015; Heckemeyer & Hemmerich, 2020). We do expect a similar result for FDI assets reported by havens vis-à-vis non-havens since these assets – because of the controlling ownership characteristic – would require more details about the ultimate owner and would hence be less well suited for tax evasion purposes after these information get collected and potentially exchanged by authorities. However, if these FDI investments were related to the setting up of sham corporations which successfully hide the true owner there might be no or even a positive effect.

[10] NFC and NBFI deposits would also not be affected in case they are not related to tax evasion purposes, of course.

4.4 Results

4.4.1 Deposits

Deposits by Non-banks

To establish comparability with estimates in the literature, we start by showing the results for non-bank deposits (Table 4.2). Column 1 reveals that deposits in haven countries decrease after a country pair has joined the AEOI framework. In column 2 we restrict the sample to country pairs that include only non-haven saver countries. This leads to a larger coefficient highlighting that AEOI treaties induce non-banks to reduce their deposits in haven countries. On average, the signature of an AEOI treaty reduces non-bank deposits by 12.5 per cent. This is similar in magnitude to the effect of information on demand treaties estimated by Johannesen and Zucman (2014) who found that non-bank deposits decrease by 11 per cent. Casi et al. (2020) find that the "CRS induced a reduction of 11.9 per cent in cross-border deposits parked in traditional offshore countries". Moreover, we find that non-bank deposits between haven countries (column 3) and those from haven countries in non-havens (column 4) are not affected by the signature of AEOI treaties.

Finally, column 5 sheds light on the timing of the response to AEOI signature. Following Johannesen and Zucman (2014) we include a dummy equal to one in the quarter t of the announcement of a country pair becoming subject to AEOI (contemp.), dummies equalling one in q + 1, q + 2, and q + 3 respectively, and a dummy equal to one in all quarters after q + 3. This allows for the fact that AEOI treaties do not enter into force immediately after a country commits to signing it into national law and provides an estimate of the longer-term effect of AEOI treaties.[11] We find that the strongest quarterly impact occurs immediately after the announcement, while the effect seems to dissipate somewhat over time, as found in Menkhoff and Miethe (2019), while remaining significantly negative.

[11] Comparing signature dates to the dates of CRS introduction into national law published by Casi et al. (2020), the average gap between committing to the CRS and introducing it into national law is 4 quarters.

TABLE 4.2: Non-bank deposits in reporting country *i* from saver country *j*

	(1)	(2)	(3)	(4)	(5)
Signed	-0.098**	-0.134***	0.060	-0.012	
	(0.044)	(0.046)	(0.119)	(0.105)	
Signed (contemp.)					-0.162***
					(0.046)
Signed (+1 quarter)					-0.140***
					(0.048)
Signed (+2 quarters)					-0.123**
					(0.052)
Signed (+3 quarters)					-0.121**
					(0.053)
Signed (>3 quarters)					-0.115*
					(0.065)
Obs.	57,782	50,810	6,972	8,354	50,810
R^2	0.94	0.94	0.93	0.94	0.94
Time period	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4
Reporting	Haven	Haven	Haven	Non-haven	Haven
Saver	All	Non-haven	Haven	Haven	Non-haven
Pair FE	yes	yes	yes	yes	yes
Reporting FE	yes	yes	yes	yes	yes
Saver time FE	yes	yes	yes	yes	yes

Note: Signed is a dummy equal to 1 if there exists a treaty providing for automatic information exchange between i and j in quarter q. Signed (contemp.) is a dummy equal to 1 in the quarter q when the legal event establishing information exchange between i and j occurs; signed (+1 quarter) is a dummy equal to 1 in q +1, and so on. Robust standard errors (clustered at the country-pair level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Deposits by Sub-sectors

To gain deeper insights of the effect of AEOI treaties we make use of the restricted version of the bilateral BIS data which provides a breakdown of the non-bank sector into sub-sectors.

Table 4.3 shows the estimation results for deposits by households. For comparability reasons column 1 reports a re-estimated coefficient for non-bank deposits for the smaller sample of country pairs that the household sector breakdown is available for. The estimate is similar to the one reported in column 2 of Table 4.2, albeit slightly larger. Column 3 of Table 4.3 highlights that households reduced their deposits in haven countries particularly strongly, i.e. by 28.5 per cent. Note that this is similar but larger than what one would obtain using the Johannesen and Zucman (2014) approximation of multiplying the non-bank deposits estimate by 2 assuming that 50 per cent of all non-bank deposits in tax havens belong to households. Column

TABLE 4.3: Deposits in reporting country *i* from saver country *j* vis-à-vis non-banks and households

	(1) Non-banks	(2)	(3)	(4) Households	(5)	(6)
Signed	-0.186*	-0.299***	-0.336***	-0.145	-0.375**	
	(0.101)	(0.081)	(0.091)	(0.181)	(0.180)	
Signed (contemp.)						-0.204**
						(0.082)
Signed (+1 quarter)						-0.240***
						(0.080)
Signed (+2 quarters)						-0.438***
						(0.106)
Signed (+3 quarters)						-0.463***
						(0.108)
Signed (>3 quarters)						-0.555***
						(0.135)
Obs.	26,489	29,557	26,489	3,068	4,485	26,489
R^2	0.96	0.96	0.95	0.95	0.95	0.95
Time period	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4
Reporting	Haven	Haven	Haven	Haven	Non-haven	Haven
Saver	Non-haven	All	Non-haven	Haven	Haven	Non-haven
Pair FE	yes	yes	yes	yes	yes	yes
Reporting FE	yes	yes	yes	yes	yes	yes
Saver time FE	yes	yes	yes	yes	yes	yes

Note: Signed is a dummy equal to 1 if there exists a treaty providing for automatic information exchange between i and j in quarter q. Signed (contemp.) is a dummy equal to 1 in the quarter q when the legal event establishing information exchange between i and j occurs; signed (+1 quarter) is a dummy equal to 1 in q +1, and so on. Robust standard errors (clustered at the country-pair level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

6 shows that the effect of the AEOI on deposits from households is very persistent and even becomes stronger over time. This result is confirmed by an alternative specification in which we replicate the case study design of Casi et al. (2020), presented in Figure 4.B.1. To gain some intuition of the economic significance of this estimate we can apply it to the estimated 416 USD billion in deposits that non-haven households deposited in tax havens during our sample period. This would imply that non-haven households withdrew approximately 119 USD billion in deposits from tax havens. As noted by Menkhoff and Miethe (2019) such estimates should be considered lower bounds of the effect of the AEOI because of the limited, albeit representative, sample of tax havens, as well as the fact that wealth stored in financial institutions other than banks is not considered.

As expected, we do not find a significant effect of AEOI signature on household deposits reported by tax havens vis-à-vis other tax haven residents (column 4), but perhaps surprisingly there is a significant negative coefficient for haven resident household deposits in non-haven banks (column 5). In fact, the latter result is consistent with the reaction to IoR treaties which Menkhoff and Miethe (2019) found for deposits from non-banks resident in tax havens to non-haven banks.[12] This may imply that tax haven resident entities deposit funds in non-havens which include funds of residents of non-havens, but disguised as tax haven residents. The fact that we document a decline in these deposits for the household sector only, which includes non-profit organisations serving households, implies – on the one hand – that funds by sham foundations and non-haven residents posing as haven residents became vulnerable to detection by the AEOI treaties and were withdrawn in response. On the other hand, since, as we document below, we do not find a similar effect for haven deposits in non-havens from NBFIs or NFCs, this might not be the case for shell companies or trusts.

Table 4.4 repeats this exercise for deposits of non-bank financial institutions. Deposits in haven countries from such companies which are resident in non-haven countries are not affected by the AEOI treaties, as evident from columns 1 and 2. However, column 3 shows that deposits in haven countries from non-bank financial institutions in other haven countries increase significantly when both countries are part of the AEOI. This points to the possibility that networks of shell companies in haven countries have become more elaborate after haven countries join the AEOI. In turn, this might make it more difficult for tax authorities in non-haven countries to identify the ultimate owner of deposits due to the complex corporate structures employed. As posited by Menkhoff and Miethe (2019) shell companies with beneficial owners close to, but not identical to, the tax evader are on example of such structures. The tax evader alleviates agency problems with these structure while retaining an element of control. At the same time AEOI treaties can be circumvented

[12]The authors argue that "the ownership structure of shell companies, private foundations, and trusts, as well as the connected bank accounts, is theoretically vulnerable to detection if, for example, the tax evader is documented as a beneficial owner. Thus, while single deposits cannot be followed through the tax haven cloud, the analysis of inbound deposits provides a second angle for tax authorities in home countries to tackle tax evasion. They can take the occurrence of such inbound deposits to investigate their ownership and look for evidence of illegal behavior." (Menkhoff & Miethe, 2019, p. 54)

TABLE 4.4: Non-bank financial institution deposits in reporting country *i* from saver country *j*.

	(1)	(2)	(3)	(4)	(5)
Signed	0.038	-0.086	0.401*	-0.107	
	(0.117)	(0.133)	(0.231)	(0.160)	
Signed (contemp.)					-0.065
					(0.114)
Signed (+1 quarter)					-0.006
					(0.132)
Signed (+2 quarters)					-0.133
					(0.152)
Signed (+3 quarters)					-0.128
					(0.162)
Signed (>3 quarters)					-0.152
					(0.186)
Obs.	15,139	12,036	3,103	4,707	12,036
R^2	0.90	0.90	0.91	0.93	0.90
Time period	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4
Reporting	Haven	Haven	Haven	Non-haven	Haven
Saver	All	Non-haven	Haven	Haven	Non-haven
Pair FE	yes	yes	yes	yes	yes
Reporting FE	yes	yes	yes	yes	yes
Saver time FE	yes	yes	yes	yes	yes

Note: Note: Signed is a dummy equal to 1 if there exists a treaty providing for automatic information exchange between i and j in quarter q. Signed (contemp.) is a dummy equal to 1 in the quarter q when the legal event establishing information exchange between i and j occurs; signed (+1 quarter) is a dummy equal to 1 in q +1, and so on. Robust standard errors (clustered at the country-pair level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

by veiling the true identity of the evader since tax haven resident banks do not have information about the actual tax evader to submit to tax agencies in non-haven countries. Table 4.A.3 shows that deposits by non-financial corporations are not affected by the AEOI framework which highlights once more the importance of looking at the data for deposits by households directly to isolate the effect of AEOI treaties, which has hitherto not been done in the literature.[13]

The importance of using the granular breakdown of deposit data is further underlined when we turn to an analysis of deposit shifting. Table 4.5 takes into account potential deposit shifting behavior by tax evaders in non-haven countries, following Johannesen and Zucman (2014). We introduce in columns 1–4 a treaty coverage variable that simply counts the number of treaties signed by saver country *j* with all havens other than reporting haven country *i*. A positive and significant coefficient

[13] As expected no significant results are found for deposits by banks (Table 4.A.4).

TABLE 4.5: Deposit shifting

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Treaty coverage: Number				Treaty coverage: Share			
	Non-bank		Household		Non-bank		Household	
Signed	-0.213***	-0.004	-0.217***	0.064	-0.228***	-0.114	-0.248***	-0.102***
	(0.055)	(0.098)	(0.064)	(0.071)	(0.052)	(0.070)	(0.028)	(0.030)
Treaty coverage	-0.002		-0.002		-0.009		-0.014	
	(0.004)		(0.005)		(0.059)		(0.027)	
Treaty cov. x Signed		-0.014*		-0.017***		-0.114		-0.135***
		(0.007)		(0.005)		(0.082)		(0.029)
Treaty cov. x (1-Signed)		0.005		0.031***		0.074		0.263***
		(0.005)		(0.009)		(0.072)		(0.057)
Observations	44,140	44,140	25,740	25,740	44,140	44,140	22,204	22,204
R-squared	0.94	0.94	0.96	0.96	0.94	0.94	0.95	0.95
Time period	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4
Reporting Haven	Haven	Haven	Haven	Haven	Haven	Haven	Haven	Haven
Saver	Non-haven	Non-haven	Non-haven	Non-haven	Non-haven	Non-haven	Non-haven	Non-haven
Pair FE	yes	yes	yes	yes	yes	yes	yes	yes
Reporting FE	yes	yes	yes	yes	yes	yes	yes	yes
Saver FE	yes	yes	yes	yes	yes	yes	yes	yes

Note: The dependent variable is the log of deposits by non-banks or households held by savers of country j in banks of tax haven i at the end of quarter t. Signed is a dummy equal to 1 if there exists a treaty providing for automatic information exchange between i and j in quarter q. In columns 1–3, Treaty coverage counts the number of treaties that j has with tax havens other than i. In columns 4–6 treaty coverage measures the share of the deposits held in 2014 by residents of country j in BIS-reporting havens that are covered by a treaty in quarter q. Robust standard errors (clustered at the country-pair level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

on this variable would indicate that an additional AEOI treaty with another haven country increases the deposits held by saver country *j*'s residents in tax haven *i*, as noted and found by Johannesen and Zucman (2014) in the case of information on request treaties.[14] The fact that we do not find a significant effect of the AEOI treaties for non-bank deposits in Table 4.5 (column 2) might suggest that deposit shifting did not occur for these new forms of information exchange. However, making use of the more granular breakdown of deposits, we find evidence that deposit shifting by households indeed takes place. Column 4 suggests that such shifting occurs to the benefit of havens which did not sign up to the AEOI framework (yet). In such havens, an additional treaty signed by non-haven *j* generates an increase of 3.1 percent in deposits from households resident in this non-haven. By contrast, the havens for which an automatic exchange of information with non-haven *j* is legislated see

[14]Notably we need to drop the time-varying saver country fixed effects due to their collinearity with the treaty coverage variable in this specification.

deposits reduced by a further 1.7 percent. These results are robust to using a measure of treaty coverage which weighs treaties according to their importance.[15] As column 8 shows, this measure of treaty coverage yields similar results to those obtained with the count measure. An AEOI treaty between a non-haven and a haven which accounted for 10 percent of deposits by the respective non-haven residents in tax havens induces a 2.6 percent increase in deposits if the haven country is not signed up to the AEOI, while it decreases the deposits by 1.35 percent if the haven already shares information with the non-haven. The fact that an additional treaty with other havens increases the effect of the bilateral signature of an AEOI type treaty indicates that the wider the web cast by this latest effort to curb international tax evasion, the more effective the measure becomes. However, our results also imply that households reacted to AEOI in a similar manner documented by Johannesen and Zucman (2014) in that they shifted deposits to non-participating havens.

4.4.2 Portfolio Investment

TABLE 4.6: Portfolio equity assets of reporting country i in country j

	(1)	(2)	(3)	(4)
Signed	-0.163***	-0.138**	-0.218	0.046
	(0.062)	(0.065)	(0.139)	(0.091)
Observations	13,140	9,602	3,538	9,002
R-squared	0.94	0.94	0.93	0.95
Time period	2014h1-2019h2	2014h1-2019h2	2014h1-2019h2	2014h1-2019h2
Reporting	Haven	Haven	Haven	Non-haven
Saver	All	Non-haven	Haven	Haven
Pair FE	yes	yes	yes	yes
Reporting time FE	yes	yes	yes	yes
Saver FE	yes	yes	yes	yes

Note: Signed is a dummy equal to 1 if there exists a treaty providing for automatic information exchange between i and j in quarter q. Signed is a dummy equal to 1 in the quarter q when the legal event establishing information exchange between i and j occurs. Robust standard errors (clustered at the country-pair level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

[15] Following Johannesen and Zucman (2014), we compute the share of *j*'s deposits in tax havens deposited in *i* at the beginning of our sample, i.e. in 2014Q1. These shares "measure the relative importance of haven *i* to tax evaders of country *j* and are exogenous to recent policy developments" (Johannesen & Zucman, 2014, p. 81). For each haven-non-haven pair (*i*, *j*), we use the shares to weigh each treaty concluded by *j* with havens other than *j*.

Table 4.6 presents the results for portfolio equity assets. We find a significantly negative effect of AEOI treaties on bilateral portfolio investment assets reported by tax havens residents vis-à-vis non-haven residents. This result is in line with Heckemeyer and Hemmerich (2020) who found a negative effect on OECD-bound portfolio investment from tax havens when they studied the effect of earlier information on request treaties. Hence, our results may imply that AEOI further reduced the amount of round-tripped investment from non-havens through havens. Such round-tripping may be in the form of deposits from non-haven residents parked in tax havens not being absorbed locally, but instead being invested in portfolio equity assets (including investment funds) in non-havens. Our results suggest that such round-tripping was further reduced with the AEOI.

4.4.3 Foreign Direct Investment

TABLE 4.7: FDI assets of reporting country i in country j

	(1)	(2)	(3)	(4)
Signed	0.116	-0.050	0.646**	-0.155**
	(0.106)	(0.098)	(0.309)	(0.073)
Observations	4,043	3,233	810	5,929
R-squared	0.97	0.97	0.96	0.95
Time period	2013-2019	2013-2019	2013-2019	2013-2019
Reporting	Haven	Haven	Haven	Non-haven
Host	All	Non-haven	Haven	Haven
Pair FE	yes	yes	yes	yes
Reporting FE	yes	yes	yes	yes
Host time FE	yes	yes	yes	yes

Note: Signed is a dummy equal to 1 if there exists a treaty providing for automatic information exchange between i and j in quarter q. Signed is a dummy equal to 1 in the quarter q when the legal event establishing information exchange between i and j occurs. Robust standard errors (clustered at the country-pair level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Starting with the assets side (Table 4.7) we find that non-havens report decreasing FDI asset positions in tax havens after joining the AEOI. This suggest that part of these assets were related to corporate structures with a tax-evading purpose. Moreover, even if these assets were not directly linked to tax evasion, the mere existence of AEOIs treaties may have induced investors to withdraw FDI funds from haven

countries to avoid triggering investigations. Interestingly, we find a positive effect on FDI assets between tax havens which would be consistent with the "network of sham NBFIs" in tax havens which we also observe in bank deposits.

TABLE 4.8: FDI liabilities in reporting country i from saver country j

	(1)	(2)	(3)	(4)
Signed	0.033	0.008	0.118	-0.142**
	(0.071)	(0.088)	(0.096)	(0.064)
Observations	4,156	3,106	1,050	8,505
R-squared	0.97	0.97	0.95	0.96
Time period	2013-2019	2013-2019	2013-2019	2013-2019
Reporting	Haven	Haven	Haven	Non-haven
Saver	All	Non-haven	Haven	Haven
Pair FE	yes	yes	yes	yes
Reporting FE	yes	yes	yes	yes
Saver time FE	yes	yes	yes	yes

Note: Signed is a dummy equal to 1 if there exists a treaty providing for automatic information exchange between i and j in quarter q. Signed is a dummy equal to 1 in the quarter q when the legal event establishing information exchange between i and j occurs. Robust standard errors (clustered at the country-pair level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Turning to the liabilities side, non-havens joining the AEOI framework report decreasing FDI liability positions vis-à-vis havens (Table 4.8). This could be evidence of a termination of round-tripping schemes as observed for portfolio equity.

4.4.4 Robustness

In order to test the robustness of our results we start by adding a a measure of financial linkages in the regression analysis, following Menkhoff and Miethe (2019). These are bilateral financial weights constructed using total claims against all international counterparties. Columns 1 and 4 of Table 4.A.5 show that these weights are statistically significant but do not change the coefficients of interest in any meaningful way. In a second robustness check, we account for the possibility that various leaks of information on account holders in tax haven countries that occurred during our sample period were actually driving the reduction of deposits in haven countries. We implement this test by including a dummy variable equal to 1 for haven and non-haven country pairs in the quarter after the leak occurred in the respective

tax haven.[16]. As shown in column 2 of Table 4.A.5 the results remain robust. Third, we exclude a potentially important country pair outlier, i.e. the Cayman Islands and the US. US savers decreased their deposits in the Caymans substantially during our sample period, more than in any other countrypair observation in our sample. However, as shown in column 3 and 6 of Table 4.A.5, the estimates of the effect of AEOI treaties are not affected by the exclusion of these observations. A fourth robustness check tests whether our results depend on our selection of the classification of tax havens based on Johannesen and Zucman (2014). As an alternative we use the narrower list of tax havens in Casi et al. (2020), which does not classify Austria, Belgium, Chile, Macao, Malaysia, and Curacao as havens. While the coefficient for non-bank deposits is slightly reduced in size and, in fact, very close to the one reported in Casi et al. (2020) (Table 4.A.5, column 4), the coefficient estimate for household deposits is virtually unaffected by the change in sample (column 8).[17] In a final robustness check, we test whether anticipation effects are affecting our results. To do so, we include a dummy equal to one two quarters prior to a given country-pair becoming part the AEOI framework. The estimates of the effects of AEOI signature remain highly statistically significant and virtually unchanged in size, as shown in columns 5 and 10. For non-bank deposits we do not find evidence of anticipation effects, whereas there is some evidence of households on non-haven countries beginning to withdraw deposits from havens in anticipation of the AEOI.[18]

4.5 Conclusion

In this chapter, we extend the literature on the effect of AEOI treaties facilitated by the OECD CRS and US FATCA by using both confidential data on deposits held in tax haven jurisdictions from the BIS locational banking statistics as well as data on portfolio investment and FDI from the IMF. Using these more detailed data and an extended sample of countries over the period 2014 until 2019 we answer some hitherto open questions regarding the effect of AEOI on deposits of non-haven residents

[16] 2014q1 for CH, 2015q4 for LU, 2016q2 for PA, 2016q4 for BH, see Ahrens and Bothner (2020). The results are robust when we do not lag the leak variables (not shown).

[17] Casi et al. (2020) restrict the sample of saver countries to OECD and EU countries. We obtain results very similar to the ones depicted in Table 4.A.5 when we do this as well.

[18] The results remain also intact when we vary the forward length between 1 and 4 quarters.

in tax havens. First, the more granular sectoral breakdown of bilateral cross-border deposit data allows us to show that the AEOI significantly reduced cross-border deposits held by non-resident households in tax havens, while deposits of non-bank financial institutions (NBFIs) and non-financial corporations (NFCs) in tax havens were unaffected. In particular, we find that bilateral household deposits from non-haven countries in haven banks decrease by 28.5 percent upon signature of the AEOI legislation, while the effect on deposits by the broader non-bank sector is found to be only 12.5 percent, similar to the 11.5 percent effect found in Casi et al. (2020). Second, we do find the impact of the AEOI to be persistent, in contrast to results documented for earlier bilateral initiatives for information exchange on demand, as documented by Menkhoff and Miethe (2019). Third, in the granular breakdown of our data, we also document evidence of deposit shifting by the household sector to havens not participating in AEOI, in line with Johannesen and Zucman (2014) for earlier information on demand treaties.

In a further extension of the literature on the effects of AEOI treaties, we document a significantly negative effect of AEOI on portfolio investment assets reported by tax havens residents vis-à-vis non-haven residents, in line with the results in Heckemeyer and Hemmerich (2020) for earlier information on demand treaties. Moreover, we show that FDI liability positions of non-havens vis-à-vis havens decline significantly after joining the AEOI. We interpret this as evidence that the AEOI also contributes to a reduction in round-tripping schemes. Moreover, we observe that non-havens report decreasing FDI asset positions in tax havens after joining the AEOI, suggesting that part of these assets were related to corporate structures with a tax-evading purpose.

However, we also find some evidence of negative side effects of the AEOI. In particular, banks in haven countries report increasing deposits from NBFIs resident in other tax havens after AEOI introduction. We interpret this as evidence that networks of shell companies used to obfuscate ultimate beneficiaries of account holders might have become more elaborate. This is corroborated by the finding that signing up to the AEOI framework is associated with a positive effect on FDI assets between tax havens. Hence, future policy initiatives should be aimed at increasing transparency regarding ultimate ownership of investments by looking-through corporate

structures.

Taken together, our result suggest that the implementation of automatic information exchange probably is effective in limiting tax evasion by less sophisticated investors. However, it might not be equally effective for those who are able to use more complex administrative structures, such as shell companies, trusts, etc., as also argued by Johannesen and Zucman (2014). Moreover, our results imply that the AEOI is more effective than earlier initiatives in that it is more persistent but remains incomplete as long as non-participating haven countries allow households to shift deposits. Hence, future policy initiatives should be aimed at widening the net of AEOI treaties, as well as increasing transparency regarding ultimate ownership of investments by looking-through corporate structures.

Appendix

4.A Additional Figures and Tables

TABLE 4.A.1: Reporting country sample BIS LBS

Non-haven		**Haven**	
Australia	Korea*	Austria	Hong Kong SAR
Brazil	Mexico	Bahamas*	Isle of Man*
Canada*	Netherlands*	Bahrain	Jersey
China	Norway	Belgium*	Luxembourg*
Chinese Taipei	Philippines	Bermuda*	Macao SAR
Denmark*	Portugal*	Cayman Islands	Malaysia
Finland	Russia	Chile	Panama
France*	Saudi Arabia	Curacao	Singapore
Greece	South Africa*	Cyprus*	Switzerland*
India	Spain	Guernsey*	
Indonesia	Sweden*		
Ireland*	Turkey		
Italy*	United Kingdom*		
Japan	United States		

Note: Reporting countries in our sample of cross-border deposit data. Countries reporting enhanced sectoral breakdown indicated by *. Tax haven classification according to Johannesen and Zucman (2014).

TABLE 4.A.2: Reporting country sample CPIS and CDIS

Non-haven		**Haven**
Albania	Latvia	Aruba
Algeria*	Lithuania	Austria
Armenia*	Mali*	Bahamas
Argentina	Mexico	Bahrain†
Australia	Moldova	Barbados†
Azerbaijan*	Lebanon	Belgium
Bangladesh	Mongolia	Bermuda†
Belarus	Montenegro*	Cayman Islands†
Benin*	Morocco*	Chile
Bhutan*	Mozambique*	Curacao*
Bolivia	Myanmar*	Costa Rica
Bosnia*	Namibia*	Cyprus
Botswana*	Nepal*	Guernsey†
Brazil	Netherlands	Gibraltar†
Bulgaria*	New Zealand	Hong Kong SAR
Burkina Faso	Niger*	Isle of Man†
Cabo Verde*	Nigeria*	Jersey†
Cambodia*	North Macedonia	Luxembourg
Canada	Norway	Macao SAR
China	Pakistan	Malaysia
Colombia	Paraguay*	Malta
Croatia*	Peru†	Panama
Czech Rep.	Philippines	Seychelles*
El Salvador*	Poland	Singapore
Côte d'Ivoire*	Portugal	Sint Maarten*
Denmark	Romania	Switzerland
Egypt†	Russia	Uruguay
Estonia	Rwanda*	
Finland	Senegal*	
France	Serbia*	
Georgia*	Saudi Arabia†	
Germany	Slovakia	
Ghana*	Slovenia	
Greece	South Africa	
Guatemala*	Spain	
Honduras	Sri Lanka*	
Hungary	Sweden	
Iceland	Tajikistan*	
India	Tanzania*	
Indonesia	Thailand	
Ireland	Togo*	
Israel	Uganda*	
Italy	Turkey	
Japan	Ukraine	
Kazakhstan	United Kingdom	
South Korea	United States	
Kosovo*	Venezuela	
Kuwait	West Bank and Gaza	
Kyrgyz Rep.*	Zambia*	

Note: Reporting countries in our sample of cross-border portfilio (CPIS) and direct investment (CDIS) data. Countries reporting in CDIS but not CPIS denoted by *, countries reporting in CPIS but not CDIS denoted by †. Tax haven classification according to Johannesen and Zucman (2014).

TABLE 4.A.3: Non financial corporation deposits in reporting country *i* from saver country *j*.

	(1)	(2)	(3)	(4)	(5)
Signed	0.132	0.132	0.136	0.239	
	(0.125)	(0.139)	(0.283)	(0.206)	
Signed (contemp.)					0.014
					(0.136)
Signed (+1 quarter)					0.085
					(0.132)
Signed (+2 quarters)					0.191
					(0.163)
Signed (+3 quarters)					0.228
					(0.160)
Signed (>3 quarters)					-0.050
					(0.220)
Obs.	19,763	16,850	2,912	4,316	16,850
R^2	0.91	0.90	0.91	0.92	0.90
Time period	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4
Reporting	Haven	Haven	Haven	Non-haven	Haven
Saver	All	Non-haven	Haven	Haven	Non-haven
Pair FE	yes	yes	yes	yes	yes
Reporting FE	yes	yes	yes	yes	yes
Saver time FE	yes	yes	yes	yes	yes

Note: Note: Signed is a dummy equal to 1 if there exists a treaty providing for automatic information exchange between i and j in quarter q. Signed (contemp.) is a dummy equal to 1 in the quarter q when the legal event establishing information exchange between i and j occurs; signed (+1 quarter) is a dummy equal to 1 in q +1, and so on. Robust standard errors (clustered at the country-pair level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

TABLE 4.A.4: Bank deposits in reporting country *i* from saver country *j*

	(1)	(2)	(3)	(4)	(5)
Signed	0.086	0.117	0.002	-0.046	
	(0.081)	(0.082)	(0.214)	(0.167)	
Signed (contemp.)					0.127
					(0.085)
Signed (+1 quarter)					0.131
					(0.092)
Signed (+2 quarters)					0.101
					(0.094)
Signed (+3 quarters)					0.162
					(0.103)
Signed (>3 quarters)					0.025
					(0.110)
Obs.	25,255	21,088	4,167	6,326	21,088
R^2	0.90	0.91	0.87	0.90	0.91
Time period	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4
Reporting	Haven	Haven	Haven	Non-haven	Haven
Saver	All	Non-haven	Haven	Haven	Non-haven
Pair FE	yes	yes	yes	yes	yes
Reporting FE	yes	yes	yes	yes	yes
Saver time FE	yes	yes	yes	yes	yes

Note: Signed is a dummy equal to 1 if there exists a treaty providing for automatic information exchange between i and j in quarter q. Signed (contemp.) is a dummy equal to 1 in the quarter q when the legal event establishing information exchange between i and j occurs; signed (+1 quarter) is a dummy equal to 1 in q +1, and so on. Robust standard errors (clustered at the country-pair level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

TABLE 4.A.5: Robustness checks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Non-bank deposits					Household deposits				
	MM weights	Leaks	No KY-US	Casi haven	Anticipation	MM weights	Leaks Leaks	No KY-US	Casi haven	Anticipation
Signed	-0.172***	-0.180***	-0.146***	-0.101*	-0.199***	-0.281***	-0.297***	-0.365***	-0.364***	-0.322***
	(0.050)	(0.053)	(0.054)	(0.054)	(0.060)	(0.092)	(0.095)	(0.110)	(0.110)	(0.103)
MM weight	0.037**					0.014***				
	(0.015)					(0.005)				
Signed (-2 quarters)					-0.069					-0.118*
					(0.056)					(0.062)
Observations	34,203	46,203	33,481	35,518	46,203	20,054	25,306	20,760	21,260	25,306
R-squared	0.95	0.94	0.95	0.94	0.95	0.97	0.96	0.96	0.96	0.96
Time period	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4	2014q1-2019q4
Reporting	Haven	Haven	Haven	Haven	Haven	Haven	Haven	Haven	Haven	Haven
Saver	Non-haven	Non-haven	Non-haven	Non-haven	Non-haven	Non-haven	Non-haven	Non-haven	Non-haven	Non-haven
Pair FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Reporting FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Saver time FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Note: Signed is a dummy equal to 1 if there exists a treaty providing for automatic information exchange between i and j in quarter q. MM weight denotes bilateral financial weight of counterparty *j* constructed using total claims against all international counterparties, as used in Menkhoff and Miethe (2019). Columns 2 and 6 include dummy variables equal to 1 for haven and non-haven country pairs in the quarter after the a leak occurred in the respective tax haven, i.e. 2014q1 for CH, 2015q4 for LU, 2016q2 for PA, 2016q4 for BH, see Ahrens and Bothner (2020). Columns 3 and 7 exclude the Cayman Island – US country pair. Columns 4 and 8 use a narrower list of tax havens as in in Casi, Spengel, and Stage (2020), which does not classify Austria, Belgium, Chile, Macao, Malaysia, and Curacao as havens. Columns 5 and 10 include a dummy equal to 1 two quarters prior to AEOI signature. *** p<0.01, ** p<0.05, * p<0.1.

4.B Event study design following Casi et al. (2020)

To test the robustness of our results to the econometric specification we replicate the case study design in Casi et al. (2020). Hence, we run the following regression specification:

$$ln(Dep_{ijt}) = \sum_{k=-4}^{4} \beta_k D_{it}^k * Haven_i + \gamma_{ij} + \theta_{jt} + \epsilon_{ijt} \tag{4.2}$$

Dep_{ijt} is the *log* of deposits in reporting country i from counterparty or "saver" country j, where saver countries are restricted to be OECD and EU member states. Dummies D_{jt}^k indicate a point in time k periods from the AEOI treatment and its interaction with $Havens_i$, which is a dummy taking the value of one when the reporting country is a tax haven. Here, the AEOI treatment is the passage of the CRS law in reporting country i at time t, as detailed in table 1 of Casi et al. (2020). The indicator for period $t-1$ is omitted, serving therefore as a benchmark, and indicators at the endpoints are binned. Country-pair and saver country time fixed effects are denoted by γ_{ij} and θ_{jt}, respectively. Pair fixed effects control for time-invariant factors like distance and common language, while saver country time fixed effects control for unobserved developments specific to saver countries. Standard errors are robust to autocorrelation and heteroscedasticity and clustered at the reporting country level. Finally, ϵ_{ijt} is the error term.

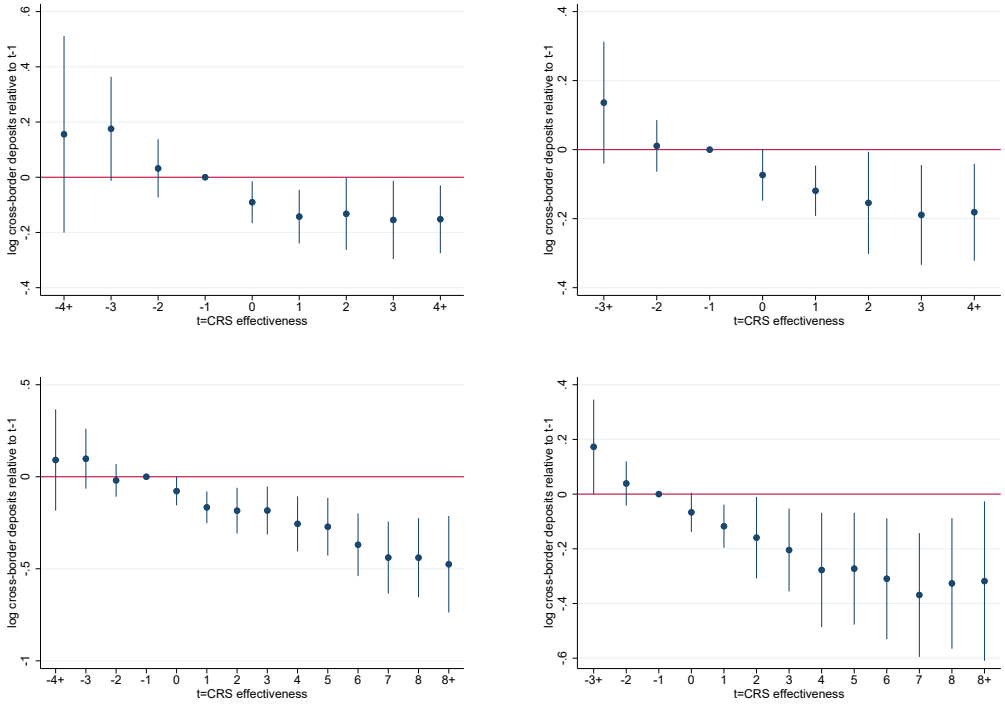


FIGURE 4.B.1: Robustness checks - Event study à la Casi, Spengel, and Stage (2020).

Note: The figures depict the coefficients of the interaction term in equation 4.2. Hence, each coefficient captures the change in cross-border deposits held in tax havens versus nonhavens around the CRS event dates (in event time) in Casi, Spengel, and Stage (2020). Each indicator term marks one quarter over the sample period relative to the quarter before the CRS event date (t = 0). Coefficient estimates are plotted with their 95% confidence intervals. Reporter-country time fixed effects as well as country-pair fixed effects are included. Standard errors are clustered at the reporting country level. From top left to bottom right panels (a) and (b) show results for the sample period used in Casi, Spengel, and Stage (2020) ('14Q4-'17Q3) while panels (c) and (d) depict results for an extended sample period ('14Q1-'19Q4). Panels on the left show results for deposits by non-banks while panels on the right show results for deposits by households.

Chapter 5

General Conclusion

This thesis provided three essays analysing some challenges financial globalisation in recent decades arguably imposed on national policy makers trying to reach domestic policy objectives, particularly in the areas of financial stability and international taxation.

Chapter 2 studied the international transmission of U.S. financial and monetary policy shocks to macroeconomic tail risks in countries around the world. Hence, it contributes to the literature on downside risks to growth and to the literature on the international transmission of U.S. shocks. The Chapter connects these two strands, as the international transmission of shocks adds a new perspective to the former literature, while the effect of shocks on different parts of the conditional growth distribution is a new aspect to the latter.

Using a Bayesian quantile VAR estimated on a panel of macroeconomic and financial data from 44 advanced and emerging countries, the Chapter shows that U.S. financial and monetary policy shocks are important structural drivers of GDP tail risk in both advanced and emerging economies. The effect of a shock to U.S. financial conditions is approximately four times stronger at the lower tail of the conditional GDP growth distribution in individual countries than the effect at the median. Similar results are obtained for the effect of U.S. monetary policy shocks on international downside risks to GDP growth. Moreover, the chapter documents that the strength of the GDP growth response systematically varies with certain country characteristics at the lower tail of the conditional GDP growth distribution but not at the median. Policymakers concerned with the possibility of large negative output growth realisations should thus pay particular attention to policy choices that expose their

economies to elevated GDP tail risks arising from external shocks. Specifically, countries with high foreign currency liability exposures, high levels of household sector leverage, and less flexible exchange rates are particularly vulnerable to downside risks to growth arising from U.S. financial shocks. This finding helps to reconcile the evidence from the impulse response analysis with the role played by the domestic exchange rate regime and private sector leverage during historical crisis episodes, such as the 1997-98 Asian financial crisis and the 2007-08 global financial crisis. In addition, our results indicate that countries with less flexible exchange rates are relatively more vulnerable to GDP tail risks arising from U.S. monetary policy shocks. The exchange rate regime thus matters for the risk of large economic downturns arising from both financial and monetary policy spillovers, creating a trilemma in macroeconomic tail risk.

Against this backdrop, the chapter argues that policymakers should respond to international financial integration by using macroprudential regulation and other financial policies in order to mitigate negative consequences of cycles in global financial conditions. While the global financial cycle is outside of the control of (most) individual countries, countries can use financial policies to break the transmission channel arising from excessive credit growth and leverage. Moreover, the classical trilemma may still exist and flexible exchange rates can help mitigate macroeconomic tail risks from spillovers of global financial shocks.

Future research could investigate which transmission channels are particularly important for the transmission of shocks to global financial conditions to downside risks to growth and investigate whether their relative importance changed over time given the evolving nature of the global financial system. In particular, the more prominent role of non-bank financial intermediation and increasing role of unconventional monetary policy tools could give rise to changing patterns in how shocks to global financial conditions are transmitted across countries, given that bank and non-bank financial intermediaries react differently to conventional and unconventional monetary policy measures (Cappiello et al., 2021).

Chapter 3 provided a fresh look at the covariates of sudden stops in gross capital inflows by combining data on capital flows with a novel database by Kose et al.

(2017) on domestic factors potentially driving sharp reversals in capital flows. Using a broader country sample than the previous literature, i.e. a quarterly panel of 98 advanced as well as emerging and developing countries from 1990 to 2018, this chapter showed that while global factors can be confirmed to be an important driver of episodes of sudden stops in gross capital inflows, domestic variables are also significantly related to the probability of incurring sharp reversals in capital inflows. The interaction between the level of leverage and negative growth shocks highlights the importance of domestic factors in determining sudden stops in gross capital inflows in line with predictions in real business cycle models with occasionally binding capital constraints and trend shocks (Akıncı & Chahrour, 2018; Flemming et al., 2019; Seoane & Yurdagul, 2019). The fact that leverage in the domestic economy tends to amplify susceptibility to sudden stops in capital inflows has important policy implications. By limiting excessive credit growth, countercyclical macroprudential policy could also serve to reduce the susceptibility of capital inflows to sudden stops, in line with theoretical postulations by Flemming et al. (2019). Therefore, policymakers should make use of the macroprudential policy toolkit to "curtail the damaging extremes of domestic financial cycles" (Carney, 2019).

Future research could investigate whether the sectoral composition of private credit plays a role regarding the probability of incurring a sudden stop. I.e., does it make a difference whether credit is extended to the household or non-financial corporate sector? A related but different open question is to which extend the lending sector plays a role, i.e. whether it makes a difference if the capital flows are intermediated by banks or non-bank financial institutions?

Chapter 4 extended the literature on the effect of the automatic change of information (AEOI) facilitated by the OECD CRS and US FATCA by using confidential data on deposits held in tax haven jurisdictions from the BIS locational banking statistics. Using more detailed data and an extended sample for 2014 until 2019 the chapter provided answers to some hitherto open questions regarding the effect of AEOI on deposits hidden by non-haven residents in tax havens. First, the more granular sectoral breakdown of bilateral cross-border deposit data allowed us to

show that the AEOI significantly reduced cross-border deposits by non-haven resident households in tax havens, while deposits of non-bank financial institutions (NBFIs) and non-financial corporations (NFCs) were unaffected. We found that bilateral household deposits from non-haven countries in haven banks decrease by 28.5 percent upon signature of the AEOI legislation, while the effect on deposits by the broader non-bank sector is found to be only 12.5 percent, similar to the 11.5 percent effect found in Casi et al. (2020). Second, we found the impact of the AEOI to be persistent, in contrast to results documented for earlier bilateral initiatives for information exchange on demand, as documented by Menkhoff and Miethe (2019). Third, due to the granular breakdown of our data, we could also document evidence of deposit shifting by the household sector, in line with Johannesen and Zucman (2014) for earlier information on demand treaties.

In a further extension of the literature on the effects of AEOI treaties, we document a significantly negative effect of AEOI on portfolio investment assets reported by tax havens residents vis-à-vis non-haven residents, in line with the results in Heckemeyer and Hemmerich (2020) for earlier information on demand treaties. Moreover, we show that FDI liability positions of non-havens vis-à-vis havens decline significantly after joining the AEOI. We interpret this as evidence that the AEOI also contributes to a reduction in round-tripping schemes. Moreover, we observe that non-havens report decreasing FDI asset positions in tax havens after joining the AEOI, suggesting that part of these assets were related to corporate structures with a tax-evading purpose.

However, the Chapter also found some evidence of negative side effects of the AEOI. In particular, banks in haven countries report increasing deposits from NBFIs resident in other tax havens after AEOI introduction. We interpret this as evidence that networks of shell companies used to obfuscate ultimate beneficiaries of account holders might have become more elaborate. This is corroborated by the finding that signing up to the AEOI framework is associated with a positive effect on FDI assets between tax havens. Hence, future policy initiatives should be aimed at increasing transparency regarding ultimate ownership of investments by looking-through corporate structures.

Taken together, the result presented in Chapter 4 suggest that the implementation of automatic information exchange probably is effective in limiting tax evasion by less sophisticated investors. However, it might not be equally effective for those who are able to use more complex administrative structures, such as shell companies, trusts, etc., as also argued by Johannesen and Zucman (2014). Moreover, our results imply that the AEOI is more effective than earlier initiatives in that it is more persistent but remains incomplete as long as non-participating haven countries allow households to shift deposits. Hence, future policy initiatives should be aimed at widening the net of AEOI treaties, as well as increasing transparency regarding ultimate ownership of investments by looking-through corporate structures.

In summary, this thesis provides empirical evidence on the importance of global factors shaping national macro-financial outcomes. In addition, the findings in this thesis highlight that domestic policy makers have tools at hand to mitigate some of the adverse consequences of financial globalisation. Policymakers in individual countries may use financial policies to break the amplification channel arising from excessive credit growth and leverage, as argued by Rey (2015). More specifically, floating exchange rates can mitigate a country's vulnerability to large downturns in GDP triggered by U.S. financial or monetary policy shocks. Moreover, macroprudential limits on leverage in the domestic economy can mitigate the effects of shocks to global financial conditions from the US on the risk of large output declines and such policies may also reduce the susceptibility of individual countries to sudden stops in capital inflows. Finally, multilateral cooperation can be effective in mitigating other adverse consequences of financial globalisation, as shown by the evidence of the effective, albeit incomplete, efforts towards limiting international tax evasion through automatic exchange of information agreements.

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