Exchange rate sensitivity and the composition of net foreign assets

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Abstract

Many currencies, especially those of countries with negative net foreign assets, depreciate during financial turbulence. Using a panel of 26 currencies over the period 1/1997 – 6/2016, I show that the composition of net foreign assets matter for the exchange rate sensitivity to changes in global financial market risk tolerance, as it is net debt liabilities, but not equity, that give rise to it. Ownership matters too, as it is especially private net foreign debt that heighten the exchange rate sensitivity. In emerging markets, the vulnerability arises from banking sector net debt, whereas the G10 currencies are instead more sensitive the more private net portfolio debt the countries have.

JEL Classifications: F31, F32, G15, G20, C23

Keywords: Exchange rates, private net foreign portfolio debt, private net foreign other investment, financial market risk tolerance, panel data

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1 Introduction

There have been large swings in both the financial sector's risk appetite and in exchange rates during the past 15 years, and many countries with large negative net foreign asset positions have seen their currencies depreciate sharply during times of global financial market turbulence. Several central banks, especially in emerging markets, responded to this by conducting substantial currency interventions to dampen the exchange rate movements and volatility. Different types of external capital are however heterogeneously influenced by global risk, and the country's underlying foreign debt and asset structure might affect the way the exchange rate reacts to financial market turmoil. This paper therefore empirically disentangles how the composition of net foreign assets impacts the sensitivity of exchange rates to global financial market uncertainty. As many central banks are concerned about the impact of global financial market shocks on their countries' exchange rates, a full understanding of these mechanisms are important for both policy design and evaluation, and for predicting future exchange rate movements.

Gabaix and Maggiori (2015) propose a theory of exchange rate determination based on global imbalances and resulting capital flows in imperfect financial markets. Financiers absorb the global currency demand imbalances and currency risk stemming from international trade and financial flows. As the financiers' risk-bearing capacity is limited, currencies of countries with large external debts must offer high expected returns to compensate for the resulting currency risk. Balance sheet changes of the financial institutions will impact the pricing (or level) of foreign currency lending, which in turn affects the exchange rate.[1] Della Corte et al. (2016) indirectly prove the theory of Gabaix and Maggiori (2015) by showing that countries' external imbalances can explain cross-sectional variation in currency excess returns. They hypothesize that net debtor countries must offer a currency risk premium in order to compensate investors for taking on the risk and financing the negative external imbalances, as their currencies tend to depreciate when risk taking is limited. Habib and Stracca (2012) also empirically confirm that currencies with large external imbalances are more vulnerable to swings in the global risk sentiment. This can also be related to the sudden stop literature that looks at the causes of sudden capital flow reversals. That literature has established that external "push" factors are the main drivers of capital flows, whereas the magnitude of such flows are determined by domestic "pull" factors (see e.g. Calvo et al., 1993; Fernández-Arias, 1996; Ghosh et al., 2014).

[1] Gabaix and Maggiori (2015) note that active exchange rate risk taking is greatly concentrated among a small number of large financial firms. About 80 % of the exchange rate flows in 2014 was concentrated among the 10 largest banks, and currency risks also account for a large share of these institutions' overall respective risk taking. According to Deutsche Bank's and Citigroup's regulatory findings, currency risk accounted for 17-35 % of total stressed value at risk in 2003. Hence, changes in the risk-bearing capacity of these large financial institutions can have potentially large impacts on the foreign exchange markets. Moreover, there is some evidence in the previous literature that financial institutions absorb a part of the currency risk, see e.g Tai (2005) or Martin and Mauer (2003).

The empirical literature has argued that international capital flows to both advanced and emerging market economies are procyclical and tend to amplify business cycle fluctuations.[2] However, not all types of capital flows are equally procyclical. Brunnermeier et al. (2012) and Avdjiev et al. (2018) note that aggregate FDI and net portfolio equity flows are generally fairly stable over the financial business cycle. This is partly due to a different investor base, but mainly because in a financial crisis the foreign equity investors absorb the valuation losses, which combined with a local currency depreciation discourages portfolio equity outflows. Debt flows, on the other hand, portray strong procyclicalities. A large share of the debt inflow is intermediated by banks, and bank lending responds not only to the credit worthiness of the project, but also to the bank's balance-sheet capacity. Moreover, debt is subject to maturity mismatch risk as investors may choose to not roll over maturing debt under uncertain market conditions. Consequently, currencies of countries with large outstanding net debt liabilities tend to be more vulnerable to changes in the banking sector risk bearing capacity or the global risk sentiment than countries with the equivalent net portfolio equity and FDI liabilities. The crash risk for the currency with large negative net portfolio debt positions should therefore be higher, which would translate into a higher currency risk premia. Avdjiev et al. (2018) moreover show that external debt flows to and from various economic sectors respond very differently to changes in the global risk sentiment. As the debtors and creditors in the various sectors respond differently to global uncertainty shocks and business cycle changes, the underlying net external position of the different creditor and lenders might have an impact on the way the exchange rate responds to these shocks. They also find that capital flows to and from advanced and emerging markets react differently to uncertainty shocks, which might also lead to different exchange rate effects in the country groups.

This paper extends the empirical exchange rate literature that focuses on the impact of global imbalances and the financial sector risk-bearing capacity in several ways. Studies such as Brunnermeier et al. (2012), Lustig et al. (2011), Menkhoff et al. (2012) have documented a significant relationship between global risk and excess currency returns or currency movements. Many previous studies have looked at the exchange rate impact of international capital flows[3], but fewer studies have looked at the exchange rate impact of a change in the global risk tolerance, conditional on this country's net foreign asset position. Habib and Stracca (2012) show that the exchange rate impact of changes in the global risk sentiment is amplified by large net foreign liabilities, but to the best of my knowledge, no study has yet properly looked at how the *composition* of net foreign assets affects the impact of financial market uncertainty on the exchange rate.

[2]See Kaminsky et al. (2004), Brunnermeier et al. (2012) Bluedorn et al. (2013), Broner et al. (2013), Araujo et al. (2015)

[3]E.g. Gourinchas and Rey (2007), Alquist and Chinn (2008), Della Corte et al. (2012), Aizenman and Binici (2015) all suggest that net foreign assets have an impact on nominal exchange rates. Ricci et al. (2013) and many others have investigated the same impact on real exchange rates.

In a panel study of 25 exchange rates against the USD over the period 1/1997–6/2016, I identify which types of net foreign assets that increase the exchange rate sensitivity to global risk intolerance. I disentangle how the relationship between the financial sector risk bearing capacity and different types of foreign capital, such as portfolio debt, equity, FDI and other investments, affects currency excess returns and the exchange rate. I differentiate between private and public net foreign assets and investments, and between the banking sector and the non-banking sector, as both public and private debtors (and financial institutions and corporates), but also investors in private and public debt, generally have different risk profiles and investment horizons. I moreover show how the relationship between risk intolerance, net foreign assets and exchange rates differ between G10 and emerging market currencies, and finally I determine how this relationship has changed over the sample period.

My main findings are that the composition of the net foreign asset position matter for the exchange rate sensitivity to changes in global financial market risk tolerance. Currencies of countries with large net external debt liabilities, and especially portfolio debt liabilities, are most sensitive to changes in the financial market risk appetite and banking sector risk. These currencies tend to depreciate far more in response to a surge in financial market risk intolerance than countries with smaller net external debt liabilities. Moreover, I find that currencies of countries with the equivalent negative net foreign equity position are much less affected by changes in the global risk sentiment. Due to these offsetting exchange rate effects of the external debt and equity positions, the negative impact of financial market imbalances is underestimated if we look only at the total net foreign assets. Secondly, I find that the ownership of the net foreign assets affects the exchange rate sensitivity. Private net foreign liabilities, and especially private net foreign debt such as portfolio debt and other investment liabilities, increase the exchange rate vulnerability much more than public net foreign debt liabilities. Importantly, I find that the exchange rate vulnerability originates from different asset classes for the G10 and emerging markets currencies. In the emerging markets, the exchange rate sensitivity is the highest in countries where the banking sector net other debt liabilities (which includes bank loans, trade credits and bank deposits) are large, as predicted by Gabaix and Maggiori (2015). This does however not apply to the G10 currencies, but these are instead more vulnerable to changes in the risk sentiment the more net external porfolio debt the countries have. Moreover, although the emerging market currencies are in general more sensitive to changes in the global financial market volatility index VIX, the net foreign asset position has a smaller impact on the total effect of a change in risk intolerance on the exchange rate. Thus, emerging market currencies seem to react more to a change in risk intolerance, regardless of their underlying net foreign asset position. Finally, I find that the relationship between banking sector risk intolerance, net external assets and exchange rates has become stronger over time, and especially after the 2007/2008 financial crisis.

These results are important for risk calculations and hedging decisions, but they also have important policy implications. In the past, many central banks[4] have engaged in currency interventions to smooth exchange rate volatility during times of financial turmoil. My results suggest that policy makers concerned about a high exchange rate sensitivity to global financial uncertainty could reduce this vulnerability by facilitating a shift from debt to equity liabilities. As there are substantial differences in how debt and equity investments are taxed in most countries, there is ample scope for intervention.

These results are also important for the evaluation of financial market reforms. Many emerging market economies have substantial restrictions on foreign ownership of debt, but especially equity products. When evaluating the costs and benefits of opening up the local financial markets to foreign investors, these findings provide important information on the heterogeneous impacts of foreign debt and equity ownership on the exchange rate. From a financial stability perspective it is crucial to know which types of liabilities that increase the exchange rate vulnerability to the global financial markets. Finally, my findings are also interesting from a corporate finance perspective. Modigliani and Miller (1958) state that if financial markets are complete, the liability structure should not affect the value of a firm. If this logic is transferred to the aggregate level, the value of a country's assets should not depend on its debt-to-equity ratio. However, as the price that investors are willing to pay for a country's currency depends on the underlying capital structure in the economy, this implies that the Modigliani-Miller theorem does not hold on the aggregate level.

The rest of the paper is structured as follows: Section 2 describes the theoretical framework underlying the model and how different types of capital might affect the relationship between global risk tolerance and exchange rates. Section 3 describes the method and models, Section 4 describes the data, Section 5 presents and discusses the results and Section 6 concludes.

2 Theoretical framework

2.1 Gabaix and Maggiori's (2015) exchange rate model

The empirical model for this study is inspired by Gabaix and Maggiori's (2015) two country model with imperfect markets, where exchange rates are financially determined by capital flows and the financial sector's risk bearing capacity. In their model, households produce goods, trade in the frictionless international goods market and invest with financiers in nominally risk-free bonds. The international capital flows resulting from households' investment decisions are intermediated by financiers, who bear the resulting currency risk. The exchange rate s_t is determined by the demand and supply of capital denominated in the different currencies, where s_t is defined as the quantity of U.S. dollars bought by 1 unit of foreign currency. Thus, s_t determines the strength of the foreign currency and $\Delta s > 0$ implies

[4] This includes among others the central banks of Mexico, Brazil, India, Malaysia, Indonesia, Russia, Poland, Japan and Switzerland.

an appreciation of the foreign currency. The financiers are subject to financial constraints, which limit their risk-bearing capacity and induce them to demand a premium for taking on the currency risk. Financiers' ability to bear risk is denoted by Γ, where a higher Γ (i.e. lower $\frac{1}{\Gamma}$) implies lower financier risk-bearing capacity.

Gabaix and Maggiori (2015) solve the financiers' constrained optimization problem[5] and arrive at an expression for the exchange rate s_0 which is affected by the foreign asset position and the financial sector risk intolerance Γ. The financiers need compensation for taking on the resulting risk, and for them to be willing to absorb the currency risk they must expect the foreign currency to appreciate.[6] This "required" appreciation can occur if the foreign currency depreciates in period 0. According to their Proposition 2, the impact of a change in the financial sector risk bearing capacity Γ on the exchange rate s_0 in a two period setting is:

$$\frac{\partial s_0}{\partial \Gamma} = \frac{-NFA_0}{2+\Gamma} \tag{1}$$

where NFA_t is the net foreign asset position in time t. This result implies that if there is a sudden worsening of the financier's risk-bearing capacity or a financial disruption, i.e. $\Gamma \uparrow$, countries with a negative net foreign asset position ($NFA_0 < 0$) see a currency depreciation against the foreign currency ($s \uparrow$), whereas countries with positive net foreign assets appreciate. This holds also when different types of net foreign assets are considered. If we consider NFA fixed and treat s as a function of only Γ, $f(\Gamma)$, by using approximation by differentials we can use $ds_0 \approx \Delta s_0$, where

$$\Delta s_0 = f'(\Gamma)\Delta\Gamma = \frac{-NFA_0}{2+\Gamma}\Delta\Gamma \tag{2}$$

2.2 Different types of foreign capital

Foreign assets are often separated into debt and equity instruments, or into more granular classifications such as direct investment (FDI), portfolio equity, portfolio debt and so called "other" investments which includes bank and corporate loans, bank deposits and trade credits. Although equity can be thought of as a debt instrument with infinite maturity, there are however some substantial differences between these two external sources of financing. Debt creates leverage, whereas equity does not. Equity financing involves more risk and profit sharing than debt financing, which dampens the role of the risk-bearing capacity of the financiers. Moreover, debt provides external financing at a fixed cost, whereas the cost of equity capital varies.

Not all types of foreign assets are equally influenced by the global risk sentiment or the financial sector risk bearing capacity. Brunnermeier et al. (2012) explain that foreign debt flows tend to be much more influenced by the global financial cycle than FDI and foreign equity flows, and Avdjiev et al.

[5] More details about this derivation are available in Appendix A.

[6] This can be related to the carry trade, where investors borrow in a low interest rate currency and invest it abroad under the expectation of obtaining both an interest rate and currency return.

(2018) note that it is in particular "Other investment debt" that is the most influenced by both the business cycle and global risk.[7] One reason for these heterogeneous reactions is the different investor base. A large share of the debt inflow is intermediated by banks, and bank lending responds not only to the credit worthiness of the project, but also to the bank's balance-sheet capacity. During times of higher global risk intolerance, less external debt is therefore issued. Moreover, during times of high global risk intolerance some of the existing foreign debt is not rolled over when maturing, but instead repatriated to the foreign financial institution causing capital outflows. Adams-Kane et al. (2017) show that foreign banks that experience an economic crisis in their home country, i.e. banks whose risk bearing capacity is suddenly reduced, cut down on their lending to developing countries substantially and often repatriate capital to boost their liquidity at home, as opposed to expanding lending in order to diversify away from the shock in their home country. Consequently, debt intermediated by the banking sector is highly procyclical and more volatile than non-bank debt flows. These factors might thus make currencies of countries with large foreign debt liabilities more sensitive to global financial market turbulence.

Foreign equity flows and FDI are much less affected by the global risk sentiment. Avdjiev et al. (2018) note that while both total debt in- and outflows are correlated with the VIX, portfolio equity flows are not. They also note that FDI flows to emerging markets are correlated with the global risk sentiment, whereas the same is not the case in advanced economies.[8] Within the sudden stop literature Levchenko and Mauro (2007) find that especially FDI but also portfolio equity flows are fairly stable during sudden capital flow stops, whereas portfolio debt and other investment flows experience substantial reversals. In a crisis, the foreign equity investors suffer both valuation losses, often in combination with a weaker local currency, which discourages portfolio equity outflows. FDI investments are often sunk in more illiquid assets, and equity related to FDI is likely to be done by investors with longer term investment horizons and is therefore less influenced by the business cycle than portfolio investments. With FDI the foreign firm has a management and strategic interest, whereas portfolio investments are generally merely financial in nature. Foreign subsidiaries often maintain access to credit through their parent companies during crises, which ameliorates the capital outflow and exchange rate effect (Blalock and Gertler, 2008). Additionally, FDI and equity investors, often corporations, pension funds or mutual funds, are typically less or not at all leveraged, which reduces the risk of sudden stops or reversals. Additionally, as equity investments allows for greater risk sharing between creditor and borrower than debt investments, this increases the riskiness of (portfolio) debt investments compared to equity and makes debt investments more susceptible to outflows

[7] Avdjiev et al. (2018) also note that in emerging markets both portfolio debt in- and outflows and "Other debt investments" outflows are positively correlated with the global risk sentiment, while "Other debt investment" inflows are acyclical. In advanced economies, "Other debt investment" in- and outflows and portfolio debt outflows are procyclical, while portfolio debt inflows are acyclical.

[8] Araujo et al. (2017) point out that in low income countries (LIC's) portfolio investment may act as a substitute to FDI in the extensive margin if the entry costs are excessively high. It could thus be that some of the less developed emerging markets with high entry costs or barriers could attract portfolio investments instead that are more strategic rather than financial in nature. However, as all the emerging markets included in my sample are at least middle income countries and have fairly developed economies, this is still fairly unlikely.

during times of low financial market risk tolerance. As international debt liabilities are more affected by global risk intolerance than international equity liabilities, an increase in global risk aversion will lead to much larger capital outflows from countries with large debt liabilities than from countries with large equity liabilities.[9] This explains why currencies of countries with large outstanding net portfolio debt are more vulnerable to changes in the financiers' risk bearing capacity than countries with the same amount of net portfolio equity and FDI. When considering the impact of financial market risk intolerance on the exchange rate, it is therefore necessary to take into account the type of assets and liabilities making up a countries' net foreign asset position.

Net foreign assets generally consist of both private and public foreign assets and liabilities. The foreign creditors financing public and private debt are also likely to differ, as private foreign debt is generally perceived as being riskier than government debt. The higher risk excludes many pension funds and other low risk investors that generally are less leveraged from investing in the private debt market. Moreover, many insurance or pension funds are required to invest a substantial share of their holdings in low risk government bonds. If the investor base for government bonds and liabilities is less leveraged or has a longer investment horizon than the investor base for private debt, this might lead to smaller international capital flows in response to higher risk intolerance. This would in turn mean that the exchange rate is also less affected by sudden financial market turbulence. Avdjiev et al. (2018) show that sovereign capital in- and outflows are mostly acyclical and respond also very little to changes in the global risk sentiment, whereas both private debt in- and outflows are positively correlated with the VIX index. They furthermore find that external debt inflows in both advanced economies and emerging markets are mainly driven by the private sector. In advanced economies the debt outflows are procyclical, positively correlated with the global financial risk sentiment, and mainly driven by the banking sector, which thus results in procyclical net external debt flows. In the emerging markets, the private debt outflows are however more acyclical and much less correlated with the global risk sentiment, which results in private net debt flows that are potentially much more procyclical than in advanced economies. Thus, a change in the global risk sentiment might therefore lead to a different exchange rate impact in the advanced and emerging market currencies as well.

3 Method

This section outlines the empirical strategy for studying the dynamics between changes risk intolerance, different types of global imbalances and the exchange rate or excess currency returns. As demonstrated in equation (1), the impact of a change in risk intolerance on the exchange rate depends on the net foreign asset position (NFA) of the country. This study tests this hypothesis empirically with help of an interaction model that disentangles the exchange rate effect of a change in risk intol-

[9] Investments in safe haven currencies such as the JPY, USD and CHF tend however to be exceptions.

erance, RI, given the net foreign asset position, where RI can be thought of as a proxy for Γ. After having done this, the NFA position is split into Net Total Debt and Net Total Equity investments, and finally into different net portfolio, net FDI and net other assets, in order to see whether the underlying asset structure has an effect on the exchange rate impact.

The variable s_t represents the log spot exchange rate in period t in units of USD per foreign currency. Thus, $\Delta s > 0$ implies an appreciation of the foreign currency against the USD, where $\Delta s_{t+1} = s_{t+1} - s_t$. The log forward rate in month t is denoted by f_t, and $fd_t = f_t - s_t$ is the forward discount. If the covered interest rate parity (CIP) holds, $f_t - s_t \approx i_{US} - i$. Monthly unconditional currency excess returns, $rx^u_{t+1} = s_{t+1} - f_t$, in period $t + 1$ are defined as the return from buying foreign currency in the forward market in period t and selling it in the spot market the next period. Conditional excess currency returns, rx_{t+1}, are defined as the returns from assuming a long position in the foreign currency, i.e. $rx_{t+1} = s_{t+1} - f_t$, if $fd_t < 0$, and a short position if $fd_t > 0$. Thus

$$rx_{t+1} = \begin{cases} s_{t+1} - f_t & \text{if } \; fd_t = f_t - s_t < 0 \\ f_t - s_{t+1} & \text{if } \; fd_t > 0 \end{cases} \tag{3}$$

If CIP holds, this trade is equivalent to the carry trade of going long the foreign currency and short the USD if $i > i_{US}$ and vice versa.

3.1 Net foreign assets

The basic panel regression equations that look at the interaction of net foreign assets and financial sector risk intolerance[10] on exchange rate changes $\Delta s_{i,t}$ (or excess returns $rx_{i,t}$) of currency i against USD in period t are based on equation (2), where the equation is augmented with the constitutive terms of the interaction between net foreign assets to GDP ($nfa_{i,t}$) and the change in global financial sector risk intolerance (ΔRI_t) and control variables. The baseline exchange rate model is thus:

$$\Delta s_{i,t} = \beta_0 + \beta_1 \Delta RI_t + \beta_2 (nfa_{i,t} \Delta RI_t) + \beta_3 nfa_{i,t} + \delta x_{i,t-1} + \gamma_i + \varepsilon_{i,t} \tag{4}$$

where x_{it} is a vector containing the control variables, the β's and δ contain the estimated coefficients, γ_i is the currency fixed effect and $\varepsilon_{i,t}$ is the error term.[11] It is however possible that it is not only the net foreign asset position that affects the exchange rate, but that the exchange rate also has an impact on the external debts and liabilities. In order to avoid this simultaneity problem, and also because I am interested in the exchange rate impact conditional on the net foreign asset position, I

[10] As the indices for risk tolerance used in this study are decreasing in the level of risk bearing capacity, it is more intuitive for the interpretation of the results to talk about a risk intolerance index rather than risk tolerance.

[11] The same model for the excess currency returns is

$$rx_{i,t} = \beta_0 + \beta_1 \Delta RI_t + \beta_2 (nfa_{i,t} \Delta RI_t) + \beta_3 nfa_{i,t} + \delta x_{i,t-1} + \gamma_i + \varepsilon_{i,t} \tag{5}$$

use the beginning of period values of the net foreign asset positions[12].

As we have an interaction model the estimated β_1 tells us the exchange rate impact of ΔRI_t when $nfa_{i,t}$ is zero. During times of low financial risk tolerance, most currencies, with the exception of a few of so called "safe haven currencies", tend to depreciate and excess returns are lower. Therefore, I expect $\beta_1 < 0$. The estimated coefficient on the interaction term β_2 is expected to be positive; countries with negative nfa react stronger to increases in risk intolerance and depreciate more (remember that $\Delta s < 0$ implies a depreciation against the USD). This is also what Proposition 2 (equation (1)) of Gabaix and Maggiori (2015) predict. When the risk bearing capacity of the financial sector is good (RI is low), the excess returns of the net debtor currencies (i.e. countries with $nfa < 0$) are positive. However, during times of financial distress when risk intolerance increases, currencies with negative net external debt positions depreciate due to foreign capital outflows. Typically, this reduces excess returns as well. Thus, $\beta_2 > 0$ would indicate that negative net debt positions increases the exchange rate sensitivity to increases in risk intolerance. The total impact of ΔRI on exchange rate changes is $\beta_1 + \beta_2\overline{nfa}$, where $\overline{nfa}$ is the average nfa.[13] The estimated coefficient β_3 on the constituent term $nfa_{i,t}$ tells us the exchange rate impact of $nfa_{i,t}$ when $\Delta RI_t = 0$. If negative net foreign asset positions lead to a currency depreciation when $\Delta RI_t = 0$, then $\beta_3 > 0$. However, if this instead leads to investors demanding consistently higher currency risk premias when $\Delta RI_t = 0$, $\beta_3 < 0$.

Control variables

Control variables are included to ensure that the impact of changes in risk sentiment is correctly identified. As deviations from relative/absolute/trend PPP give rise to excess currency returns according to among others Coakley and Fuertes (2001), Habib and Stracca (2012), Jorda and Taylor (2012) and Hossfeld and MacDonald (2015), relative PPP ($PPP_{i,t}$) is also included. As mentioned in Rossi (2013), interest rate and inflation differentials have an impact on the exchange rate. Moreover, differences in economic outlooks might also affect the potential return differences in the stock market, which could also have an impact on the exchange rate. The difference in local stock market performance versus the US ($\Delta stock_{i,t} - \Delta SP500$), inflation differentials ($\pi_{i,t} - \pi_{US,t}$) and 3 month interbank rate differentials ($i_{i,t} - i_{US,t}$) (or $fd_{i,t}$) are therefore included to control for yield differentials. To account for carry trade reversals, an interaction term between the interest differential and risk intolerance (here proxied by VIX), $(i_{i,t} - i_{US,t}) * VIX_t$, is also included like in Habib and Stracca (2012). Finally, log changes in central bank currency reserves ($\Delta Res_{i,t}$) are included to capture central bank currency interventions. As the exchange rate might have an effect on inflation, interest rates and stock markets, lags of all the control variables are used instead of the contemporaneous values to avoid possible simultaneity issues.[14]

[12] The results are also robust to the use of further lags of the net foreign assets and to the use of end of period values.

[13] The standard error of this term is $\text{se}(\beta_1 + \beta_2\overline{nfa}) = \sqrt{var(\beta_1) + \overline{nfa}^2 var(\beta_2) + 2\overline{nfa}\ cov(\beta_1, \beta_2)}$

[14] As inflation and the stock market returns are forward looking variables, it might be that current values of these are correlated with future nfa. To ensure that the results are not driven by inflation, stock market or interest rate

3.2 Different types of foreign capital

3.2.1 Net total foreign debt and net total foreign equity

As explained above, not all types of foreign capital flows are procyclical and equally influenced by the global risk sentiment. To distinguish between the impact of different types of net foreign assets on the exchange rate change, the variable nfa is split into 3 components; net total debt[15] ($nTotDebt$), net total equity[16] ($nTotEquity$) and foreign reserve assets (res). Net total debt and net total equity are the variables of interest and the change in central bank currency reserves, ΔRes, is included as a control variable in x. The empirical model for the exchange rate impact is presented below:

$$\begin{aligned} \Delta s_{i,t} = {} & \beta_1 \Delta RI_t + \beta_2 (nTotDebt_{i,t} \Delta RI_t) + \beta_3 (nTotEquity_{i,t} \Delta RI_t) \\ & + \beta_4 nTotDebt_{i,t} + \beta_5 nTotEquity_{i,t} + \delta x_{i,t-1} + \gamma_i + \varepsilon_{i,t} \end{aligned} \tag{6}$$

Currencies with negative net foreign debt assets are expected to be most affected by the global financial business cycle, as foreign banks often repatriate their capital during times of low risk tolerance, whereas equity investors are discouraged to sell their assets due to the depressed equity prices. The estimated coefficient on the interaction term including net total foreign debt is therefore expected to be positive, i.e. $\beta_2 > 0$. Moreover, I also expect β_2 to be larger in magnitude than β_3, as I expect net foreign equity liabilities to have a much smaller destabilizing exchange rate impact. The β_1 is again expected to be negative. The total effect of a change in global risk intolerance RI, as proxied either by VIX or TED, is thus $\beta_1 + \beta_2 \overline{nTotDebt} + \beta_3 \overline{nTotEquity}$, where the bar denotes the averages of the series. β_4 and β_5 tell us the impact of $nTotDebt_{i,t}$ and $nTotEquity_{i,t}$ on $\Delta s_{i,t}$ when RI is unchanged.

3.2.2 Portfolio debt and equity

There are also substantial differences between different types of debts and equity. Equity related to FDI is likely to be done by investors with longer term investment horizons and could therefore be less influenced by the business cycle than portfolio equity. Also, portfolio debt issued by banks might also be more sensitive to business cycle fluctuations than trade credits. The net total debt and net total equity are therefore split into 4 components; net portfolio equity ($nPEquity$), net portfolio debt ($nPDebt$), net FDI ($nFDI$) and net "other" investment ($nOther$). The variables $nPDebt$, $nPEquity$, $nOther$ and $nFDI$ and their interaction with ΔRI are our variables of interest. The model allowing

expectations, for robustness further lags of these are also included in the model.

[15] Total debt assets include portfolio debt, FDI debt and other debt such as bank loans and deposits, other loans, trade credits and other accounts payable and receivable.

[16] Total equity assets include Portfolio equity, FDI equity and other equity.

for a differential impact on exchange rate changes Δs of the different assets is:

$$\begin{aligned}\Delta s_{i,t} = \beta_1 \Delta RI_t + \beta_2 (nPDebt_{i,t} \Delta RI_t) + \beta_3 (nPEquity_{i,t} \Delta RI_t) \\ + \beta_4 (nFDI_{i,t} \Delta RI_t) + \beta_5 (nOther_{i,t} \Delta RI_t) + \beta_6 nPDebt_{i,t} \\ + \beta_7 nPEquity_{i,t} + \beta_8 nFDI_{i,t} + \beta_9 nOther_{i,t} + \delta x_{i,t-1} + \gamma_i + \varepsilon_{i,t}\end{aligned} \tag{7}$$

The total impact of a change in RI_t on $\Delta s_{i,t}$ is $\beta_1 + \beta_2 \overline{nPDebt} + \beta_3 \overline{nPEquity} + \beta_4 \overline{nFDI} + \beta_5 \overline{nOther}$, where the bars again signify averages. If portfolio debt is more highly affected by the financier's risk bearing capacity than portfolio equity and FDI, the exchange rate of a country with larger net debt would react more strongly to a change in financial market risk intolerance. Therefore, the estimated β_2 on the interaction term including $nPDebt$ should be much larger than β_3 with $nPEquity$ and β_4 with $nFDI$. The category "other investment" includes among other things bank loans and trade credits, which are highly influenced by banking sector risk tolerance. I therefore expect the estimated coefficient on the $nOther$ interaction term, β_5, to be positive and larger than β_3 and β_4.

3.2.3 Public and private net foreign debt

The net foreign assets consist of both private and public foreign assets and liabilities. As Avdjiev et al. (2018) point out, capital flows to and from both the private and public sector, but also different sectors within the private sector, tend to respond differently to global uncertainty shocks. The foreign creditors financing public and private debt are also likely to differ, both in their risk tolerance and investment horizon. If the investor base for government bonds and liabilities is less leveraged or has a longer investment horizon than the investor base for private debt, this might lead to smaller international capital flows in response to higher global risk intolerance. This would in turn mean that the exchange rate would also be less affected by sudden financial market turbulence. Alfaro et al. (2014) also note that net public debt flows (sovereign-to-sovereign flows) are negatively correlated with growth in developing countries, whereas the correlation between net private capital inflows and growth is instead positive. As the different sources and recipients of external financing are heterogeneously related to the real economy, it could be that the exchange rate response is also affected by the ownership structure of the net foreign asset position. The exchange rate impact of the size of private ($PRIV$) and general government ($GOVT$) net foreign assets, net total debt, net portfolio debt and net other investments on the exchange rate is therefore considered separately as well. Finally as financial institutions might have different investment objectives than corporations and households, the private net foreign assets are also separated into net foreign assets held by deposit taking financial institutions, $BANK$, and non-bank sectors (which is mostly the corporate sector), $OSECT$.

3.2.4 Emerging markets versus G10 currencies

Bluedorn et al. (2013) note that net capital flows have been roughly equally volatile for emerging market and advanced economies since 1980. Emerging market investments, both debt, equity and other investments, are however generally perceived as being riskier than investments in most of the advanced economies. The higher risk of emerging market investments compared to similar investments in the G10 currency countries[17] might attract a different foreign investor base and at the same time exclude some low risk investors that generally are less leveraged. Moreover, Bluedorn et al. (2013) note that net capital flows to emerging markets are driven primarily by foreign investors, whereas in advanced economies the net flows are driven by both foreign and domestic financiers. If the international investor base in the emerging markets is very different from the one in advanced economies, more leveraged or more affected by the global financial business cycle, this might lead to larger international capital flows in response to changes in risk intolerance. This would in turn mean that the exchange rates of the emerging markets would be more affected by financial market turbulence. The sample is therefore split into a G10 currency and an emerging market currency sample as well.

3.2.5 An evolving relationship

It is possible that the relationship between imbalances, risk-bearing capacity and exchange rates has changed over time for several reasons. First, financial innovation has led to a wider range of financial products, which allows for different investment (and hedging) opportunities, which could have an effect on the above mentioned relationship. Second, changes in financial openness, financial reforms and financial integration has also altered the characteristics of the capital flows between countries. Third, changes in banking regulations (both global and domestic) after the recent financial crisis has also changed the amount and type of risk taking allowed by financial institutions. Finally, the global role of the emerging market economies has evolved over time, which could have had impacted the international capital flow dynamics. Also, it might be that the impact of financial market uncertainty was stronger during the financial crisis than in normal times due to additional negative spill over effects. I therefore investigate whether these dynamics have changed over time, and in particular during and after the financial crisis. The sample is therefore split into a pre financial crisis sample (1/1997–3/2007), a financial crisis sample (4/2007–12/2009) and a post-crisis sample (1/2010–6/2016).

4 Data

The analysis is done using monthly data for an unbalanced panel of 26 advanced (G10) and emerging market (EM) currencies over the period 1/1997 to 6/2016. The included countries and currencies are listed in Appendix B. Bilateral (end of period) exchange rates and 1 month forward rates against

[17] The G10 currency countries are Australia (AUD), Canada (CAD), Eurozone (EUR), Japan (JPY), New Zealand (NZD), Norway (NOK), Sweden (SEK), Switzerland (CHF), UK (GBP) and USA (USD).

the USD are downloaded from Bloomberg. The included currencies are freely floating or at least subject to a managed float for most of the sample period. The observations for currencies which were temporarily subject to exchange rate pegs or strict capital controls, such as the 1.20 floor on EUR/CHF during 2011-2014, are excluded. The INR is excluded from 1/2014 onward due to the strict capital controls implemented by the Indian government since then. EUR is included from 1/1999 onwards and some extreme outliers for CLP (6-11/2008), and TRY (2000) are also omitted. Excess returns rx are computed as outlined in 3 and the cross-sectional averages for both Δs and rx are presented in Figure 1. The correlation between Δs and rx in the sample is 0.66.

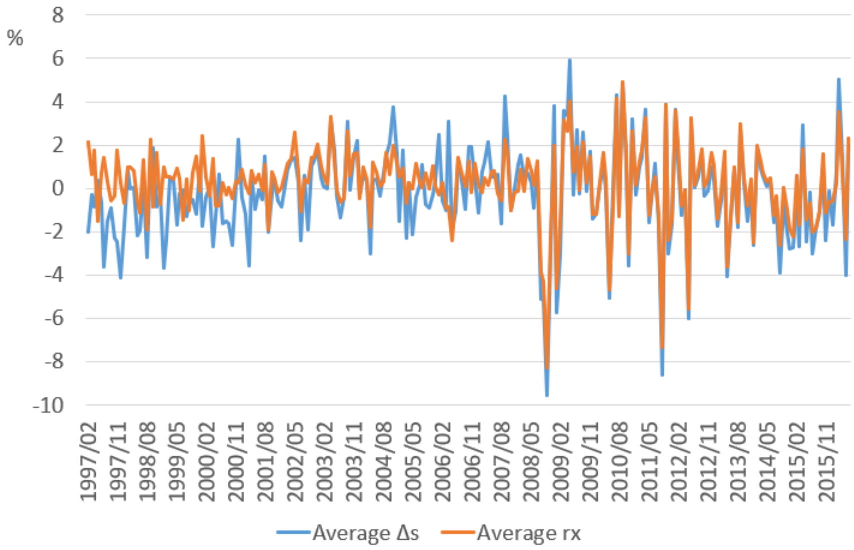

Figure 1: Average Δs and rx

External assets and liabilities

Data on total external assets and liabilities, FDI, external portfolio debt assets and liabilities and the subcomponents are collected from IMF's Balance of Payments and International Investment Position Statistics (BoP-IIP, 2016). As these data are only available at a quarterly frequency, the last known value is used until the data is updated next quarter. External assets is the USD value of the assets a country owns abroad, and external or foreign liabilities refers to the USD value of domestic assets owned by foreigners. Net foreign assets (nfa) is the difference between external assets and liabilities relative to GDP. Net total debt ($nTotDebt$), net total equity ($nTotEquity$), net portfolio debt ($nPDebt$), net portfolio equity ($nPEquity$), net direct investment assets ($nFDI$) and net other investments ($nOther$) are defined in a similar manner and depicted in Figures 2 and 3. Net Total Debt consists of Portfolio investment: Debt securities, Direct investment: Debt instruments and Other investment: Currency and deposits, loans, Other accounts receivable, Trade credits and advances. Net Total Equity is in turn made up of Portfolio investment: Equity and investment fund shares, Direct investment: Equity and investment fund shares, and Other investment: Other equity. The underlying net foreign asset positions can also be split into net foreign assets or investments held either by the private sector (nfa^{PRIV}) or the general government (nfa^{GOVT})[18]. The privately held net assets are in turn made up of assets and liabilities held by deposit taking corporations, labeled $BANK$, and other sectors, $OSECT$, which includes nonfinancial corporations, other financial corporations, households and other sectors. This breakdown is also available for the net total debt, portfolio debt and other intestment assets ($nTotDebt$, $nPDebt$, $nOther$).[19] The private net foreign position is created by subtracting the private foreign liabilities from the private foreign assets, and the same applies to the other ownership positions. As the ownership breakdown is a novel feature of the BoP-IIP statistics, a note of caution is however needed, especially as the reporting standards of the emerging market countries varies somewhat.

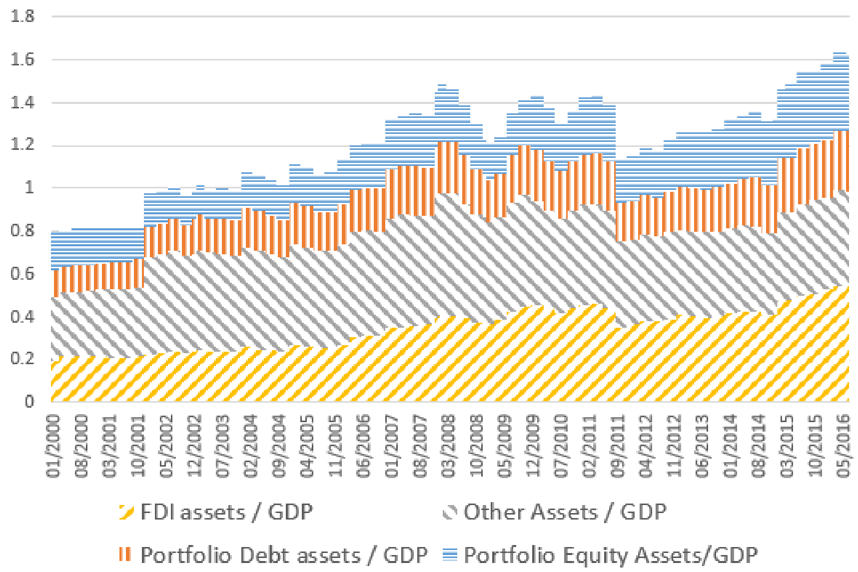

Figure 2: Different types of foreign assets in the sample

Risk intolerance

This paper uses two different proxies for global financial sector risk intolerance, the VIX index and the TED spread. The volatility index VIX of the Chicago Board Options Exchange (CBOE) is a commonly used measure of financial sector risk, which measures the implied volatility of S&P 500 index options. Several papers have found that the VIX is closely related to different types of financial market risk and risk intolerance (Collin-Dufresne et al., 2001). A surge in the VIX index ($\Delta VIX > 0$) implies higher financial market volatility and typically higher market uncertainty and risk intolerance. The TED spread is generally used as a measure of the banking sector risk intolerance. The TED spread is the difference between the 3 month interest rates on interbank loans (LIBOR) and short-term government

[18]This breakdown is unavailable for India, Mexico, New Zealand and Singapore.

[19]This data is missing for Canada, New Zealand, Peru, Singapore and Switzerland. The general government ownership data is missing for Brazil, India, Mexico, the Philippines, Romania, South Africa and Turkey.

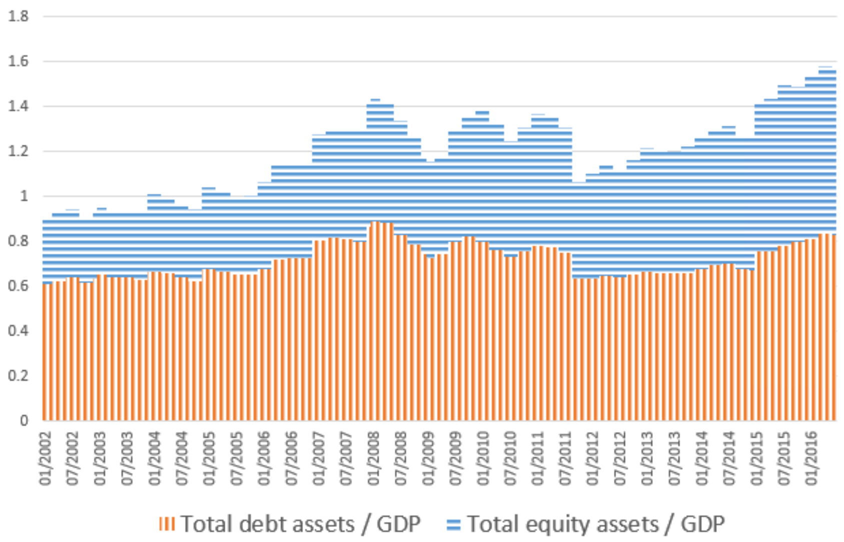

Figure 3: Total foreign debt vs. total foreign equity in the sample

debt (T-bills). The TED spread can be seen as an indicator of credit or banking sector risk, as the short-term government debt can be considered risk free, whereas the interbank rate reflects the credit risk of borrowing to banks. An surge in the TED spread ($\Delta TED > 0$) signals increased interbank default risks, which implies that the banking sector risk bearing capacity is lower and risk intolerance is higher. This paper uses a weighted TED spread which combines the TED spreads of the US, UK, the Eurozone (Germany), Canada, Switzerland and Japan. The contribution of each country to the weighted TED spread is determined by their relative GDP. To make the weighted TED spread exogenous to the changes in banking sector uncertainty for the countries included in the weighted TED spread, the contribution of the own-country TED spread is excluded from the global average for the countries that make up the weighted TED spread (i.e. EA, the UK, Japan, Switzerland and Canada). Data for the TED spreads and the VIX index are downloaded from Bloomberg. To make the VIX and TED series comparable, they are normalized to have a mean of 0 and a standard deviation of 1.

Control variables

As for the control variables, 3 month interbank interest rates, inflation (CPI), output (GDP), PPP and stock market data are downloaded from Bloomberg. The interest rate differential is the 3 month interbank rate difference[20] between the foreign country and the US. The stock market differential captures the monthly differences between the main stock market index of the foreign country versus the US, and the inflation differential is the difference between foreign and US CPI.[21] The change in foreign currency reserves is defined as the change in foreign reserve assets relative to GDP.

[20] For Chile the 1 year swap rate difference is used instead of the interbank rate difference.

[21] To ensure that the results are not driven by a correlation with nfa and future inflation or stock market returns, as these might be forward looking, in the robustness check the models are also estimated with 4 month lags of the inflation and stock market return differentials.

5 Results

The results from models (4) - (7), which regress exchange rate changes or excess currency returns on net foreign assets, changes in risk intolerance and the interaction of these two are presented below. The models are estimated both without and with control variables[22] for the full sample, and for the subsamples of G10 and emerging market (EM) currencies. As it is possible that the impact of external assets and liabilities has changed over time due to either changes in financial market integration or regulation, or because the relationship might have been different during the great financial crisis, the sample is also split into three subperiods, a pre-crisis period, 1/1997–3/2007, a crisis period 4/2007–12/2009 and a post-crisis period, 1/2010–6/2016.[23]

5.1 Net foreign assets

First, the results from the regressions of equations (4) and (5), which look at the impact of total nfa on the exchange rate or excess returns, are presented below. As can be seen from Table 1, the coefficients on the change in global risk intolerance ΔRI, as proxied either by an increase in financial market volatility, ΔVIX, or banking sector uncertainty, ΔTED, and on the interaction terms of nfa and a change in risk intolerance, are significant and of the expected sign. The negative estimated coefficient on ΔRI, $\hat{\beta}_1$, implies that a surge in RI leads to a significant currency depreciation against the USD (as $\Delta s < 0$ imply foreign currency depreciation) and a reduction in currency excess returns rx in countries with zero net foreign assets.[24] As the results and conclusions for rx are very similar to the ones for Δs, for the sake of space I only present the results for Δs in the rest of the paper, but the same conclusions apply. When the sample is split into G10 and EM currencies in the lower panel of Table 1, the same conclusion can be drawn and the Chow tests[25] does not reject the null hypothesis of no structural differences between the G10 and EM subsamples. However, when the sample period is split into pre-, crisis and post-crisis periods this changes, and the Chow test points to structural instabilities in the relationship over time.

The interaction effect of a change in risk intolerance, as measured either by ΔVIX or ΔTED, and nfa on Δs (and rx) is significant in the full, crisis and the post-crisis sample, and the coefficient on the interaction term is positive. The positive coefficients imply that countries with negative net foreign assets ($nfa < 0$) pay lower excess currency returns and depreciate in case of a sudden worsening of the financial market sentiment (ΔVIX or $\Delta TED > 0$). Countries with a positive net foreign asset

[22] For the sake of space the control variables are not presented in the tables included in the text. The full tables with the control variables for a selection of the models can be found in Appendix C.

[23] Currency specific Bai and Perron (2003) breakpoint tests for an unknown breakpoint suggest that for the large majority of the currencies there is a break in the relationship between net external liabilities, exchange rate and risk tolerance changes at some point between 7/2007–10/2008.

[24] A lagged dependent variable was initially included in the models, but as it was in most cases close to zero and rarely significant, and the panel Durbin Watson test indicates the absence of serial correlation, it was excluded. When lags of the interaction terms are added to the models, the sign of the estimated coefficients on lagged interaction variables are in most cases positive but insignificant.

[25] The Chow test for structural stability tests whether the true coefficients of the linear regressions on different datasets are identical.

position, on the other hand, experience a much smaller currency depreciation (if at all any) and pay relatively higher excess currency returns when risk intolerance increase.

The total estimated impact on Δs or rx of a change in RI is $\hat{\beta}_1 + \hat{\beta}_2\overline{nfa}$. As an illustration, the results in column (ii) suggest that a one standard deviation increase in the VIX volatility index would depreciate currencies with no net foreign assets by 1.4 % against the USD. However, countries with negative net foreign assets will experience a much larger depreciation. For example Mexico, which has an average negative nfa among the net debtor countries, would depreciate by an additional 0.3 %-points against USD, so in total by 1.7 %. The exchange rate impact of the increase in VIX is thus around 20 % larger for the MXN than for a country with zero net foreign assets. The effect on a net creditor currency like the Swiss franc, CHF, is the opposite. Due to its positive net foreign asset, the effect of a one standard deviation increase in the VIX index is much smaller and results in CHF depreciating by only 0.5 % against the USD. The total impact of a change in risk intolerance on the dependent variable, Avg. ΔRI impact, for the average nfa position is also reported in the tables.[26]

The estimated interaction coefficients including ΔTED are all much smaller in magnitude compared to the ones including ΔVIX for the full sample and for the G10 and EM subsamples, presented in the lower panel of Table 1, and the average impact of a change in VIX is in most cases twice as large compared to the same change in TED. The $\bar{R}^2$ is also substantially higher for the models using VIX to proxy risk intolerance as compared to the ones using TED. It thus seems like in the full sample, the main channel through which large external debt positions affect the exchange rate is via the change in financial market volatility and the uncertainty resulting from that, rather than via banking sector uncertainty.

Next I proceed to looking at whether the ownership of the net foreign assets matter for the exchange rate sensitivity, and the net foreign assets are split into net private (nfa^{PRIV}) and general government holdings (nfa^{GOVT}). The results for the full, post-crisis, G10 and EM samples are presented in Table 2. The impact of private negative net foreign assets on the exchange rate sensitivity is much larger than that of negative public ones, as is suggested by the much larger and more significant coefficients on the interaction terms involving the private net external assets than the sovereign ones. The coefficients for the full and the post-crisis estimates are not significantly different from each other in the estimations involving ΔVIX, but are almost twice as large in the post-crisis period as in the full sample in the models including ΔTED, suggesting that the exchange rate impact has intensified since the crisis. When the positions are split into private net foreign assets held by the banking sector (nfa^{BANK}) and other sectors (nfa^{OSECT}), the results suggest that the effect is the largest for net foreign liabilities held by the banking sector, and this is especially the case for the emerging market currencies. Thus, negative private net foreign assets seem to be the channel through which the vulnerability arises.

[26]As the average nfa position in the sample is rather small (and globally it should be zero), the average ΔRI impact is however fairly close to the estimated impact of ΔRI for when $nfa = 0$.

	Full sample							
Dep. Var	Δs				rx			
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
ΔVIX	-1.504***	-1.403***			-1.583***	-1.441***		
	(0.089)	(0.085)			(0.090)	(0.085)		
ΔTED			-0.778***	-0.744***			-0.829***	-0.763***
			(0.115)	(0.110)			(0.117)	(0.112)
ΔVIX*nfa	0.861***	0.781***			0.891***	0.783***		
	(0.133)	(0.128)			(0.134)	(0.127)		
ΔTED*nfa			0.429**	0.406**			0.446***	0.434***
			(0.170)	(0.164)			(0.173)	(0.166)
nfa	0.072	0.171	0.117	0.198	0.308	0.077	0.361	0.109
	(0.233)	(0.239)	(0.241)	(0.245)	(0.240)	(0.241)	(0.247)	(0.248)
Avg. ΔRI impact	-1.590***	-1.481***	-0.821***	-0.784***	-1.671***	-1.519***	-0.874***	-0.806***
	(0.10)	(0.09)	(0.12)	(0.12)	(0.10)	(0.09)	(0.12)	(0.12)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
N	25	25	25	25	25	25	25	25
Obs	5,180	5,180	5,180	5,180	4,986	4,986	4,986	4,986
$\bar{R}^2$	0.081	0.102	0.012	0.045	0.091	0.122	0.013	0.061
DW	1.97	2.03	1.95	1.99	1.99	2.04	1.96	2.01

	G10		EM		Pre-crisis, 1/1997-3/2007		Crisis, 4/2007-12/2009		Post-crisis, 1/2010-6/2016	
Dep. Var	Δs		Δs		Δs		Δs		Δs	
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)
ΔVIX	-1.185***		-1.574***		-0.369***		-2.489***		-1.403***	
	(0.130)		(0.106)		(0.140)		(0.244)		(0.118)	
ΔTED		-0.484***		-0.940***		-0.343***		-1.208***		-1.366***
		(0.160)		(0.150)		(0.132)		(0.209)		(0.343)
ΔVIX*nfa	1.008***		0.528***		0.980***		0.755***		0.618***	
	(0.238)		(0.131)		(0.210)		(0.289)		(0.166)	
ΔTED*nfa		0.544*		0.194		0.118		0.389*		0.895
		(0.310)		(0.165)		(0.236)		(0.222)		(0.547)
nfa	-0.373	-0.432	0.420	0.503	0.800**	0.794**	2.311*	2.736**	1.850**	2.008**
	(0.390)	(0.392)	(0.305)	(0.314)	(0.346)	(0.341)	(1.222)	(1.244)	(0.764)	(0.790)
Avg. ΔRI	-1.165***	-0.474***	-1.670***	-0.976***	-0.491***	-0.358**	-2.545***	-1.237***	-1.450***	-1.434***
	(0.13)	(0.16)	(0.12)	(0.17)	(0.15)	(0.15)	(0.25)	(0.21)	(0.12)	(0.35)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	9	9	16	16	25	25	25	25	25	25
Obs	1,982	1,982	3,198	3,198	2,493	2,493	812	812	1,875	1,875
$\bar{R}^2$	0.087	0.041	0.116	0.053	0.042	0.033	0.249	0.154	0.193	0.115
DW	2.04	2.02	2.02	1.98	1.99	1.97	2.16	2.04	2.27	2.26
Chow	0.99	0.96	0.99	0.96	9.15***	9.29***	9.15***	9.29***	9.15***	9.29***

Note: White SE in parentheses. Symbols ***, ** and * denote significance at the respective 1%, 5% and 10 % levels. A constant and currency fixed effects are included. Avg. ΔRI impact=$\hat{\beta}_1 + \hat{\beta}_2\, \overline{nfa}$, where RI is proxied either by VIX or TED. DW refers to the panel Durbin-Watson test statistic for serial correlation and Chow to the Chow test for poolability of the EM and G10 samples, or the pre-, crisis and post-crisis samples, with H_0 : no structural difference between the samples.

Table 1: Panel regression of models (1) and (2)

	Full sample				Post-crisis			
	07/1997-06/2016				1/2010-6/2016			
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
ΔVIX	-0.974***	-0.746***			-0.911***	-0.641***		
	(0.109)	(0.125)			(0.152)	(0.174)		
ΔTED			-0.671***	-0.594***			-0.571	-0.115
			(0.149)	(0.168)			(0.484)	(0.531)
ΔVIX*nfa^{PRIV}	1.792***				1.532***			
	(0.249)				(0.386)			
ΔVIX*nfa^{GOVT}	0.135	0.584*			0.280	0.686**		
	(0.301)	(0.322)			(0.297)	(0.333)		
ΔVIX*nfa^{OSEC}		1.308***				1.044**		
		(0.279)				(0.436)		
ΔVIX*nfa^{BANK}		4.086***				3.858***		
		(0.752)				(1.006)		
ΔTED*nfa^{PRIV}			1.250***				2.969**	
			(0.282)				(1.185)	
ΔTED*nfa^{GOVT}			-1.246	-1.003			-0.164	0.653
			(0.766)	(0.811)			(1.068)	(1.179)
ΔTED*nfa^{OSEC}				1.070***				2.250*
				(0.321)				(1.279)
ΔTED*nfa^{BANK}				2.100**				6.944**
				(0.916)				(2.952)
N	22	22	22	22	21	21	21	21
Obs	4,145	4,145	4,145	4,145	1,512	1,512	1,512	1,512
$\bar{R}^2$	0.10	0.11	0.05	0.05	0.18	0.19	0.11	0.12
DW	2.05	2.06	2.02	2.02	2.25	2.25	2.24	2.25
Chow					7.02***	7.63***	6.74***	7.44***

	G10				EM			
	1/1997-6/2016				1/1997-6/2016			
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
ΔVIX	-0.964***	-0.477*			-1.051***	-1.435***		
	(0.140)	(0.247)			(0.257)	(0.260)		
ΔTED			-0.526***	-0.165			-0.409	-0.604*
			(0.184)	(0.299)			(0.330)	(0.346)
ΔVIX*nfa^{PRIV}	1.776***				1.478***			
	(0.333)				(0.574)			
ΔVIX*nfa^{GOVT}	0.167	0.464			0.454	-0.288		
	(0.311)	(0.326)			(1.043)	(1.026)		
ΔVIX*nfa^{OSEC}		0.953*				-1.615**		
		(0.513)				(0.775)		
ΔVIX*nfa^{BANK}		3.755***				11.84***		
		(0.960)				(2.198)		
ΔTED*nfa^{PRIV}			0.713**				2.578***	
			(0.335)				(0.758)	
ΔTED*nfa^{GOVT}			-2.082**	-1.465			-1.904	-2.118
			(0.884)	(0.908)			(1.339)	(1.316)
ΔTED*nfa^{OSEC}				0.114				1.290
				(0.525)				(0.976)
ΔTED*nfa^{BANK}				2.326**				7.513**
				(1.175)				(3.546)
N	8	8	8	8	14	14	14	14
Obs	1,616	1,616	1,616	1,616	2,529	2,529	2,529	2,529
$\bar{R}^2$	0.09	0.09	0.04	0.04	0.11	0.13	0.06	0.06
DW	2.05	2.07	2.02	2.03	2.06	2.06	2.03	2.03
Chow	0.52	0.80	1.32*	0.99	0.52	0.80	1.32*	0.99

Note: White SE in parentheses, symbols ***, ** and * denote significance at the respective 1%, 5% and 10 % levels. Constant, constitutive terms, control variables and currency fixed effects are included. DW refers to the panel Durbin-Watson test statistic for serial correlation and Chow to the Chow test for poolability of the EM and G10 samples, or the pre-, crisis and post-crisis samples, with H_0 : no structural difference between the samples.

Table 2: NFA in different sectors for different samples

5.2 Different types of foreign capital

Net total debt and net total equity

As not all types of capital are equally affected by the business cycle, the foreign assets are first split into two components, net total debt, ($nTotDebt$) and net total equity ($nTotEquity$). This allows us to see whether net external debt, consisting of portfolio debt, bank and corporate loans, bank deposits, trade credits and "other debt", has a different impact on the exchange rate than net foreign equity (portfolio equity, direct investment equity and "other equity"). Moreover, it tells us whether currencies with negative net foreign total debt are more sensitive to risk sentiment changes than countries with similar net foreign total equity positions. As the results for using Δs and rx as dependent variables are fairly similar and rarely significantly different from each other, only the results using Δs are presented from now on for the sake of space. The conclusions regarding the relationship between net foreign assets, ΔRI and Δs thus also apply for the excess currency returns for the rest of the paper.

As can be seen from Table 3, in both the full sample and in the subsamples, the estimated coefficients on the ΔRI proxies are all negative and in most cases significant. The negative coefficients on the ΔRI terms again imply that countries with zero net total debt and equity experience a currency depreciation against the USD when global risk intolerance increases. The interaction terms including $nTotDebt$ and the change in either VIX or the TED spread are positive and significant in almost all models (with the exception of column (vi) in the EM sample and ($viii$) for the pre-crisis period). The positive and significant interaction terms imply that negative net total debt positions increase the exchange rate sensitivity to surges in risk intolerance so that the currency depreciates even further, whereas countries with positive net total debt depreciate much less or not at all. The impact of net equity positions on the exchange rate sensitivity is small and insignificant in most cases, although for the EM currencies the results indicate that currencies of countries with net equity liabilities tend to depreciate when the banking sector uncertainty increases.

For the sample split between G10 and EM currencies in columns (iii)$-$(vi), two observations can be made. First, the coefficients on both ΔVIX and ΔTED are much larger for the EM than for the G10 currencies, implying that EM countries with no net debt or equity experience much larger depreciations against the USD than the G10 currencies. The average impact of a change in risk intolerance on the exchange rate is moreover significantly larger for the EM than for the G10 currencies, even though the interaction term on total debt and risk intolerance is smaller. This suggests that the EM currencies are much more vulnerable to changes in the global risk sentiment than the G10 currencies, regardless of their net foreign debt or equity positions.

When the sample is divided into a pre-crisis, crisis and a post-crisis sample to see whether the relationship between Δs, ΔRI and $nTotDebt$ has stayed constant over time, the Chow tests again suggest that there are structural differences between the sub-periods. As can be seen from columns

(vii) to (xii), the impact of changes in VIX has been fairly constant over the full currency sample, which raises suspicions that the significant Chow statistic is driven by some large residuals during the crisis period. The impact of banking sector uncertainty, TED, is however much larger after the crisis. The interaction effect between net total debt and the TED spread is much stronger in the post-crisis sample, which suggests a tighter relationship between the banking sector and foreign exchange markets now than during the beginning of this millennium. My results thus suggest that the interaction between net total debt and banking sector risk intolerance has a much larger impact on the exchange rate since the financial crisis. The substantially higher $\bar{R}^2$ also confirm that the factors included in the models explain a larger share of the variation in Δs since the credit crisis.

The total exchange rate impact of a change in risk intolerance, RI, is $\hat{\beta}_1 + \hat{\beta}_2\ \overline{nTotDebt} + \hat{\beta}_3\ \overline{nTotEquity}$. As the average net debt and net equity position in the sample are rather small (as the sample consists of both net debtor and net creditors), the average total impact of a change in risk intolerance is fairly close to the impact for $nTotDebt$ and $nTotEquity$=0. Figure 4 therefore illustrates how the different currencies in the sample respond to changes in VIX and TED. According to the figure, reactions between the different currencies vary substantially. An increase in the VIX index or the TED spread causes the CHF to appreciate against the USD, whereas the HUF, NZD and PLN depreciate the most due to their countries' large negative net debt positions. Again can be seen that the impact of the banking sector risk intolerance, the TED spread, has a much smaller impact on the exchange rate than a change in the VIX index.

When the net total debt positions are split into private and government holdings Table 4, the results suggest that the exchange rate sensitivity to the VIX index is more than two times higher in countries with private net total debt than in countries with the same government net total debt[27]. This is the case both in the full and the post-crisis sample, and for the emerging markets currencies this difference is even larger. The estimates including VIX are not significantly different in the full and post-crisis sample, but the TED estimates in columns (x)-(xii) in the upper panel are somewhat larger, again suggesting that the impact of banking sector uncertainty on exchange rates has intensified since the crisis. The results in column (v) and (x) indicate that only private net debt makes the exchange rate respond stronger to a change in banking sector risk bearing capacity, although the reaction is much smaller than compared to the change in VIX. When the net private debt is split into banking sector holdings and non-bank holdings, the exchange rate vulnerability is high both in countries with substantial corporate and banking sector net debt liabilities, as both interaction terms with $nTotDebt^{OSEC}$ and $nTotDebt^{BANK}$ are significant in most full-sample models. When the sample is split into G10 and EM currencies the results however suggest that the exchange rate vulnerability

[27]Note the variation in sample size between the different models, as government $nTotDebt$ data is unavailable for a number of countries.

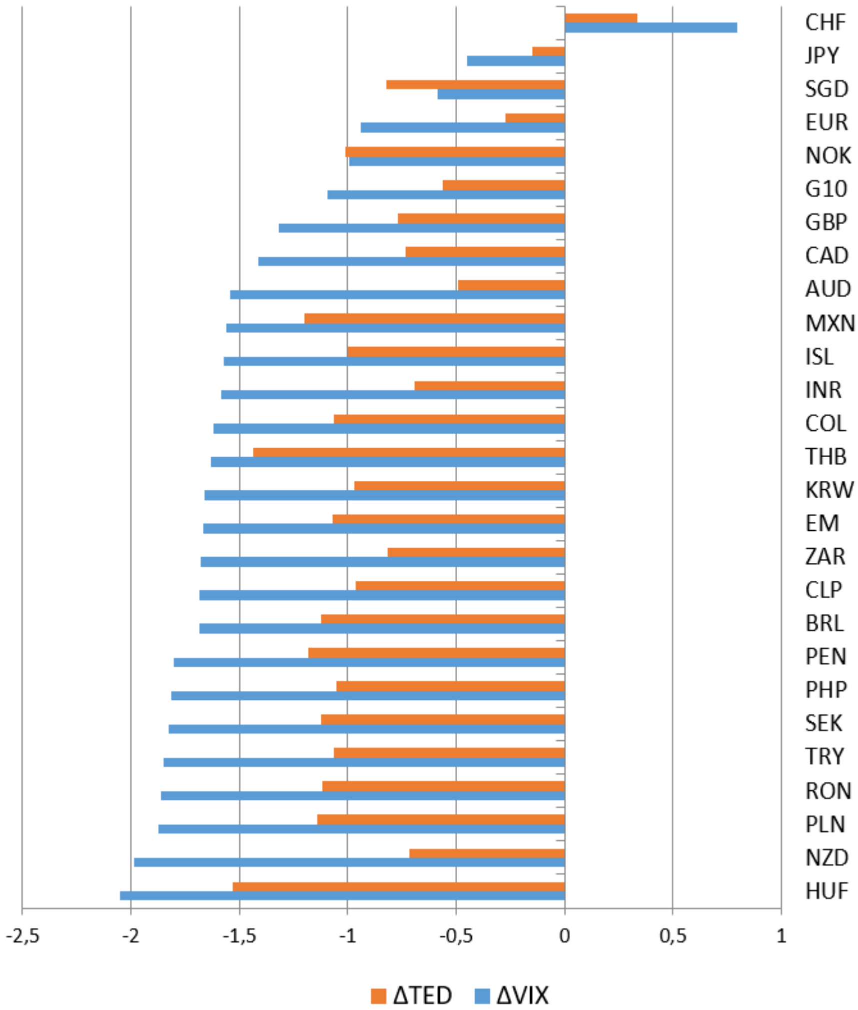

Figure 4: Total effect of ΔRI taking the impact of nTotDebt and nTotEquity into account

	Full sample		**G10**		**EM**		**Pre-crisis,** 1/1997-3/2007		**Crisis,** 4/2007-12/2009		**Post-crisis,** 1/2010-6/2016	
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)	(xi)	(xii)
ΔVIX	-1.156***		-0.737***		-1.560***		-0.130		-2.391***		-1.117***	
	(0.096)		(0.158)		(0.208)		(0.154)		(0.279)		(0.131)	
ΔTED		-0.654***		-0.247		-0.643**		-0.294**		-1.134***		-0.860**
		(0.121)		(0.180)		(0.264)		(0.147)		(0.223)		(0.400)
ΔVIX*nTotDebt	1.376***		1.525***		1.055***		1.162***		1.189***		1.370***	
	(0.205)		(0.312)		(0.261)		(0.248)		(0.456)		(0.305)	
ΔVIX*nTotEquity	0.231		-0.359		-0.461		0.899		-0.233		-0.044	
	(0.289)		(0.426)		(0.745)		(0.614)		(0.865)		(0.330)	
ΔTED*nTotDebt		0.610**		0.620*		0.244		-0.001		0.614*		2.387**
		(0.238)		(0.333)		(0.333)		(0.292)		(0.346)		(0.979)
ΔTED*nTotEquity		0.734		-1.477*		1.659*		1.570**		0.284		-0.309
		(0.456)		(0.880)		(0.887)		(0.618)		(0.660)		(1.085)
Avg. ΔRI impact	-1.458	-0.837	-1.112	-0.569	-1.665	-1.071	-0.420	-0.423	-2.557	-1.261	-1.463	-1.447
N	25	25	9	9	16	16	24	24	24	24	25	25
Obs	5,022	5,022	1,982	1,982	3,040	3,040	2,383	2,383	779	779	1,860	1,860
$\bar{R}^2$	0.104	0.045	0.095	0.044	0.118	0.055	0.041	0.037	0.242	0.148	0.196	0.113
DW	2.04	2.01	2.05	2.02	2.04	2.01	2.01	1.99	2.17	2.05	2.26	2.26
Chow			1.09	1.15	1.09	1.15	8.49***	8.73***	8.49***	8.73***	8.49***	8.73***

Note: Dependent variable: Δs. White SE in parentheses, symbols ***, ** and * denote significance at the respective 1%, 5% and 10 % levels. Constant, constitutive terms, control variables and currency fixed effects included. Avg. ΔRI impact= $\hat{\beta}_1 + \hat{\beta}_2 \overline{nTotDebt} + \hat{\beta}_3 \overline{nTotEquity}$, where RI is proxied either by VIX or TED. DW refers to the panel Durbin-Watson test statistic for serial correlation and Chow to the Chow test for poolability of the EM and G10 samples, or the pre-, crisis and post-crisis samples, with H_0 : no structural difference between the samples.

Table 3: Panel regression of model (3) for different samples

arises from the banking sector net liabilities rather than the non-bank (mostly corporate) sector.

My findings that large private debt liabilities especially in the banking sector increase the exchange rate sensitivity to financial market risk intolerance are in line with Gabaix's and Maggiori's (2015) exchange rate theory, which hypothesizes that currencies of net debtor countries depreciate in case of a sudden deterioration in the market sentiment. They posit that the main channel which this effect operates through is the balance sheet channel of banks. If there is a deterioration in the bank's risk bearing capacity, this leads the bank to reprice their currency lending which in turn affects both capital flows and the exchange rate. One would however expect the coefficient on the interaction between ΔTED and $nTotdebt$ to be of larger than the coefficients on the terms including VIX, if the main impact channel is via the banking sector risk bearing capacity. Although the coefficient was mostly significant and positive as expected in most models, it is only in the post-crisis period that TED has had a larger impact on the exchange rate vulnerability than VIX. Also, in all the models that use the TED spread as the measure of risk intolerance produced substantially smaller $\bar{R}^2$'s than the same models that use VIX instead. This would suggest that it is not only the banking sector risk bearing capacity that plays a role, but also the risk bearing capacity of other financial market players. My finding that the influence of ΔTED has become stronger after the financial crisis however gives support to Gabaix and Maggiori's (2015) theory that the exchange rate vulnerability originates from changes in the international financial sector risk bearing capacity.

	Full sample 7/1997-6/2016						**Post-crisis** 1/2010-6/2016					
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)	(xi)	(xii)
ΔVIX	-0.83***	-0.93***	-1.19***				-0.64***	-0.67***	-1.09***			
	(0.16)	(0.19)	(0.12)				(0.19)	(0.24)	(0.16)			
ΔTED				-1.04***	-1.22***	-0.82***				-0.28	-0.277	-0.700
				(0.28)	(0.30)	(0.16)				(0.58)	(0.679)	(0.466)
ΔVIX*nTotDebt^{PRIV}	3.49***						3.27***					
	(0.60)						(0.73)					
ΔVIX*nTotDebt^{GOVT}	1.19*	1.10					1.57**	1.54**				
	(0.70)	(0.70)					(0.73)	(0.74)				
ΔVIX*nTotDebt^{OSEC}		4.88***	4.36***					3.61**	4.27***			
		(1.21)	(0.96)					(1.56)	(1.37)			
ΔVIX*nTotDebt^{BANK}		2.85***	2.68***					3.09***	2.42**			
		(0.87)	(0.74)					(1.14)	(0.98)			
ΔTED*nTotDebt^{PRIV}				1.80**						5.42**		
				(0.91)						(2.11)		
ΔTED*nTotDebt^{GOVT}				-1.19	-1.25					1.47	1.721	
				(1.59)	(1.61)					(2.33)	(2.349)	
ΔTED*nTotDebt^{OSEC}					4.92***	1.74					5.672	8.587**
					(1.66)	(1.27)					(4.746)	(4.151)
ΔTED*nTotDebt^{BANK}					0.40	1.51*					5.609*	5.567**
					(1.15)	(0.92)					(3.144)	(2.815)
N	13	13	20	13	13	20	12	12	19	12	12	19
Obs	1,776	1,776	3,478	1,776	1,776	3,478	867	867	1,405	867	867	1,405
$\bar{R}^2$	0.139	0.139	0.117	0.075	0.076	0.053	0.196	0.195	0.201	0.121	0.121	0.127
DW	2.12	2.12	2.04	2.08	2.08	2.01	2.22	2.22	2.26	2.22	2.23	2.25
Chow							3.51***	3.22***	3.08***	3.28***	8.59***	8.82***

	G10						**EM**					
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)	(xi)	(xii)
ΔVIX	-0.68***	-0.77	-0.54				-0.79**	-1.13***	-1.58***			
	(0.21)	(0.54)	(0.36)				(0.34)	(0.38)	(0.22)			
ΔTED				-0.88**	-0.94	-0.11				-1.50***	-1.94***	-1.25***
				(0.36)	(0.68)	(0.37)				(0.53)	(0.72)	(0.30)
ΔVIX*nTotDebt^{PRIV}	2.85***						7.01***					
	(0.63)						(2.36)					
ΔVIX*nTotDebt^{GOVT}	0.53	0.48					0.60	-0.82				
	(0.80)	(0.86)					(1.44)	(1.51)				
ΔVIX*nTotDebt^{OSEC}		3.38	2.12					-1.08	-4.05*			
		(2.75)	(1.98)					(4.13)	(2.24)			
ΔVIX*nTotDebt^{BANK}		2.59	3.11**					12.51***	10.49***			
		(1.59)	(1.25)					(3.58)	(2.02)			
ΔTED*nTotDebt^{PRIV}				1.70**						1.47		
				(0.86)						(4.55)		
ΔTED*nTotDebt^{GOVT}				-5.59***	-5.58***					0.09	-0.80	
				(2.15)	(2.15)					(2.44)	(2.65)	
ΔTED*nTotDebt^{OSEC}					2.11	0.38					-5.41	-3.44
					(3.28)	(2.05)					(7.61)	(2.78)
ΔTED*nTotDebt^{BANK}					1.52	2.36*					3.29	6.73**
					(1.77)	(1.40)					(4.71)	(3.33)
N	6	6	6	6	6	6	7	7	14	7	7	14
Obs	899	899	1,098	899	899	1,098	877	877	2,380	877	877	2,380
$\bar{R}^2$	0.120	0.118	0.102	0.063	0.061	0.047	0.160	0.164	0.138	0.094	0.093	0.065
DW	2.06	2.06	2.04	2.02	2.02	2.00	2.14	2.15	2.05	2.12	2.12	2.02
Chow	0.41	0.51	0.70	0.45	0.98	1.23	0.41	0.51	0.70	0.45	0.98	1.23

Note: Dependent variable: Δs. White SE in parentheses, symbols ***, ** and * denote significance at the respective 1%, 5% and 10 % levels. Constant, constitutive terms, control variables and currency fixed effects included. DW refers to the panel Durbin-Watson test statistic for serial correlation and Chow to the Chow test for poolability of the EM and G10 samples, or the pre-, crisis and post-crisis samples, with H_0 : no structural difference between the samples.

Table 4: Panel regression of model (3) for the full sample

Net portfolio debt and equity, net FDI and net Other investment

The net foreign assets are eventually split into four different components, net portfolio debt ($nPDebt$), net portfolio equity ($nPEquity$), net portfolio FDI ($nFDI$) and net other investment ($nOther$), where the other investments include among other items bank and corporate loans, bank deposits and trade credits. As can be seen from the results in Table 5, the positive interaction coefficients on $nPDebt$ and $nOther$ suggest that in the full sample, negative net foreign portfolio debt and negative net foreign other investments lead to a significantly larger currency depreciation during times of financial turbulence than countries with positive net positions. These results imply that currencies of countries with large negative portfolio debt holdings and negative net other investments are the most vulnerable to a sudden worsening in the global financial market risk sentiment. As a large share of the foreign debt inflow is intermediated via foreign banks whose risk bearing capacity decreases during times of financial uncertainty, an increase in risk intolerance translates into larger currency depreciation for countries with large portfolio and other debt liabilities.

Currencies of countries that have the same amount of outstanding external liabilities in portfolio equity are however not affected by swings in the market sentiment to the same extent. There are some minor indications that the less cyclical net external portfolio equity holdings might insulate the exchange rate from an increase in financial market risk aversion, as coefficients on the interaction terms including $nPEquity$ and VIX or TED in columns (i), (xi) and (xii) are negative, although only significant at the 10 % level. A potential explanation to this could be that debt and equity financing are substitutes, so countries that have more net equity financing have less net debt financing, which reduces the exchange rate impact of the global risk sentiment. Thus, negative net external portfolio debt and other investments increase the exchange rate vulnerability to financial market volatility, whereas external portfolio equity reduces this impact somewhat. As the exchange rate impact of ΔTED is again much smaller than ΔVIX, this however suggests that it is not only the banking sector risk that matter for the exchange rate sensitivity to global risk aversion, but that the risk intolerance of other financial market players matters as well.

When the sample is split between the G10 and emerging market currencies, we see that in the G10 sample the vulnerability to changes in the VIX index is significantly higher the higher the net portfolio debt liabilities are, and for the emerging market sample, this vulnerability is instead higher the larger the net other investment liabilities are. The substantially higher $\bar{R}^2$ for both the crisis and post-crisis period also point to global risk intolerance and external imbalances playing a much bigger role for both exchange rate movements and excess currency returns nowadays. As the Chow test indicates structural instabilities in the series over time, more weight should be given to the post-crisis results.

The sensitivity of the currencies in the sample to changes in global financial market risk intolerance are illustrated in Figure 5. Again, the CHF is associated with a small exchange rate appreciation (depreciation) in case of a sudden increase (decrease) in RI, whereas the reaction of the NZD, HUF and RON to changes in VIX is over 50 % larger than for the average currency in the sample. As can be seen from the figure as well, the impact of a change in banking sector risk intolerance, as measured by ΔTED, on the exchange rate is much smaller than for ΔVIX.

	Full sample		**G10**		**EM**		**Pre-crisis,** 1/1997-3/2007		**Crisis,** 4/2007-12/2009		**Post-crisis,** 1/2010-6/2016	
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)	(xi)	(xii)
ΔVIX	-1.04***		-0.97***		-1.19***		0.12		-2.41***		-1.02***	
	(0.13)		(0.26)		(0.32)		(0.24)		(0.37)		(0.16)	
ΔTED		-0.59***		-0.39		-0.16		-0.42**		-0.85***		-0.57
		(0.16)		(0.30)		(0.51)		(0.21)		(0.27)		(0.48)
ΔVIX*nPDebt	1.12***		1.03**		0.86		1.18***		1.16**		1.06***	
	(0.24)		(0.47)		(0.60)		(0.32)		(0.58)		(0.34)	
ΔVIX*nPEquity	-0.72*		-0.59		-0.55		-0.25		-1.63		-0.75*	
	(0.38)		(0.49)		(1.06)		(0.89)		(1.32)		(0.43)	
ΔVIX*nFDI	0.79*		0.93		0.44		0.17		0.18		0.45	
	(0.43)		(1.38)		(0.81)		(0.70)		(1.18)		(0.58)	
ΔVIX*nOther	3.07***		3.13		2.85**		4.47**		2.59		2.90**	
	(1.02)		(2.84)		(1.39)		(1.87)		(2.38)		(1.41)	
ΔTED*nPDebt		0.09		-0.07		-1.13		-0.37		0.21		1.92*
		(0.28)		(0.53)		(0.86)		(0.36)		(0.41)		(1.08)
ΔTED*nPEquity		-0.07		-1.38		2.91		0.97		-0.68		-2.35*
		(0.67)		(1.01)		(1.84)		(0.94)		(1.03)		(1.42)
ΔTED*nFDI		1.38**		0.19		2.44**		1.99***		0.18		0.53
		(0.54)		(1.43)		(1.06)		(0.70)		(0.86)		(1.81)
ΔTED*nOther		1.68		3.44		2.77		-0.66		4.93**		5.48
		(1.31)		(3.64)		(1.98)		(1.60)		(2.22)		(4.16)
Avg. ΔRI impact	-1.52	-0.92	-1.20	-0.53	-1.68	-0.62	-0.49	-0.35	-2.67	-1.35	-1.43	-1.39
N	23	23	9	9	14	14	23	23	23	23	23	23
T	233	233	233	233	233	233	122	122	33	33	78	78
Obs	4,699	4,699	1,959	1,959	2,740	2,740	2,233	2,233	747	747	1,719	1,719
$\bar{R}^2$	0.107	0.047	0.101	0.050	0.117	0.055	0.045	0.037	0.248	0.154	0.193	0.112
DW	2.04	2.01	2.05	2.03	2.04	2.01	2.01	1.99	2.17	2.06	2.27	2.27
Chow			0.89	1.18	0.89	1.18	7.76***	7.98***	7.76***	7.98***	7.76***	7.98***

Note: Dep. var: Δs. White SE in parentheses, symbols ***, ** and * denote significance at the respective 1%, 5% and 10 % levels. Constant, constituent terms, controls and currency fixed effects included. Avg. ΔRI impact$= \hat{\beta}_1 + \hat{\beta}_2\ \overline{nPDebt} + \hat{\beta}_3\ \overline{nPEquity} + \hat{\beta}_4\ \overline{nFDI} + \hat{\beta}_5\ \overline{nOther}$, where RI is proxied either by VIX or TED. DW refers to the panel Durbin-Watson test statistic for serial correlation and Chow to the Chow test for poolability of the EM and G10 samples, or the pre-, crisis and post-crisis samples, with H_0 : no structural difference between the samples.

Table 5: Panel regression of model (4)

Finally, I look at how the ownership of portfolio debt and other investments affect the exchange rate sensitivity[28]. As can be seen from Table 6, it's the net foreign portfolio debt and other investments (which consists of mostly bank loans) of the private sector that gives rise to the exchange rate vulnerability in the full and the post-crisis sample. When I look at the separate impact of the banking sector and non-bank sector (i.e. mostly corporate sector), I find that the sensitivity is boosted by both corporate and banking sector net private debt liabilities, and banking sector net other liabilities.

When I separate between the G10 and emerging market currencies, I find that the exchange rate sensitivity originates from different sources in the different currency groups. As the Chow test now points to structural differences between the G10 and EM currencies, more weight should be given

[28] As there is insufficient data on portfolio equity and FDI holdings by sector, the analysis is limited to net external portfolio debt and net external other investments. As the net other investments by the government are either missing, zero or very small for a large number of the countries in the sample, these are also excluded from the analysis. Note also that the sample for the net portfolio government debt is missing for a number of countries, so the N in Table 6 varies between the different models.

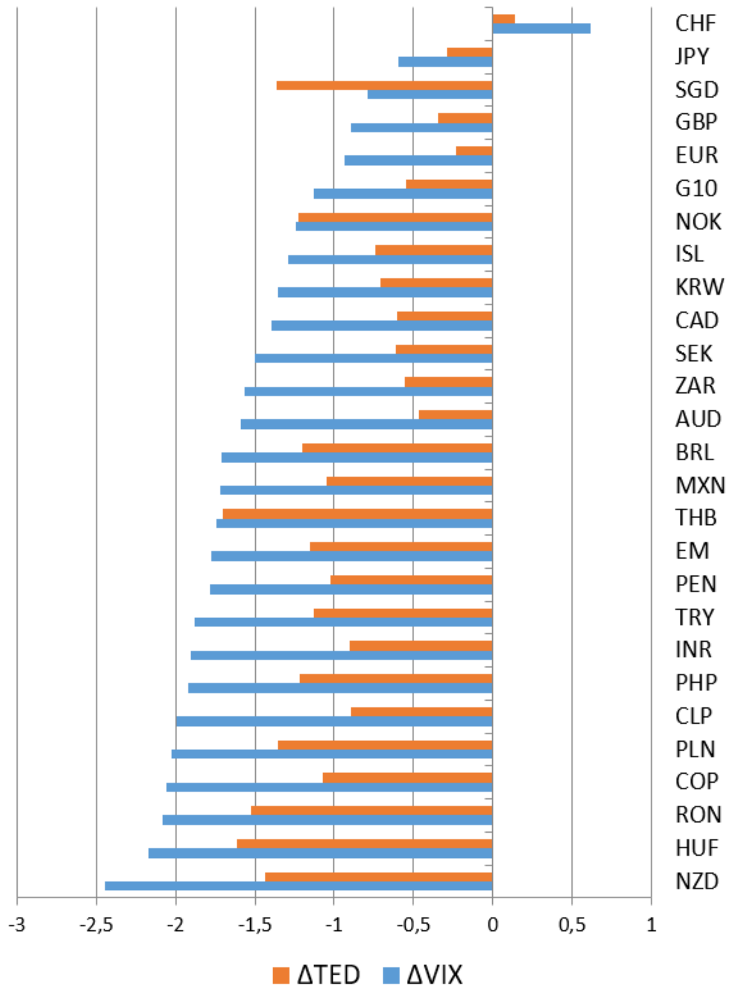

Figure 5: Total effect of ΔRI on Δs taking the impact of net portfolio debt, equity, fdi and other investments into account

to the results from the sub-samples. The exchange rate sensitivity in the G10 currency pairs arises from the private net portfolio debt, whereas in the emerging markets the vulnerability originates from the net other investment liabilities, and in particular from the net other investment liabilities in the banking sector. This can be linked to Adams-Kane et al.'s (2017) findings, that during crises foreign banks reduce their foreign lending to developing countries, which subsequently leads to the exchange rate being more vulnerable to swings in the global risk sentiment as well. As this vulnerability arises from the banking sector in particular, this gives support to Gabaix and Maggiori's (2015) theory that a reduction in the risk tolerance can lead to an exchange rate depreciation of the debtor country due to a scale back in the foreign lending. For the G10 currencies the vulnerability is not only high when the banking sector net portfolio liabilities are high, but it applies also to the corporate (or non-bank) sector.

	Full sample			Post-crisis			G10			EM		
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)	(xi)	(xii)
ΔVIX	-1.16***	-0.71***	-1.29***	-0.88***	-0.35	-1.16***	-1.13***	-1.05***	-0.93***	-1.24***	-1.22***	-1.31***
	(0.17)	(0.23)	(0.17)	(0.20)	(0.26)	(0.21)	(0.30)	(0.32)	(0.25)	(0.20)	(0.16)	(0.16)
ΔVIX*nPDebt^{PRIV}	3.16***	3.19***		2.66***	3.09***		3.21***	3.18***		0.96		
	(0.63)	(0.67)		(0.73)	(0.75)		(0.63)	(0.72)		(4.01)		
ΔVIX*nOther^{PRIV}	3.38***	5.05***		4.93***	7.03***		-2.98	-1.73		5.79***	5.57***	
	(1.31)	(1.88)		(1.58)	(2.20)		(2.23)	(2.41)		(1.56)	(1.36)	
ΔVIX*nPDebt^{GOVT}		0.79			1.44*			0.41				
		(0.75)			(0.77)			(0.82)				
ΔVIX*nPDebt^{OSEC}			5.60***			5.57***			3.88**			
			(1.15)			(1.39)			(1.55)			
ΔVIX*nOther^{OSEC}			1.63			-5.15						-1.56
			(1.93)			(3.28)						(1.99)
ΔVIX*nPDebt^{BANK}			2.18***			2.18**			2.99***			
			(0.84)			(0.93)			(1.05)			
ΔVIX*nOther^{BANK}			4.02**			11.57***						12.60***
			(1.64)			(2.82)						(2.37)
N	20	14	20	19	12	19	6	6	6	14	15	15
Obs	3,478	1,836	3,478	1,405	867	1,405	1,098	899	1,098	2,380	2,977	2,977
$\bar{R}^2$	0.116	0.137	0.117	0.201	0.197	0.210	0.116	0.129	0.108	0.132	0.125	0.131
DW	2.05	2.12	2.05	2.25	2.21	2.25	2.04	2.06	2.04	2.05	2.03	2.03
Chow				8.41***	5.41***	8.12***	1.72***	1.79***	1.15	1.72***	2.60***	2.60***

	Full sample			Post-crisis			G10			EM		
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)	(xi)	(xii)
ΔTED	-0.82***	-1.13***	-0.82***	-0.17	0.10	-0.53	-0.63*	-1.41***	-0.37	-0.91***	-0.60***	-0.65***
	(0.22)	(0.38)	(0.23)	(0.58)	(0.76)	(0.64)	(0.37)	(0.52)	(0.23)	(0.28)	(0.21)	(0.22)
ΔTED*nPDebt^{PRIV}	1.60*	1.42		5.31**	4.89**		2.23***	2.44**		-5.65		
	(0.86)	(1.14)		(2.09)	(2.16)		(0.80)	(1.08)		(6.68)		
ΔTED*nOther^{PRIV}	1.53	2.84		11.47**	10.91*		-1.77	-2.30		4.89*	6.02***	
	(1.91)	(3.22)		(4.83)	(6.30)		(2.20)	(2.94)		(2.72)	(2.22)	
ΔTED*nPDebt^{GOVT}		-3.61**			0.73			-6.13***				
		(1.67)			(2.45)			(2.21)				
ΔTED*nPDebt^{OSEC}			1.76			10.35**			1.59			
			(1.76)			(4.68)			(1.72)			
ΔTED*nOther^{OSEC}			1.67			-5.67						3.45
			(2.41)			(9.23)						(2.40)
ΔTED*nPDebt^{BANK}			1.50			4.87*			2.30**			
			(1.13)			(2.83)			(1.15)			
ΔTED*nOther^{BANK}			1.47			23.29***						9.05**
			(1.99)			(8.04)						(3.69)
N	20	14	20	19	12	19	6	6	6	14	15	15
Obs	3,478	1,836	3,478	1,405	867	1,405	1,098	899	1,098	2,380	2,977	2,977
$\bar{R}^2$	0.053	0.077	0.052	0.126	0.119	0.128	0.053	0.069	0.046	0.064	0.058	0.059
DW	2.01	2.08	2.01	2.25	2.22	2.25	2.01	2.04	2.00	2.02	2.01	2.01
Chow				8.78***	4.97***	8.27***	1.30	0.99	1.45**	1.30	1.35*	1.49**

Note: Dep. var: Δs. White SE in parentheses, symbols ***, ** and * denote significance at the respective 1%, 5% and 10 % levels. Constant, constituent terms, controls and currency fixed effects included. DW refers to the panel Durbin-Watson test statistic for serial correlation and Chow to the Chow test for poolability of the EM and G10 samples, or the pre-, crisis and post-crisis samples, with H_0 : no structural difference between the samples.

Table 6: Panel regression of model (4)

5.3 Robustness

Finally, some robustness tests are conducted to confirm that the results are not driven by the choice of base currency, some underlying time trend or outliers. These results are presented in Appendix D.

Base currency and endogeneity concerns

What matters from a policy maker's perspective is not necessarily currency movements against the USD, but the currency movements against the country's most important trading partners. The analysis is therefore done using the change in the trade weighted currency basket as dependent variable. From the results in Table 11 in Appendix D can be seen that the same conclusions as for currencies against the USD apply. The biggest difference to the main results are that the impact of ΔTED is much stronger and comparable to the impact of ΔVIX.

As the USD is used as the base currency and the VIX Index is a risk intolerance measure originating from stock options on U.S. stocks, there is the potential risk that a change in USD has an impact on the VIX. To exclude this possibility, the analysis is done with different G10 currencies and the bigger EM currencies like KRW as base currency, while excluding USD from the sample. Changes in GBP and EUR, but especially changes in smaller currencies like the SEK and KRW against all other currencies, are very unlikely to have a significant impact on the VIX or TED spread. The results for using EUR, GBP, SEK and KRW as base currency can be found in Table 12. From there can be seen that when using different base currencies and excluding USD from the sample, the same conclusion as in the main analysis can be drawn. Therefore, it seems very unlikely that the results and conclusions are driven by the impact of USD on VIX. Finally, one could argue that a big change in USD could have an impact on VIX via JPY and CHF against other currencies, as USD, JPY and CHF all tend to move in the same direction in case of an increase in financial market turbulence due to their (perceived) 'safe haven' status. As the original conclusion also prevails even after excluding USD, JPY and CHF from the sample, this strongly suggests that the results are not driven by reverse causality. These results are not reported for the sake of space, but are available upon request.

Regarding endogeneity concerns between the net foreign asset position and exchange rate changes, I reach the same conclusion even if I condition the exchange rate response on the net foreign asset position from over a year back, i.e. if I use the nfa positions lagged by 12 months.

Impact of RI instead of ΔRI

In Gabaix's and Maggiori's (2015) model, an increase in the financial sector risk intolerance leads to a depreciation of the net debtor currency against the net creditor one. It is however also possible that net debtor currencies depreciate whenever the risk bearing capacity is low (i.e. risk intolerance is high), instead of only being affected by the change in risk intolerance. The analysis is therefore repeated using the levels of VIX and the TED spread instead of the changes. The results in Table 13 reveal that the same conclusions as for ΔVIX apply also for VIX, but not for the TED spread. Thus, higher financial market uncertainty, i.e. a higher VIX index, is also associated with an exchange rate depreciation in the negative net foreign asset countries. However, once I include both the risk sentiment level and change in the model, only the interaction terms with the net foreign assets and ΔVIX or ΔTED are significant, and the interaction terms with VIX or TED and the net foreign assets are insignificant.[29] This suggests that the baseline specification is more appropriate than the one in Table 13. Finally, most of the conclusions for a change in VIX hold also for the change in the external finance premium by Gilchrist and Zakrajšek (2012) (although these results are not reported for the sake of space).

Gross foreign asset and liability positions

Forbes and Warnock (2012) show that gross foreign capital inflows can behave very differently from net foreign capital inflows during sudden capital flow stops. Although looking at the relationship between gross capital flows or gross positions and exchange rates is a fundamentally different question, I show that my conclusions based on the net positions hold also for gross positions. To see how the underlying stock of assets and liabilities affect the impact of ΔRI on Δs, the net total foreign debt and equity positions are split into total foreign debt assets $Assets_TotDebt$, total foreign debt liabilities $Liab_TotDebt$, total foreign equity assets $Assets_TotEquity$ and total foreign equity liabilities $Liab_TotEquity$. In this way, I can disentangle the separate effects of the gross positions on the exchange rate sensitivity to risk intolerance. Fairly similar conclusions can be drawn from the results presented in Table 14 in Appendix D as from the analysis on net foreign assets. The significantly negative coefficients for the gross total debt and equity liabilities imply that both foreign debt and equity liabilities are associated with weaker currencies against the USD, while total debt assets significantly reduce the sensitivity of the foreign currency to changes in the financial market risk intolerance. These conclusions apply also to the private sector assets and liabilities. These results are thus generally supporting the claim that higher foreign debt liabilities makes the exchange rate more sensitive to changes in VIX or TED, and this negative effect is offset by holding foreign debt assets.

Time fixed effects or time trend

As both the VIX index and the weighted TED spread are global indices, the inclusion of time fixed effects is not possible as the time fixed effect and the risk intolerance measure would be linearly dependent. In order to circumvent this problem and confirm that the results are not driven by some underlying time trend, I run the regressions with time fixed effects included and ΔVIX or ΔTED excluded. As can be seen from the results presented in Table 15, the previous conclusions hold and

[29] These results are not reported here but are available upon request.

are robust to the inclusion of time fixed effects. The conclusions are also robust to the inclusion of currency specific time trends (not reported here), where the time trends are allowed to have a different impact on the different currency pairs.

Final robustness tests

Finally, some additional robustness checks are done. These are not reported for the sake of space, but are available upon request. As the residuals might be subject to cross-sectional correlation, I adjust the standard errors with the Driscoll and Kraay (1998) procedure. The standard errors do not change much, and my conclusions are still valid. To ensure that the results are not driven by extreme outliers the analysis is conducted using winzorized data.[30] The same conclusions can be drawn as in the main analysis. Also, if the covered interest rate parity (CIP) holds, then the forward discount $fd_t = f_t - s_t \approx i^{US} - i$. When I use fd as a control variable instead of the interest rate difference, my results do not change much. Moreover, as inflation and the stock market returns are forward looking variables, it might be that current values of these are correlated with future net foreign assets. To ensure that the results are not driven by inflation, stock market or interest rate expectations, further lags of these are also included in the model to confirm this. Additionally, as the log change in central bank reserves are related to the actual reserves to GDP (which are included in the total nfa position but not in the decompositions into debt and equity), I also confirm that the results and conclusions do not change if I exclude ΔRes from the control variables or if I exclude the reserves from the net foreign asset position. Also, to rule out that the results are driven by omitted variable bias because I use lagged control variables, I confirm that my conclusions hold also when the contemporaneous values of the control variables are used. The conclusions are also robust to the deletion of single countries from the sample as well as to the use data on total net foreign assets, net foreign debt and net foreign equity instead of the ratios of these to the countries' GDP.

6 Conclusion

In this panel study of 25 advanced economy and emerging market currency pairs against the USD over the time period 1/1997 – 6/2016, I show that the composition of net foreign assets affects the way exchange rates and excess currency returns react to financial market uncertainty.

Gabaix and Maggiori's (2015) exchange rate theory predicts that the exchange rates of countries with net foreign liabilities are more sensitive to reductions in financial market risk bearing capacity. I find that this is indeed the case, but more importantly, I show that different types of net foreign assets have different effects on this exchange rate vulnerability. Net foreign debt liabilities, and in particular

[30] A 95 % winsorization involves computing the lowest 2.5 and 97.5 quantiles of the data, and replacing the values in these quantiles by the respective 2.5 and 97.5 cutoff values.

private net debt liabilities, increase the exchange rate sensitivity to especially changes in financial market uncertainty. Net foreign equity liabilities, on the other hand, do not have this effect, and if anything seem to even ameliorate the negative exchange rate and excess currency return impact of financial market uncertainty somewhat. Due to these offsetting exchange rate effects of the different types of net foreign assets, if one only considers the impact of the total net foreign asset position, the negative impact of different external imbalances on exchange rate stability is underestimated. Thus, the exchange rates of countries with large net foreign debt liabilities depreciate much more in response to a drop in the global risk sentiment than countries with the equivalent net foreign equity position. This phenomenon can partially be explained by the observation that net debt investments are more procyclical than net equity investments, owing to both a different investor base, different degrees of risk sharing, the fact that a large share of foreign debt is issued and intermediated by international banks and the debt roll-over risk. Net FDI positions do not have any significant impact on the relationship between risk intolerance and the exchange rate, which can be explained by FDI flows being less influenced by the global financial cycle. I also find that emerging market currencies are overall more influenced by the global risk sentiment than the G10 currencies. The interaction effect between different types of net foreign assets and risk intolerance is nevertheless smaller for the emerging markets than for the G10 currencies.

Another important finding of this paper is that private and public net foreign assets have different effects on the exchange rate vulnerability. The sensitivity of both the G10 and EM exchange rates to global financial market uncertainty seems to be driven largely by private net foreign liabilities, whereas public net foreign liabilities do not add to the exchange rate vulnerability to the same extent or at all. This can be explained by the lower risk associated with government debt as compared to corporate, which makes it easier for governments to attract financing during crisis times than corporations. Moreover, private investors are often more leveraged than public ones, which suggests that the investors are more affected by both banking sector and general financial market uncertainty. Interestingly, I also find that the exchange rate vulnerability originates from different asset classes for the G10 and emerging market currencies. In the G10 countries, where both the external portfolio debt and other investment markets are large, it is the net external portfolio debt, and not the other investment debt, that give rise to the sensitivity. In the emerging markets, where external "other investment debt" like loans, deposits and trade credits are the most common, the EM currencies are more sensitive the more external net other investment debt in the banking sector, whereas the net external portfolio liabilities or net liabilities by the non-bank sector do not add to the impact. This gives support to Gabaix and Maggiori's (2015) theory that changes in the risk bearing capacity of international financiers can give rise to exchange rate movements in debtor country currencies. However, it is worth mentioning that Gabaix and Maggiori's (2015) model (which the empirical model is partly based on) does not allow for different types of external debtors or creditor, nor for several different types of foreign assets.

Extending the model to allow for both investor and asset heterogeneity thus remains as an important task for the future.

Although the currencies react to changes in global banking sector uncertainty, as measured by the TED spread, I find that the impact of global financial market risk intolerance, as proxied by the VIX index, is much larger. This suggests that not all of the impact is coming from the change in the banking sector's risk bearing capacity, but also via non-bank investors and additional channels. My results suggest that the relationship between the exchange rates, different net foreign assets and the VIX index has remained fairly constant over the sample period, although the Chow test points to some structural instability in the full sample. The exchange rate impact of the TED spread, and the interaction effect with different types of net foreign assets, has nevertheless become larger and stronger after the financial crisis of 2007-2008. Currencies of countries with negative net debt thus respond more strongly to changes in banking sector risk now than before the credit crisis.

My findings are of importance for central banks that are worried that their exchange rates are too sensitive to the global financial business cycle, and for the evaluation of the impact of financial reforms. My results imply that a policy maker concerned about exchange rate volatility should be more alert when the net foreign private and portfolio debt liabilities are large. As the impact of the banking sector uncertainty has become stronger in the past six years, this also warrants more attention than at the beginning of the millennium. The finding that foreign debt liabilities reduce exchange rate stability whereas foreign equity liabilities even marginally supports it, weakens the justification for levying lower taxes on debt investments than on equity investments. My results suggest that policy makers could reduce the exchange rate sensitivity to fluctuations in the financial market risk sentiment by reducing their dependence on debt financing and shifting towards more equity financing. Knowledge of the differential impact of net foreign debt equity on the exchange rate vulnerability is furthermore important for the countries that are currently considering reducing restrictions on foreign ownership of both equity and debt instruments. In this paper I only briefly look at the separate impact of gross foreign assets and liabilities, but as the foreign and domestic capital flows tend to behave differently, it would also be interesting to take a closer look at the relationship between the gross asset positions and exchange rate movements in the future.

References

Adams-Kane, J., J. A. Caballero, and J. J. Lim (2017). Foreign bank behavior during financial crises. *Journal of Money, Credit and Banking 49*(2-3), 351–392.

Aizenman, J. and M. Binici (2015). Exchange market pressure in oecd and emerging economies: Domestic vs. external factors and capital flows in the old and new normal.

Alfaro, L., S. Kalemli-Ozcan, and V. Volosovych (2014). Sovereigns, upstream capital flows, and global imbalances. *Journal of the European Economic Association 12*(5), 1240–1284.

Alquist, R. and M. D. Chinn (2008). Conventional and unconventional approaches to exchange rate modelling and assessment. *International Journal of Finance and Economics, John Wiley & Sons, Ltd. 13*(1), 2–13.

Araujo, J. D., A. C. David, C. van Hombeeck, and C. Papageorgiou (2015). Joining the club? procyclicality of private capital inflows in low income developing countries. *IMF Working Paper No. 15/163*.

Araujo, J. D., P. Lastauskas, and C. Papageorgiou (2017). Evolution of bilateral capital flows to developing countries at intensive and extensive margins. *Journal of Money, Credit and Banking 49*(7), 1517–1554.

Avdjiev, S., B. Hardy, S. Kalemli-Ozcan, and L. Servén (2018). Gross capital flows by banks, corporates and sovereigns. NBER Working Papers 23116, National Bureau of Economic Research.

Bai, J. and P. Perron (2003). Computation and analysis of multiple structural change models. *Journal of Applied Econometrics 18*(1), 1–22.

Blalock, G. and P. J. Gertler (2008). Welfare gains from foreign direct investment through technology transfer to local suppliers. *Journal of International Economics 74*.

Bluedorn, J., R. Duttagupta, J. Guajardo, and P. Topalova (2013). Capital flows are fickle; anytime, anywhere. *IMF Working Papers 13/183*.

BoP-IIP (2016). Balance of payments and international investment position statistics. Database, International Monetary Fund.

Broner, F., T. Didier, A. Erce, and S. Schmukler (2013). Gross capital flows: Dynamics and crises. *Journal of Monetary Economics 60*(1), 113–133.

Brunnermeier, M., D. Rodrik, J. D. Gregorio, B. Eichengreen, M. El-Erian, A. Fraga, T. Ito, P. R. L. J. Pisani-Ferry, E. Prasad, R. Rajan, M. Ramos, H. Rey, K. Rogoff, H. S. Shin, A. Velasco, B. W. di Mauro, and Y. Yu (2012). Banks and cross-border capital flows: Policy challenges and regulatory responses. Technical report, Brookings Committee on International Economic Policy and Reform.

Calvo, G. A., L. Leiderman, and C. M. Reinhart (1993). Capital inflows and real exchange rate appreciation in latin america: The role of external factors. *IMF Staff Papers 40*, 108–151.

Coakley, J. and A.-M. Fuertes (2001). A non-linear analysis of excess foreign exchange returns. *Manchester School 69*.

Collin-Dufresne, P., R. S. Goldstein, and J. S. Martin (2001). The determinants of credit spread changes. *The Journal of Finance 56*.

Della Corte, P., S. Riddiough, and L. Sarno (2016). Currency premia and global imbalances. *Review of Financial Studies 29*.

Della Corte, P., L. Sarno, and G. Sestieri (2012). The predictive information content of external imbalances for exchange rate returns: How much is it worth? *Review of Economics and Statistics 94*.

Driscoll, J. and A. Kraay (1998). Consistent covariance matrix estimation with spatially dependent panel data. *The Review of Economics and Statistics 80*(4), 549–560.

Fernández-Arias, E. (1996). The new wave of private capital flows: Push or pull? *Journal of Development Economics 48*, 389–418.

Forbes, K. J. and F. E. Warnock (2012). Capital flow waves: Surges, stops, flight, and retrenchment. *Journal of International Economics 88*(2), 235–251.

Gabaix, X. and M. Maggiori (2015). International liquidity and exchange rate dynamics. *Quarterly Journal of Economics 130*, 1369–1420.

Ghosh, Atish R.and Qureshi, M. S., J. I. Kim, and J. Zalduendo (2014). Surges. *Journal of International Economics 92*, 266–285.

Gilchrist, S. and E. Zakrajšek (2012). Credit spreads and business cycle fluctuations. *American Economic Review 102*(4).

Gourinchas, P.-O. and H. Rey (2007). International financial adjustment. *Journal of Political Economy 115*, 665–703.

Habib, M. and L. Stracca (2012). Getting beyond carry trade: What makes a safe haven currency? *Journal of International Economics 87*, 50–64.

Hossfeld, O. and R. MacDonald (2015). Carry funding and safe haven currencies: A threshold regression approach. *Journal of International Money and Finance 59*, 185–202.

Jorda, O. and A. M. Taylor (2012). The carry trade and fundamentals: Nothing to fear but feer itself. *Journal of International Economics 88*, 74–90.

Kaminsky, G. L., C. M. Reinhart, and C. A. Vegh (2004). When it rains, it pours: Procyclical capital flows and macroeconomic policies. Nber working papers 10780, National Bureau of Economic Research.

Levchenko, A. and P. Mauro (2007). Do some forms of financial flows help protect against "sudden stops"? *The World Bank Economic Review 21*, 389–411.

Lustig, H., N. Roussanov, and A. Verdelhan (2011). Common risk factors in currency markets. *Review of Financial Studies*.

Martin, A. D. and L. J. Mauer (2003). Exchange rate exposures of us banks: A cash flow-based methodology. *Journal of Banking and Finance 27*.

Menkhoff, L., L. Sarno, M. Schmeling, and A. Schrimpf (2012). Carry trades and global foreign exchange volatility. *The Journal of Finance 67*, 681–718.

Modigliani, F. and M. Miller (1958). The cost of capital, corporation finance and the theory of investment. *American Economic Review 48*, 261–297.

Ricci, L. A., G. M. Milesi-Ferretti, and J. Lee (2013). Real exchange rates and fundamentals: A cross-country perspective. *Journal of Money, Credit and Banking 45*, 845–865.

Rossi, B. (2013). Exchange rate predictability. *Journal of Economic Literature 51*(4), 1063–1119.

Tai, C.-S. (2005). Asymmetric currency exposure of us bank stock returns. *Journal of Multinational Financial Management 15*.

Appendix

Appendix A. Gabaix and Maggiori's (2015) exchange rate model

The empirical model for this study is *inspired* by Gabaix and Maggiori's (2015) two country model with imperfect markets, where exchange rates are financially determined by capital flows and the financial sector's risk bearing capacity. In their model, households produce tradeable and nontradeable goods, trade in the frictionless international goods market and invest with financiers in nominally risk-free bonds. The international capital flows resulting from households' investment decisions are intermediated by financiers, who bear the resulting currency risk. The exchange rate s_t is determined by the demand and supply of capital denominated in the different currencies, where s_t is defined as the quantity of U.S. dollars bought by 1 unit of foreign currency. Thus, s_t determines the strength of the foreign currency and $\Delta s > 0$ implies an appreciation of the foreign currency. The financiers are subject to financial constraints, which limit their risk-bearing capacity and induce them to demand a premium for taking on the currency risk. Financiers' ability to bear risk is denoted by Γ, where a higher Γ (i.e. lower $\frac{1}{\Gamma}$) implies lower financier risk-bearing capacity.

This imperfect risk-bearing capacity creates a demand function for foreign assets. By solving the financiers' constrained optimization problem for a two period model, they arrive at the financiers' aggregate demand for assets:

$$Q_0 = \frac{1}{\Gamma} E\left[s_0 - s_1 \frac{R^*}{R}\right] \tag{8}$$

The financiers aggregate demand for dollar assets Q_0 is decreasing in the strength of the dollar (s_0, where a higher s implies a weaker USD) and the foreign risk-free interest rate R^*, and is increasing in the U.S. interest rate R and the expected future value of the dollar (s_1).

U.S. exports to the foreign country in time t are denoted as ξ_t, $\imath_t$ are the time t U.S. imports from the foreign country, and the dollar value of the exports is $\xi_t s_t$. Total U.S. net foreign assets or net exports in the two period model are thereby defined as $NFA_t = \xi_t s_t - \imath_t$, where a surplus in the first period has to be offset by a deficit in the second. The market clearing conditions (and the equilibrium USD "flow" demand) in period 0 and 1 for the USD against the foreign currency, which states that the net demand for dollar must be zero, are:

$$\xi_0 s_0 - \imath_0 + Q_0 = 0 \qquad \text{and} \qquad \xi_1 s_1 - \imath_1 + RQ_0 = 0 \tag{9}$$

By combining equations (8) and (9) and making the simplifying assumptions $R^* = R = 1$ and $\xi_t = 1$ for $t = 0, 1$ to focus on the key results, Gabaix and Maggiori (2015) reach the following expression for the period 0 exchange rate:

$$s_0 = \frac{(1+\Gamma)\imath_0 + E[\imath_1]}{2+\Gamma} \tag{10}$$

The exchange rate is thus affected by the foreign asset position ($\imath_0$ and $\imath_1$) and the financial sector risk intolerance Γ. The net foreign asset position at the end of the period 0 can be rewritten as $NFA_0 = \xi_0 s_0 - \imath_0 = \frac{E[\imath_1]-\imath_0}{2+\Gamma}$. This implies that if the U.S. has a positive NFA_0, and is thereby financing the deficit in the foreign country, the financiers are long the foreign (debtor) currency and short the creditor currency, i.e. the US dollar. The financiers need compensation for taking on this resulting risk, and for them to be willing to absorb the currency risk they must expect the foreign currency to appreciate.[31] This "required" appreciation can occur if the foreign currency depreciates in time 0.

According to their Proposition 2, the impact of a change in the financial sector risk bearing capacity Γ on the exchange rate s_0 is thus the following:

$$\frac{\partial s_0}{\partial \Gamma} = \frac{-NFA_0}{2+\Gamma} \tag{11}$$

This result implies that if there is a sudden worsening of the financier's risk-bearing capacity or a financial disruption, i.e. $\Gamma \uparrow$, countries with a negative net foreign asset position ($NFA_0 < 0$) see a currency depreciation against the foreign currency ($s \uparrow$), whereas countries with positive net foreign assets appreciate. If we consider NFA fixed and treat (10) as a function of only Γ, $f(\Gamma)$, by using approximation by differentials we can use $ds_0 \approx \Delta s_0$, where

$$\Delta s_0 = f'(\Gamma)\Delta\Gamma = \frac{-NFA_0}{2+\Gamma}\Delta\Gamma \tag{12}$$

The same results are reached if $R^* \neq R \neq 1$ is assumed and when the time frame is extended to three periods. A positive interest rate difference between the debtor and creditor countries would provide incentives for the international investors to finance the imbalance. During times of worsening funding conditions, the resulting exchange rate depreciation would thus be dampened by a higher debtor interest rate.

There are many different types of foreign assets that differ both in their investor base and sensitivity to global risk tolerance. Gabaix's and Maggiori's (2015) conclusion that the net foreign asset position affects the way currencies react to changes in the financial sector risk bearing capacity holds also when different types of net foreign assets are considered. When foreign debt is added to the model, the impact of a change in Γ on s is:

$$\frac{\partial s_0}{\partial \Gamma} = \frac{-NFA_0^L}{2+\Gamma} + \frac{-NFA_0^D}{2+\Gamma} \tag{13}$$

where NFA_0^L denotes the net foreign loans and NFA_0^D the net foreign debt position needed to finance the imbalance at the end of period 0.

[31] This can be related to the carry trade, where investors borrow in a low interest rate currency and invest it abroad under the expectation of obtaining both an interest rate and currency return.

Appendix B. List of countries, currencies, variables and descriptive statistics

Australia (AUD), Brazil (BRL), Canada (CAD), Chile (CLP), Colombia (COP), Euro Area (EUR), Hungary (HUF), India (INR), Israel (ISL), Japan (JPY), Korea (KRW), Mexico (MXN), New Zealand (NZD), Norway (NOK), Peru (PEN), Philippines (PHP), Poland (PLN), Romania (RON), Singapore (SGD), South Africa (ZAR), Sweden (SEK), Switzerland (CHF), Thailand (THB), Turkey (TRY), United Kingdom (GBP), and United States (USD).

Variable	**Description**
nfa	Net foreign assets
nfa^{PRIV}	Net foreign assets held by the private sector
nfa^{GOVT}	Net foreign assets held by the government
nfa^{OSEC}	Net foreign assets held by nonfinancial corporations, households and NPISH
nfa^{BANK}	Net foreign assets held by deposit taking corporations
nTotDebt	Net total foreign debt assets
nTotEquity	Net total foreign equity assets
nToTDebt^{PRIV}	Net total foreign debt assets held by the private sector
nToTDebt^{GOVT}	Net total foreign debt assets held by the government
nToTDebt^{OSEC}	Net total foreign debt assets held by nonfinancial corporations, households & NPISH
nToTDebt^{BANK}	Net total foreign debt assets held by deposit taking corporations
nPDebt	Net foreign portfolio debt assets
nPEquity	Net foreign portfolio equity assets
nFDI	Net foreign direct investment
nOther	Net foreign other investment

Table 7: A description of the net foreign asset variables

	Total sample					G10					EM				
	count	mean	sd	min	max	count	mean	sd	min	max	count	mean	sd	min	max
ΔVIX	5180	-0.005	0.58	-1.44	2.53	1982	-0.003	0.58	-1.44	2.53	3198	-0.005	0.58	-1.44	2.53
ΔTED	5180	0.004	0.43	-1.41	2.20	1982	0.003	0.45	-1.41	2.20	3198	0.005	0.42	-1.41	2.20
nfa	5180	-0.095	0.59	-1.28	2.65	1982	0.046	0.58	-0.93	1.82	3198	-0.182	0.59	-1.28	2.65
nfa^{priv}	4591	-0.219	0.38	-1.15	1.48	1617	0.019	0.50	-1.15	1.48	2974	-0.348	0.21	-1.12	0.09
nfa^{osect}	4591	-0.131	0.35	-0.75	1.34	1617	0.181	0.38	-0.56	1.34	2974	-0.301	0.17	-0.75	0.16
nfa^{bank}	4641	-0.088	0.14	-0.64	0.22	1617	-0.162	0.20	-0.64	0.22	3024	-0.049	0.07	-0.37	0.07
nfa^{govt}	4152	-0.091	0.22	-0.56	2.09	1617	-0.035	0.30	-0.29	2.09	2535	-0.128	0.12	-0.56	0.12
nTotDebt	5180	-0.201	0.42	-1.20	1.48	1982	-0.202	0.51	-1.12	1.39	3198	-0.201	0.35	-1.20	1.48
nTotEquity	5024	-0.087	0.26	-0.92	1.50	1982	0.130	0.26	-0.51	1.50	3042	-0.229	0.15	-0.92	0.23
nTotDebt^{priv}	3484	-0.128	0.19	-0.68	0.42	1101	-0.169	0.31	-0.68	0.42	2383	-0.109	0.10	-0.45	0.04
nTotDebt^{osect}	4142	0.011	0.22	-0.31	1.27	1527	0.124	0.33	-0.19	1.27	2615	-0.055	0.07	-0.31	0.21
nTotDebt^{bank}	3578	-0.091	0.15	-0.67	0.13	1122	-0.200	0.21	-0.67	0.13	2456	-0.041	0.07	-0.31	0.08
nTotDebt^{govt}	2174	-0.111	0.15	-0.58	0.75	1063	-0.081	0.16	-0.29	0.75	1111	-0.140	0.14	-0.58	0.12
nPDebt	5124	-0.036	0.35	-0.75	1.60	1982	-0.062	0.41	-0.75	1.24	3142	-0.020	0.31	-0.44	1.60
nPEquity	4928	0.005	0.22	-0.70	1.36	1960	0.024	0.26	-0.70	1.36	2968	-0.007	0.20	-0.33	1.19
nFDI	4954	-0.101	0.24	-1.26	0.86	1982	0.076	0.20	-0.43	0.86	2972	-0.219	0.19	-1.26	0.11
nOther	5180	-0.123	0.14	-0.67	0.24	1982	-0.091	0.13	-0.49	0.20	3198	-0.143	0.14	-0.67	0.24
nPDebt^{priv}	3484	-0.030	0.16	-0.61	0.51	1101	-0.062	0.29	-0.61	0.51	2383	-0.015	0.04	-0.12	0.09
nPDebt^{osect}	4142	0.040	0.19	-0.19	1.10	1527	0.116	0.29	-0.19	1.10	2615	-0.004	0.03	-0.08	0.12
nPDebt^{bank}	3578	-0.040	0.13	-0.66	0.20	1122	-0.113	0.21	-0.66	0.20	2456	-0.006	0.02	-0.10	0.05
nPDebt^{govt}	2458	-0.090	0.13	-0.38	0.75	1063	-0.089	0.16	-0.29	0.75	1395	-0.091	0.09	-0.38	0.10
nOther^{priv}	4595	-0.087	0.10	-0.49	0.24	1617	-0.087	0.12	-0.49	0.24	2978	-0.086	0.08	-0.38	0.16
nOther^{osect}	4595	-0.031	0.07	-0.26	0.29	1617	0.008	0.08	-0.16	0.29	2978	-0.053	0.06	-0.26	0.13
nOther^{bank}	4641	-0.056	0.08	-0.52	0.14	1617	-0.095	0.10	-0.52	0.14	3024	-0.035	0.05	-0.26	0.07
nOther^{govt}	3857	-0.019	0.04	-0.23	0.05	1607	0.008	0.02	-0.22	0.05	2250	-0.038	0.04	-0.23	0.03
$stock - stock^{US}$	5180	0.002	0.05	-0.29	0.40	1982	-0.001	0.04	-0.21	0.18	3198	0.004	0.06	-0.29	0.40
$\pi - \pi^{US}$	5180	1.730	5.74	-4.26	101.0	1982	-0.608	1.39	-4.26	4.23	3198	3.179	6.83	-4.26	101.0
$i - i^{US}$	5180	3.476	7.06	-6.76	103.6	1982	0.335	2.24	-6.76	6.34	3198	5.422	8.22	-3.36	103.6
ΔRes	5180	0.004	0.05	-0.51	0.44	1982	0.003	0.06	-0.39	0.39	3198	0.004	0.05	-0.51	0.44
PPP	5180	1.853	2.18	-1.93	7.09	1982	1.161	1.63	-0.38	5.15	3198	2.281	2.36	-1.93	7.09
Assets	5180	1.451	2.03	0.01	10.72	1982	2.141	1.70	0.28	7.58	3198	1.024	2.10	0.01	10.72
Assets^{bank}	4641	0.252	0.46	0.00	2.43	1617	0.617	0.62	0.04	2.43	3024	0.056	0.04	0.00	0.24
Assets^{osect}	4595	0.344	0.49	0.00	3.00	1617	0.747	0.64	0.10	3.00	2978	0.125	0.13	0.00	0.66
Assets^{govt}	4152	0.046	0.19	0.00	2.25	1617	0.095	0.29	0.00	2.25	2535	0.014	0.02	0.00	0.14
Liab	5180	1.546	1.61	0.03	8.39	1982	2.095	1.46	0.35	7.71	3198	1.206	1.61	0.03	8.39
Liab^{bank}	4641	0.340	0.49	0.01	2.60	1617	0.778	0.62	0.14	2.60	3024	0.105	0.08	0.01	0.51
Liab^{osect}	4641	0.390	0.38	0.01	2.33	1617	0.690	0.50	0.05	2.33	3024	0.229	0.10	0.01	0.55
Liab^{govt}	4641	0.136	0.10	0.01	0.59	1617	0.130	0.08	0.01	0.32	3024	0.139	0.11	0.01	0.59
AssetsTotDebt	5180	0.691	1.21	0.00	6.41	1982	1.056	1.03	0.10	4.57	3198	0.465	1.27	0.00	6.41
AssetsTotEquity	5070	0.468	0.61	0.00	3.35	1982	0.732	0.55	0.03	2.80	3088	0.298	0.58	0.00	3.35
LiabTotDebt	5180	0.892	1.00	0.02	5.27	1982	1.258	0.85	0.23	4.11	3198	0.665	1.02	0.02	5.27
LiabTotEquity	5134	0.551	0.56	0.01	3.52	1982	0.602	0.50	0.02	2.83	3152	0.519	0.59	0.01	3.52
AssetsPDebt	5124	0.203	0.33	0.00	1.72	1982	0.364	0.32	0.02	1.46	3142	0.101	0.29	0.00	1.72
$\text{AssetsPDebt}^{bank}$	4113	0.047	0.08	0.00	0.44	1374	0.126	0.10	0.00	0.44	2739	0.008	0.01	0.00	0.05
$\text{AssetsPDebt}^{osect}$	4318	0.106	0.19	0.00	1.21	1607	0.248	0.26	0.02	1.21	2711	0.022	0.03	0.00	0.14
$\text{AssetsPDebt}^{govt}$	2539	0.024	0.09	-0.00	0.84	1143	0.042	0.13	0.00	0.84	1396	0.010	0.02	-0.00	0.11
LiabPDebt	5180	0.238	0.22	0.00	1.18	1982	0.426	0.24	0.05	1.18	3198	0.121	0.08	0.00	0.46
LiabPDebt^{bank}	3934	0.077	0.14	0.00	0.74	1355	0.201	0.19	0.00	0.74	2579	0.012	0.02	0.00	0.10
LiabPDebt^{osect}	4455	0.064	0.08	0.00	0.45	1527	0.139	0.10	0.01	0.45	2928	0.026	0.02	0.00	0.14
LiabPDebt^{govt}	4550	0.097	0.08	0.00	0.38	1527	0.129	0.08	0.01	0.30	3023	0.081	0.07	0.00	0.38
AssetsOthInv	5180	0.445	0.86	0.00	4.88	1982	0.632	0.67	0.07	2.69	3198	0.329	0.94	0.00	4.88
$\text{AssetsOther}^{bank}$	4641	0.205	0.38	0.00	2.04	1617	0.499	0.53	0.04	2.04	3024	0.048	0.04	0.00	0.19
$\text{AssetsOther}^{osect}$	4595	0.099	0.14	0.00	0.77	1617	0.189	0.20	0.02	0.77	2978	0.051	0.04	0.00	0.27
LiabOther	5180	0.568	0.85	0.02	4.91	1982	0.723	0.69	0.11	2.81	3198	0.472	0.93	0.02	4.91
LiabOther^{bank}	4641	0.261	0.42	0.00	2.22	1617	0.594	0.57	0.08	2.22	3024	0.084	0.07	0.00	0.38
LiabOther^{osect}	4641	0.132	0.12	0.01	0.73	1617	0.181	0.17	0.03	0.73	3024	0.106	0.06	0.01	0.39
AssetsPEquity	4928	0.229	0.30	0.00	1.70	1960	0.379	0.27	0.03	1.55	2968	0.130	0.28	0.00	1.70
LiabPEquity	5112	0.220	0.25	0.00	1.71	1960	0.355	0.32	0.04	1.71	3152	0.136	0.14	0.00	0.92
AssetsFDI	5180	0.349	0.47	0.00	2.45	1982	0.529	0.40	0.03	2.45	3198	0.238	0.48	0.00	2.28
LiabFDI	4954	0.465	0.53	0.00	3.55	1982	0.453	0.30	0.01	1.90	2972	0.473	0.63	0.00	3.55

Note: All the series are ratios to GDP.

Table 8: Descriptive statistics

Appendix C. Full tables for selected models

	Full sample		G10		EM		Pre-crisis		Crisis		Post-crisis	
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)	(xi)	(xii)
Constant	0.01	0.00	0.14	0.27	0.46	0.44	-9.66***	-9.53***	-13.11	-18.35*	20.40***	25.61***
	(0.88)	(0.91)	(1.29)	(1.31)	(1.21)	(1.26)	(1.94)	(1.95)	(10.14)	(10.76)	(4.48)	(4.47)
ΔVIX	-1.40***		-1.18***		-1.57***		-0.37***		-2.49***		-1.40***	
	(0.09)		(0.13)		(0.11)		(0.14)		(0.24)		(0.12)	
ΔTED		-0.74***		-0.48***		-0.94***		-0.34***		-1.21***		-1.37***
		(0.11)		(0.16)		(0.15)		(0.13)		(0.21)		(0.34)
ΔVIX*nfa	0.78***		1.01***		0.53***		0.98***		0.76***		0.62***	
	(0.13)		(0.24)		(0.13)		(0.21)		(0.29)		(0.17)	
ΔTED*nfa		0.41**		0.54*		0.19		0.12		0.39*		0.90
		(0.16)		(0.31)		(0.17)		(0.24)		(0.22)		(0.55)
nfa	0.17	0.20	-0.37	-0.43	0.42	0.50	0.80**	0.79**	2.31*	2.74**	1.85**	2.01**
	(0.24)	(0.25)	(0.39)	(0.39)	(0.30)	(0.31)	(0.35)	(0.34)	(1.22)	(1.24)	(0.76)	(0.79)
ΔRes_{-1}	1.97*	2.22**	1.70	1.80	1.95	2.43	2.23	2.47	4.39*	8.55***	-4.01**	-5.81***
	(1.06)	(1.09)	(1.21)	(1.25)	(1.71)	(1.75)	(1.57)	(1.59)	(2.56)	(2.65)	(1.60)	(1.73)
$(stocks\text{-SP500})_{-1}$	4.53***	4.76***	7.14***	7.61***	4.12***	4.33***	2.67	2.30	3.35	4.14	6.73***	10.78***
	(1.18)	(1.20)	(2.17)	(2.23)	(1.35)	(1.37)	(1.67)	(1.68)	(2.37)	(2.53)	(1.88)	(1.96)
$(\pi - \pi^{US})_{-1}$	0.03*	0.03	0.20***	0.20***	0.02	0.02	0.07***	0.07***	0.06	0.08	0.12**	0.10*
	(0.02)	(0.02)	(0.07)	(0.07)	(0.02)	(0.02)	(0.02)	(0.02)	(0.07)	(0.07)	(0.05)	(0.06)
$(i - i^{US})_{-1}$	0.12***	0.20***	0.54***	0.66***	0.10**	0.17***	0.07	0.09	0.10	0.28*	0.69***	0.93***
	(0.04)	(0.05)	(0.13)	(0.14)	(0.04)	(0.05)	(0.06)	(0.06)	(0.13)	(0.15)	(0.12)	(0.12)
$(i - i^{US})_{-1}$*VIX	-0.01***	-0.01***	-0.02***	-0.03***	-0.01***	-0.01***	0.00	0.00	-0.02***	-0.02***	-0.03***	-0.04***
	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
PPP_{-1}	-0.02	-0.03	0.04	-0.06	-0.20	-0.20	5.38***	5.30***	7.84	10.61*	-10.68***	-13.34***
	(0.45)	(0.47)	(1.11)	(1.13)	(0.50)	(0.52)	(1.06)	(1.07)	(5.57)	(5.91)	(2.25)	(2.25)
N	25	25	9	9	16	16	25	25	25	25	25	25
Obs	5,180	5,180	1,982	1,982	3,198	3,198	2,493	2,493	812	812	1,875	1,875
$\bar{R}^2$	0.102	0.045	0.087	0.041	0.116	0.053	0.042	0.033	0.249	0.154	0.193	0.115
DW	2.03	1.99	2.04	2.02	2.02	1.98	1.99	1.97	2.16	2.04	2.27	2.26

Note: White SE in parentheses, symbols ***, ** and * denote significance at the respective 1%, 5% and 10 % level. Currency fixed effects included. DW refers to the panel Durbin-Watson test statistic for serial correlation.

Table 9: Panel regression of model (1) with constituent terms and controls presented

	Full sample		**G10**		**EM**		**Pre-crisis,** 1/1997-3/2007		**Crisis,** 4/2007-12/2009		**Post-crisis,** 1/2010-6/2016	
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)	(xi)	(xii)
Constant	-0.01	-0.02	-0.18	-0.07	0.35	0.31	-9.90***	-9.85***	-11.14	-15.76	18.69***	23.51***
	(0.87)	(0.91)	(1.27)	(1.29)	(1.20)	(1.25)	(1.84)	(1.85)	(10.58)	(11.16)	(4.49)	(4.50)
ΔVIX	-1.16***		-0.74***		-1.56***		-0.13		-2.39***		-1.12***	
	(0.10)		(0.16)		(0.21)		(0.15)		(0.28)		(0.13)	
ΔTED		-0.65***		-0.25		-0.64**		-0.29**		-1.13***		-0.86**
		(0.12)		(0.18)		(0.26)		(0.15)		(0.22)		(0.40)
ΔVIX*nTotDebt	1.38***		1.53***		1.05***		1.16***		1.19***		1.37***	
	(0.20)		(0.31)		(0.26)		(0.25)		(0.46)		(0.31)	
ΔVIX*nTotEquity	0.23		-0.36		-0.46		0.90		-0.23		-0.04	
	(0.29)		(0.43)		(0.75)		(0.61)		(0.87)		(0.33)	
ΔTED*nTotDebt		0.61**		0.62*		0.24		0.00		0.61*		2.39**
		(0.24)		(0.33)		(0.33)		(0.29)		(0.35)		(0.98)
ΔTED*nTotEquity		0.73		-1.48*		1.66*		1.57**		0.28		-0.31
		(0.46)		(0.88)		(0.89)		(0.62)		(0.66)		(1.08)
nTotDebt	0.70**	0.69*	0.51	0.54	1.02**	1.04**	0.37	0.26	1.80	2.10*	1.51	1.28
	(0.35)	(0.37)	(0.63)	(0.65)	(0.42)	(0.45)	(0.58)	(0.58)	(1.16)	(1.23)	(0.94)	(0.98)
nTotEquity	-0.25	-0.25	-0.60	-0.63	-0.48	-0.41	1.01	1.00	2.82	3.15	0.71	0.93
	(0.33)	(0.34)	(0.40)	(0.42)	(0.63)	(0.63)	(0.76)	(0.75)	(2.25)	(2.34)	(0.86)	(0.88)
ΔRes_{-1}	2.12**	2.42**	1.91	1.73	2.13	2.80	2.32	2.72*	4.52*	8.82***	-3.93**	-6.03***
	(1.06)	(1.08)	(1.20)	(1.25)	(1.72)	(1.76)	(1.54)	(1.56)	(2.59)	(2.68)	(1.62)	(1.77)
$(stocks\text{-SP500})_{-1}$	3.73***	4.09***	6.59***	7.50***	3.19**	3.54***	1.16	0.78	3.25	4.15	6.66***	10.82***
	(1.09)	(1.11)	(2.18)	(2.25)	(1.24)	(1.25)	(1.52)	(1.52)	(2.42)	(2.59)	(1.88)	(1.98)
$(\pi - \pi^{US})_{-1}$	0.02	0.02	0.22***	0.22***	0.01	0.01	0.06***	0.06***	0.06	0.08	0.13**	0.12**
	(0.02)	(0.02)	(0.07)	(0.07)	(0.02)	(0.02)	(0.02)	(0.02)	(0.07)	(0.07)	(0.06)	(0.06)
$(i - i^{US})_{-1}$	0.13***	0.20***	0.51***	0.66***	0.10**	0.17***	0.08	0.10*	0.07	0.24	0.66***	0.89***
	(0.04)	(0.04)	(0.13)	(0.14)	(0.04)	(0.05)	(0.05)	(0.05)	(0.14)	(0.16)	(0.12)	(0.12)
$(i - i^{US})_{-1}$*VIX	-0.01***	-0.01***	-0.02***	-0.03***	-0.01***	-0.01***	0.00	0.00	-0.02***	-0.02***	-0.03***	-0.04***
	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
PPP_{-1}	0.04	0.03	0.46	0.39	-0.14	-0.13	5.59***	5.55***	7.04	9.51	-9.65***	-12.12***
	(0.45)	(0.47)	(1.09)	(1.11)	(0.50)	(0.52)	(1.03)	(1.04)	(5.75)	(6.08)	(2.25)	(2.25)
N	25	25	9	9	16	16	24	24	24	24	25	25
Obs	5,022	5,022	1,982	1,982	3,040	3,040	2,383	2,383	779	779	1,860	1,860
$\bar{R}^2$	0.104	0.045	0.095	0.044	0.118	0.055	0.041	0.037	0.242	0.148	0.196	0.113
DW	2.04	2.01	2.05	2.02	2.04	2.01	2.01	1.99	2.17	2.05	2.26	2.26
Chow			1.09	1.15	1.09	1.15	8.49***	8.73***	8.49***	8.73***	8.49***	8.73***

Note: Dependent variable: Δs. White SE in parentheses, symbols ***, ** and * denote significance at the respective 1%, 5% and 10 % levels. Constant, constitutive terms, control variables and currency fixed effects included.

Table 10: Panel regression of model (3) for the different samples with controls and constituent terms presented

Appendix D. Additional Results

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)	(xi)	(xii)
ΔVIX	-0.19***		-0.13**		-0.16*		-0.17*		-0.06		-0.13	
	(0.05)		(0.06)		(0.09)		(0.09)		(0.07)		(0.11)	
ΔVIX*nfa	0.21***											
	(0.06)											
ΔVIX*nTotDebt			0.28***									
			(0.10)									
ΔVIX*nTotEquity			0.24									
			(0.15)									
ΔVIX*nTotDebt^{PRIV}					1.19***							
					(0.38)							
ΔVIX*nTotDebt^{OSEC}							1.76**					
							(0.72)					
ΔVIX*nTotDebt^{BANK}							0.93**					
							(0.41)					
ΔVIX*nPDebt									0.23**			
									(0.11)			
ΔVIX*nPEquity									-0.11			
									(0.20)			
ΔVIX*nFDI									0.29			
									(0.23)			
ΔVIX*nOther									1.17*			
									(0.66)			
ΔVIX*nPDebt^{PRIV}											1.09***	
											(0.40)	
ΔVIX*nOther^{PRIV}											1.53**	
											(0.70)	
ΔTED		-0.28***		-0.16**		-0.35***		-0.35***		-0.15		-0.44***
		(0.07)		(0.08)		(0.13)		(0.13)		(0.09)		(0.15)
ΔTED*nfa		0.47***										
		(0.10)										
ΔTED*nTotDebt				0.52***								
				(0.13)								
ΔTED*nTotEquity				1.10***								
				(0.23)								
ΔTED*nTotDebt^{PRIV}						1.21**						
						(0.54)						
ΔTED*nTotDebt^{OSEC}								2.50**				
								(0.98)				
ΔTED*nTotDebt^{BANK}								0.58				
								(0.53)				
ΔTED*nPDebt										0.32**		
										(0.14)		
ΔTED*nPEquity										0.49		
										(0.36)		
ΔTED*nFDI										1.29***		
										(0.29)		
ΔTED*nOther										1.06		
										(0.79)		
ΔTED*nPDebt^{PRIV}												1.60**
												(0.65)
ΔTED*nOther^{PRIV}												0.10
												(0.94)
N	26	26	26	26	21	21	21	21	24	24	21	21
Obs	5,413	5,413	5,255	5,255	3,640	3,640	3,640	3,640	4,932	4,932	3,640	3,640
$\bar{R}^2$	0.053	0.057	0.052	0.057	0.065	0.065	0.065	0.066	0.053	0.059	0.065	0.065

Note: Dep. var: Δ Trade weighted currency basket. White SE in parentheses, ***, ** and * denote significance at the respective 1%, 5% and 10 % levels. Constant, constitutive terms, control variables and currency FE included. Full sample, T=233.

Table 11: Panel regressions for a trade weighted currency basket

Base currency:			**EUR**						**GBP**			
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)	(xi)	(xii)
ΔVIX	-0.36***		-0.15		-0.02		-1.04***		-0.80***		-0.639***	
	(0.08)		(0.09)		(0.13)		(0.09)		(0.10)		(0.136)	
ΔTED		-0.25**		-0.17		-0.04		-0.16		-0.06		0.045
		(0.11)		(0.12)		(0.17)		(0.11)		(0.12)		(0.164)
ΔVIX*nfa	0.79***						0.93***					
	(0.12)						(0.13)					
ΔTED*nfa		0.40***						0.45***				
		(0.13)						(0.17)				
ΔVIX*nTotDebt			1.22***						1.37***			
			(0.16)						(0.20)			
ΔVIX*nTotEquity			0.12						0.15			
			(0.22)						(0.27)			
ΔTED*nTotDebt				0.49***						0.59**		
				(0.18)						(0.23)		
ΔTED*nTotEquity				0.46						0.78*		
				(0.39)						(0.46)		
ΔVIX*nPDebt					1.13***						1.092***	
					(0.19)						(0.235)	
ΔVIX*nPEquity					-0.74**						-0.500	
					(0.32)						(0.363)	
ΔVIX*nFDI					0.44						0.140	
					(0.37)						(0.421)	
ΔVIX*nOther					2.97***						4.035***	
					(1.02)						(1.067)	
ΔTED*nPDebt						0.16						0.117
						(0.23)						(0.273)
ΔTED*nPEquity						0.01						0.417
						(0.61)						(0.657)
ΔTED*nFDI						0.64						1.204**
						(0.50)						(0.542)
ΔTED*nOther						2.16						1.990
						(1.32)						(1.309)
N	24	24	24	24	22	22	24	24	24	24	22	22
Obs	4,796	4,796	4,651	4,651	4,364	4,364	4,947	4,947	4,789	4,789	4,466	4,466
$\bar{R}^2$	0.038	0.025	0.037	0.024	0.044	0.027	0.060	0.016	0.059	0.016	0.064	0.019
Base currency:			**SEK**						**KRW**			
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)	(xi)	(xii)
ΔVIX	0.05		0.22**		0.32**		-0.01		0.25**		0.46***	
	(0.09)		(0.10)		(0.13)		(0.11)		(0.13)		(0.17)	
ΔTED		-0.23*		-0.22*		-0.09		0.98***		1.02***		1.10***
		(0.12)		(0.13)		(0.18)		(0.15)		(0.16)		(0.22)
ΔVIX*nfa	0.78***						0.93***					
	(0.13)						(0.15)					
ΔTED*nfa		0.45***						0.42*				
		(0.15)						(0.22)				
ΔVIX*nTotDebt			1.32***						1.49***			
			(0.19)						(0.23)			
ΔVIX*nTotEquity			-0.11						0.14			
			(0.25)						(0.30)			
ΔTED*nTotDebt				0.64***						0.53*		
				(0.22)						(0.31)		
ΔTED*nTotEquity				-0.04						0.48		
				(0.49)						(0.55)		
ΔVIX*nPDebt					1.28***						1.29***	
					(0.24)						(0.26)	
ΔVIX*nPEquity					-0.95***						-0.93**	
					(0.35)						(0.40)	
ΔVIX*nFDI					0.45						0.39	
					(0.40)						(0.50)	
ΔVIX*nOther					2.51**						4.01***	
					(1.06)						(1.36)	
ΔTED*nPDebt						0.45						0.22
						(0.29)						(0.39)
ΔTED*nPEquity						-0.29						-0.47
						(0.68)						(0.81)
ΔTED*nFDI						-0.06						0.69
						(0.58)						(0.72)
ΔTED*nOther						2.36*						2.21
						(1.35)						(1.67)
N	24	24	24	24	22	22	24	24	24	24	22	22
Obs	4,947	4,947	4,789	4,789	4,466	4,466	4,947	4,947	4,789	4,789	4,466	4,466
$\bar{R}^2$	0.016	0.011	0.019	0.012	0.024	0.013	0.007	0.010	0.009	0.010	0.014	0.011

Note: Dependent variable: Δs, where s= either EUR, GBP, SEK or KRW. White SE in parentheses, symbols ***, ** and * denote significance at the respective 1%, 5% and 10 % levels. Constant, constitutive terms, control variables and currency fixed effects included. Full sample, T=233.

Table 12: Panel regressions with different base currencies

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)	(xi)	(xii)
VIX	-0.28***		-0.20***		-0.16**		-0.18**		-0.26***		-0.14	
	(0.06)		(0.06)		(0.08)		(0.08)		(0.09)		(0.11)	
VIX*nfa	0.23**											
	(0.09)											
VIX*nTotDebt			0.38***									
			(0.14)									
VIX*nTotEquity			0.28									
			(0.24)									
VIX*nTotDebt^{PRIV}					1.15***							
					(0.39)							
VIX*nTotDebt^{OSEC}							1.46**					
							(0.67)					
VIX*nTotDebt^{BANK}							1.03**					
							(0.51)					
VIX*nPDebt									0.34**			
									(0.16)			
VIX*nPEquity									0.02			
									(0.32)			
VIX*nFDI									0.51*			
									(0.30)			
VIX*nOther									0.13			
									(0.73)			
VIX*nPDebt^{PRIV}											1.17***	
											(0.44)	
VIX*nOther^{PRIV}											1.43	
											(0.95)	
TED		-0.18***		-0.17***		-0.03		-0.04		-0.21**		0.00
		(0.06)		(0.06)		(0.08)		(0.08)		(0.09)		(0.11)
TED*nfa		0.10										
		(0.08)										
TED*nTotDebt				0.20								
				(0.12)								
TED*nTotEquity				-0.09								
				(0.23)								
TED*nTotDebt^{PRIV}						0.96***						
						(0.37)						
TED*nTotDebt^{OSEC}								0.88				
								(0.60)				
TED*nTotDebt^{BANK}								1.02**				
								(0.49)				
TED*nPDebt										0.15		
										(0.15)		
TED*nPEquity										-0.03		
										(0.33)		
TED*nFDI										-0.04		
										(0.29)		
TED*nOther										0.02		
										(0.67)		
TED*nPDebt^{PRIV}												0.82*
												(0.47)
TED*nOther^{PRIV}												1.30
												(0.90)
N	25	25	25	25	20	20	20	20	23	23	20	20
Obs	5,180	5,180	5,022	5,022	3,478	3,478	3,478	3,478	4,699	4,699	3,478	3,478
$\bar{R}^2$	0.040	0.037	0.039	0.035	0.046	0.042	0.046	0.042	0.040	0.035	0.047	0.042

Note: Dependent variable: Δs. White SE in parentheses, symbols ***, ** and * denote significance at the respective 1%, 5% and 10 % level. Constant, constitutive terms, control variables and currency fixed effects included. Full sample, T=233.

Table 13: Panel regressions using the level of VIX or TED instead of their changes

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
ΔVIX	-1.15***		-0.84***		-1.39***		-1.31***	
	(0.14)		(0.17)		(0.14)		(0.20)	
ΔVIX*Assets	1.01***							
	(0.17)							
ΔVIX*Liab	-1.15***							
	(0.22)							
ΔVIX*Assets_TotDebt			1.76***					
			(0.26)					
ΔVIX*Assets_TotEquity			-0.06					
			(0.32)					
ΔVIX*Liab_TotDebt			-1.51***					
			(0.29)					
ΔVIX*Liab_TotEquity			-0.74**					
			(0.35)					
ΔVIX*Assets_TotDebt^{priv}					3.66***			
					(0.55)			
ΔVIX*Liab_TotDebt^{priv}					-3.14***			
					(0.55)			
ΔVIX*Assets_TotDebt^{osec}							2.42*	
							(1.31)	
ΔVIX*Assets_TotDebt^{bank}							4.64***	
							(1.27)	
ΔVIX*Liab_TotDebt^{osec}							-3.02**	
							(1.33)	
ΔVIX*Liab_TotDebt^{bank}							-3.55***	
							(0.81)	
ΔTED		-0.46**		-0.35		-0.93***		-1.06***
		(0.19)		(0.22)		(0.19)		(0.26)
ΔTED*Assets		0.69***						
		(0.24)						
ΔTED*Liab		-0.87***						
		(0.32)						
ΔTED*Assets_TotDebt				1.00***				
				(0.37)				
ΔTED*Assets_TotEquity				0.55				
				(0.53)				
ΔTED*Liab_TotDebt				-0.95***				
				(0.36)				
ΔTED*Liab_TotEquity				-1.11**				
				(0.53)				
ΔTED*Assets_TotDebt^{priv}						1.91**		
						(0.78)		
ΔTED*Liab_TotDebt^{priv}						-1.60**		
						(0.75)		
ΔTED*Assets_TotDebt^{osec}								2.29
								(1.75)
ΔTED*Assets_TotDebt^{bank}								1.62
								(1.30)
ΔTED*Liab_TotDebt^{osec}								-0.11
								(1.68)
ΔTED*Liab_TotDebt^{bank}								-1.98**
								(0.96)
Observations	5,180	5,180	5,022	5,022	3,478	3,478	3,478	3,478
R^2	0.11	0.05	0.11	0.05	0.13	0.06	0.13	0.06

Note: Dependent variable: Δs. White SE in parentheses, symbols ***, ** and * denote significance at the respective 1%, 5% and 10 % levels. Constant, constitutive terms, control variables and currency fixed effects and time fixed effects included. Full sample, T=233.

Table 14: Panel regression with gross assets and liabilities instead of net

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)	(xi)	(xii)
ΔVIX*nfa	0.79***											
	(0.10)											
ΔVIX*nTotDebt			1.29***									
			(0.15)									
ΔVIX*nTotEquity			0.15									
			(0.19)									
ΔVIX*nTotDebt^{priv}					2.92***							
					(0.45)							
ΔVIX*nTotDebt^{osect}							5.50***					
							(0.92)					
ΔVIX*nTotDebt^{bank}							1.73***					
							(0.48)					
ΔVIX*nPDebt									1.35***			
									(0.15)			
ΔVIX*nPEquity									-0.60**			
									(0.24)			
ΔVIX*nFDI									0.90***			
									(0.28)			
ΔVIX*nOther									1.63***			
									(0.55)			
ΔVIX*nPDebt^{priv}											3.19***	
											(0.52)	
ΔVIX*nOther^{priv}											1.87**	
											(0.94)	
ΔTED*nfa		0.44***										
		(0.13)										
ΔTED*nTotDebt				0.58***								
				(0.18)								
ΔTED*nTotEquity				0.42								
				(0.35)								
ΔTED*nTotDebt^{priv}						1.24*						
						(0.66)						
ΔTED*nTotDebt^{osect}								2.82**				
								(1.31)				
ΔTED*nTotDebt^{bank}								0.50				
								(0.67)				
ΔTED*nPDebt										0.24		
										(0.21)		
ΔTED*nPEquity										-0.08		
										(0.53)		
ΔTED*nFDI										0.82**		
										(0.40)		
ΔTED*nOther										1.60*		
										(0.91)		
ΔTED*nPDebt^{priv}												1.57**
												(0.76)
ΔTED*nOther^{priv}												0.34
												(1.42)
Obs.	5,180	5,180	5,022	5,022	3,478	3,478	3,478	3,478	4,699	4,699	3,478	3,478
R^2	0.45	0.45	0.47	0.46	0.47	0.46	0.47	0.46	0.48	0.47	0.47	0.46

Note: Dependent variable: Δs. White SE in parentheses, symbols ***, ** and * denote significance at the respective 1%, 5% and 10 % levels. Constant, constitutive terms, control variables and currency fixed effects and time fixed effects included. Full sample, T=233.

Table 15: Models including time fixed effects but no ΔTED or ΔVIX