What drives the funding currency mix of banks?

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Abstract

We draw on a new dataset on the use of Swiss francs and other currencies by European banks to assess the determinants of foreign currency funding. We find that these determinants vary across funding currencies, as well as across countries. Swiss franc use in emerging European countries is affected by exchange rate and lending volumes in Swiss franc, in line with the predictions of a simple model. By contrast, risk-related considerations, such as the comovements between various exchange rates, matter for financial centers in the euro area, while funding costs play a role for other euro area countries. The determinants of funding in foreign currencies other than the Swiss franc are also heterogeneous, and appear less sensitive to movements in the explanatory variables than funding in Swiss franc.

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1 Introduction

Banks' use of foreign currency for funding its operations is a much-discussed channel of transmission of foreign and exchange rate shocks to domestic bank funding conditions, and hence, to financial stability and macroeconomic performance. Recent research stresses the impact of monetary and financial shocks in so-called monetary center countries, whose currency is used in international lending, on funding conditions in so-called periphery countries. The existing literature focuses on the international role of the US dollar and the transmission of US funding and monetary shocks to foreign banks' balance sheets. Recent contributions include McCauley et al. [2015], Bruno and Shin [2014], Avdjiev et al. [2012], Cetorelli and Goldberg [2012], Cetorelli and Goldberg [2011] and Milesi-Ferretti and Tille [2011].

While the US dollar clearly plays a central role in the international monetary system, banks also make substantial use of other foreign currencies in their lending and funding. The euro and the Swiss franc notably play important roles in the activity of banks in Europe. This raises the question of how monetary and financial shocks in the home countries of those foreign currencies are transmitted across borders through bank balance sheets, and whether this transmission depends on the particular foreign currencies used in bank funding.

While a growing literature analyzes the use of domestic and foreign currencies in banks loans and deposits, the non-deposit funding activities of banks has received less attention.[1] In addition, most contributions contrast the role of the domestic currency and foreign currency, without contrasting the transmission of shocks across different foreign currencies. Our understanding of the drivers of bank funding in different foreign currencies is thus limited.

This paper contributes to filling this gap by contrasting the role of various drivers on funding currencies, including monetary policy, exchange rate movements, risk, and movements in loans and deposits in foreign currencies. We address these questions by focusing on the use of the Swiss franc, and contrasting it with the use of other foreign currencies. The Swiss franc is of particular interest, as its role as a bank funding currency is not well understood, and because its drivers as a funding currency are likely to differ from euro and USD. Swiss franc assets are considered safe and the Swiss franc is perceived as a safe haven currency at times of international financial stress (Ranaldo and Sderlind [2010], Nitschka 2015 forthcoming). Moreover, in the years after the introduction of the euro, the low volatility of the Swiss franc euro exchange rate and the low interest rate on Swiss franc funding made it an attractive funding currency. Notably, the Swiss franc became popular as a funding currency for mortgages to households and non-financial firms in a number of European countries. Some countries, such as Austria and Hungary, saw a steep rise in bank lending in Swiss francs to non-bank customers in the years leading up the financial crisis. The growth of lending in

[1] Brown and Stix [2014] focus on the currency composition of households' deposits. They focus on the determinants of saving in foreign or local currencies, but not on what drives the positions across different foreign currencies.

Swiss francs raised the need for European banks to fund themselves in that currency.

To frame our analysis, we first derive a simple model of banks' allocation of wholesale funding across various currencies. Banks are faced with exogenous shifts if exchange rates, interest rates, and the values of loans and deposits, and react by adjusting their funding currency mix. This mix reflects the relative funding costs across the available currencies, the fluctuations in loans and deposits (with an increase in loans denominated in currency i leading to higher funding in that currency), past and expected future exchange rate movements. The model points to the need to control for the net positions in the various currencies. For instance, an increase in the expected volatility of the exchange rate between the domestic currency and a foreign currency can raise or lower funding in that currency. The higher volatility leads to a reduction in the magnitude of the bank's net position in the foreign currency. If that position is initially long, this reduction is achieved through higher funding in foreign currency.

We then assess the model implications using a new and unique data set of bank balance sheets in European countries. Our data allow us to distinguish between the use of local currency, the Swiss franc, and other foreign currencies in the funding of European banks. We distinguish between euro area and other European countries as the former primarily use the US dollar in their foreign currency funding, while the later primarily use euro. Both country groups use Swiss franc, but to a lessor extent.

We document a set of stylized facts on European banks' use of Swiss franc and contrast it to the use of other foreign currencies. The role of the Swiss franc as a funding currency differs from the roles of the US dollar and the euro, and this difference depends upon whether the host country is a financial center. Three features of Swiss franc funding stand out. First, in countries that are not financial centers, the Swiss franc is used for domestic lending to a higher degree than other foreign currencies. Second, a greater share of Swiss franc funding takes the form of cross-border interbank funding, compared to other foreign funding currencies. Third, Swiss franc lending tends to be underfunded on balance sheet (banks tend to be long Swiss francs), while lending in other foreign currencies tends to be overfunded (short other currencies).

The implications from the model for the use of funding currencies are assessed in an econometric analysis taking advantage of the panel structure of our data. The period since 2007 was one of great upheaval, offering substantial variation in policy and financial variables, both across time and across home as well as host countries of international funding currencies. The strong appreciation of the Swiss franc that began in 2008 and continued until the summer of 2011, led to increased credit risk on European banks' Swiss franc mortgage portfolios (Ranciere et al. [2010] and Yesin [2013]). At the same time, European banks' need to roll over Swiss franc whole-sale funding was met by a frozen interbank money market in the early stages of the global financial crisis, as perceived counterparty credit risk in global bank funding markets had increased, and a flight to safety erupted during the crisis (Auer et al. [2012]).

Financial and policy developments in other funding countries during the crisis differed in nature and timing, but were equally forceful and hence provide for additional useful variation in external developments.

We contrast the drivers of foreign currency funding along two dimensions. The first is across groups of countries, where we distinguish between emerging economies, financial centers, and euro-area countries that are not financial centers. The second is across foreign currencies, where we split the funding in Swiss franc from the funding in other foreign currencies. Our analysis points to substantial heterogeneity in the determinants of wholesale funding across countries and currencies. The use of Swiss franc in countries outside the euro area is primarily driven by exchange rate considerations and lending in Swiss franc. An appreciation of the Swiss franc reduces the funding in that currency, as it becomes more costly. We find that both future and lagged movements matter, suggesting that exchange rate expectations can entail a backward looking component. Banks also use funding in Swiss franc to limit their net currency exposure following movements in the volumes of lending in that currency.

By contrast, banks located in euro area countries that are not financial centers adjust their Swiss franc funding primarily in response to the interest rate differential between the Swiss franc and the local currency. Funding activity in financial centers is impacted by risk considerations. A higher comovement between the exchange rate relative to the Swiss franc and the exchange rate relative to the dollar leads banks to increase their reliance on the Swiss franc as it then offers a closer alternative to the dollar. Risk appetite, as proxied by the Vix index, also matters.

Funding in foreign currencies other that the Swiss franc is also quite heterogeneous. In emerging economies, it is sensitive to exchange rate movements, as well as lending in Swiss franc, suggesting that the euro and Swiss franc are viewed as partial substitutes to limit the exchange rate exposure stemming from lending activities. By contrast, funding activities in euro area countries display little sensitivity to the various factors we consider. This suggests that funding in euro or US dollar is a steady feature reflecting structural considerations, whereas fudning in Swiss franc is more an adjustment variable in response to the various drivers we consider.

The remainder of the paper proceeds as follows. Section 2 gives an overview of related literature. Section 3 presents the model and derives some testable implications. The data and stylized facts are presented in Section 4, and Section 5 presents the variables we consider and the econometric setup. Section 6 presents the econometric results, and the final section concludes. Supporting materials are provided in the Appendix

2 Related literature

Our work ties to two broad streams of literature, namely the analyses of foreign currency lending and deposits, and of the international transmission of shocks through international

banking activity. Contributions in the first stream of literature have focused on the drivers of foreign currency lending. For instance, Brown and Haas [2012] consider the role of foreign banks in issuing foreign currency lending. One of their findings is a link between the two sides of the balance sheet, as that movements in foreign currency deposits are transmitted to foreign currency lending. Other papers consider banks' liabilities. Brown and Stix [2014] focus on households' deposits and shows a connection with macroeconomic volatility and households' experiences of a past currency crisis. Their work however does not consider the determinants of other funding sources such as interbank loans. This line of research contrasts the positions in foreign and local currencies, but does not consider any heterogeneity across different foreign currencies. Our database allows us to assess this heterogeneity by positions in Swiss francs with positions in other foreign currencies.

Several recent contributions take a focused look on lending in Swiss francs. Brown et al. [2009] document a substantial heterogeneity across countries. Yesin [2013] relies on the same dataset as we do to assess the currency mismatch between assets and liabilities. Auer et al. [2012] focus on the refinancing of Swiss franc lending by Austrian banks. They show a clear break during the crisis when funding through the unsecured interbank market and bond issuance was replaced by funding through the repo market and reliance on the central bank.

The second stream of the literature to which our work is related is the international transmission of shocks through the activity of global banks, with several papers stressing their central role in the crisis (Takats [2010], Avdjiev et al. [2012], McCauley et al. [2015], Milesi-Ferretti and Tille [2011]). Cetorelli and Goldberg [2011] document the spreading of shocks through cross-border lending and operations of local affiliates. Cetorelli and Goldberg [2012] stress the relevance of banks' internal capital markets as affiliates in more robust countries can be used as sources of funds for the parent in a crisis.

3 A Simple Model of Funding Choice

This section presents the main elements and results from a simple model of a bank's funding decisions across currencies. Additional elements are given in Appendix A.[2] We first present the structure of the model, and then turn to the derivation and interpretation of the funding choices.

3.1 Building blocks

3.1.1 Timing and exchange rates

We consider a model focusing on the wholesale funding decision of a bank across the local currency and two foreign currencies, which we refer to as the Swiss franc and the euro. The

[2] A full description of the analysis under a more general parametrization is presented in a technical appendix available on request.

model consists of three periods. In period 0 the bank is endowed with a portfolio of loans and deposits in the three currencies. The initial currency mix of loans and deposits is treated as exogenous, in order to allow us to focus squarely on wholesale funding decisions. The bank chooses its funding knowing that shocks can affect the exchange rate and returns on loans in the final period 2. In period 1 the bank faces shifts in the amounts of loans and deposits, in realized exchange rates, and in the distribution of exchange rates in the final period 2. These shifts are fully unexpected from the point of view of period 0 and lead the bank to revise its funding allocation in period 1.

The exchange rates in terms of units of local currency per unit of foreign currency $i = eur, chf$ is denoted by S^i. Its values in the three periods are S_0^i, $S_1^i = S_0^i \exp\left(\nu_1^{S,i}\right)$ and $S_2^i = S_0^i \exp\left(\nu_1^{S,i} + \tau_2^{S,i}\nu_2^{S,i} + \varepsilon_2^{S,i}\right)$. The exchange rate is affected by a shock $\varepsilon_2^{S,i}$ and two shifters, $\nu_1^{S,i}$ and $\nu_2^{S,i}$. While the bank knows at time 0 that the shock $\varepsilon_2^{S,i}$ can happen in the final period, and knows its distribution, it does not expect the shifters to occur (i.e. it considers their expectations and variances to be both zero). The shifters are revealed at period 1 and thus lead to a reallocation of funding. Our assumption that the shifters are fully unexpected is a short-cut for the sake of simplicity, as otherwise the funding portfolio decision at period 0 would reflect a hedging against these shifters, making the solution substantially more complex.

From the point of view of period 0 the bank considers that $\nu_1^{S,i} = \nu_2^{S,i} = 0$ with probability one, and that the expected value of the exchange rate vis-à-vis currency i is $-0.5\sigma_{i,0}^2$, with variance $\sigma_{i,0}^2$ and covariance $\rho_0\sigma_{eur,0}\sigma_{chf,0}$ between the two exchange rates. The bank's perception changes at period 1 for several reasons. First, it learns that the exchange rate has moved by $\nu_1^{S,i}$, which is a first-order term (i.e. proportional to the standard deviation of the shock $\varepsilon_2^{S,i}$). Second, it learns that the expected exchange rate movement in period 2 is $\tau_2^{S,i}\nu_2^{S,i}$. The shifter $\nu_2^{S,i}$ is a first-order term, and the scaling factor $\tau_2^{S,i}$ is a second-order term (i.e. proportional to the variance of the shock $\varepsilon_2^{S,i}$). This ensures that the expected movement of the exchange rate is not large enough to swamp any risk hedging considerations. Finally, the bank learns that the moments of the exchange rate distribution have changed. Specifically, the variance of the exchange rate vis-à-vis currency i is now $\sigma_{i,0}^2\left(1 + \nu_2^{\sigma,i}\right)$where $\nu_2^{\sigma,i}$ is a first-order shifter. The correlation between the exchange rate also changes, and the diagonal term of the covariance matrix becomes $0.5\sigma_{eur,0}\sigma_{chf,0}\left[\nu_2^{\rho} + \rho_0\left(2 + \nu_2^{\sigma,eur} + \nu_2^{\sigma,chf}\right)\right]$ where ν_2^{ρ} is a first-order shifter denoting the change in the correlation between exchange rates. The new information on exchange rate expectations and volatilities leads the bank to adjust its funding structure in period 1. For simplicity, we consider that the exchange rates are initially independent and equally volatile ($\sigma_{chf,0}^2 = \sigma_{eur,0}^2 = \sigma_{fx}^2$ and $\rho_0 = 0$).

3.1.2 Components of the balance sheet: loans

The bank enters period zero with an endowment of loans in the three currencies, with the domestic currency value of loans denominated in currency i being $S_0^i C_0^i$. Without loss of generality, we consider that the return on loans in the absence of any shocks and shifters is zero, with a similar assumption for the return on deposits and wholesale funding positions.[3]

In period 1 the value of loans is affected by the unexpected shift in the exchange rate, $\nu_1^{S,i}$, as well as an unexpected shift in the loan value in its currency of denomination, $\nu_1^{C,i}$. This second shifter can vary depending on the currency of denomination of the loans, and reflect the issuance of new loans, or gains and losses on existing loans. The domestic currency value of loans in period 1 is thus $S_0^i C_0^i \exp\left(\nu_1^{S,i} + \nu_1^{C,i}\right)$, with $i = dom, eur, chf$.[4]

In the final period 2 the payoff of loans is realized. The payoff across all three currencies is affected by a shock ε_2^{dom} which is independent from the exchange rates. An unexpected appreciation of foreign currencies also reduces the payoffs of loans denominated in the respective currencies, with the sensitivity captured by a parameter λ. The domestic currency value of loans is thus $S_0^i C_0^i \exp\left(\nu_1^{C,i} + \varepsilon_2^{dom} + (1-\lambda)\left(\nu_1^{S,i} + \tau_2^{S,i}\nu_2^{S,i} + \varepsilon_2^{S,i}\right)\right)$.

3.1.3 Components of the balance sheet: deposits and wholesale funding

The bank enters period zero with an endowment of deposits in the three currencies, with the domestic currency value of deposits denominated in currency i being $S_0^i D_0^i$.In period 1 the value is affected by the unexpected shift in the exchange rate, $\nu_1^{S,i}$, as well as an unexpected shift in the deposits values in its currency of denomination, $\nu_1^{S,i}$. This second shifter reflects exogenous variations in deposits. The domestic currency value of deposits in period 1 is thus $S_0^i D_0^i \exp\left(\nu_1^{S,i} + \nu_1^{D,i}\right)$, with $i = dom, eur, chf$. In the final period 2 the value of deposits in foreign currencies is affected by exchange rate movements. The domestic currency value of deposits thus $S_0^i D_0^i \exp\left(\nu_1^{S,i} + \nu_1^{S,i} + \tau_2^{S,i}\nu_2^{S,i} + \varepsilon_2^{S,i}\right)$.

In addition to deposits, the bank funds itself through wholesale borrowing, and can choose the currency allocation of this source of funding.[5] We denote the initial domestic currency value of funding in currency i being $S_0^i F_0^i$. At the beginning of period 1, the value of funding reflects exchange rate movements and is given by $S_0^i F_0^i \exp\left(\nu_1^{S,i}\right)$. In that period the bank picks a new value of wholesale funding, subject to constraints described below, which is written in terms of domestic currency value as $S_0^i F_1^i \exp\left(\nu_1^{S,i}\right)$.

In the final period 2 the value of funding positions reflects the exchange rates as well as frictions. Specicially, the value of domestic currency funding is $F_1^{dom} \exp\left(\tau_2^{q,dom}\nu_2^{q,dom}\right)$ where $\nu_2^{q,dom}$ is a first-order shifter revealed at period 1 and $\tau_2^{q,dom}$ is a second-order scaling variable. The domestic currency value of funding in foreign currency i is $S_0^i F_1^i \exp\left(\nu_1^{S,i} + \tau_2^{S,i}\nu_2^{S,i} + \varepsilon_2^{S,i} + \tau_2^{q,i}\left(1 + \nu_2^{q,i}\right)\right)$

[3] Therefore all components of the balance sheets grow in step in the absence of shocks and shifts.

[4] Of course $S_0^{dom} = 1$ and $\nu_1^{S,dom} = 0$.

[5] As we do not consider short-term liquid assets, the wholesale funding can also be interpreted as representing the value of wholesale funding net of liquid assets in the corresponding currency.

where $\nu_2^{q,i}$ is a first-order shifter revealed at period 1 and $\tau_2^{q,i}$ is a second-order scaling variable. In the absence of any shifter and shocks the exponential term multiplying F_1^{dom} is equal to one and the term multiplying $S_0^i F_1^i$ is equal to $\exp\left(\tau_2^{q,i}\right)$. The term $\tau_2^{q,i}$ thus reflects any gap between the funding cost in domestic currency and the funding cost in the foreign currency i, with a negative value indicating cheaper funding in the foreign currency. This gap is second-order as otherwise the cost differential would be so big as to swamp any risk hedging consideration. The shifters $\nu_2^{q,dom}$ and $\nu_2^{q,i}$ capture movements in the funding costs of the various currencies that are revealed at period 1, and remain small enough so as not to dominate the hedging of risks.

3.1.4 Equity and budget constraints

The bank is initially endowed with an equity position K_0 in domestic currency. As the values of loans and deposits are exogenous, the value of overall wholesale funding is also given and the bank's choice is solely on its allocation across currencies:

$$\sum_{i=dom,eur,chf} S_0^i F_0^i = \sum_{i=dom,eur,chf} S_0^i \left[C_0^i - D_0^i\right] - K_0 \tag{1}$$

In period 1 the bank reallocates its funding across currencies. The total value of wholesale funding reflects the exchange rate movements between periods 0 and 1 as well as the shifts in the amounts of loans and deposits (the terms $\nu_1^{C,i}$ and $\nu_1^{D,i}$) as any net shift must be funded through a change in the wholesale position:

$$\begin{aligned}\sum_{i=dom,eur,chf} S_0^i F_1^i \exp\left(\nu_1^{S,i}\right) \;=\; & \sum_{i=dom,eur,chf} S_0^i F_0^i \exp\left(\nu_1^{S,i}\right) \\ & + \sum_{i=dom,eur,chf} \exp\left(\nu_1^{S,i}\right) S_0^i C_0^i \left[\exp\left(\nu_1^{C,i}\right) - 1\right] \\ & - \sum_{i=dom,eur,chf} \exp\left(\nu_1^{S,i}\right) S_0^i D_0^i \left[\exp\left(\nu_1^{D,i}\right) - 1\right]\end{aligned} \tag{2}$$

The bank's equity in the final period reflects the overall changes in the values of loans, deposits, and wholesale funding, with the exact expression given in the appendix.

3.2 Solution of the model

3.2.1 Initial allocation

The objective of the bank is to maximize an expected concave utility of its final payoff:

$$U_t = E_t \frac{(K_2)^{1-\gamma}}{1-\gamma}$$

subject to the constraints (1) and (2), depending on the time t at which the optimization is undertaken. Notice that in the absence of any shocks and shifters, the various components of the balance sheet are constant.

From the point of view of period 0 the shifters are fully unexpected. The bank's optimization then implies that the expected discounted excess returns in the two foreign currencies are zero (for $i = eur, chf$):

$$0 = E_0 \left(K_2\right)^{-\gamma} \left[\exp\left(\tau_2^{q,i} + \varepsilon_2^{S,i}\right) - 1\right] \tag{3}$$

We approximate this non-linear system around the allocation where no shocks or shifters occur. As the funding choice is a portfolio optimization, our approximation needs to capture the second moments of the model, as well as any shifts in these moments. This is done in general by taking a cubic approximation of (3), as in the portfolio choice models of Tille and van Wincoop [2014] and Tille and van Wincoop [2010]. As from the point of view of period 0 the bank does not expect the second moments to shift, the initial funding allocation is derived from a quadratic approximation of the optimality conditions, and implies:

$$S_0^i F_0^i = S_0^i \left[(1-\lambda) C_0^i - D_0^i\right] - \frac{K_0}{\gamma} \frac{\tau_2^{q,i}}{\sigma_{fx}^2} \tag{4}$$

which we can rewrite as:

$$Net_0^i = S_0^i \left[(1-\lambda) C_0^i - D_0^i - F_0^i\right] = \frac{K_0}{\gamma} \frac{\tau_2^{q,i}}{\sigma_{fx}^2}$$

The term Net_0^i reflects the first-order impact of the exchange rate on equity. An appreciation of the foreign currency i raises the absolute value of the initial net position in that currency and reduces the payoffs on loans by a factor λ. The first component of (4) indicates that the bank chooses the currency composition of funding to bring this impact to zero and thus hedge itself against exchange rate movements. It deviates from this choice if the risk-adjusted cost of funding differs across currencies, with F_0^i being larger when it represents a cheaper funding source than the domestic currency ($\tau_2^{q,i} < 0$).

3.2.2 Re-allocation of funding

In period 1 the bank learns about the various shifters and re-assesses its funding portfolio, subject to the constraint (2). It is convenient to write the new funding positions as the product of the initial position and a term that reflects any reallocation in period 1: $F_1^i = F_0^i \exp\left(f_1^i\right)$ where $f_1^i = 0$ in the absence of reallocation.

The optimization again implies that the expected discounted excess returns are zero (for

$i = eur, chf$):

$$0 = E_1 \left(K_2\right)^{-\gamma} \left[\exp\left(\tau_2^{q,i}\left(1+\nu_2^{q,i}\right)+\tau_2^{S,i}\nu_2^{S,i}+\varepsilon_2^{S,i}\right)-\exp\left(\tau_2^{q,dom}\nu_2^{q,dom}\right)\right] \tag{5}$$

We take a cubic approximation of (5). The Taylor expansion consists of a linear term (that includes second- and third order components), a quadratic term (with second- and third order components) and a cubic term (with third order component). The second-order components lead to the initial funding allocation (4). The third-order component gives the funding reallocation, f_1^i. For instance, the wholesale funding position in Swiss francs is:

$$\begin{aligned} S_0^{chf}F_0^{chf}f_1^{chf} &= -\frac{K_0}{\gamma}\frac{\tau_2^{q,chf}\nu_2^{q,chf}+\tau_2^{S,chf}\nu_2^{S,chf}-\tau_2^{q,dom}\nu_2^{q,dom}}{\sigma_{fx}^2} \\ &+\frac{\tau_2^{q,chf}}{\sigma_{fx}^2}\left(Net_0^{eur}\nu_1^{S,eur}+Net_0^{chf}\nu_1^{S,chf}\right) \\ &+S_0^{chf}\left(1-\lambda\right)C_0^{chf}\left(\nu_1^{C,chf}-\lambda\nu_1^{S,chf}\right)-S_0^{chf}D_0^{chf}\nu_1^{D,chf} \\ &+\left(1-\left(1+\gamma\right)\left(K_0\right)^{-1}\right)Net_0^{chf}\nu_1^{S,chf} \\ &+Net_0^{chf}\nu_2^{\sigma,chf}+\frac{1}{2}Net_0^{eur}\nu_2^{\rho} \end{aligned} \tag{6}$$

(6) shows that the bank increases its use of Swiss franc funding ($f_1^{chf} > 0$) for the following five reasons. First, a lower cost of Swiss franc funding than expected at period 0, which can reflect a direct decrease in the funding cost ($\nu_2^{q,chf} < 0$), a depreciation of the Swiss franc (or at least a smaller appreciation than expected, $\nu_2^{S,chf} < 0$), or a higher funding cost in the local currency ($\nu_2^{q,dom} > 0$). Second, a depreciation of the local currency in period 1 against either the euro ($\nu_1^{S,eur} > 0$) or the Swiss franc ($\nu_1^{S,chf} > 0$), provided the bank holds long positions in these currencies ($Net_0^{eur} > 0$ or $Net_0^{chf} > 0$). This effect is present if the net position in Swiss franc is positive ($\tau_2^{q,chf}/\sigma_{fx}^2 > 0$). Intuitively, a depreciation of the local currency raises the local currency value of net positions in foreign currencies, and funding adjusts to offsets this valuation effect to some extent. Third, an increase in the amount of loans denominated Swiss franc, either exogenously ($\nu_1^{C,chf} > 0$) or indirectly through a depreciation of the Swiss franc that raises payoffs ($\lambda\nu_1^{S,chf} < 0$). Fourth, an exogenous decrease in the amount of deposits denominated in Swiss franc ($\nu_1^{D,chf} < 0$). Finally, an increase in the volatility of the Swiss franc exchange rate ($\nu_2^{\sigma,chf} > 0$), provided the initial net position is long in Swiss franc ($Net_0^{chf} > 0$). While this effect can seem odd, recall that the initial net position Net_0^{chf} is proportional to the volatility adjusted funding cost $\tau_2^{q,chf}/\sigma_{fx}^2$. The position is long when that cost is positive. A higher exchange rate volatility reduces the volatility adjusted funding cost, and thus pushes the bank towards reducing its long position in Swiss franc by getting more wholesale funding in that currency. The final reason is a higher correlation of the exchange rates against the Swiss franc and the euro ($\nu_2^{\rho} > 0$), if the bank initially has a long net position

in euro ($Net_0^{eur} > 0$). Note also that the impact of an unexpected movement in the exchange rate vis-à-vis the Swiss franc in the first period, $\nu_1^{S,chf}$, is ambiguous.

In general terms, the Swiss franc funding position at time t is written as $S_t^{chf} F_t^{chf} = S_0^{chf} F_0^{chf} \exp\left[s_t^{chf} + f_t^{chf}\right]$. A linear approximation shows that the position reflects both an exchange rate valuation term, s_t^{chf}, and a position term, f_t^{chf}, given by (6): $S_t^{chf} F_t^{chf} = S_0^{chf} F_0^{chf} \left[1 + s_t^{chf} + f_t^{chf}\right]$. The change in the position similarly reflects the dynamics of the exchange rate, $s_t^{chf} - s_{t-1}^{chf}$, and capital flows, $f_t^{chf} - f_{t-1}^{chf}$.

4 Data and Stylized Facts

4.1 The Swiss Franc Lending Monitor

We make use of the Swiss franc lending monitor, a database maintained by the Swiss National Bank using inputs from 20 participating central banks. The purpose of the monitor is to provide information on the role of the Swiss franc in bank lending and funding across a broad range of European countries. The data set provides quarterly data on various components of banks' balance sheet positions starting at the latest in the first quarter of 2009. As data start earlier for some of the sample countries, we use an unbalanced sample that starts in the first quarter of 2007.[6] This allows us to cover a part of the the pre-financial crisis period as well. We include 18 of the 20 European countries in our sample.[7] Denmark and Iceland are not included due to insufficient data coverage. Moreover, Poland is only included on the funding side, as Poland's data coverage of foreign assets is incomplete. The covered balance sheet items reflect aggregates across all banks with residency in the given country, including subsidiaries of foreign banks, but not foreign bank branches. Subsidiaries of foreign banks, especially European ones, account for a very large share of the market, particularly in some Eastern European countries.

A unique feature of this data set is its breakdown of balance sheet positions across currencies.[8] Specifically, all positions are divided between Swiss francs, other foreign currencies, and local currency. This provides exceptionally detailed information on developments in balance sheet positions in the Swiss franc. Other foreign currency positions are not broken down into individual currencies, however. As we are interested in analyzing developments in the individual foreign currency positions *per se*, we estimate this breakdown based on information on the currency weights of bank balance sheets of the sample countries. Moreover, we show that the primary non-Swiss franc foreign currency used by euro countries is the US dollar, whereas

[6] The individual country charts in Appendix reflect the period covered for each country.

[7] Austria, Bulgaria, Czech Republic, Croatia, Estonia, France, Germany, Greece, Hungary, Italy, Latvia, Luxembourg, Poland, Romania, Serbia, Slovenia, Slovakia, and the United Kingdom. Luxembourg is an outlier due to its small size and large international financial center. We hence only include Luxembourg selectively and with its outlier status in mind.

[8] An advantage of using this data set over the BIS locational banking statistics for currency breakdown is that it includes more European countries than the BIS reporting countries. It hence allows us to make more detailed analysis of developments in foreign currency positions of European bank balance sheet.

the primary non-Swiss franc foreign currency used by non-euro countries is the euro. Hence, by dividing euro and non-euro countries, we can to some extent associate the non-Swiss franc foreign currencies with US dollars and euros respectively.

The data set divides bank asset positions on lending and other assets, while liability positions are divided on deposits (including repo and interbank borrowing), own securities issuance and other liabilities. Lending and deposits are further divided on counterparty types, including resident households, resident non-financial corporations, resident banks (domestic interbank), government, non-resident banks and non-resident non-banks.[9] To focus on changes in positions between the domestic banking sector and the rest of the economy, we exclude domestic interbank positions. As the breakdown on households, non-financial corporations and government is incomplete for many of the sample countries, we focus on the split between total domestic non-bank, foreign bank and foreign non-bank positions.[10]

4.2 Some stylized facts on European banks' funding currency mix

We now present the main stylized facts characterizing the differences foreign funding currencies among European banks. The foreign currency funding mix is highly heterogenous across countries. An important part of this heterogeneity reflects two aspects, namely whether or not a country is a financial center, and whether or not is is part of the euro area. We pay particular attention to these dimensions in the stylized facts we present below. While our primary focus os on the funding side of bank balance, we also draw on the asset side when this sheds additional light on the characteristics of the data.

Six main stylized facts emerge from the data. First, countries considered financial centers tend use foreign currencies for lending to foreign banks, and raise funds through issuance of foreign currency denominated securities to a higher degree than non-financial center countries. Second, foreign currency positions represent a larger share of banks' assets and liabilities in countries outside the euro area than in countries who use the euro. Third, cross-border positions represent a larger share of total positions (and exceed foreign currency positions) in euro area countries than in other countries. Fourth, banks tend to use the Swiss franc for lending to non-bank residents, while other foreign currencies are more prevalent for cross-border lending. At the same time, Swiss franc funding is mainly in the form of foreign interbank positions, while residents' non-bank deposits are more prevalent in other foreign currency funding. Fifth, as a result of the above trends, banks tend to have long positions in Swiss francs, with assets exceeding liabilities, but short positions in other foreign currencies. Finally, the share of total banks positions denominated in foreign currencies shows a slight downwards trend during the sample period, with a steady composition across currencies.

[9] The data unfortunately does not divide positions with foreign bank counterparties on positions vis-a-vis a foreign parent bank and positions vis-a-vis an unrelated foreign bank.

[10] For the countries that do provide this split, the share of Swiss franc loans to domestic government is very small. We can hence consider non-bank lending to be lending to private non-bank residents.

4.2.1 Foreign currency positions differ for financial centers

Banks' use of foreign currency and cross border funding and lending differs in financial center relative to other countries. As financial centers are home to the headquarters of internationally active banks, they tend to have higher cross border lending to foreign banks denominated in foreign currency, as well as sizeable issuance of own securities in foreign currencies for their funding. We focus on two indicators presented for Swiss franc positions and other foreign currency positions respectively in Figure 1. The first indicator is the percentage of foreign currency funding obtained through issuance of own securities in the given currency (blue bars). The second indicator is the amount of cross border interbank lending in foreign currency in percent of GDP (red bars), reflecting the importance of international foreign currency funding intermediation in the country.

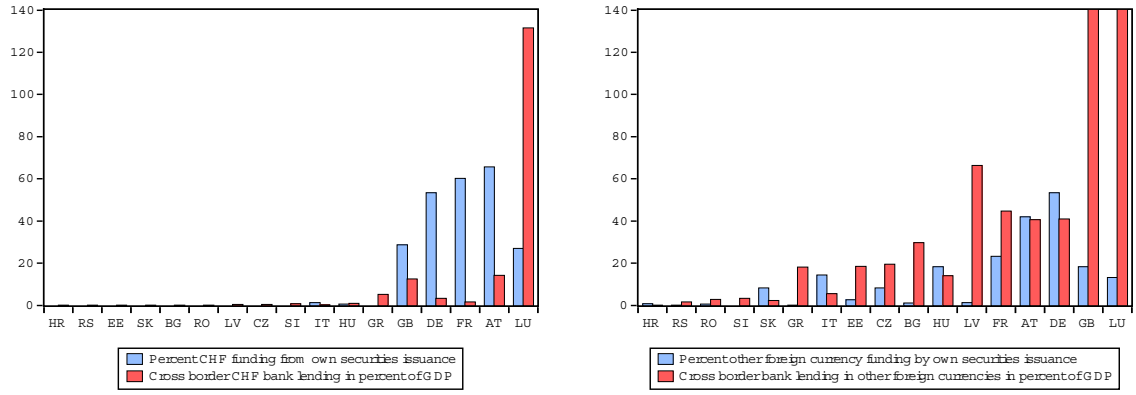


Figure 1: **The role of FX in financal centers vs other countries (2007-2014 averages)**
The blue bars reflect the percentage of foreign currency funding obtained from issuance of own securities. The red bars depict the percentage of cross border lending in foreign currency in percent of GDP of the lending country banking sector. The left hand panel shows the pattern for positions in Swiss franc while the right hand panel shows the pattern for other foreign currencies. The vertical axis of both charts are capped at 140%. The UK and Luxembourg both exceed this number for other foreign currency lending to foreign banks in percent of GDP (these numbers are 340% and 953% respectively). Source: SNB.

We contrast the patterns between the Swiss franc and other foreign currencies. Five countries show high values of both indicators for the Swiss franc, namely France, Germany, Austria, Luxembourg and the UK (left panel). By contrast the other countries rely only marginally on the issuance of own securities to raise funding of Swiss francs, and engage in only little cross border interbank lending in Swiss franc. While the picture is less clear for other foreign currencies (right panel in Figure)[11], the same five countries still stand out. In

[11] Note that the right hand panel is capped at 140% - the lending in percent of GDP exceeds this cap for the UK and Luxembourg)

the remainder of the paper, we thus refer to them as the financial center countries.

4.2.2 Foreign currency positions are higher in non-Euro countries

The currency mix in lending and funding positions of European banks vary considerably across countries. Figure 2 shows the share of foreign currency positions in assets (top-left panel) and liabilities (top-right panel), with a breakdown across the various currencies. The corresponding values for cross-border assets and liabilities are presented in the bottom panel.

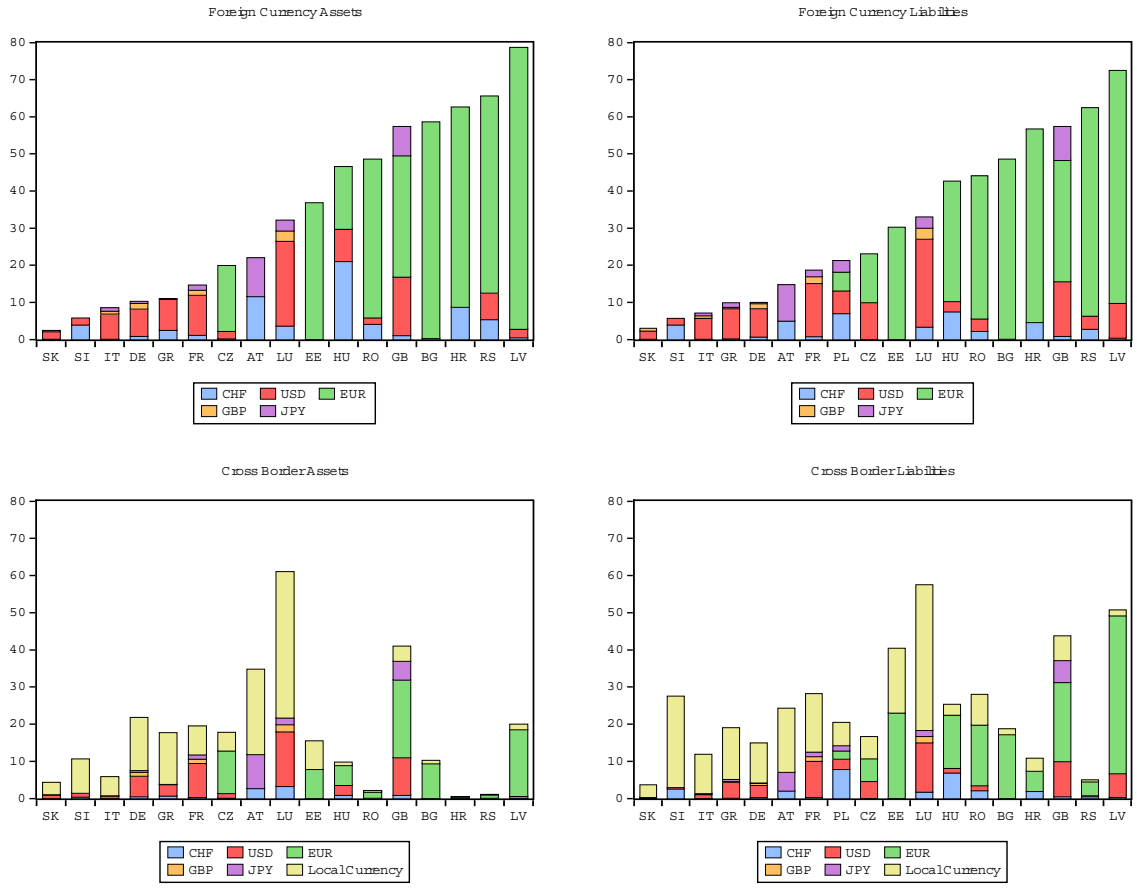


Figure 2: **Foreign currency composition across countries**
The upper panels show foreign currency assets and liabilities, in percent of total balance sheet positions (2007-2014 averages). As Austria, Czech Republic, France and Poland neither report total assets and liabilities nor other assets and other liabilities, the bars for these countries reflect only the remaining balance sheet items. The lower panels show lending and deposits to or from foreign residents, in percent of total balance sheet positions. In the left hand panels, foreign currency and cross border assets of Poland are set to zero as Poland does not report asset positions in foreign currency. Source: SNB.

The euro area countries display a relatively low presence of foreign currencies on the two sides of banks' balance sheets, with a prominent role of the US dollar (red bars). The Swiss

franc plays a role in some euro area countries, primarily in Austria (blue bars). Among the other countries, foreign currency positions make a larger share of total assets and liabilities. While the euro plays a dominant role (green bars), the Swiss franc is also use, primarily in Hungary and Poland, and—to a smaller extent—Croatia.

4.2.3 Cross-border positions are higher in Euro countries

Our data allow us to contrast the currency composition of positions and their cross-border composition, as these two aspects can differ. For instance, a euro-denominated loan granted by a Czech bank to a local resident constitutes a euro-denominated domestic asset position of the Czech banking sector, and not a cross border position. If the Czech resident receiving the loan deposits the euros in an Italian bank account, this would constitute a cross border liability denominated in domestic currency for the Italian banking sector. Cross border positions are thus not a subset of foreign currency positions (or conversely).

The shares of cross-border assets and liabilities in total positions are shown in the lower panels of Figure 2, along with the currency breakdown. Cross border positions are defined as lending to non-residents and deposits from non-residents respectively. [12] The countries in the lower panel of Figure 2 are sorted as in the upper panels, allowing for direct comparison of the importance of foreign currency denomination with cross border positions.

The situation is again contrasted between countries in the euro area and countries outside it. With only a few exceptions, the former tend to have larger cross-border positions than the later. In fact, euro-area countries tend to have larger cross-border positions than foreign currency denominated positions. This reflects both the fact that cross-border positions of euro-area countries are to large extent denominated in euro (the yellow bars), and the high degree of financial integration in the euro area.[13] By contrast, the cross-border positions in countries outside the euro area are invariably lower than the foreign currency positions, reflecting the high degree of eurorization in these countries.

4.2.4 The Swiss franc is used mostly for lending, and other foreign currencies mostly for funding

The use of different foreign currencies shows substantial heterogeneity across the components of banks' lending and funding. Figure 3 presents the share of the various categories of assets (left panels) and liabilities (right panel) to the total. Lending is split across lending to non-bank residents (blue bars), lending to foreign banks (red bars), lending to foreign non-banks (green bars) and other assets (orange bars). The liabilities consist of deposits by non-bank

[12] This definition may underestimate the cross border positions to some degree, as the positions "other assets", "other liabilities" and "own securities" may also partly reflect cross border positions. Our data however do not provide us with the counterparty to these positions.

[13] This degree of cross border bank positions in euros is likely to have come down during the sample period, as Europe experienced financial fragmentation during the European debt crisis. We do not investigate this further here.

residents (blue bars), foreign interbank funding (red bars), funding by non-resident non-banks (green bars), issuance of own securities (orange bars), and other (purple bars). The figure contrasts the pattern for the Swiss franc (top panels) and other foreign currencies (bottom panels).

Assets denominated in Swiss francs (top left panel) are dominated by lending to domestic non-banks for most countries, with the exception of a few countries which have very little overall Swiss franc lending (Estonia and Czech Republic). Interbank lending plays a large role in the financial centers. This use of the Swiss franc for domestic retail lending amounts to a relaxation of the domestic borrowing constraint as pointed by Ranciere et al. [2010]. It is consistent with the pattern documented by Yesin [2013], who describes it as the "small man's carry trade" taking advantage of the low interest rate on Swiss francs and a stable Swiss franc exchange rate prior to the global financial crisis. Austria plays a two-sided role, as a financial center that also has a large share of Swiss franc lending going to domestic residents. Assets denominated in other foreign currencies (bottom left panel) show a less predominant role for domestic retail lending compared to the the Swiss franc. By contrast, lending to foreign banks and non-banks play a more important role.

Turning to liabilities, the Swiss franc denominated positions (top right panel) show that domestic resident' deposits represent only a small share of funding, with foreign interbank funding playing the dominant role. By contrast, funding in other foreign currencies (bottom right panel) relies more on domestic residents' deposits in foreign currency. This pattern likely reflects that the euro and – to some degree – the dollar are used and circulate in European economies alongside domestic currencies, which is not the case for the Swiss franc. Finally, we notice that the ratio of funding from foreign non-banks relative to funding from foreign banks (the green bars relative to the red bars) tends to be lower for other foreign currencies than for Swiss francs (not shown).

We conclude that on the asset side, the Swiss franc is particularly geared toward domestic retail lending in non-financial centers, whereas other foreign currencies are relatively more prevalent in cross border bank intermediation. On the funding side, the Swiss franc is funded through cross border interbank borrowing to a higher degree than other foreign currencies. Cross border Swiss franc funding tends to be very much bank intermediated.

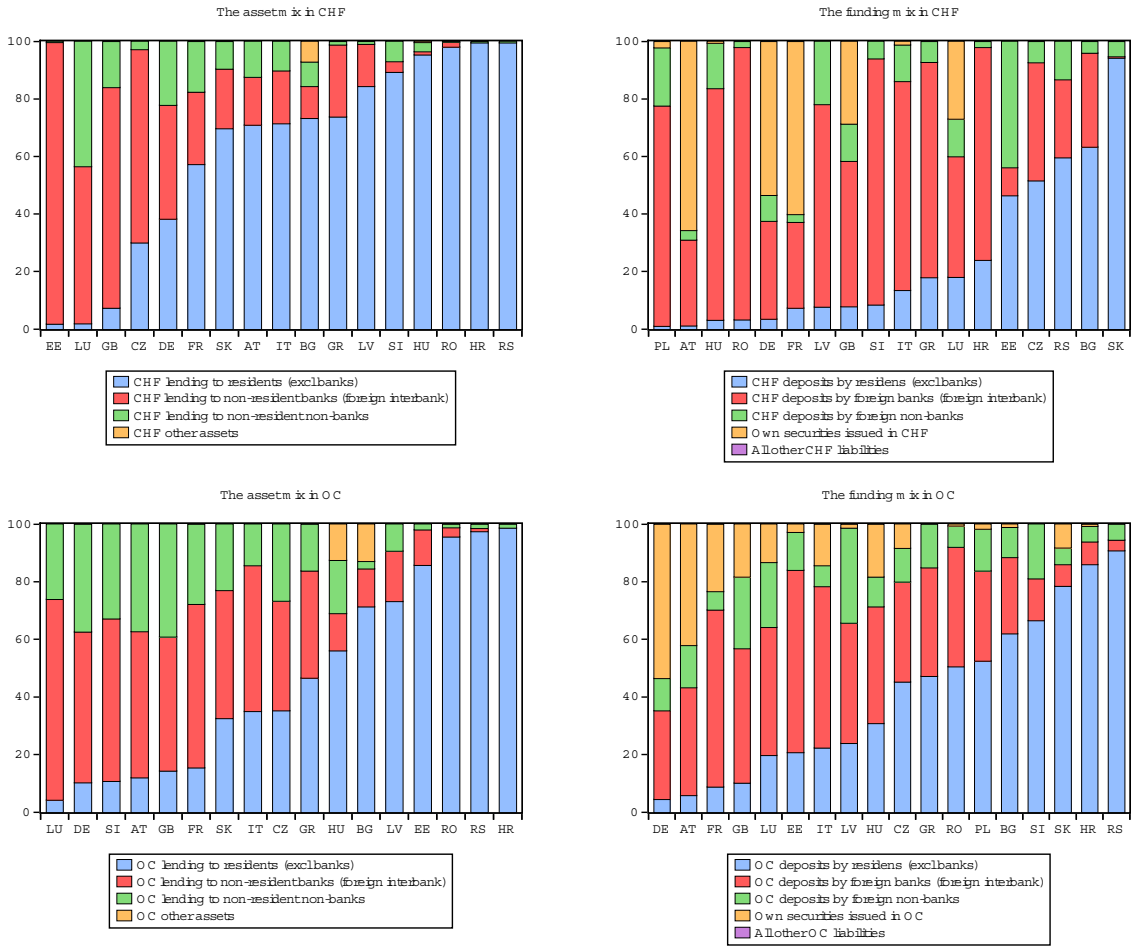


Figure 3: **The composition of foreign currency positions by types or counterparties (2007-2014 average, in percent of total)**
The left hand panels depicts bank foreign currency assets by counterparties or types in percent of total foreign currency assets, for Swiss francs (upper panel) and for other foreign currencies (lower panel). The right hand panels depicts the percentage of bank funding by counterparties or types in total bank funding in Swiss francs (upper panels) and in other foreign currencies (lower panel). As Austria, Czech Republic, France and Poland do not report "other assets" and "other liabilities", the bars for these countries are in percent of total assets less these missing categories. Poland does not report on foreign currency assets, and is hence excluded from the left panels. Sorted by the importance of lending to / deposits from domestic residents. Source: SNB.

4.2.5 Long net positions in Swiss franc, short positions in other foreign currencies

The on-balance sheet currency mismatch is contrasted between the Swiss franc and other foreign currencies. Figure 4 shows the net position in foreign currencies (assets minus liabilities, as a percentage of assets) across the various countries, contrasting positions in Swiss franc (left panel) with that in other foreign currencies (right panel). With the exception of Estonia,

all countries in our sample (including financial centers) hold Swiss franc assets in excess of their Swiss franc funding. The pattern is opposite for the other foreign currencies, with only four countries showing assets moderately higher than liabilities. All other countries have short position in other foreign currencies, showing that these currencies are predominantly used as funding currencies.

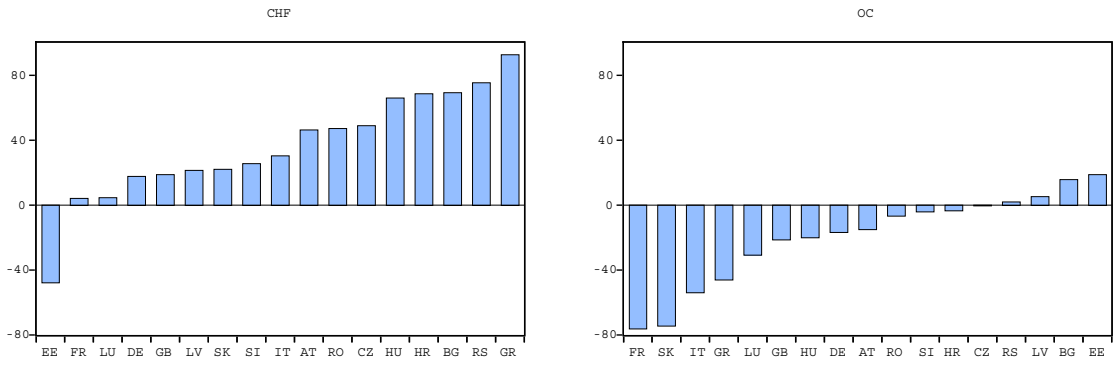


Figure 4: **Balance sheet mismatch, averages for 2007-2014**
Measured as foreign currency assets in excess of foreign currency liabilities, in percent of foreign currency assets. The left hand panels reflects on-balance sheet mismatches in Swiss francs whereas the right hand panel reflects those in other foreign currencies. Poland does not report on foreign currency assets, and is hence excluded. Source: SNB.

In part, this mismatch is likely to reflect the practise in some countries of granting loans denominated in domestic currency but indexed to the exchange and interest rate of the Swiss franc. Such Swiss franc-indexed loans are Swiss franc loan for all practical purposes, and are recorded as such in the Swiss franc lending monitor. The use of these indexed loans reflect the fact that the Swiss franc is not circulating or used for transactions or savings in these countries, and hence the borrower does not actually need Swiss francs. No Swiss francs actually change hands when such loans are granted, and thus the granting of the loan does not give rise to the creation of an off-shore Swiss franc deposit, but rather, a domestic currency deposit. The mismatch could also reflect currency hedging practises. European banks often hedge their Swiss franc exposures in the currency swap market, which is off-balance sheet and hence not reflected in the mismatch measure. We do not have access to data on the extent of off-balance sheet hedging of currency exposure.

In short, banks are long Swiss francs and short other foreign currencies in their on-balance sheet positions.

4.2.6 Foreign currency positions have been stable to declining over time

Finally, we complement the previous stylized facts based on country averages with an assessment of the variation across time. Figure 5 shows the average share of foreign currency

compositions, along with the split across currencies, for assets (left panels) and liabilities (right panel) across countries. We again contrast the pattern for members of the euro-area (top panels) and other countries (bottom panels). We observe that the share of positions in foreign currencies shows a slight decreasing trend. Overall, there is little variation across time in the currency composition of positions.

Figure 5: **Foreign currency composition over time**
In percent of total bank balance sheet positions, quarterly from 2009 to 2014. The upper two panels reflect the average foreign currency composition for euro area countries, but excluding France due to short sample size. The lower two panels reflect the average currency composition of foreign currency positions of non-euro countries. Estonia and Latvia are excluded due to conversion to euro in the latter part of the sample. For Austria, Czech Republic and Poland, which neither report total assets and liabilities nor other assets and other liabilities, the remaining balance sheet items are included in the averages. Poland is excluded from averages for non-euro country assets due to lack of data. Source: SNB.

The use of foreign currencies has declined slightly more than suggested by Figure 5 when controlling for the valuation effects of the depreciation that many of the sample countries experienced during the sample period (see Figure 9 in appendix). While the breakdown on

non-Swiss franc foreign currencies is estimated using constant currency weights, the breakdown between Swiss franc denominated positions and positions denominated in other foreign currencies is observed in the data. This breakdown is rather stable across time for non-euro countries, and slightly less stable for euro countries. The relative stability of Swiss franc denomination and denomination of other currencies lends support to our use of constant foreign currency weights when computing valuation adjusted flows in Section **??**.

5 Econometric Specification and Variables

We now turn to our econometric assessment of the drivers of foreign banks' use of Swiss francs as a funding currency. We first present the explanatory variables included in our analysis. We then discuss our measure of funding flows, which adjusts for the valuation effects of exchange rates movements, before laying out the specifications used in the regression analysis.

5.1 Explanatory variables

The model presented in Section 3 points to the role of the cost of funding in various currencies. Instead of focusing on the interest rate, we also consider the quantitative easing measures undertaken by central banks to directly impact the availability of funding. The model also points to the role of exchange rate movements, as well as shift in the loans and deposits in foreign currency should be included.

5.1.1 Monetary policy in funding countries

During the sample period, central banks have substantially increased the availability of funding, including to the provision of swap lines with foreign central banks. We proxy for these policy actions by the monetary base. The left hand panel in Figure 6 shows that while all central banks massively increased liquidity provision, this was especially pronounced in Switzerland where the monetary based reached reached the highest value (relative to GDP) among the countries considered. [14]

In addition, the SNB provided swap lines with the European Central Bank and the Polish and Hungarian central banks from late 2008 and until January 2010.[15],[16] The Federal Reserve similarly provided US dollar funding through swap lines with foreign central banks. This policy tool is illustrated by the right hand panel of Figure 6 which shows the amounts of swaps extended by the SNB and the Federal Reserve, scaled by these countries' respective GDP.

[14] Note that the Swiss monetary base definition was revised in June 2013 to include deposits by the Swiss Postfinance. We therefore include a dummy for the second quarter 2013.

[15] For the nature and role of the swap agreements, see Auer and Kraenzlin [2011].

[16] Other unconventional policy measures had balance sheet effects were also taken, but is not discussed in detail here, see Kettemann and Krogstrup [2014] and Christensen and Krogstrup [2014]

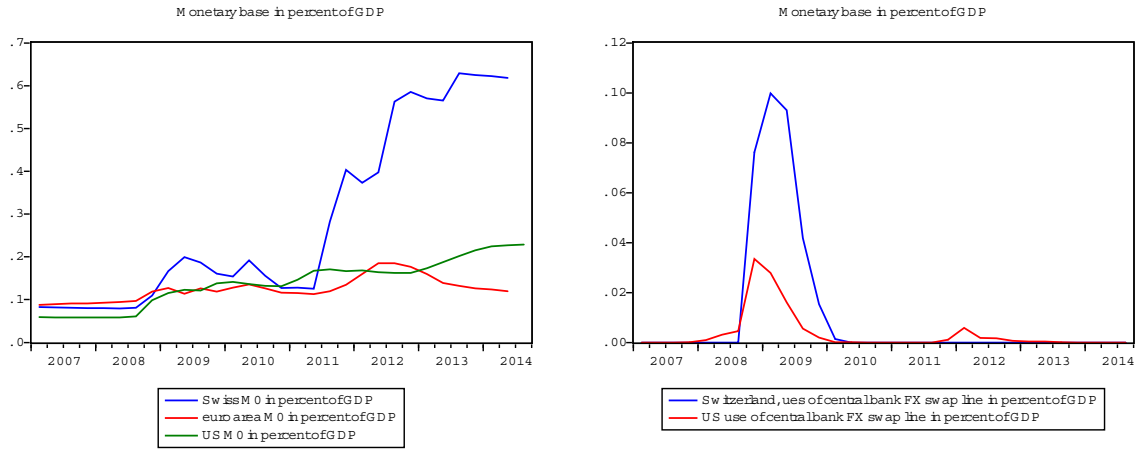


Figure 6: **Monetary bases and central bank FX swap lines.**
In percent of GDP, quarterly averages. Source: SNB and BIS.

Finally, we consider the cost of wholesale borrowing of international funds, proxied by the money market interest rate. In most cases, banks cannot directly access the regular liquidity provided by foreign central banks. Banks with sufficiently high credit ratings can issue their own debt securities in foreign currency. These tend to be located in financial centers, as shown in Section 4. Banks without this access, but with sufficiently high credit rating and high quality collateral would have access to secures borrowing (e.g. the Swiss repo platform) to obtain foreign currency funding. Other banks would borrow in the unsecured market. The cost of funding for the average participant in the unsecured foreign currency money market can be proxied by a three month money market interest rate for interbank borrowing. We use the 3 month libor rate or equivalent unsecured money market interest rate as a proxy for market funding costs.[17] As what matters is the cost of foreign currency funding relative to the cost of domestic currency funding, we consider the spread between short-term interest rates.

To sum up, our indicators of the cost of foreign currency funding are:[18]

- *M0 in percent of GDP*: quarter to quarter change in the ratio of the monetary base to GDP.

- *The money market spread*: spread between the 3-month money market interest rate

[17] When risks related to international interbank lending in European banks increased during the sample period, the cost of and access to Swiss franc funding by foreign banks increased compared with Swiss banks, by a foreign-bank specific money market funding risk premium. To try to capture this and thereby introduce more variation in the money market funding cost measure, we followed Fleming and Klagge [2010] and computed the spread between 3-month unsecured funding in Swiss francs by non-Swiss banks and by Swiss banks as reported by the contributing banks in the CHF Libor panel. This spread turned out not to be significant in any regressions, and we have hence left it out.

[18] The exact definitions of all variables are listed in Appendix A

between the foreign and domestic currency.

- *Dummy Postfinance*: dummy equal to one in 2013 Q3.

5.1.2 Exchange Rate Developments

The theoretical model indicates that the expected future appreciation, previous appreciation, volatility and correlations of exchange rates of foreign currencies matter for the use of foreign funding currencies.

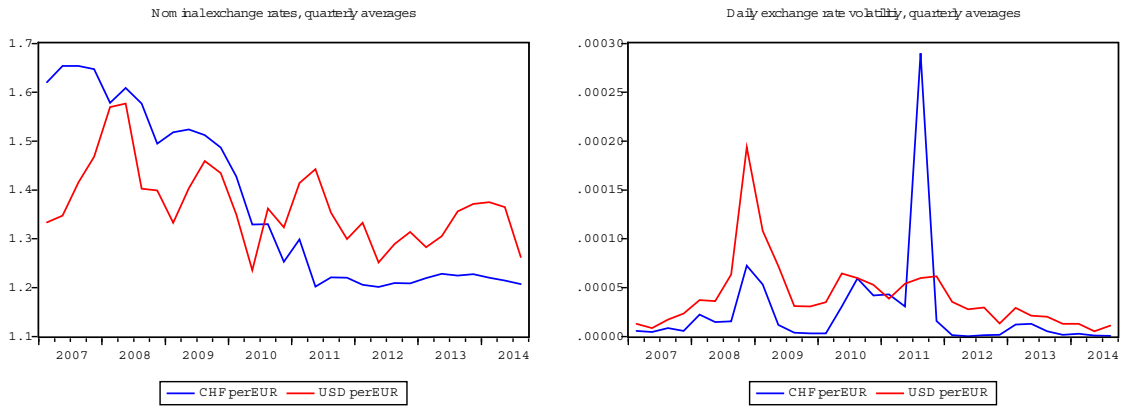


Figure 7: **Swiss franc exchange rate and volatility against the euro, quarterly.**
Source: SNB.

As summary measures of exchange rate developments during the sample period, Figure 7 depicts the Swiss franc and the US dollar nominal exchange rates and daily volatility against the euro in on a quarterly average basis. The large peak in Swiss franc exchange rate volatility in the third quarter of 2011 reflects intra-quarter volatility in the months of July and August, which ended with the imposition of the exchange rate floor against the euro in September 2011. This peak in volatility was a shock to foreign banks' use of the Swiss franc and we hence want to include it in our regressions (we do not treat it as an outlier). We check the robustness of the results to this decision by including a dummy for that quarter.

It is important to note here that the Swiss National Bank was actively managing the exchange rate during the larger part of the sample period. This has not been the case for the other two foreign currencies. From March 2009 to August 2011, this management involved foreign exchange interventions and liquidity expansions. From September 2011 to January 2015, the exchange rate was managed through the floor, which required occasional foreign exchange interventions. During the floor period, Swiss franc has remained largely stable against the euro. Volatility was very low, and there were very little change in the Swiss franc value.

The model indicates that both past and expected future movements in the exchange rate matters, and that their impact depends on whether the bank has a long or short net position in the foreign currency (the Net_0^{chf} and Net_0^{eur} terms in (6)). We therefore interact the measures of exchange rate fluctuations with the average net position presented in Figure 4.

We thus take account of the potential effects of foreign currency appreciation and volatility by including the following measures:

- *Expected foreign funding currency appreciation*: percent appreciation of the foreign funding currency vis--vis the local currency between the current quarter and the following one.

- *Past foreign funding currency appreciation*: percent appreciation of the foreign funding currency vis--vis the local currency between the previous quarter and the current one, interacted with the net position in the foreign currency.

- *Past other foreign currency appreciation*: percent appreciation of the foreign currency other than the funding one vis--vis the local currency between the previous quarter and the current one, interacted with the net position in the foreign non-funding currency and the net position in the foreign funding currency.

- *Expected foreign funding currency daily exchange rate volatility*: daily volatility of the exchange rate between the foreign funding currency and the local currency in the following quarter, interacted with the net position in the foreign currency.

5.1.3 Other drivers of foreign currency funding

The model indicates the need to control for changes in lending and domestic deposits in foreign currency. Moreover, global financial conditions can matter for banks' willingness to take on risk in the form of foreign currency lending and borrowing. This can be understood as changes in the risk aversion γ. The impact is the same as a change in the volatility of the exchange rate relative to the funding currency, and also reflects the net position in that currency.

Traditionally, risk taking in global markets has been proxied by the VIX index of the implied volatility in S&P 500 stock index option prices from Chicago Board Options Exchange (CBOE). The VIX is depicted on a quarterly basis in the upper panel in Figure 8, and we use it in our regressions to control for risk appetite in global banking.

The VIX has been criticized as an imprecise measure of risk taking in more recent years. Adrian and Boyarchenko [2012] instead consider the leverage of broker and dealers in the United States. They argue that the two-quarter growth in the leverage of US securities brokers and dealers, depicted in the right hand of Figure 8, is a good measure of risk appetite in global financial intermediaries. This measure however suffers from shortcoming, as recent

movements such as the swings in the third and fourth quarters of 2008 are unlikely to solely reflect risk sentiment changes. We therefore focus on the VIX and use the broker-dealer leverage as an additional control variable for robustness.[19]

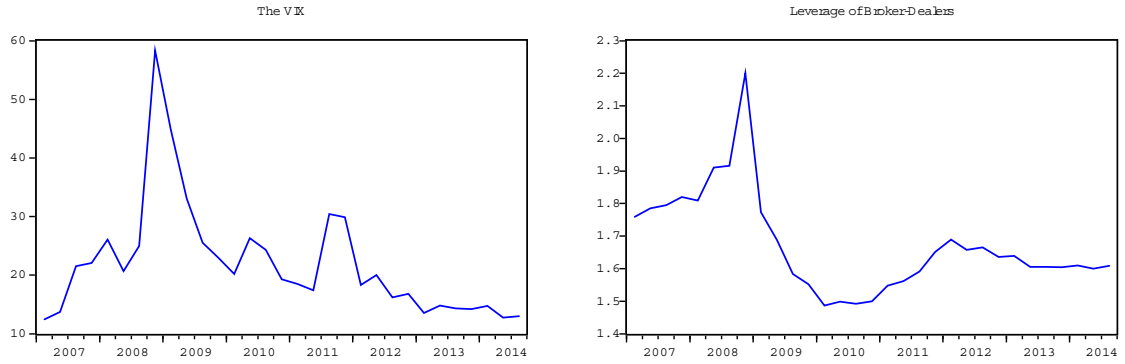


Figure 8: **Global Risk Sentiment**
Quarterly averages of the Vix index (left) and the two-quarter growth in US broker dealer leverage (right). Source: Datastream and US Financial Accounts.

The variables we consider for the additional drivers of funding are thus as follows:

- *Growth in foreign currency loans*: quarter to quarter growth of volume of lending denominated in the foreign funding currency.
- *Growth in foreign currency denominated deposits*: quarter to quarter growth of volume of domestic deposits denominated in the foreign funding currency.
- *VIX*: the VIX index, interacted with the net position in the foreign currency.

5.2 Measures of financial flows

Our analysis focuses on the change in funding positions that does not reflect the direct valuation impact of exchange rate movements. Consider the wholesale funding position of country c in a foreign currency j. We denote its value in domestic currency at the end of period t by $L_t^{c,j}$. The total change in the value of the position between periods $t-1$ and t consists of the capital flows $F_t^{c,j}$ and the valuation impact of the exchange rate. We denote the exchange rate in terms of units of local currency per unit of foreign currency as $S_t^{c,j}$ (so an increase is an appreciation of the foreign currency). The dynamics of the position are then:

$$L_t^{c,j} = L_{t-1}^{c,j} + F_t^{c,j} + \frac{dS_t^{c,j}}{S_{t-1}^{c,j}} L_{t-1}^{c,j}$$

[19] When considering the growth rate of broker-dealer leverage instead of the VIX, we found the significance of the coefficient on that variables to be highly sensitive to the quarters included in the sample.

Which we rewrite as:

$$\dot{l}_t^{c,j} = f_t^{c,j} + \dot{S}_t^{c,j}$$

where $\dot{l}_t^{c,j} = dL_t^{c,j}/L_{t-1}^{c,j}$, $f_t^{c,j} = F_t^{c,j}/L_{t-1}^{c,j}$ and $\dot{S}_t^{c,j} = dS_t^{c,j}/S_{t-1}^{c,j}$. There is one such relation for positions in CHF and one for positions in other foreign currencies. The latter is a weighted sum across various currencies, where $\varpi^{c,j}$ is the share of foreign currency j in the other foreign currency positions (i.e. foreign currency positions excluding Swiss franc positions):

$$\dot{l}_t^{c,CH} = f_t^{c,CH} + \dot{S}_t^{c,CH} \quad (7)$$

$$\dot{l}_t^{c,FX} = f_t^{c,FX} + \sum_j \varpi^{c,j} \dot{S}_t^{c,j} \quad (8)$$

where $f_t^{c,FX} = \sum_j \varpi^{c,j} f_t^{c,j}$ and $\dot{l}_t^{c,FX} = \sum_j \varpi^{c,j} \dot{l}_t^{c,j}$.

The Swiss franc lending monitor provides us with the changes in positions, $\dot{l}_t^{c,CH}$ and $\dot{l}_t^{c,FX}$, but not the individual $\dot{l}_t^{c,j}$. We also observe exchange rates $\dot{S}_t^{c,CH}$ and the various $\dot{S}_t^{c,j}$.

While we can directly back out the flows related to CHF positions $f_t^{c,CH}$, we need to estimates the flows related to positions in other foreign currency, $f_t^{c,FX}$. This relies on the weights $\varpi^{c,j}$ that we construct using estimates of the currency composition across other foreign currencies. Specifically, we rely on three sources. The first is the ECB annual report on the international role of the euro (the latest of which is ECB [2014]) that gives the composition of overall deposits and bank loans for selected countries. The second is information gathered from the websites of the national central banks. The third source is a regression analysis, where we assume that exchange rate movements immediately affect the local currency value of the positions denominated in foreign currencies, but affect outright flows only with a lag. Regressing $\dot{l}_t^{c,FX}$ on the various $\dot{S}_t^{c,j}$ then gives estimates for the coefficients $\varpi^{c,j}$ in (8). We run such a regression for each country, considering the euro, US dollars, British pounds and yen as foreign currencies. The coefficients are re-scaled to add up to one, giving us estimates for $\varpi^{c,j}$.

The values we consider for the $\varpi^{c,j}$ across the various countries are given in the appendix Table 1. Appendix C provides country specific details on the selection of these currency weights. In many cases, a currency (primarily the euro) plays a overwhelming role and we then assume that the non-CHF positions in foreign currencies are in that currency. In other cases the regression results provide a good fit of the composition across several currencies and we rely on them. In some cases the regression results are problematic, for instance when the country holds a peg against the euro. In these cases, we rely on information from the ECB and national sources.

5.3 Specification of regressions

We compute estimates of the funding (6) across three groups of countries. The first one comprise emerging economies that are not members of the euro area. The second one consists of countries in the euro are that are financial centers (Austria, France, Germany, Luxembourg), and the final one comprises the other euro area countries. For each of these group we assess the determinants of funding in Swiss francs and other foreign currency. That last currency is the Euro for the emerging economies and the US dollar for the two groups of advanced economies.

The funding solution (6) gives an expression for the level of the funding position in a foreign currency (in terms of deviations from the steady state) controlling for the valuation impact of the exchange rate. We first consider a specification for the level of Swiss franc funding, adjusted by the exchange rate:

$$\begin{aligned}
& \ln\left(Funding_t^{chf}\right) - \ln\left(S_t^{chf}\right) \\
= \; & \alpha_0 + \alpha_1 \frac{M_{t-1}^{chf}}{Y_{t-1}^{chf}} - \alpha_2 \frac{M_{t-1}^{eur}}{Y_{t-1}^{eur}} - \alpha_3 \frac{M_{t-1}^{usd}}{Y_{t-1}^{usd}} + \alpha_4 \left(i_{t-1}^{dom} - i_{t-1}^{chf}\right) \\
& -\alpha_5 \ln\left(S_{t+1}^{chf}\right) + \alpha_6 \ln\left(S_{t-1}^{chf}\right) Net_{t-1}^{chf} + \alpha_7 \ln\left(S_{t-1}^{fx}\right) Net_{t-1}^{fx} Net_{t-1}^{chf} \\
& +\alpha_8 Var\left(S_{t+1}^{chf}\right) Net_{t-1}^{chf} + \alpha_9 Covar\left(S_{t+1}^{chf}, S_{t+1}^{fx}\right) Net_{t-1}^{fx} + \alpha_{10} Vix_{t-1} Net_{t-1}^{chf} \\
& +\alpha_{11}\left[\ln(Loan_{t-1}^{chf}) - \ln\left(S_{t-1}^{chf}\right)\right] - \alpha_{12}\left[\ln(Deposit_{t-1}^{chf}) - \ln\left(S_{t-1}^{chf}\right)\right] \\
& +\alpha_{13}\left[\ln(Loan_{t-1}^{fx}) - \ln\left(S_{t-1}^{fx}\right)\right] + \alpha_{14}\left[\ln(Deposit_{t-1}^{fx}) - \ln\left(S_{t-1}^{fx}\right)\right] \\
& +\alpha_{15} Dpost_{t-1} + fixed_region
\end{aligned} \tag{9}$$

The α's are coefficients that we expect to be positive based on our model. $Funding_t^{chf}$ is the amount of Swiss franc denominated funding, which we adjust for the valuation impact of the exchange rate (where a higher value of S_t^{chf} is a stronger Swiss franc). We first control for monetary conditions proxied by the ratio of monetary base to GDP in Switzerland, the Euro are and the United States, which enter with a lag to alleviate reverse causality concerns. We also control for the short interest spread between the domestic currency and the Swiss franc. We proxy for expectations of the future exchange rate by its level, and control for past exchange rate movements interacted with the net positions in the Swiss franc and other foreign currencies.

Risk considerations enter in the form of the future volatility of the exchange rate, the covariance between the exchange rate vis-a-vis the Swiss franc and vis-a-vis the other foreign currency, and the level of the Vix index. All risk variables are interacted with the long positions in foreign currencies in line with the theory. The variance and covariance of exchange rate are computed based on movements at a weekly frequency within the following quarter. The next group of variables captures movements in loans and deposits in Swiss franc and the

other foreign currency, adjusted for the direct valuation impact of exchange rate movements. We finally include fixed effects for each group of countries.

While our theory implies a specification in levels, it assumes that banks face no costs of adjusting their balance sheet. In the presence of such costs, the adjustment of balance sheets would show a substantial inertia, making the level specification disputable. We therefore also consider a specification in first difference (where $\Delta X_t = X_t - X_{t-1}$):

$$\begin{aligned}
& \Delta \ln\left(Funding_t^{chf}\right) - \Delta \ln\left(S_t^{chf}\right) \\
= \; & \beta_0 + \beta_1 \Delta\left(\frac{M_{t-1}^{chf}}{Y_{t-1}^{chf}}\right) - \beta_2 \Delta\left(\frac{M_{t-1}^{eur}}{Y_{t-1}^{eur}}\right) - \beta_3 \Delta\left(\frac{M_{t-1}^{usd}}{Y_{t-1}^{usd}}\right) + \beta_4 \Delta\left(i_{t-1}^{dom} - i_{t-1}^{chf}\right) \\
& -\beta_5 \Delta \ln\left(S_{t+1}^{chf}\right) + \beta_6 \left(\Delta \ln\left(S_{t-1}^{chf}\right)\right) Net_{t-1}^{chf} + \beta_7 \left(\Delta \ln\left(S_{t-1}^{fx}\right)\right) Net_{t-1}^{fx} Net_{t-1}^{chf} \\
& +\beta_8 \left(\Delta Var\left(S_{t+1}^{chf}\right)\right) Net_{t-1}^{chf} + \beta_9 \left(\Delta Covar\left(S_{t+1}^{chf}, S_{t+1}^{fx}\right)\right) Net_{t-1}^{fx} + \beta_{10} \left(\Delta Vix_{t-1}\right) Net_{t-1}^{chf} \\
& +\beta_{11} \left[\ln(Loan_{t-1}^{chf}) - \ln\left(S_{t-1}^{chf}\right)\right] - \beta_{12} \left[\Delta \ln(Deposit_{t-1}^{chf}) - \Delta \ln\left(S_{t-1}^{chf}\right)\right] \\
& +\beta_{13} \left[\Delta \ln(Loan_{t-1}^{fx}) - \Delta \ln\left(S_{t-1}^{fx}\right)\right] + \beta_{14} \left[\Delta \ln(Deposit_{t-1}^{fx}) - \Delta \ln\left(S_{t-1}^{fx}\right)\right] \\
& +\beta_{15} \Delta Dpost_{t-1}
\end{aligned} \tag{10}$$

We consider similar specification for the funding position in other foreign currencies. For instance, for emerging economies where that currency is the euro we consider the level specification:

$$\begin{aligned}
& \ln\left(Funding_t^{eur}\right) - \ln\left(S_t^{eur}\right) \\
= \; & \gamma_0 - \gamma_1 \frac{M_{t-1}^{chf}}{Y_{t-1}^{chf}} + \gamma_2 \frac{M_{t-1}^{eur}}{Y_{t-1}^{eur}} - \gamma_3 \frac{M_{t-1}^{usd}}{Y_{t-1}^{usd}} + \gamma_4 \left(i_{t-1}^{dom} - i_{t-1}^{eur}\right) \\
& -\gamma_5 \ln\left(S_{t+1}^{eur}\right) + \gamma_6 \ln\left(S_{t-1}^{eur}\right) Net_{t-1}^{eur} + \gamma_7 \ln\left(S_{t-1}^{chf}\right) Net_{t-1}^{eur} Net_{t-1}^{chf} \\
& +\gamma_8 Var\left(S_{t+1}^{eur}\right) Net_{t-1}^{eur} + \gamma_9 Covar\left(S_{t+1}^{chf}, S_{t+1}^{eur}\right) Net_{t-1}^{chf} + \gamma_{10} Vix_{t-1} Net_{t-1}^{eur} \\
& +\gamma_{11} \left[\ln(Loan_{t-1}^{chf}) - \ln\left(S_{t-1}^{chf}\right)\right] + \gamma_{12} \left[\ln(Deposit_{t-1}^{chf}) - \ln\left(S_{t-1}^{chf}\right)\right] \\
& +\gamma_{13} \left[\ln(Loan_{t-1}^{eur}) - \ln\left(S_{t-1}^{eur}\right)\right] - \gamma_{14} \left[\ln(Deposit_{t-1}^{eur}) - \ln\left(S_{t-1}^{eur}\right)\right] \\
& +\gamma_{15} Dpost_{t-1} + fixed_region
\end{aligned} \tag{11}$$

and the first-difference specification:

$$
\begin{aligned}
& \Delta \ln \left(Funding_t^{eur} \right) - \Delta \ln \left(S_t^{eur} \right) \\
= \; & \delta_0 - \delta_1 \Delta \left(\frac{M_{t-1}^{chf}}{Y_{t-1}^{chf}} \right) + \delta_2 \Delta \left(\frac{M_{t-1}^{eur}}{Y_{t-1}^{eur}} \right) - \delta_3 \Delta \left(\frac{M_{t-1}^{usd}}{Y_{t-1}^{usd}} \right) + \delta_4 \Delta \left(i_{t-1}^{dom} - i_{t-1}^{eur} \right) \\
& - \delta_5 \Delta \ln \left(S_{t+1}^{eur} \right) + \delta_6 \left(\Delta \ln \left(S_{t-1}^{eur} \right) \right) Net_{t-1}^{eur} + \delta_7 \left(\Delta \ln \left(S_{t-1}^{chf} \right) \right) Net_{t-1}^{eur} Net_{t-1}^{chf} \\
& + \delta_8 \left(\Delta Var \left(S_{t+1}^{eur} \right) \right) Net_{t-1}^{eur} + \delta_9 \left(\Delta Covar \left(S_{t+1}^{chf}, S_{t+1}^{eur} \right) \right) Net_{t-1}^{chf} + \delta_{10} \left(\Delta Vix_{t-1} \right) Net_{t-1}^{eur} \\
& + \delta_{11} \left[\Delta \ln (Loan_{t-1}^{chf}) - \Delta \ln \left(S_{t-1}^{chf} \right) \right] + \delta_{12} \left[\Delta \ln (Deposit_{t-1}^{chf}) - \Delta \ln \left(S_{t-1}^{chf} \right) \right] \\
& + \delta_{13} \left[\ln (Loan_{t-1}^{eur}) - \Delta \ln \left(S_{t-1}^{eur} \right) \right] - \delta_{14} \left[\Delta \ln (Deposit_{t-1}^{eur}) - \Delta \ln \left(S_{t-1}^{eur} \right) \right] \\
& + \delta_{15} \Delta Dpost_{t-1}
\end{aligned}
\tag{12}
$$

6 Econometric Analysis

We now turn to our econometric assessment of the drivers of foreign currency funding. We first assess the determinants of funding in Swiss francs, and then turn to the funding in other foreign currencies. While we construct estimated of the split of the other foreign currencies across specific currencies (specifically the euro and the US dollar) in section 5.2, it turns out that we cannot fine-tune our empirical specification across these two currencies. This is because the exchange rates between them and the domestic currencies are highly colinear, leading to imprecise estimates. We thus opt not to split the positions in non-CHF foreign currencies further. We of course still need to take a stance of which currency these positions consist of. For the subsample of countries that are not in the euro area, we consider the Euro to be the non-CHF foreign currency. For the other two groups of countries in the euro area, we instead consider the US dollar. The weights computed in section 5.2 are used as interactions with the $Loan_{t-1}^{fx}$ and $Deposit_{t-1}^{fx}$ variables in the regression specifications (9)-(12).

The dependent variable is the growth rate of wholesale liabilities, adjusted for valuation change from exchange rates (the changes are recorded at end-of-quarter). The sample goes from the first quarter of 2007 to the third quarter of 2014, and is unbalanced. Explanatory variables are recorded in quarterly averages (or changes in quarterly averages).

6.1 Funding in Swiss franc

The results for funding in Swiss franc are presented in Table 1. The left panel presents the results for the countries that are not in the euro area, both in terms of the first-difference specification (10) (first column), which is our preferred specification, and the level specification (9) (second column). The middle panel shows the results for the euro area countries that are not financial centers, with the results for financial centers presenting in the right panel.

The drivers of Swiss franc funding are quite heterogeneous across the three country groups.

For emerging economies, four main results emerge. First, future exchange rate movements matter, in line with the theory. Assuming that these movements are expected, an appreciation of the Swiss franc raises the cost of funding in that currency and reduces the volume. This effect is observed in both specifications. Past appreciations (interacted with the net positions in the respective foreign currencies) matter, but with a sign opposite to that implied by the theory. A potential explanation is that expectations about exchange rates entail a backward looking element. Recall that net exposure in Swiss franc is positive for most countries, and net exposure in euro is negative. Under backward looking expectations, an appreciation of the Swiss franc raises the expected cost of funding in that currency and reduces its use, consistent with our empirical finding. An appreciation of the euro that is expected to persists makes the Swiss franc more attractive and raises its use, as our empirical finding suggests (as net exposure in euro is negative).

Second, movements in the lending positions in Swiss francs (adjusted for exchange rate valuations) matter, with coefficients close to unity. As residents' deposits in Swiss francs are limited, this indicates that banks in emerging countries rely on wholesale funding to limit their marginal exposure to the Swiss franc when granting more Swiss franc loans. Third, risk-related variables, including the exchange rate volatility, correlation, and risk appetite (proxied by the vix) do not drive Swiss franc funding. Fourth, policy variables such as the interest rate spread and the liquidity provision are not significant either.

The drivers of funding among euro countries that are not financial centers (middle panel) are quite different. First, the interest rate spread plays a significant role in line with the theory in both specifications. Second, we find some evidence of an impact of lagged exchange rate movements vis--vis the other foreign currency (the US dollar), which could reflect adaptive expectations. Third, the level specification shows an impact of exchange rate volatility (albeit inconsistent with the theory), Swiss franc deposits (which are however small), and lending and deposits in other foreign currencies. These effects are however not robust to the exact specification.

	Emerging Europe		Euro non-financial centers		Euro financial centers	
	FX = EUR		FX = USD		FX = USD	
Explanatory Variable	First diff.	Level	First diff.	Level	First diff.	Level
Constant	**0.14** *	2.58	-0.02	-6.96	-0.03	**10.67** *
Swiss M0 in % GDP	-0.20	-0.35	1.62	**-1.29** **	0.08	**-1.37** ***
Euro M0 in % GDP	-3.56	1.89	0.48	3.46	**-5.52** *	-0.99
US M0 in % GDP	-6.01	-1.20	-0.29	-1.03	-2.01	-2.81
Spread between interest rate on domestic and CHF funding	0.03	**-0.02** **	**0.18** *	**0.20** **	0.00	0.08
CHF exchange rate (+1)	**-0.36** ***	**-0.44** ***	0.94	1.39	0.59	**-2.09** ***
CHF exchange rate (-1) * net exposure to CHF (-1)	**-1.54** **	-0.02	-0.07	0.04	-1.27	0.80
FX exchange rate (-1) * net exposure to FX (-1) * net exposure to CHF (-1)	**-4.54** ***	0.04	**-1.41** **	0.07	60.47	8.94
CHF exchange rate volatility (+1) * net exposure to CHF (-1)	0.65	1.11	-34.40	**-162.40** **	-536.5	-732.60
Correlation of CHF and FX exchange rates (+1) * net exposure to FX (-1)	1.50	0.47	-3.58	0.06	**1.32** *	**-1.07** **
VIX (-1) * net exposure to CHF (-1)	0.00	0.00	0.00	0.00	**0.02** **	0.01
Valuation adjusted CHF loans (-1)	**0.78** **	**1.39** ***	-0.20	-0.48	0.03	**0.41** **
Valuation adjusted CHF deposits (-1)	-0.13	0.07	0.19	**0.61** **	0.00	**-0.26** *
Valuation adjusted FX loans (-1) * FX currency weight (-1)	0.75	0.19	0.49	**0.46** **	-0.07	**-1.62** **
Valuation adjusted FX deposits (-1) * FX currency weight (-1)	-0.71	**-0.74** **	0.41	**1.41** ***	-0.02	**1.13** ***
Dummy postfinance (-1)	**0.65** ***	0.12	0.24	0.31	**-0.14** *	0.20
Number of observations	199	213	95	102	76	82
Number of cross sections	8	8	4	4	4	4
R-Squared	0.10	0.97	0.37	0.98	0.22	0.89

Table 1: **Determinants of CHF funding: baseline panel regressions**

Dependent variable is valuation adjusted growth in Swiss franc wholesale funding. */**/*** denote significance at the 10%/5%/1% levels, using white clustered standard errors. Poland is not included in the sample due to missing data on foreign currency assets.

Turning to the financial centers (right panel) shows again a different pattern. First, risk-related variables matter. A higher correlation of the exchange rates vis--vis the Swiss franc and the other currency (the US dollar), interacted with the net exposures, raises the funding in Swiss franc as predicted by theory (this pattern is however sensitive to the specification). An increase in risk aversion, proxied by the vix, also raises Swiss franc funding when countries initially have a long exposure to the franc. Second, we find some effect of monetary conditions in the euro area, with a more expansionnary policy reducing the use of Swiss franc. This effect is however sensitive to the specification. Fourth, the level specification points to a role of future exchange rate movements against the Swiss franc, as well as changes in Swiss franc loans and deposits (all in line with the theory) and loans and deposits in other foreign currencies.

Overall, our analysis shows a highly contrasted situation. Among emerging economies, the funding activity in Swiss franc appears primarily driven by exchange rate movements and lending activity in that currency. By contrast, funding costs matter for euro area countries that are not financial centers, while risk related considerations play a role for financial centers.

6.2 Funding in other foreign currency

We now turn to the determinants of funding in foreign currencies other than the Swiss franc, with the results presented in Table 2 which is structured along the same lines as Table 1. The drivers of non-CHF funding also display a substantial extent of heterogeneity across the three groups of countries.

Starting with emerging economies (left panel), three points emerge. First, future exchange rate developments matter, with an appreciation of the foreign currency reduces its use is funding. Second, lending in Swiss franc also plays a role. This suggests that banks in emerging economies view the euro and Swiss franc as substitutable to some extend when offsetting the exchange rate exposure stemming from higher volumes of loans in Swiss francs. Both the exchange rate and loan volumes effects are however sensitive to the specification.

Third, the specification in level points to several additional aspects. Monetary stances matter, with euro funding rising when the stances are tighter in Switzerland or looser in the euro area and the United States. The interest rate differential also play a role. Past and future exchange rate movements also matter, the sign being albeit opposite than expected on future movements.[20] A higher exchange rate volatility raises funding when countries have a long exposure, in line with the theory. Movements in loan deposit volumes also matter, in line with our model.

[20] To the extent that expectations are backward looking, the past exchange rate movements could be a better indicator of forthcoming funding costs.

	Emerging Europe		Euro non-financial centers		Euro financial centers	
		FX = EUR		FX = USD		FX = USD
Explanatory Variable	First diff.	Level	First diff.	Level	First diff.	Level
Constant	0.12	**7.43** ***	-0.03	2.24	-0.04	**13.39** ***
Swiss M0 in % GDP	0.17	**-0.43** ***	**2.20** **	**-1.11** ***	0.43	0.33
Euro M0 in % GDP	-5.56	**1.62** *	-1.06	**2.41** *	-5.89	**-2.15** *
US M0 in % GDP	-7.56	**2.12** ***	5.17	-0.78	-0.82	**-4.39** ***
Spread between interest rate on domestic and FX funding	0.02	**0.01** **	0.15	0.04	0.07	0.01
FX exchange rate (+1)	**-0.29** ***	**0.40** ***	-1.06	0.57	0.42	0.01
FX exchange rate (-1) * net exposure to FX (-1)	1.52	**-0.69** ***	**-15.65** *	**0.16** **	-2.23	0.01
CHF exchange rate (-1) * net exposure to FX (-1) * net exposure to CHF (-1)	3.45	-0.07	-0.22	**-0.03** **	22.44	**-3.84** *
FX exchange rate volatility (+1) * net exposure to FX (-1)	-4.28	**34.52** ***	-13720	**-3030** **	1658	**-9643** *
Correlation of CHF and FX exchange rates (+1) * net exposure to CHF (-1)	0.14	**-0.08** ***	-0.06	0.01	-0.08	-0.08
VIX (-1) * net exposure to FX (-1)	-2.46	0.00	-6.02	0.00	0.00	0.01
Valuation adjusted CHF loans (-1)	**0.64** **	-0.05	0.17	0.11	0.02	**-0.12** **
Valuation adjusted CHF deposits (-1)	-0.24	**-0.06** *	0.09	-0.07	-0.04	**-0.10** **
Valuation adjusted FX loans (-1) * FX currency weight (-1)	0.75	**0.40** ***	0.49	**-0.17** ***	-0.09	0.04
Valuation adjusted FX deposits (-1) * FX currency weight (-1)	-0.47	**-0.35** *	0.44	**0.74** ***	0.01	0.17
Dummy postfinance (-1)	**0.61** ***	-0.04	**0.46** **	**0.19** *	**-0.11** *	0.01
Number of observations	199	213	95	102	76	82
Number of cross sections	8	8	4	4	4	4
R-Squared	0.07	0.96	0.23	0.99	0.15	0.99

Table 2: **Determinants of other foreign currency funding: baseline panel regressions**
Dependent variable is valuation adjusted growth in non-Swiss franc wholesale foreign currency funding. */**/*** reflect significance at the 10%/5%/1% levels, using white clustered standard errors. Poland is not included in the sample due to missing data on foreign currency assets.

Turning to the euro area countries that are not financial centers (middle panel), we find that past exchange rate movements matter, with the sign of the coefficient possibly reflecting backward-looking expectations. The level specification points to a role for liquidity availability in the Swiss franc and the euro, as well as exchange rate movements and volatility and changes in loans and deposits (albeit with the wrong signs). We finally find limited evidence of significant drivers for financial centers (right panel). Only the level specification shows coefficients that are statistically significant, but with sign that are not consistent with our theory (with the exception of the impact of exchange rate movements vis-a-vis the Swiss franc, if expectations are backward looking to some extent).

Overall, funding in foreign currencies other than the Swiss franc is driven by exchange rate movements and Swiss franc lending for emerging economies. Among advanced economies, we find some evidence for exchange rate movements outside of financial center. A striking contrast with Table 1 is that fewer coefficients display significance. This suggests that funding in euro and US dollar could be of a more structural nature, reflecting the long-standing role of the euro in emerging European economies for instance, with limited sensitivity to changing conditions. The use of the Swiss franc by contrast shows more sensitivity, and that currency represents the main variable of adjustment in foreign currency funding by banks.

7 Conclusion and Further Work

This paper considers the determinants of banks' wholesale funding in foreign currencies by relying on a novel database on the use of the Swiss franc and other currencies by banks outside Switzerland. We develop a simple model of funding currency choice that highlights the role of the relative cost of funding, past and future movements of exchange rates, exchange rate volatility, and fluctuations in foreign currency lending and deposits. The model points that the impact of several variables depend on the banks' net position in the foreign currencies.

Our empirical analysis finds support for several implications of the model, and shows that the drivers are highly contrasted across different foreign funding currencies. Swiss franc funding in emerging European countries is primarily affected by exchange rate movements, in line with the model, as well as variations in loans denominated in Swiss francs. The cost of Swiss franc funding does not play a role for these countries, but matter in euro area countries that are not financial center. Finally, risk-related considerations play a larger role among financial centers. Funding in foreign currencies other than the Swiss franc is also affected by exchange rates and lending activity among emerging economies, but overall displays less sensitivity to movements in the various factors than Swiss franc funding does.

Our results thus point to substantial heterogeneity across currencies, as well as across countries. Our results display some sensitivity to the specifications considered, pointing to the need to carefully disentangle level and dynamic aspects. A dynamic VAR analysis is thus a promising additional step to assess the determinants of funding.

Appendix

A Theoretical model

A.1 Bank equity

Equity is the residual value of loans minus deposits and wholesale funding. At period 1 we have:

$$K_1 = \sum_{i=dom,eur,chf} S_0^i \left[C_0^i - D_0^i - F_0^i\right] \exp\left(\nu_1^{S,i}\right)$$

which from (2) can also be written as:

$$\begin{aligned} K_1 &= \sum_{i=dom,eur,chf} S_0^i \left[C_0^i \exp\left(\nu_1^{C,i} + \nu_1^{S,i}\right) - D_0^i \exp\left(\nu_1^{D,i} + \nu_1^{S,i}\right)\right] \\ &\quad - \sum_{i=dom,eur,chf} S_0^i F_1^i \exp\left(\nu_1^{S,i}\right) \end{aligned}$$

At period 2 equity is given by:

$$\begin{aligned} K_2 &= \sum_{i=dom,eur,chf} S_0^i C_0^i \exp\left(\nu_1^{C,i} + \varepsilon_2^{dom} + (1-\lambda)\left(\nu_1^{S,i} + \tau_2^{S,i}\nu_2^{S,i} + \varepsilon_2^{S,i}\right)\right) \\ &\quad - \sum_{i=dom,eur,chf} S_0^i D_0^i \exp\left(\nu_1^{D,i} + \nu_1^{S,i} + \tau_2^{S,i}\nu_2^{S,i} + \varepsilon_2^{S,i}\right) \\ &\quad - F_1^{dom} \exp\left(\tau_2^{q,dom}\nu_2^{q,dom}\right) \\ &\quad - \sum_{i=eur,chf} S_0^i F_1^i \exp\left(\nu_1^{S,i} + \tau_2^{q,i}\left(1 + \nu_2^{q,i}\right) + \tau_2^{S,i}\nu_2^{S,i} + \varepsilon_2^{S,i}\right) \end{aligned}$$

Using (2) and the notation $F_1^i = F_0^i \exp\left(f_1^i\right)$, we rewrite it as:

$$\begin{aligned} K_2 &= \sum_{i=dom,eur,chf} S_0^i C_0^i \begin{bmatrix} \exp\left(\varepsilon_2^{dom} + (1-\lambda)\left(\nu_1^{S,i} + \tau_2^{S,i}\nu_2^{S,i} + \varepsilon_2^{S,i}\right)\right) \\ -\exp\left(\nu_1^{S,i} + \tau_2^{q,dom}\nu_2^{q,dom}\right) \end{bmatrix} \exp\left(\nu_1^{C,i}\right) \\ &\quad - \sum_{i=dom,eur,chf} S_0^i D_0^i \begin{bmatrix} \exp\left(\tau_2^{S,i}\nu_2^{S,i} + \varepsilon_2^{S,i}\right) \\ -\exp\left(\tau_2^{q,dom}\nu_2^{q,dom}\right) \end{bmatrix} \exp\left(\nu_1^{D,i} + \nu_1^{S,i}\right) \\ &\quad + \sum_{i=dom,eur,chf} S_0^i \left[C_0^i - D_0^i - F_0^i\right] \exp\left(\nu_1^{S,i} + \tau_2^{q,dom}\nu_2^{q,dom}\right) \\ &\quad - \sum_{i=eur,chf} \left[\exp\begin{pmatrix} \tau_2^{q,i}\left(1 + \nu_2^{q,i}\right) \\ +\tau_2^{S,i}\nu_2^{S,i} + \varepsilon_2^{S,i} \end{pmatrix} - \exp\left(\tau_2^{q,dom}\nu_2^{q,dom}\right)\right] \exp\left(f_1^i + \nu_1^{S,i}\right) \end{aligned} \tag{13}$$

A.2 Initial optimization

From the point of view of period 0 shifters are fully unexpected. The bank thus does not expect to revise its allocation in period 1 ($F_0^i = F_1^i$), and thus the Lagrangian is:

$$E_0 \frac{(K_2)^{1-\gamma}}{1-\gamma} + \phi_0 \left[\sum_{i=dom,eur,chf} S_0^i F_0^i - \bar{F}_0 \right]$$

where $\bar{F}_0$ is given by (1) and:

$$\begin{aligned} K_2 \;=\; & \sum_{i=dom,eur,chf} S_0^i C_0^i \exp\left(\varepsilon_2^{dom} + (1-\lambda)\,\varepsilon_2^{S,i}\right) - \sum_{i=dom,eur,chf} S_0^i D_0^i \exp\left(\varepsilon_2^{S,i}\right) \\ & -F_0^{dom} - \sum_{i=deur,chf} S_0^i F_0^i \exp\left(\tau_2^{q,i} + \varepsilon_2^{S,i}\right) \end{aligned}$$

The first-order conditions with respect to the three F_0^i lead to a system of two portfolio Euler equations (3).

We solve the model through a cubic approximation of the Euler equations. The expansion is taken with respect to the shocks ε's and $\tau_2^{q,eur}$ and $\tau_2^{q,chf}$, and we only keep terms up to order 3. It is useful to notice that the expected value of any cubic product of ε's is zero as all ε's are symmetrically distributed around zero. The expansion of (3) for currency i takes the form:

$$0 = linear_{i,0} + \frac{1}{2} quadratic_{i,0} + \frac{1}{6} cubic_{i,0}$$

The linear term has first-, second- and third order components, the quadratic terms has second- and third order components, and the cubic term has a third-order components. All these components are zero except for the second-order ones in the linear and quadratic terms:

$$\begin{aligned} linear_{i,0}\,(2) &= (K_0)^{-\gamma} \left(\tau_2^{q,i} - \frac{1}{2}\sigma_{fx}^2\right) \\ quadratic_{i,0}\,(2) &= (K_0)^{-\gamma}\,\sigma_{fx}^2 - 2\gamma\,(K_0)^{-\gamma-1}\,Net_0^i \sigma_{fx}^2 \end{aligned}$$

Combining these terms leads to (4).

A.3 Funding reallocation

From the point of view of period 1 the shifters are revealed and the Lagrangian is:

$$E_1 \frac{(K_2)^{1-\gamma}}{1-\gamma} + \phi_0 \left[\sum_{i=dom,eur,chf} S_0^i F_1^i \exp\left(\nu_1^{S,i}\right) - \bar{F}_1 \right]$$

where $\bar{F}_1$ is given by (2). The first-order conditions with respect to the three F_1^i lead to a system of two portfolio Euler equations (5).

We take a cubic expansion with respect to the shocks ε's, $\tau_2^{q,eur}$ and $\tau_2^{q,chf}$, the shifters ν's and the f's. The expansion of (5) for currency i takes the form:

$$0 = linear_{i,1} + \frac{1}{2} quadratic_{i,1} + \frac{1}{6} cubic_{i,1}$$

The linear term has first-, second- and third order components, the quadratic terms has second- and third order components, and the cubic term has a third-order components. The second-order components in the linear and quadratic terms are the same as from the point of view of period 0:

$$linear_{i,1}(2) = linear_{i,0}(2) \quad ; \quad quadratic_{i,1}(2) = quadratic_{i,0}(2)$$

The third-order components of the linear, quadratic and cubic terms are:

$$\begin{aligned}
linear_{i,1}(3) &= (K_0)^{-\gamma} \left(\tau_2^{q,i} \nu_2^{q,i} + \tau_2^{S,i} \nu_2^{S,i} - \frac{1}{2} \sigma_{fx}^2 \nu_2^{\sigma,i} - \tau_2^{q,dom} \nu_2^{q,dom} \right) \\
quadratic_{i,1}(3) &= (K_0)^{-\gamma} \sigma_{fx}^2 \nu_2^{\sigma,i} \\
&\quad -2\gamma (K_0)^{-\gamma-1} \left(\tau_2^{q,i} - \frac{1}{2} \sigma_{fx}^2 \right) \sum_{k=eur,chf} Net_0^k \nu_1^{S,k} \\
&\quad -2\gamma (K_0)^{-\gamma-1} \left[Net_0^i \sigma_{fx}^2 \nu_2^{\sigma,i} - Net_0^j \sigma_{fx}^2 \frac{1}{2} \nu_2^{\rho} \right] \\
cubic_{i,1}(3) &= -3\gamma (K_0)^{-\gamma-1} \sigma_{fx}^2 \sum_{k=eur,chf} Net_0^k \nu_1^{S,k} \\
&\quad -6\gamma (K_0)^{-\gamma-1} \left[\begin{array}{c} Net_0^i \nu_1^{S,i} + (1-\lambda) S_0^i C_0^i \left(\nu_1^{C,i} - \lambda \nu_1^{S,i} \right) \\ -S_0^i D_0^i \nu_1^{D,i} - S_0^i F_0^i f_1^i \end{array} \right] \sigma_{fx}^2 \\
&\quad -6\gamma (-\gamma - 1) (K_0)^{-\gamma-2} Net_0^i \nu_1^{S,i} \sigma_{fx}^2
\end{aligned}$$

where the index j denotes the foreign currency other than i. Combining these terms leads to (6).

B Data Sources and Definitions

- Nominal GDP: Quarterly, seasonally adjusted, quarterly values, not annualized. Source: IFS.
- Real GDP: Index, 2005=100, seasonally adjusted. Source: IFS.
- Exchange rate vis-a-vis the EURO: Local currency per euro nominal exchange rate. Includes the euro exchange rates for euro countries, relating to their pre-euro currency. Source: Datastream.
- Exchange rate vis-a-vis the USD: Local pre-euro currency per USD, average rate of the

last week of the quarter. Source: Datastream.

- Exchange rate vis-a-vis the CHF: Local currency per Swiss franc. For euro countries, the euro Swiss franc exchange rate has been used. The Estonian exchange rate is the pre-euro rate up until 2010Q4, and the euro exchange rate from 2011Q1. Source: Datastream.
- Exchange rate volatilities are computed as the quarterly average of the daily squared change in the log of the exchange rate.
- Pairwise exchange rate correlations are computed as the correlation in labor-daily data of the two exchange rates over the quarter.
- US Monetary Base. Adjusted for reserve requirement changes. Quarterly average of monthly levels. Source: St Louis Federal Reserve. In millions USD.
- euro Area monetary base: Quarterly average of monthly levels. Source: BIS. In millions euro.
- Swiss monetary base: Quarterly average of monthly levels. Source: SNB. In millions of Swiss francs.
- Federal Reserve bilateral USD currency swap volumes. Source: Federal Reserve. Quarterly averages, in millions of USD.
- SNB bilateral Swiss franc currency swap volumes. Source: SNB. Quarterly averages, in millions of Swiss francs.
- VIX: Options based expected stock price volatility, based on the S&P, calculated by the CBOE. Source: Datastream.
- Money market spread: Spread between 3-month libor and 3-month ois rate in the respective currency. Quarterly average of daily spreads. Source: SNB
- Leverage of US securities brokers and dealers: As defined in Arian et al. [2014], page 9. Source of total assets and liabilities of securities brokers and dealers: US Financial Accounts (http://www.federalreserve.gov/datadownload/Build.aspx?rel=Z1). Quarterly, based on end-of-quarter accounts.

C Adjustment for Valuation Effects

To measure the extent to which Swiss franc funding and lending stocks have changed across quarters in absolute terms and when adjusted for movements in the Swiss franc exchange

rate, we compute a valuation adjusted flows of the various funding and lending categories using equations 7 and 8.

Stocks are recorded end of quarter and current exchange rates. We use the average of the daily local currency Swiss franc exchange rate of the last week of the quarter. This reduces the influence of daily volatility in exchange rates on the adjusted flow, while staying as close as possible to the end-of-quarter value prevailing when funding and lending stocks are recorded. The resulting valuation adjusted flows are measured in local currency and depicted for different funding and lending categories in Figures.

C.1 Currency composition of non-CHF FX currency flows

To adjust non-CHF foreign currency flows for valuation effects due to exchange rate movements, we need a proxy for the currency composition of the stocks. This information is not available in our dataset, nor is it available consistently for the sample countries in any other unified data source. We hence assess the currency composition using three different approaches, namely regressions that estimate the sensitivity of stocks to changes in the relevant exchange rates, the series of ECB publications on the international role of the euro (see ECB [2014]), providing data on the share of euros in bank lending and deposits in non-euro European countries, and country specific data sources when these are readily available. We simplify by assuming that currency weights have remained constant across the sample period. This assumption is clearly a limitation, as the figures included in Section **??** suggest that currency weights have fluctuated in the sample period. It is a necessary assumption, however, because the three data sources do not contain sufficient information to compute time varying weights.

Our choice of weights is summarized in Table 1.

- AT. The Austrian central bank reports that the bulk of non-CHF FX lending to domestic households is in Yen. Non-CHF FX lending to domestic non-financial firms is about one quarter in yen, the rest is in other currencies. The bulk of foreign currency lending in Austria is to households. The central bank offers no information on currency breakdown of foreign currency deposits or other liabilities. See Austria National Bank, http://www.oenb.at/isaweb/report.do?report=3.78. Note also that since Austria does not report total assets and total liabilities, we have used total lending and total deposits for Austria instead. We consider that all non-CHF FX is in yen for all subcategories.

- BG. Bulgaria's non-CHF FX positions are largely in euros (see papers by Brown and coauthors). Bulgaria has pegged to the euro during the sample period, and we have hence excluded the euro from the regressions. Given the overwhelming role of the euro, we consider that all non-CHF FX is in euro for all subcategories.

- CZ. Czech banks non-CHF FX positions are primarily denominated in euro, but also USD. ECB [2014] suggests that

- DE. Germany: Bundesbank offers detailed stats on currency composition of non-euro assets and liabilities vis-Ã -vis residents (but not for non-residents), see table 19: http://www.bundesbank.de/Navigation/DE/Statistiken/Banken_und_andere_finanzielle_Institute/Banken_
  or http://www.bundesbank.de/Redaktion/DE/Downloads/Statistiken/Banken_Und_Andere_Finanzielle_In
  We have based the currency weights for Germany on the Bundesbank data.

- GB, England. Bank of England's homepage did not come up with data on the currency breakdown of balance sheet positions of UK banks. The regression estimates of currency weights are plausible, and we have based the currency weights that we use on these.

- GR, Greece: Central bank homepage offers detailed information on currency breakdown for lending and deposits in non-CHF foreign currency across time. We have computed currency weight averages for the sample period based on these data. See http://www.bankofgreece.gr/Pages/en/Statistics/monetary/assets_debit.aspx.

- HR, Croatia. It was not possible to find statistics on the central bank homepage. We consider that all non-CHF FX is in euro for all subcategories.

- HU, Hungary. It was not possible to find statistics on the central bank homepage. The regression estimates of currency weights are plausible and in line with the information in ECB [2014], and we have based the currency weights that we use on these.

- LV, Latvia. Latvia has pegged to the euro during the sample period, and we have hence excluded the euro from the regressions. It was not possible to find statistics on the central bank homepage. We hence rely on ECB [2014] for determining FX currency weights for Latvia.

- RO, Romania's central bank offers stats on currency breakdown of lending and deposits on domestic, see see http://www.bnro.ro/Loans-to-households-6374.aspx.

- RS, Serbia's central bank offers detailed statistics on currency breakdown of lending to and deposits from residents, see http://www.nbs.rs/internet/english/80/index.html. We use the ECB [2014] numbers for Serbia.

- SI, Slovenia: It was not possible to find statistics on the central bank homepage. We consider that all non-CHF FX is in USD for all subcategories.

D Tables

Table 1. Currency Weights (A)

Austria	CHF		Euro		USD		Pound		Yen	
	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability
Weights used, in total FX	52%	34%	0%	0%	0%	0%	0%	0%	48%	66%
Weights used, in non-CHF FX			0%	0%	0%	0%	0%	0%	100%	100%

National source indicate that the positions in foreign currencies other than the Swiss franc are in yen.

Bulgaria	CHF		Euro		USD		Pound		Yen	
	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability
Weights used, in total FX	1%	0%	99%	100%	0%	0%	0%	0%	0%	0%
Weights used, in non-CHF FX			100%	100%	0%	0%	0%	0%	0%	0%

The ECB indicates an overwhelming role for the Euro, so we assume that all positions in foreign currency other than the Swiss franc are in Euro.

Czech Republic	CHF		Euro		USD		Pound		Yen	
	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability
Weights used, in total FX	1%	1%	89%	92%	10%	7%	0%	0%	0%	0%
Weights used, in non-CHF FX			90%	93%	10%	7%	0%	0%	0%	0%

We assume that all non-CHF positions are denominated in euro. These weights apply prior to accession in 2011.

Germany	CHF		Euro		USD		Pound		Yen	
	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability
Weights used, in total FX	9%	7%	0%	0%	71%	78%	15%	13%	5%	3%
Weights used, in non-CHF FX			0%	0%	78%	84%	16%	14%	6%	3%

National sources indicate a strong role for the US dollar, and some role for the Pound and the yen. We use the shares from the Bundesbank, and allocate the positions in foreign currencies other than the Swiss franc across US dollar Pound and Yen in all subcategories by using their respective shares in the aggregate

For each country, the first row shows the percentage allocation of foreign currency assets (and liabilities) between the Swiss Franc, the Euro, the US Dollar, the British Pound, and the Yen. The second row show the allocation across the foreign currencies other than the Swiss franc, corresponding to the weight $\omega^{c,j}$ in the regressions. The weights do not always sum to 100% due to rounding.
The shares combine three sources: the ECB *International role of the euro* publication, information from national central banks, and a regression of the change in positions in foreign currencies other than the Swiss franc on the respective exchange rates.

Table 1. Currency Weights (B)

Estonia	CHF		Euro		USD		Pound		Yen	
	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability
Weights used, in total FX	1%	1%	100%	100%	0%	0%	0%	0%	0%	0%
Weights used, in non-CHF FX			100%	100%	0%	0%	0%	0%	0%	0%

We assume that all non-CHF positions are denominated in euro. These weights apply prior to accession in 2011.

France	CHF		Euro		USD		Pound		Yen	
	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability
Weights used, in total FX	3%	4%	0%	0%	78%	77%	10%	10%	10%	10%
Weights used, in non-CHF FX			0%	0%	80%	80%	10%	10%	10%	10%

We allocate non-CHF FX positions among USD, GBP and JPY.

United Kingdom	CHF		Euro		USD		Pound		Yen	
	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability
Weights used, in total FX	2%	2%	56%	56%	27%	26%	0%	0%	14%	16%
Weights used, in non-CHF FX			58%	58%	28%	26%	0%	0%	14%	16%

The ECB, and regression analysis give similar weights. As the US dollar plays a role, we consider the shares computed from the regression analysis.

Greece	CHF		Euro		USD		Pound		Yen	
	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability
Weights used, in total FX	23%	3%	0%	0%	75%	81%	0%	4%	2%	12%
Weights used, in non-CHF FX			0%	0%	97%	83%	0%	4%	3%	12%

National sources indicate a role for the US dollar. We use the shares from the Bank of Greece and allocate the positions in foreign currencies other than the Swiss franc across US dollar Pound and Yen in all subcategories by using their respective shares in the aggregate (that is 63/(63+11); 11/(63+11) for assets and 74/(74+4); 4/(74+4) for liabilities).

For each country, the first row shows the percentage allocation of foreign currency assets (and liabilities) between the Swiss Franc, the Euro, the US Dollar, the British Pound, and the Yen. The second row show the allocation across the foreign currencies other than the Swiss franc, corresponding to the weight $\omega^{c,j}$ in the regressions. The weights do not always sum to 100% due to rounding.
The shares combine three sources: the ECB *International role of the euro* publication, information from national central banks, and a regression of the change in positions in foreign currencies other than the Swiss franc on the respective exchange rates.

Table 1. Currency Weights (C)

Croatia	CHF		Euro		USD		Pound		Yen	
	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability
Weights used, in total FX	13%	0%	87%	100%	0%	0%	0%	0%	0%	0%
Weights used, in non-CHF FX			100%	100%	0%	0%	0%	0%	0%	0%

The ECB indicates an overwhelming role for the Euro, so we assume that all positions in foreign currency other than the Swiss franc are in Euro.

Hungary	CHF		Euro		USD		Pound		Yen	
	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability
Weights used, in total FX	45%	18%	55%	82%	0%	0%	0%	0%	0%	0%
Weights used, in non-CHF FX			100%	100%	0%	0%	0%	0%	0%	0%

The ECB, national source, and regression analysis give similar weights. As the US dollar plays a role, we consider the shares computed from the regression analysis.

Italy	CHF		Euro		USD		Pound		Yen	
	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability
Weights used, in total FX	2%	2%	0%	0%	78%	78%	10%	10%	10%	10%
Weights used, in non-CHF FX			0%	0%	80%	80%	10%	10%	10%	10%

We allocate non-CHF FX positions among USD, GBP and JPY.

Luxembourg	CHF		Euro		USD		Pound		Yen	
	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability
Weights used, in total FX	11%	10%	0%	0%	71%	72%	9%	9%	9%	9%
Weights used, in non-CHF FX			0%	0%	80%	80%	10%	10%	10%	10%

We allocate non-CHF FX positions among USD, GBP and JPY.

For each country, the first row shows the percentage allocation of foreign currency assets (and liabilities) between the Swiss Franc, the Euro, the US Dollar, the British Pound, and the Yen. The second row show the allocation across the foreign currencies other than the Swiss franc, corresponding to the weight $\omega^{c,j}$ in the regressions. The weights do not always sum to 100% due to rounding.
The shares combine three sources: the ECB *International role of the euro* publication, information from national central banks, and a regression of the change in positions in foreign currencies other than the Swiss franc on the respective exchange rates.

Table 1. Currency Weights (D)

Latvia	CHF		Euro		USD		Pound		Yen	
	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability
Weights used, in total FX	1%	1%	96%	86%	3%	13%	0%	0%	0%	0%
Weights used, in non-CHF FX			97%	87%	3%	13%	0%	0%	0%	0%

The ECB indicates a strong role for the Euro (prior to accession in January 2014), and some role for the US dollar. We use the shares from the ECB, and allocate the positions in foreign currencies other than the Swiss franc across Euro and US dollar by using their respective aggregate shar

Poland	CHF		Euro		USD		Pound		Yen	
	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability
Weights used, in total FX	60%	33%	29%	30%	11%	37%	0%	0%	19%	19%
Weights used, in non-CHF FX			49%	35%	19%	43%	0%	0%	32%	22%

We take the euro weights from the ECB publication and assume that the remaining FX is in usd and yen according to the liabilities regressions resu

Romania	CHF		Euro		USD		Pound		Yen	
	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability
Weights used, in total FX	8%	5%	87%	87%	5%	8%	0%	0%	0%	0%
Weights used, in non-CHF FX			95%	92%	5%	8%	0%	0%	0%	0%

The ECB indicates a strong role for the Euro, and some role for the US dollar. We use the shares from the ECB, and allocate the positions in foreign currencies other than the Swiss franc across Euro and US dollar in all subcategories by using their respective shares in the aggregate

Serbia	CHF		Euro		USD		Pound		Yen	
	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability
Weights used, in total FX	8%	4%	81%	90%	11%	6%	0%	0%	0%	0%
Weights used, in non-CHF FX			88%	94%	12%	6%	0%	0%	0%	0%

The ECB indicates a strong role for the Euro, and some role for the US dollar. We use the shares from the ECB, and allocate the positions in foreign currencies other than the Swiss franc across Euro and US dollar in all subcategories by using their respective shares in the aggregate

For each country, the first row shows the percentage allocation of foreign currency assets (and liabilities) between the Swiss Franc, the Euro, the US Dollar, the British Pound, and the Yen. The second row show the allocation across the foreign currencies other than the Swiss franc, corresponding to the weight $\omega^{c,j}$ in the regressions. The weights do not always sum to 100% due to rounding.
The shares combine three sources: the ECB *International role of the euro* publication, information from national central banks, and a regression of the change in positions in foreign currencies other than the Swiss franc on the respective exchange rates.

Table 1. Currency Weights (E)

Slovenia	CHF		Euro		USD		Pound		Yen	
	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability
Weights used, in total FX	66%	69%	0%	0%	34%	31%	0%	0%	0%	0%
Weights used, in non-CHF FX			0%	0%	100%	100%	0%	0%	0%	0%

The ECB indcates that the foreign exchange positions are in Swiss franc or US dollar. We allocate all the positions in foreign currencies other than the Swiss franc in US dollar.

Slovakia	CHF		Euro		USD		Pound		Yen	
	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability	Asset	Liability
Weights used, in total FX	5%	3%	0%	0%	83%	74%	0%	23%	12%	0%
Weights used, in non-CHF FX			0%	0%	88%	76%	0%	24%	12%	0%

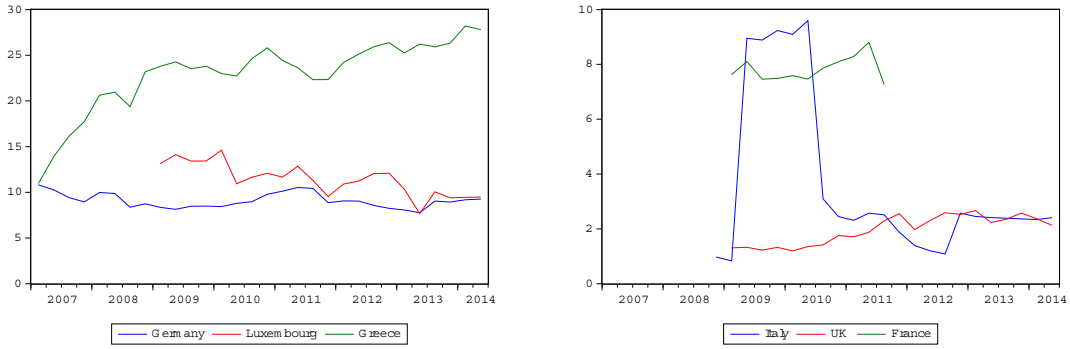
We allocate non-CHF FX positions among USD, GBP and JPY according to regressions. These weights apply post-euro accession in 2009.

For each country, the first row shows the percentage allocation of foreign currency assets (and liabilities) between the Swiss Franc, the Euro, the US Dollar, the British Pound, and the Yen. The second row show the allocation across the foreign currencies other than the Swiss franc, corresponding to the weight $\omega^{c,j}$ in the regressions. The weights do not always sum to 100% due to rounding.
The shares combine three sources: the ECB *International role of the euro* publication, information from national central banks, and a regression of the change in positions in foreign currencies other than the Swiss franc on the respective exchange rates.

E Charts

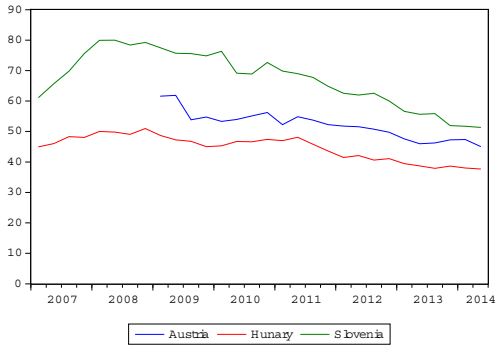
Figure 9: **Valuation adjusted foreign currency composition of assets and liabilities across time**

In percent of total valuation adjusted bank balance sheet positions, quarterly from 2007 to 2014. The upper two panels reflect the average foreign currency composition for valuation adjusted bank balance sheet positions of euro area countries, but excluding France due to short sample size. The lower two panels reflect the average currency composition of valuation adjusted foreign currency positions of non-euro countries. Estonia and Latvia are excluded due to conversion to euro in the latter part of the sample. For Austria, Czech Republic and Poland, which neither report total assets and liabilities nor other assets and other liabilities, the remaining balance sheet items are included in the averages. Poland is excluded from averages for non-euro country assets due to lack of data. Source: SNB.

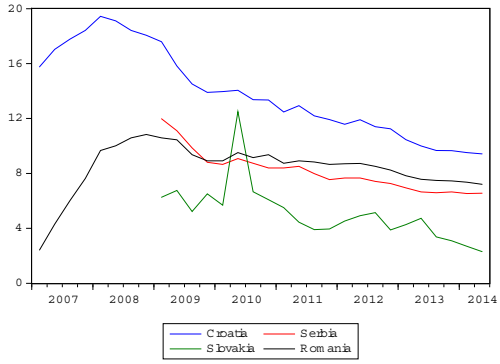


(a)

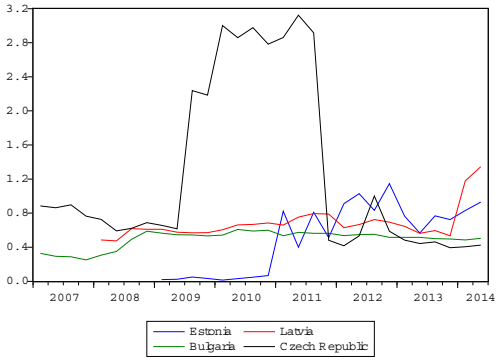
(b)



(c)

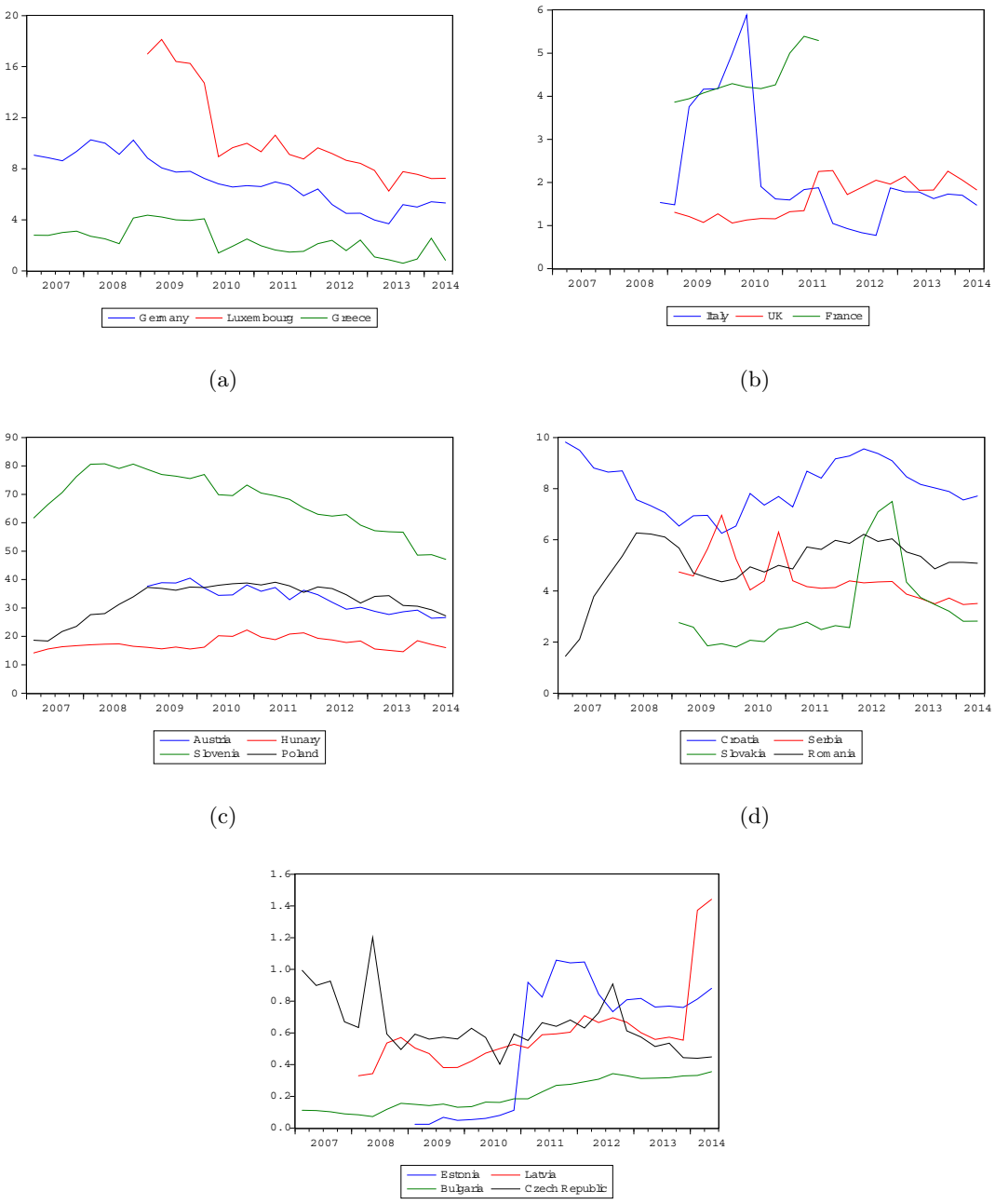


(d)



(e)

Figure 10: **Swiss franc denominated assets in percent of total foreign currency assets.**
Source: SNB.

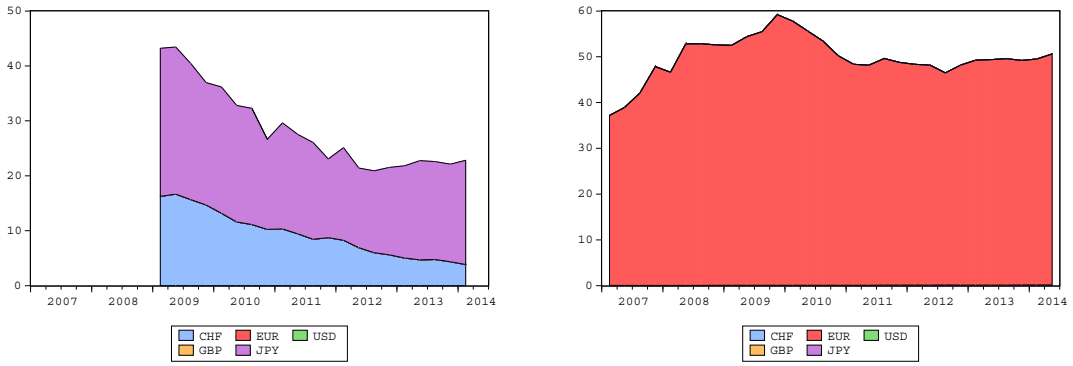


(a) (b)

(c) (d)

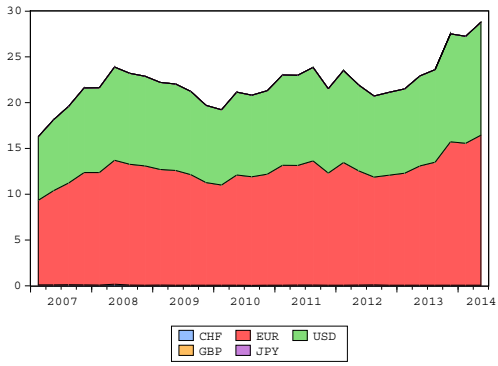
(e)

Figure 11: **Swiss franc denominated liabilities in percent of total foreign currency liabilities.**
Source: SNB.

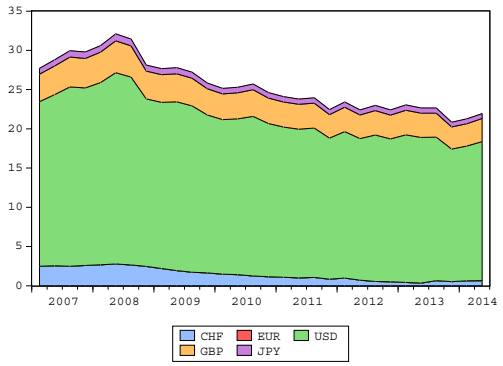


(a) Austria

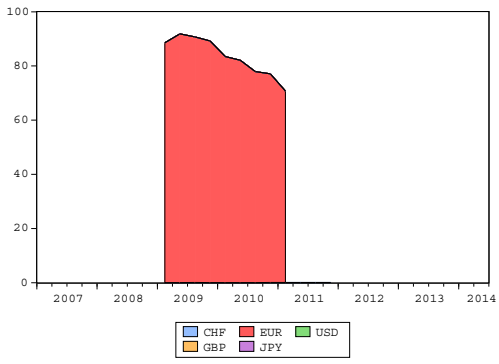
(b) Bulgaria



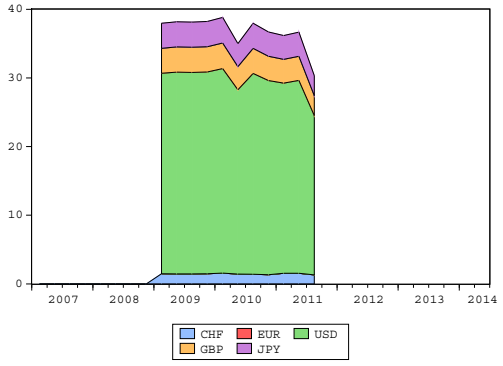
(c) Czech Republic



(d) Germany



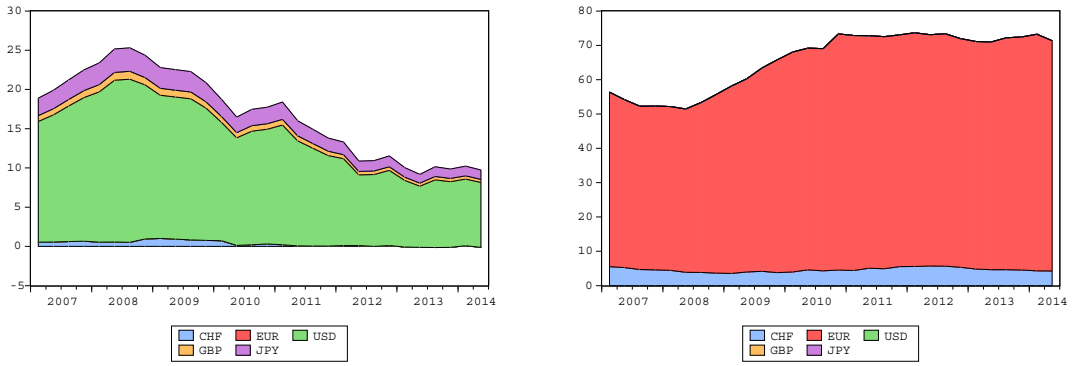
(e) Estonia



(f) France

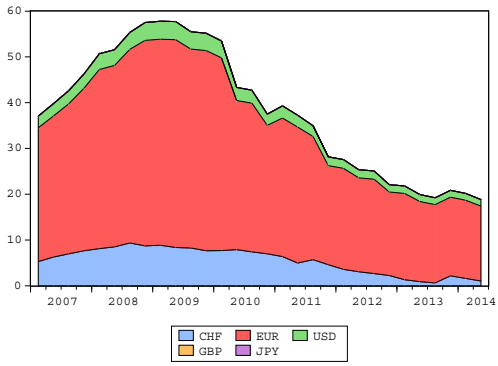
Figure 12: **Quarterly foreign currency funding, stocks adjusted for valuation effects, in percent of GDP.**

The panels show the estimated valuation adjusted FX liabilities divided on currencies. Estimates are based on the initial stock value and flows adjusted for valuation effects, and on estimates of the currency composition of non-CHF foreign currency funding. For Austria, Czech Republic, France and Poland, other labilities are not available. For these countries, the subcategories of funding do not necessarily sum to total FX funding. Source: SNB.

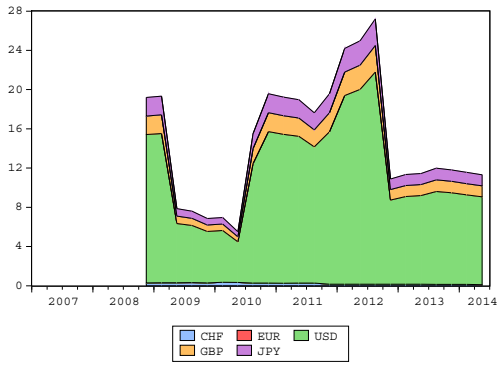


(a) Greece

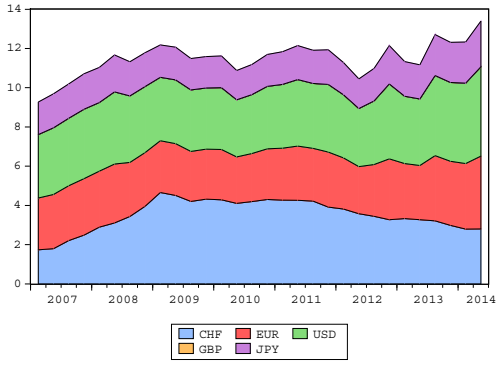
(b) Croatia



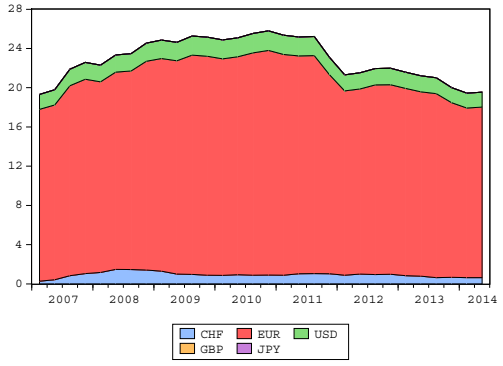
(c) Hungary



(d) Italy



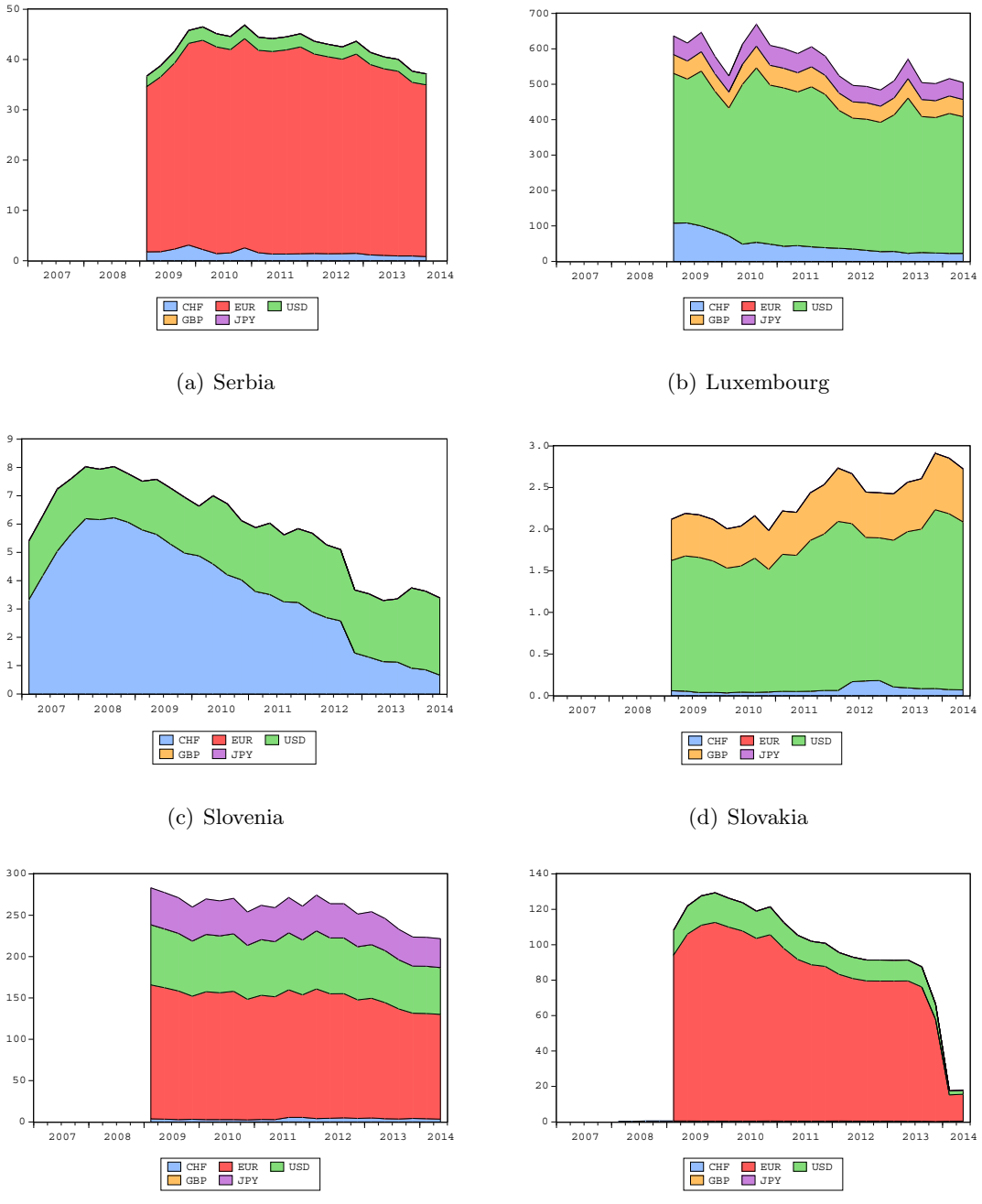
(e) Poland



(f) Romania

Figure 13: **Quarterly foreign currency funding, stocks adjusted for valuation effects, in percent of GDP.**

The panels show the estimated valuation adjusted FX liabilities divided on currencies. Estimates are based on the initial stock value and flows adjusted for valuation effects, and on estimates of the currency composition of non-CHF foreign currency funding. For Austria, Czech Republic, France and Poland, other labilities are not available. For these countries, the subcategories of funding do not necessarily sum to total FX funding. Source: SNB.



(a) Serbia

(b) Luxembourg

(c) Slovenia

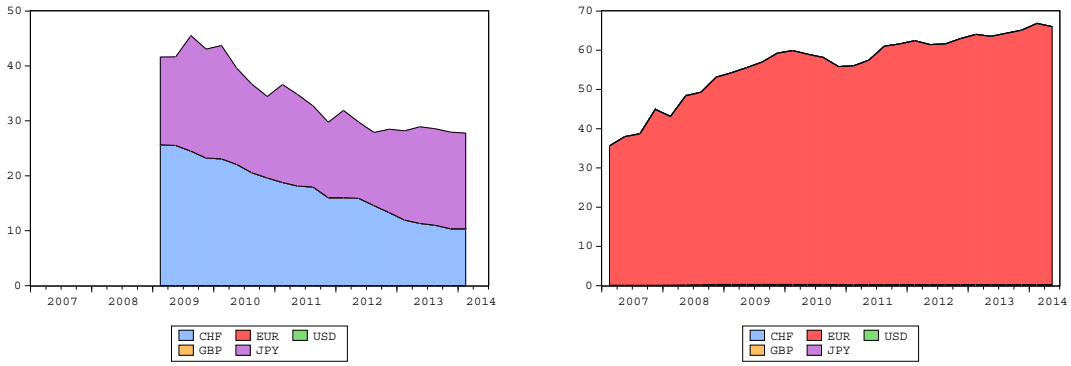
(d) Slovakia

(e) United Kingdom

(f) Latvia

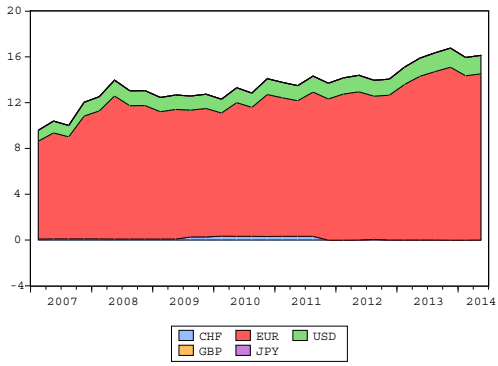
Figure 14: **Quarterly foreign currency funding, stocks adjusted for valuation effects, in percent of GDP.**

The panels show the estimated valuation adjusted FX liabilities divided on currencies. Estimates are based on the initial stock value and flows adjusted for valuation effects, and on estimates of the currency composition of non-CHF foreign currency funding. For Austria, Czech Republic, France and Poland, other labilities are not available. For these countries, the subcategories of funding do not necessarily sum to total FX funding. Source: SNB.

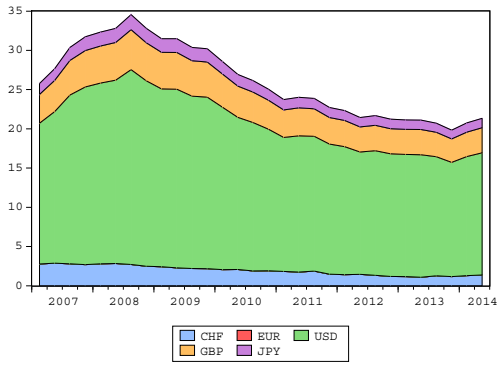


(a) Austria

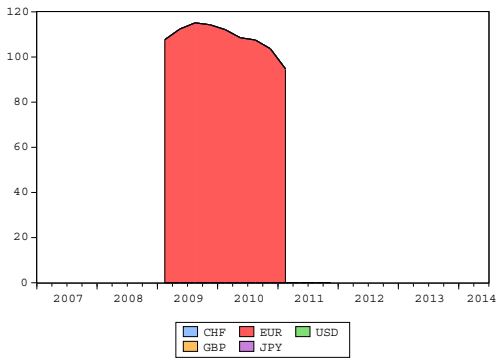
(b) Bulgaria



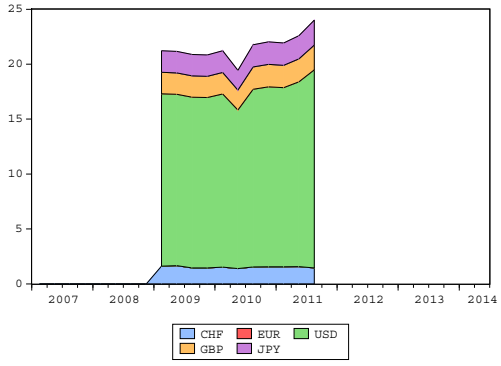
(c) Czech Republic



(d) Germany

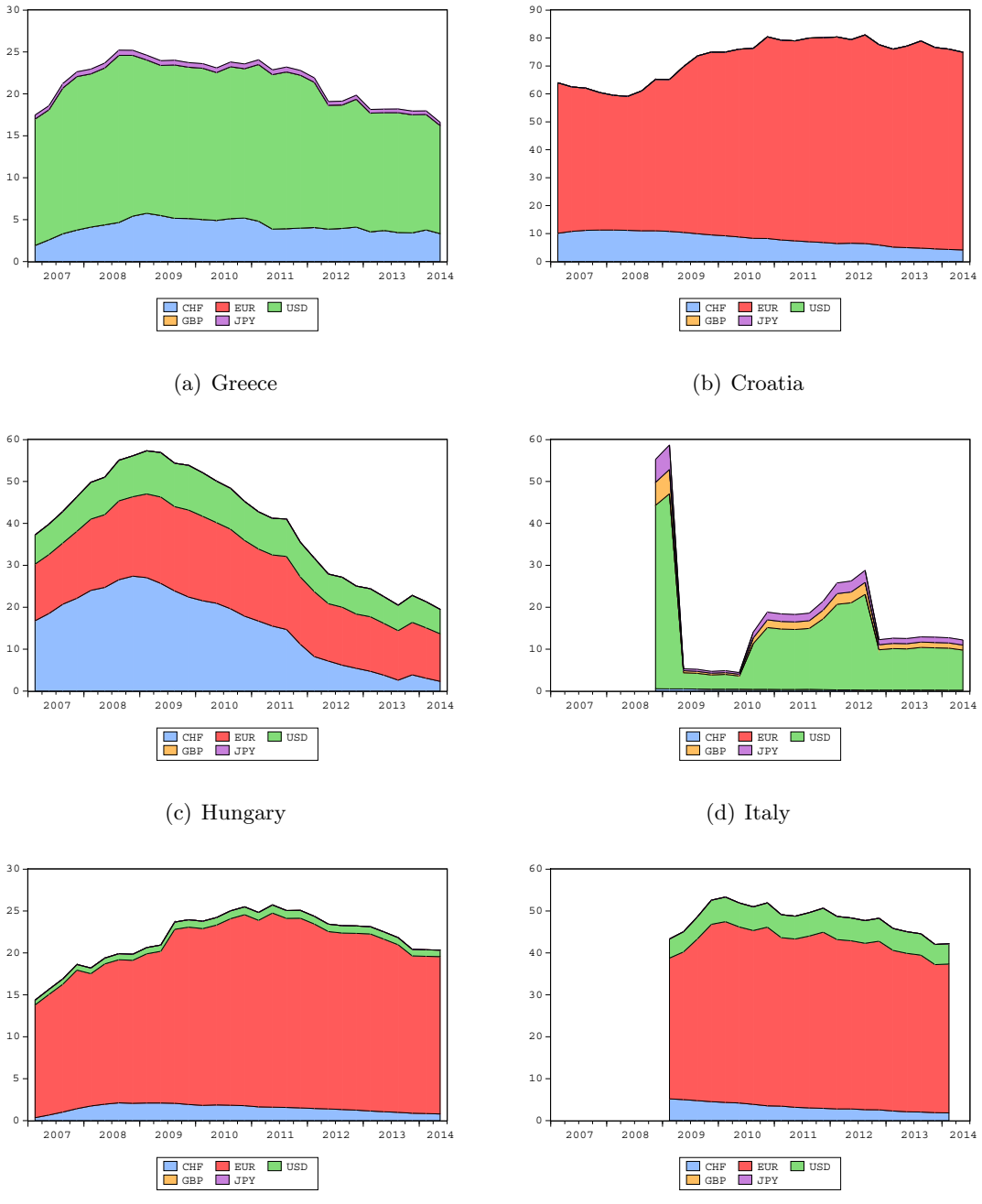


(e) Estonia



(f) France

Figure 15: **Quarterly foreign currency assets, stocks adjusted for valuation effects, in percent of GDP.**
The panels show the estimated valuation adjusted FX assets divided on currencies. Estimates are based on the initial stock value and flows adjusted for valuation effects, and on estimates of the currency composition of non-CHF foreign currency funding. For Austria, Czech Republic, and France, other assets are not available. For these countries, the subcategories of funding do not necessarily sum to total FX assets. Poland does not provide data on lending, and is hence not depicted. Source: SNB.



(a) Greece

(b) Croatia

(c) Hungary

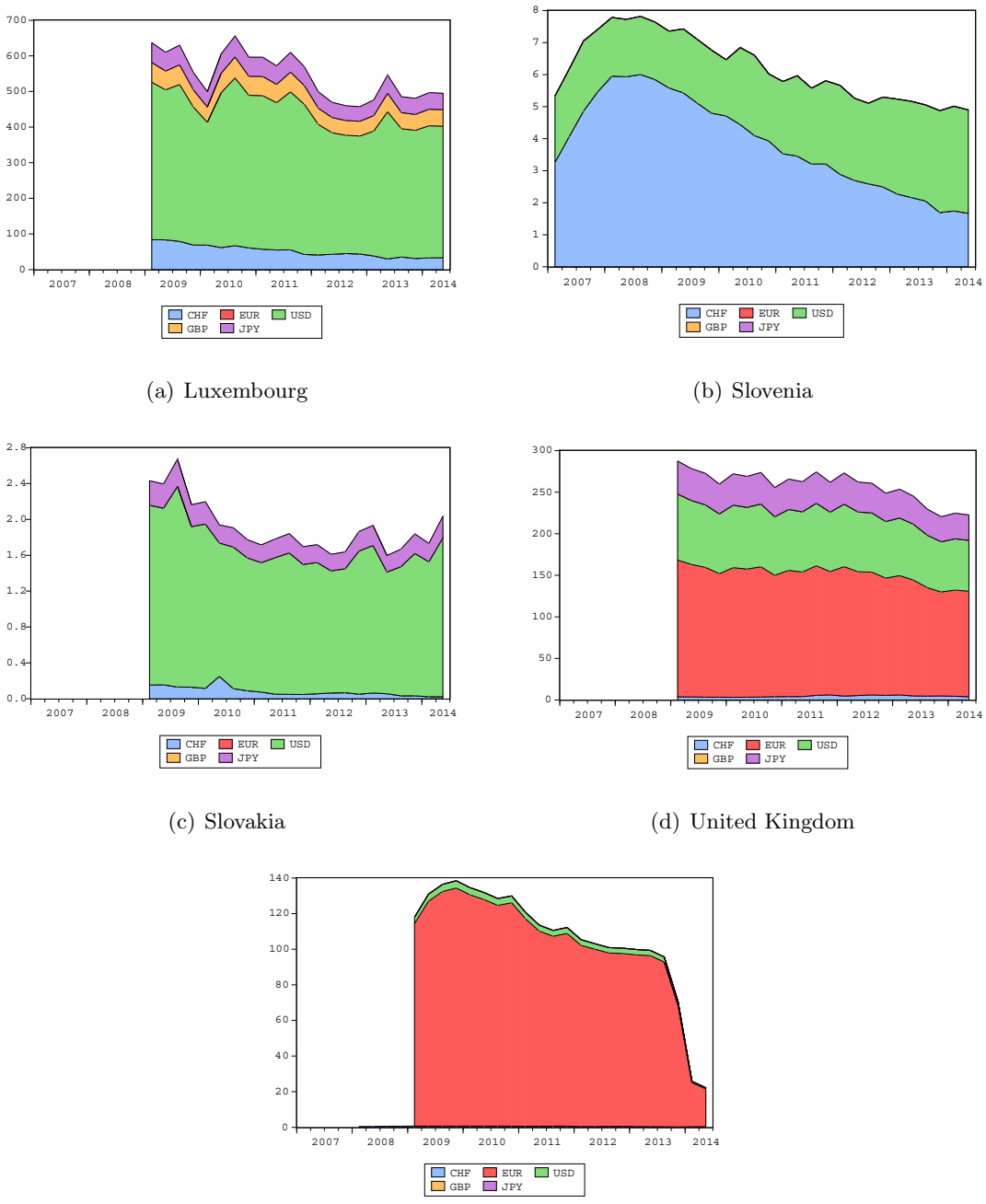
(d) Italy

(e) Romania

(f) Serbia

Figure 16: **Quarterly foreign currency assets, stocks adjusted for valuation effects, in percent of GDP.**

The panels show the estimated valuation adjusted FX assets divided on currencies. Estimates are based on the initial stock value and flows adjusted for valuation effects, and on estimates of the currency composition of non-CHF foreign currency funding. For Austria, Czech Republic, and France, other assets are not available. For these countries, the subcategories of funding do not necessarily sum to total FX assets. Poland does not provide data on lending, and is hence not depicted. Source: SNB.



(a) Luxembourg

(b) Slovenia

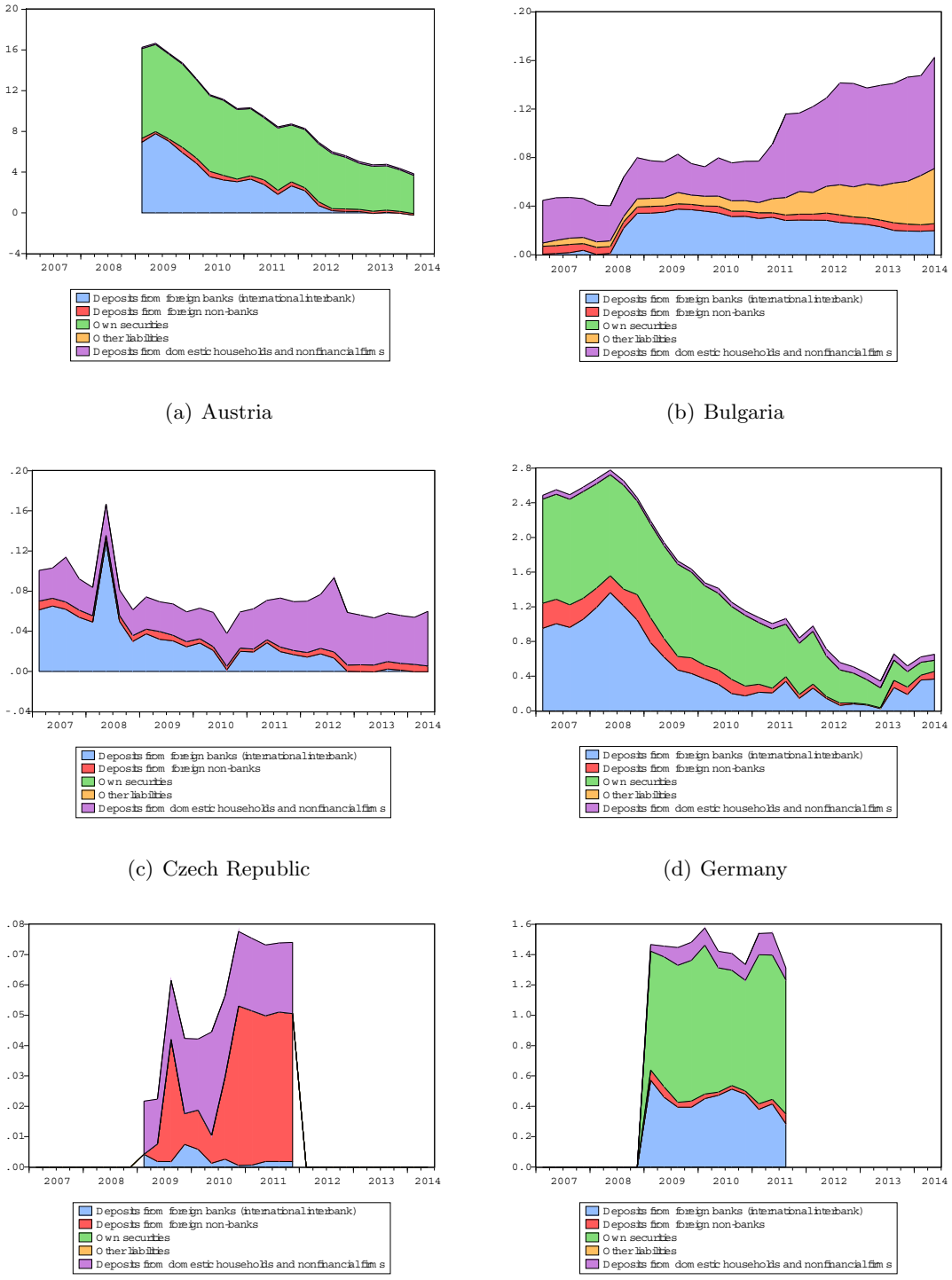
(c) Slovakia

(d) United Kingdom

(e) Latvia

Figure 17: **Quarterly foreign currency assets, stocks adjusted for valuation effects, in percent of GDP.**

The panels show the estimated valuation adjusted FX assets divided on currencies. Estimates are based on the initial stock value and flows adjusted for valuation effects, and on estimates of the currency composition of non-CHF foreign currency funding. For Austria, Czech Republic, and France, other assets are not available. For these countries, the subcategories of funding do not necessarily sum to total FX assets. Poland does not provide data on lending, and is hence not depicted. Source: SNB.



(a) Austria

(b) Bulgaria

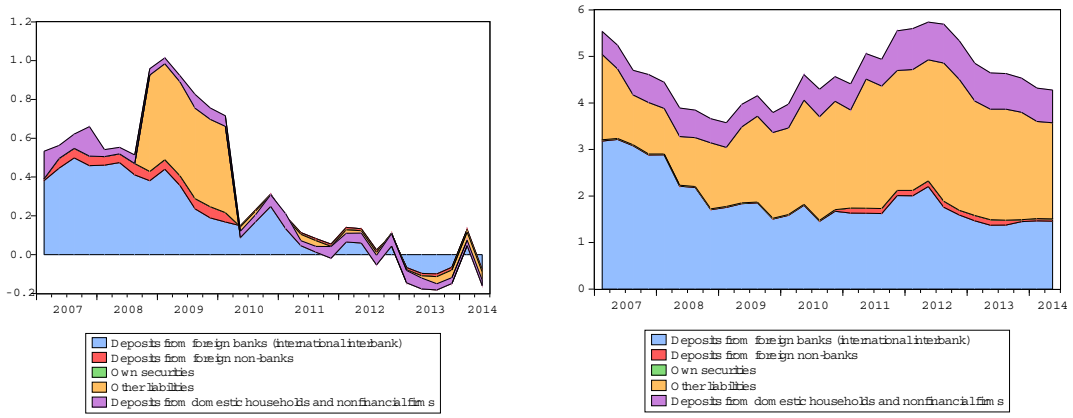
(c) Czech Republic

(d) Germany

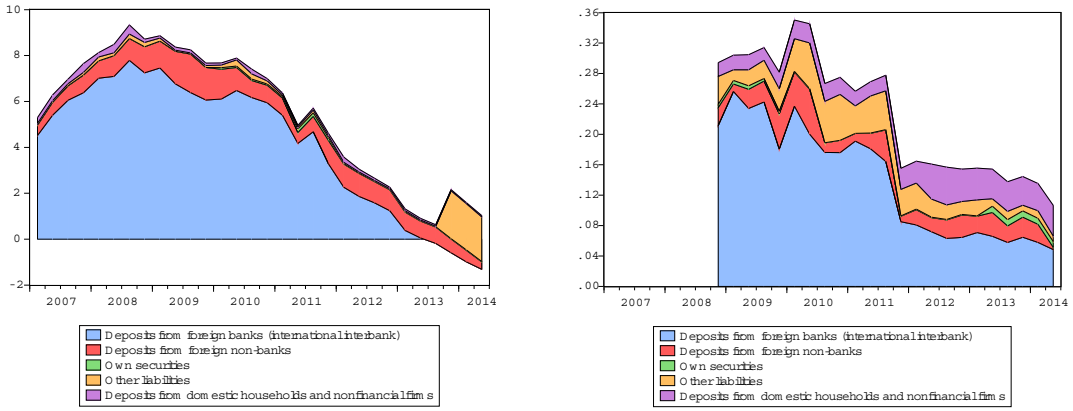
(e) Estonia

(f) France

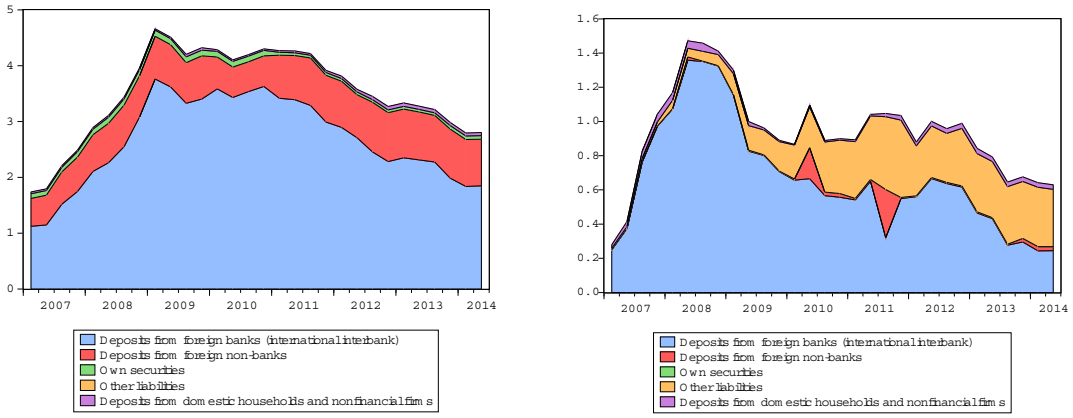
Figure 18: **Quarterly Swiss franc funding categories, stocks adjusted for valuation effects, in percent of GDP.**
The panels show the valuation adjusted stocks in different funding categories, simulations are based on the initial stock value and flows adjusted for valuation effects. For some countries, subcategories of funding (such as deposits from households) are available later than other data series, and the total stacked area may hence not sum to total across the entire sample range. Source: SNB.



(a) Greece (b) Croatia



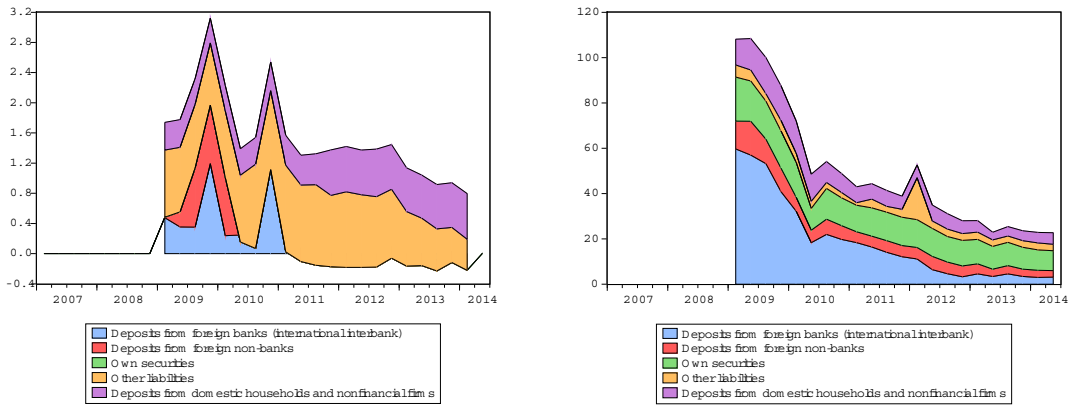
(c) Hungary (d) Italy



(e) Poland (f) Romania

Figure 19: **Quarterly Swiss franc funding categories, stocks adjusted for valuation effects, in percent of GDP.**

The panels show the valuation adjusted stocks in different funding categories, simulations are based on the initial stock value and flows adjusted for valuation effects. Note that for some countries, subcategories of funding (such as deposits from households) are available later than other data series, and the total stacked area may hence not sum to total across the entire sample range. Source: SNB.



(a) Serbia

(b) Luxembourg

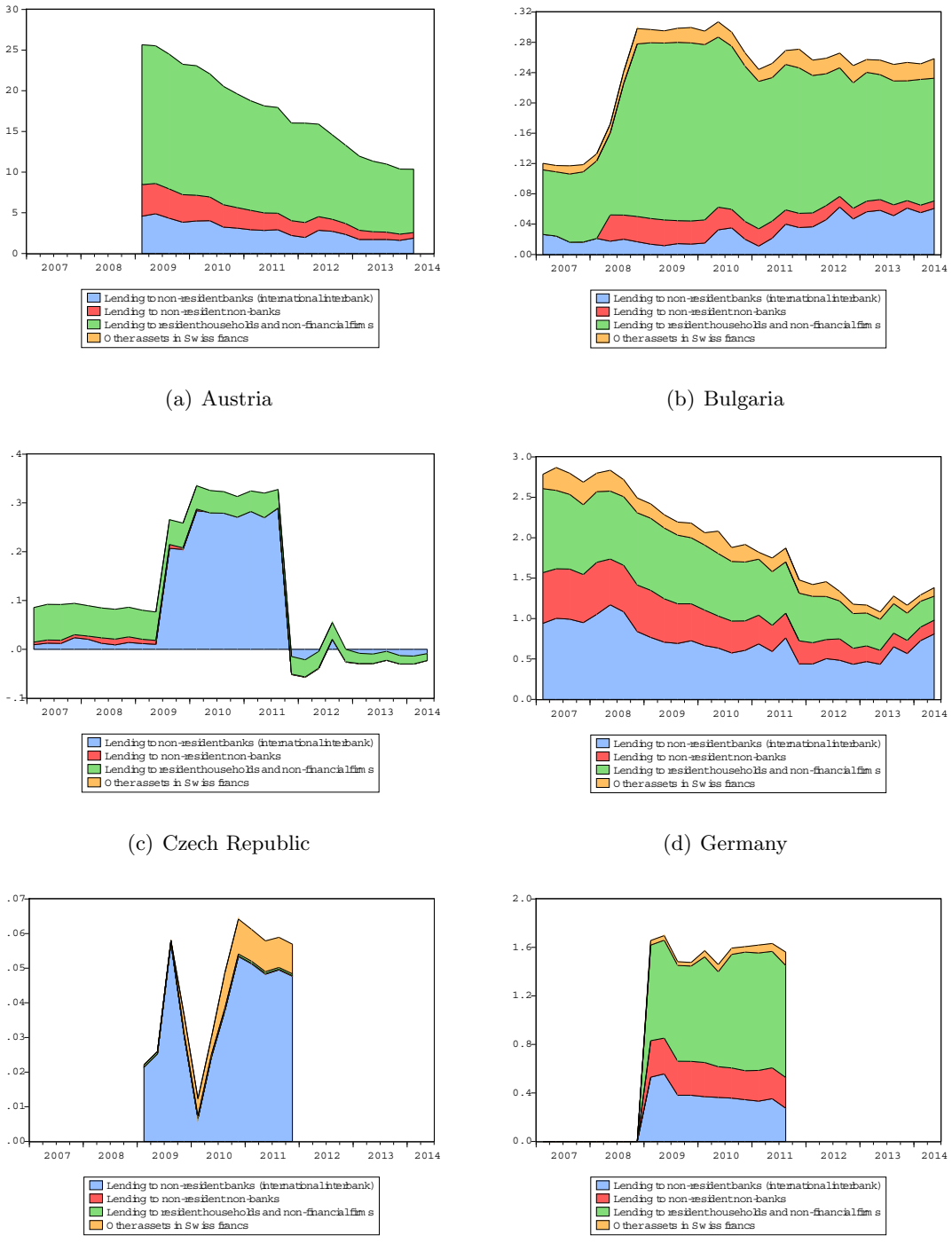
(c) Slovenia

(d) Slovakia

(e) United Kingdom

(f) Latvia

Figure 20: **Quarterly Swiss franc funding categories, stocks adjusted for valuation effects, in percent of GDP.**
The panels show the valuation adjusted stocks in different funding categories, simulations are based on the initial stock value and flows adjusted for valuation effects. Note that for some countries, subcategories of funding (such as deposits from households) are available later than other data series, and the total stacked area may hence not sum to total across the entire sample range. Source: SNB.



(a) Austria

(b) Bulgaria

(c) Czech Republic

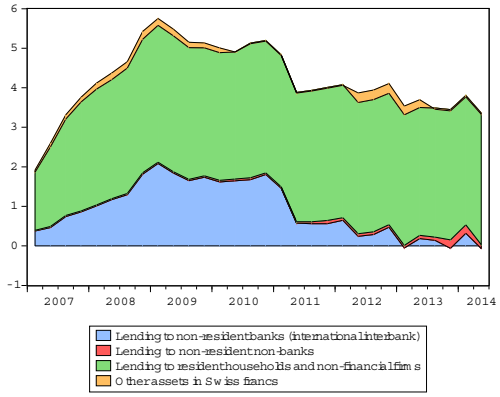
(d) Germany

(e) Estonia

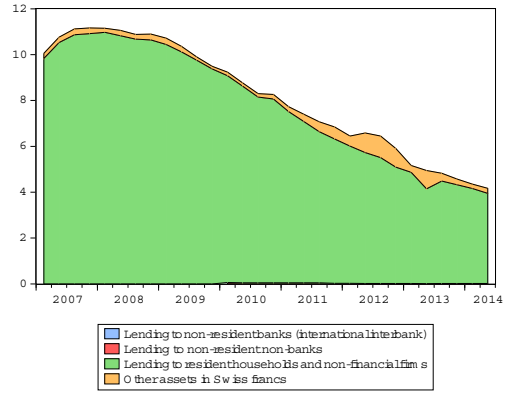
(f) France

Figure 21: **Quarterly Swiss franc Lending categories, stocks adjusted for valuation effects, in percent of GDP.**

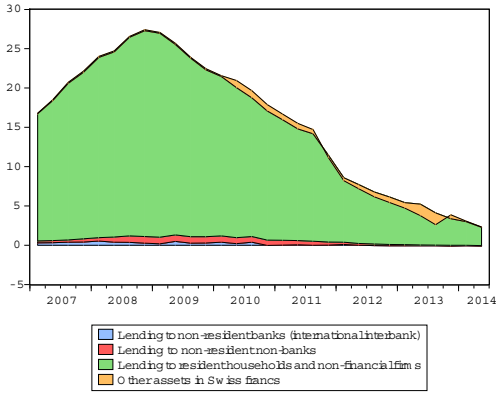
The panels show the valuation adjusted stocks in different lending categories, simulations are based on the initial stock value and flows adjusted for valuation effects. Note that for Austria, Czech Republic and France, other assets are not available, and the total stacked area may hence not sum to total across the entire sample range. Poland does not provide data on foreign currency assets and is hence not depicted. Source: SNB.



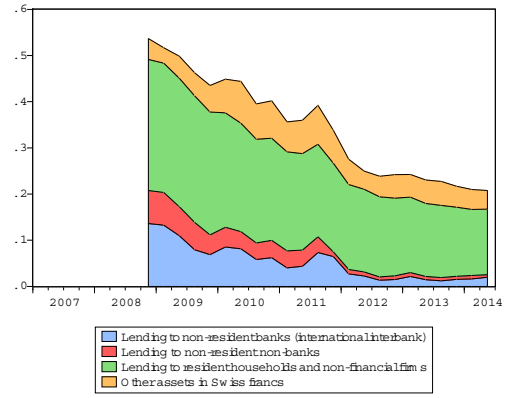
(a) Greece



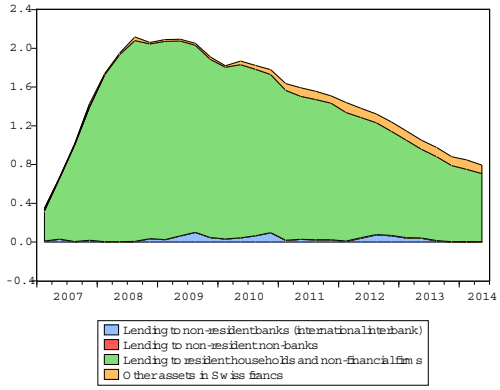
(b) Croatia



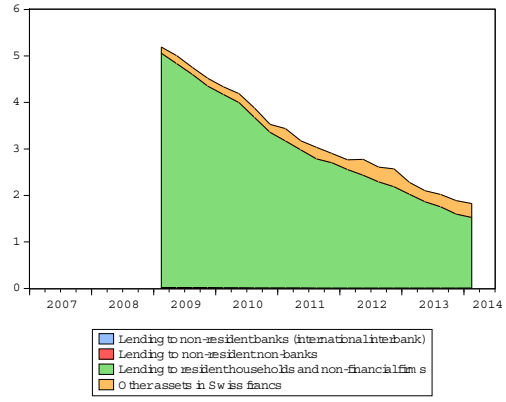
(c) Hungary



(d) Italy



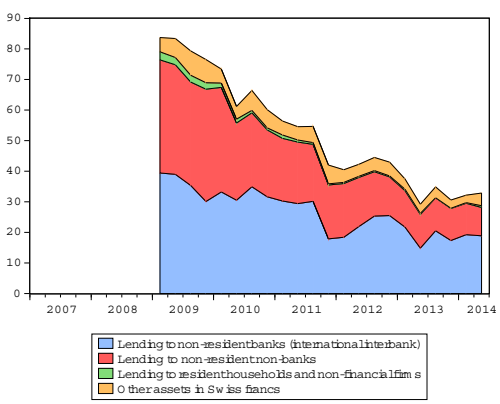
(e) Romania



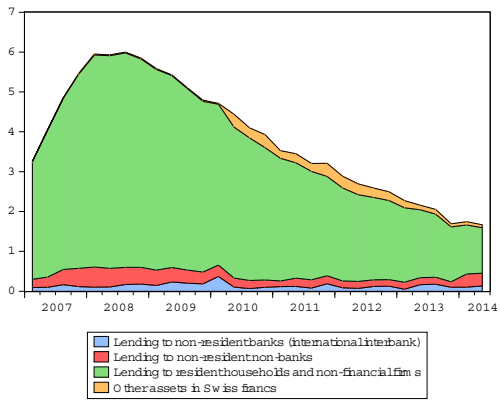
(f) Serbia

Figure 22: **Quarterly Swiss franc Lending categories, stocks adjusted for valuation effects, in percent of GDP.**

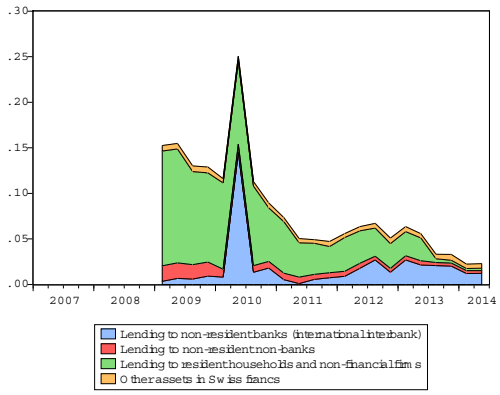
The panels show the valuation adjusted stocks in different lending categories, simulations are based on the initial stock value and flows adjusted for valuation effects. Note that for Austria, Czech Republic and France, other assets are not available, and the total stacked area may hence not sum to total across the entire sample range. Poland does not provide data on foreign currency assets and is hence not depicted. Source: SNB.



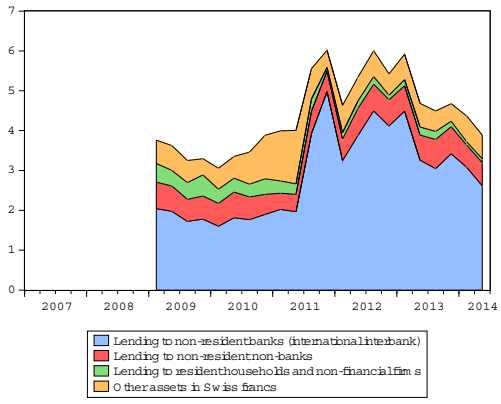
(a) Luxembourg



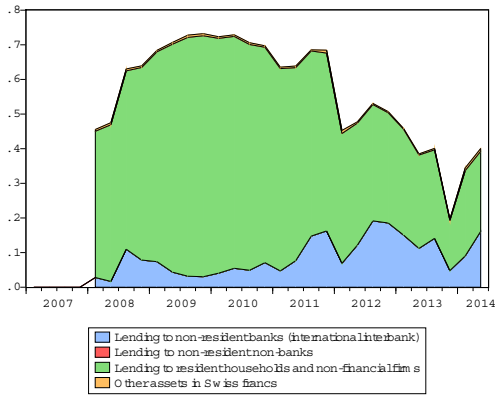
(b) Slovenia



(c) Slovakia



(d) United Kingdom



(e) Latvia

Figure 23: **Quarterly Swiss franc Lending categories, stocks adjusted for valuation effects, in percent of GDP.**
The panels show the valuation adjusted stocks in different lending categories, simulations are based on the initial stock value and flows adjusted for valuation effects. Note that for Austria, Czech Republic and France, other assets are not available, and the total stacked area may hence not sum to total across the entire sample range. Poland does not provide data on foreign currency assets and is hence not depicted. Source: SNB.

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