What drives the funding currency mix of banks?

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Abstract

We draw on a new data set on the use of Swiss francs and other foreign currencies by European banks to assess the determinants of banks wholesale funding mix across foreign currencies. The data points to substantial heterogeneity in banks' use of foreign funding currencies, both across countries and across different foreign currencies. We find that banks increase their wholesale funding in a given foreign currency when the relative funding costs of the foreign currency in question falls relative to the cost of domestic currency funding, when the foreign currency appreciates and the bank is long in that currency, and when banks issue new loans in the given currency. These findings are consistent across different foreign currencies and in line with the predictions of a simple model. In contrast, we find that movements in exchange rates of other foreign currencies and exchange rate risk factors have ambiguous impacts on banks' foreign currency funding. The impact of these factors depends on the specific funding currency as well as on the type of country in question.

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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 (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]). The previous literature focusses on banks' use of foreign currency compared to their use of domestic currency, without distinguishing between different foreign currencies. However, the transmission of shocks, and hence the drivers of foreign currency bank funding, may depend on the funding currency in question. Our current understanding of such cross currency heterogeneity is limited. This paper aim to fill this gap by assessing the drivers of bank foreign currency wholesale funding, and contrasting these across foreign currencies.

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 in exchange rates, interest rates, and the values of loans and deposits, and react by adjusting their funding currency mix. We find that the currency mix of banks' foreign currency funding reflects external factors including the relative funding costs across the available currencies and past and expected future exchange rate movements, and domestic developments captured by fluctuations in loans and deposits (with an increase in loans denominated in currency i leading to higher funding in that currency).

We assess the model's implications for the drivers of the funding currency mix using a new data set on aggregate bank balance sheets in 18 European countries. The data set allows us to distinguish between banks' use of local currency, the Swiss franc, and other foreign currencies. Given this structure of the data, we focus on the use of the Swiss franc as a funding currency by European banks, and compare it with banks' use of the US dollar and the euro as alternative foreign funding currencies. The Swiss franc became a relatively important bank funding currency in the years after the introduction of the euro, when the low volatility of the Swiss franc euro exchange rate and the low interest rate on the Swiss franc made it attractive as a funding currency. While the rise in Swiss franc funding must be partly seen in light of the popularity of Swiss franc mortgages to households and non-financial firms in some European countries, the Swiss franc's broader role as a foreign funding currency, and how it compares to other foreign currencies, is not well understood. A first look at the data suggests that the role of the Swiss franc as a funding currency differs from the roles of the US dollar and the euro in several dimensions. Notably, Swiss franc bank funding tends to be cross border to a higher degree than bank funding in other foreign currencies. Moreover, Swiss franc funding tends to fall short of Swiss franc lending on balance sheet, making European banks long in Swiss francs. This is not generally the case for funding in other foreign currencies.

We assess the model's implications about the external drivers of foreign currency funding

in an econometric analysis taking advantage of the panel structure of our data. Our analysis points to substantial heterogeneity in the foreign factors that determine the wholesale funding mix across countries and currencies.

The use of the Swiss franc in countries outside the euro area is primarily driven by exchange rate developments and bank lending in Swiss francs. Specifically, an appreciation of the Swiss franc reduces funding in that currency, and both future and lagged movements in the exchange rate matter. 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. We find that funding activity in financial centers is mainly driven 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 substantial Swiss franc lending activities. By contrast, foreign currency funding in euro area countries display little sensitivity to the various factors we consider. One way to interpret this is that funding in euros or US dollars are more structural features of bank funding, whereas funding in Swiss franc is adjusted in response to the various drivers we consider (what do we mean here?).

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, which also presents the variables we consider and the econometric setup. Section 5 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. The first is the analysis of foreign currency lending and deposits. 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 analyze banks' foreign currency lending in Swiss francs specifically. Brown et al. [2009] document substantial heterogeneity across countries in Swiss franc lending. Yesin [2013] relies on the same dataset as we do to assess the currency mismatch between assets and liabilities and illustrates a stricking underfunding of Swiss francs on European banks' balance sheets. Auer et al. [2012] focus on the refinancing of Swiss franc lending by Austrian banks. They find 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 for funding.

The second stream of the literature to which our work is related is the international transmission of shocks through the activity of global banks. Several papers stress global bank funding structures and networks as central in the cross border transmission of the global financial 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 bank lending and operations of banks' local affiliates. Cetorelli and Goldberg [2012] underline the role of banks' internal capital markets, and show that global banks' affiliates in more robust countries can be used as sources of funds for the parent in a crisis. Central to this literature is the assessment of the role that financial and monetary developments in global financial markets, or in the home country of the foreign funding currency play in driving funding conditions in the host country, see also Bruno and Shin [2014]. A general finding is that global financial factors, usually captured by the VIX, drive domestic bank funding costs, and that monetary and financial conditions in the US also affects bank foreign currency funding costs. The monetary and financial conditions prevailing in other home countries to bank foreign funding currencies have not been investigated and compared across important funding currency. We take this next step with this paper.

3 A Simple Model of Funding Choice

This section presents the main elements and results from a simple portfolio balance model of a bank's funding decisions across currencies, following Tille and van Wincoop [2014a] and Tille and van Wincoop [2014b]. Additional elements to the model are given in the appendix.[1] We first present the structure of the model, and then turn to the derivation and interpretation of the drivers of bank funding.

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

3.1 Building blocks

3.1.1 Timing and exchange rates

The model focuses 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 model consists of two periods. In period 1 the bank is endowed with a portfolio of loans and deposits in the three currencies. It chooses its funding knowing that shocks can affect the exchange rate and returns on loans in the final period 2. A central aspect of our approach is the distinction between the various "orders" of variables, which are related to the degree of proportionality with the model shocks. Specifically, the zero-order component of a variable is independent from the shocks. The first-order component is linearly proportional to the shocks (or their expected value). The second-order component is linearly proportional to the square of the shocks (or the variance), and the third-order component is linearly proportional to the cube of the shocks.

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 two periods are $S_1^i = S_0^i \exp\left(\nu_1^{S,i}\right)$ and $S_2^i = S_0^i \exp\left(\nu_1^{S,i} + \tau_2^{S,i}\nu_2^{S,i} + \varepsilon_2^{S,i}\right)$. S_0^i is the zero-order component of the exchange rate, which can be thought of as the steady state, or long term average value. $\nu_1^{S,i}$ is a first-order term known in period 1 which allows us to consider the impact of deviation of the exchange rate from its zero-order value in the initial period. $\nu_2^{S,i}$ is also a first-order term known in period 1 which captures any expected movement in the exchange rate between the two periods. $\tau_2^{S,i}$ is a second-order term which ensures a well-behaved solution of the model.

The various components of the exchange rate are proportional to the moments of stochastic exchange rate shock, $\varepsilon_2^{S,i}$, which is realized in period two. The variance of $\varepsilon_2^{S,i}$ is $\sigma_{fx}^2\left(1 + \nu_2^{\sigma,i}\right)$ where σ_{fx}^2 is a second-order term. The term $\nu_2^{\sigma,i}$, which is a first-order, allows us to capture the impact of a changing variance on the funding decision. Specifically, the variance of the exchange rate is normally equal to σ_{fx}^2, but there can be periods when the exchange rate is more volatile than usual ($\nu_2^{\sigma,i} > 0$). The expected value of $\varepsilon_2^{S,i}$ is given by $-0.5\sigma_{fx}^2\left(1 + \nu_2^{\sigma,i}\right)$, which offset a Jensen inequality term. The covariance between the exchange rates vis-à-vis the euro and vis-à-vis the Swiss franc is $0.5\sigma_{fx}^2\nu_2^{\rho}$, where ν_2^{ρ} is a first-order term. The role of ν_2^{ρ} is to allow for a changing covariance between the two exchange rates, in a similar way as $\nu_2^{\sigma,i}$ allows for a changing variance. Specifically, the covariance of the exchange rates is normally zero, but there can be periods when the two exchange rates are expected to move more in step ($\nu_2^{\rho} > 0$).

3.1.2 Components of the balance sheet: loans

The bank enters period one with an endowment of loans in the three currencies. The values of the loans include terms of various orders. In period 1, the domestic currency value of loans

denominated in currency i is $S_0^i C_0^i \exp\left(\nu_1^{S,i} + \nu_1^{C,i}\right)$.[2] C_0^i is a zero-order term and $\nu_1^{C,i}$ is a first-order term that reflects exogenous deviations of the amount of loans from the zero-order allocation. Without loss of generality, we consider that the return on loans in the absence of any shocks is zero, with a similar assumption for the return on deposits and wholesale funding positions.

In the final period 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 $S_0^i C_0^i \exp\left(\nu_1^{C,i} + \varepsilon_2^{dom} + (1-\lambda)\left(\nu_1^{S,i} + \tau_2^{S,i}\nu_2^{S,i} + \varepsilon_2^{S,i}\right)\right)$.

While the size and currency composition of loans can change over time due to shocks, the bank cannot actively change the lending currency mix and volumes. We assume this exogeneity of loans to keep our focus squarely on the banks' choice of funding currency mix. It could be relaxed. For example, Ivashina and Stein [2015] consider a similar model with only one foreign currency, where the lending currency mix is endogenous, in order to study how shocks to the funding currency mix translate into changes in the lending currency mix.

3.1.3 Components of the balance sheet: deposits and wholesale funding

The bank enters period one with an endowment of deposits in the three currencies. As for the loans, the values of the deposits include terms of various orders. In period 1, the domestic currency value of deposits denominated in currency i is $S_0^i D_0^i \exp\left(\nu_1^{S,i} + \nu_1^{D,i}\right)$. D_0^i is a zero-order term and $\nu_1^{D,i}$ is a first-order term that reflects exogenous deviations of the amount of deposits from the zero-order allocation. In the final period the value of deposits in foreign currencies is affected by exchange rate movements. The domestic currency value of deposits thus $S_0^i D_0^i \exp\left(\nu_1^{D,i} + \nu_1^{S,i} + \tau_2^{S,i}\nu_2^{S,i} + \varepsilon_2^{S,i}\right)$. As for loans, the bank cannot actively change the size and currency composition of its deposits.

In addition to deposits, the bank funds itself through wholesale borrowing, and can choose the currency allocation of this source of funding.[3] We denote the initial domestic currency value of funding in currency i by $S_0^i F_1^i \exp\left(\nu_1^{S,i}\right)$. The total amount of wholesale funding is exogenous, however, as it must reflects the amounts of loans, deposits, and initial equity. The bank's choice consists of the allocation of overall wholesale funding across the various currencies. It is this choice that we are interested in explaining. In the final period, the value of funding positions reflects the exchange rates as well as funding costs (interest rates). Specifically, 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 term known at period 1 which captures the interest rate cost of funding. A

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

[3] As we do not consider short-term liquid assets, the wholesale funding represents the value of funding net of liquid assets in the corresponding currency.

period where funding in the domestic currency is unusually expensive then corresponds to $\nu_2^{q,dom} > 0$. $\tau_2^{q,dom}$ is a second-order scaling term.

The domestic currency value of funding in foreign currency i is

$$S_0^i F_1^i \exp\left(\tau_2^{q,i}\left(1+\nu_2^{q,i}\right)+\nu_1^{S,i}+\tau_2^{S,i}\nu_2^{S,i}+\varepsilon_2^{S,i}\right)$$

The last three term reflect the movements in the exchange rate (expected or not) detailed above. The first term in the exponent reflects the interest rate cost of funding, in a similar way to the cost of domestic currency funding above. $\nu_2^{q,i}$ is a first-order term known at period 1 which captures the cost of funding in currency i (with for instance $\nu_2^{q,i} < 0$ indicating that funding in currency i is cheaper than usual). $\tau_2^{q,i}$ is again a second-order scaling term. Notice that $\tau_2^{q,i}$ also enters on its own in addition to its interaction with $\nu_2^{q,i}0$. The idea is to capture both average and time-varying differentials in funding costs. Specifically, $\tau_2^{q,i} < 0$ indicates that currency i is normally a cheaper funding currency than the domestic one. By contrast, $\tau_2^{q,i}\nu_2^{q,i} - tau_2^{q,dom}\nu_2^{q,dom} < 0$ indicates a period where the interest rate on currency i is unusually low compared to the domestic currency.

Note that banks can fund themselves in a foreign currency by directly borrowing in that currency on balance sheet, or by borrowing in another currency and then swap that other currency for the desired currency in the swap market (Fender and McGuire [2010]). In normal times, the cost of these two strategies will be very close, ensured by arbitrage and covered interest parity (Akram et al. [2008]). During the global financial crisis, however, important deviations from CIP was observed across many currency markets (Ivashina et al. [2012]). This may have resulted in strong shifts in banks' foreign currency funding strategies between outright foreign currency funding and synthetic foreign currency funding using swaps. To keep the model simple, we do not explicitly model the use of currency swaps. But since data only allow us to assess outright foreign currency funding, we allow for funding costs using swaps to affect this amount in our empirical analysis in Section 3.2.2.

3.1.4 Equity

The bank is initially endowed with an equity position K_1 in domestic currency:

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

We assume that banks cannot raise new equity within the time frame that we are considering. The bank's equity in period 2, K_2, then reflects the overall changes in the values of loans, deposits, and wholesale funding due to shocks, as well as the bank's choice of whole-sale funding currency mix, with the exact expression given in the appendix.

3.2 Solution of the model

3.2.1 First-order conditions

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

$$U_1 = E_1 \frac{(K_2)^{1-\gamma}}{1-\gamma}$$

subject to the constraint that overall wholesale funding is given initially. It is convenient to write the funding positions as $F_1^i = F_0^i \exp\left(f_1^i\right)$ where F_0^i is the zero-order component of the position and f_1^i is the first-order component. The optimization implies that the expected discounted excess returns are zero (for $i = eur, chf$):

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

We take a cubic approximation of (1). 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 zero- and first-order terms are all of value zero. Taking the second-order terms gives the solution for the zero-order component of the funding positions:

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

which we can rewrite as:

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

The term Net_0^i captures the long-term average of steady state net exposure of the bank to currency i, and is defined as steady state assets in currency i less total liabilities in currency i, multiplied by the steady state exchange rate. The model shows that this term captures the first-order impact of the exchange rate on equity, and hence, that it is central to how banks respond to developments in the foreign exchange market. The bank faces a tradeoff in its risk management of currency exposure. On the one hand, the bank is risk averse and wishes—all else equal—-to reduce any exchange rate exposure to zero. Thus, an appreciation of foreign currency i changes the absolute value of the initial net position in currency i , as captured by the first component of expression (2). The bank will react by changing its currency composition of funding to bring this impact to zero, so as to hedge itself against exchange rate mismatch. On the other hand, the bank accepts currency exposure to the extent that the risk-adjusted cost of funding differs across currencies and provides for returns, with F_0^i being larger when it represents a cheaper funding source than the domestic currency ($\tau_2^{q,i} < 0$). This mitigates the bank's response to changes in the net exposure to a currency due to exchange

rate movements.

Note that the taking the third-order terms in the approximation of expression (1) gives the solution for the first-order component of the funding positions f_1^i. To gain intuition about the drivers of the foreign currency funding mix, we focus on the wholesale funding position in Swiss francs and discuss its implications:

$$\begin{aligned} S_0^{chf} F_0^{chf} f_1^{chf} &= \frac{K_0}{\gamma \sigma_{fx}^2} \left(\tau_2^{q,dom} \nu_2^{q,dom} - \tau_2^{q,chf} \nu_2^{q,chf} - \tau_2^{S,chf} \nu_2^{S,chf} \right) \\ &+ \frac{\tau_2^{q,chf}}{\sigma_{fx}^2} \left(Net_0^{eur} \nu_1^{S,eur} + Net_0^{chf} \nu_1^{S,chf} \right) \\ &+ Net_0^{chf} \nu_2^{\sigma,chf} + \frac{1}{2} Net_0^{eur} \nu_2^{\rho} \\ &+ S_0^{chf} (1-\lambda) C_0^{chf} \left(\nu_1^{C,chf} - \lambda \nu_1^{S,chf} \right) - S_0^{chf} D_0^{chf} \nu_1^{D,chf} \\ &+ \left(1 - (1+\gamma) (K_0)^{-1} \right) Net_0^{chf} \nu_1^{S,chf} \end{aligned} \tag{3}$$

Expression (3) captures the bank's active demand for Swiss francs as a result of various shifters and shocks (remember that f_1^{chf} is net of valuation effects). It shows that the bank's demand for Swiss franc funding ($f_1^{chf} > 0$) is driven by four distinct drivers.

The first driver is captured in the first term in expression 3 and reflects relative funding cost considerations. Specifically, a positive value for the parenthesis indicates that the funding cost in the Swiss franc (including the expected exchange rate movement) is cheaper than the funding cost in the domestic currency. We can interpret the term as deviations from interest parity. A low relative funding cost in Swiss franc can reflect a high interest rate in the local currency ($\nu_2^{q,dom} > 0$), a low interest rate in the Swiss franc ($\nu_2^{q,chf} < 0$), or an expected depreciation of the Swiss franc ($\nu_2^{S,chf} < 0$).

The second driver is portfolio rebalancing considerations due to the valuation effects of exchange rate movements, a la Hau and Rey [2008]. This driver is related to developments in the first-order components in exchange rate markets. Thus, a local currency depreciation in period 1 against either the euro ($\nu_1^{S,eur} > 0$) or the Swiss franc ($\nu_1^{S,chf} > 0$) results in a valuation effect that increases the exposure to the Swiss franc and the foreign currency, provided the bank holds long positions in these foreign currencies ($Net_0^{eur} > 0$ or $Net_0^{chf} > 0$). If the bank holds short positions in these currencies, the net exposure will narrow as a result, with the opposite implications for the bank's currency funding choice. The effect of changes in the net foreign currency positions on the demand for the SWiss franc in turn again depends on the extent to which the bank is long the Swiss franc, hence the double interaction with the Swiss franc net position.

The third driver captures the bank's response to changes in foreign exchange market risk perceptions. This demand for Swiss franc funding is related to the bank's demand for

hedging of risks and volatilities associated with currency mismatches, which in turn are driven by current and expected developments in the second order components of foreign exchange markets (volatilities and correlations). First, an increase in the volatility of the Swiss franc exchange rate ($\nu_2^{\sigma,chf} > 0$) will tend to increase the demand for Swiss franc wholesale funding, provided the initial net position is long in Swiss francs ($Net_0^{chf} > 0$). 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 francs by getting more wholesale funding in that currency. Another way of putting it that higher volatility of the Swiss franc reduces the bank's demand for Swiss franc exposure given its risk aversion. If the bank is long, the exposure is reduced by increase its liabilities in Swiss francs, and thus, its wholesale funding. Conversely, if the bank is short the Swiss franc, it would want to reduce this short position by reducing its Swiss franc liabilities. Second, a higher correlation of the local currency exchange rates against the Swiss franc and the euro respectively ($\nu_2^{\rho} > 0$) will tend to increase the demand for Swiss francs if the bank initially has a long net position in euro ($Net_0^{eur} > 0$). The intuition here is that an increase in the correlation of the two currencies results in an increased concentration of the risk related to the net exposure of the euro. If the bank is long the euro, it will hence seek to reduce the liabilities held in the Swiss franc. By symmetry, an increase in the correlation of the two currencies will also result in a reduction in the liabilities held in euro, if the bank is net long the Swiss franc.

The fourth driver captures the portfolio rebalancing of the change in the net currency exposure due to shocks to shifts in the value of lending and deposits in Swiss francs that are not driven by exchange rate movements. Thus, banks' demand for Swiss franc funding will increase if the amount of loans denominated Swiss franc increases ($\nu_1^{C,chf} > 0$) (take out: or indirectly through a depreciation of the Swiss franc that raises payoffs ($\lambda\nu_1^{S,chf} < 0$)), or if the amount of Swiss franc deposits fall. In other words, if Swiss franc lending less Swiss franc deposits increases, all else equal, the bank will want to rebalance its portfolio by off-setting this increased currency mismatch through higher Swiss franc wholesale funding.

The expression in (3) reflects the first-order component of the funding position measured in Swiss franc.[4] The first-order component of the same position measured in the domestic currency of course also includes the first-order components of the exchange rate. Our empirical test of (3) below will therefore require filtering out the direct impact of the exchange rate on the domestic currency value of the Swiss franc (and euro) funding position.

[4]We can also interpret this terms as the dynamic response in the funding position following movements in the exogenous variables such as the exchange rate

3.2.2 An Empirical Specification

The described four drivers of the wholesale funding currency mix resulting from the model are in terms of deviations from the steady state, adjusted for changes in the value of wholesale funding due to exchange rates (i.e. adjusted for valuation effects). We want to base our empirical estimating equation for a panel regression analysis on these drivers. Below, we first lay out a specification for the log level of Swiss franc funding adjusted for exchange rate valuation effects, and subsequently consider corresponding specifications for funding in other foreign currencies. Specifically, the valuation-adjusted Swiss franc funding in country j is:

$$\begin{aligned} & \ln\left(Funding_{j,t}^{CHF}\right) \\ = \; & \alpha_0 + \alpha_1\left(UIP_{j,t}^{CHF}\right) + \alpha_2\left(CIP_{j,t}^{CHF}\right) \\ & + \alpha_3 Net_j^{CHF} \ln\left(S_{j,t}^{CHF}\right) + \alpha_4 Net_j^{CHF} Net_j^{EUR} \ln\left(S_{j,t}^{EUR}\right) \\ & + \alpha_5 Net_j^{CHF} Var\left(\ln\left(S_{j,t+1}^{CHF}\right)\right) + \alpha_6 Net_j^{EUR} Covar\left(\ln\left(S_{j,t+1}^{CHF}\right), \ln\left(S_{j,t+1}^{EUR}\right)\right) \\ & + \alpha_7 \ln\left(Loan_{j,t}^{CHF}\right) - \alpha_8 \ln\left(Deposit_{j,t}^{CHF}\right) \\ & + fixed_j + \epsilon_t \end{aligned} \tag{4}$$

where Net_j^{CHF} is the sample average of the net position denominated in Swiss francs (loans minus deposits minus wholesale funding). α's are coefficients that we expect to be positive based on our model. FC denotes other foreign currencies than Swiss francs and t denotes time. $Funding_{j,t}^{CHF}$ is the amount of Swiss franc denominated funding used by banks in country j in time period t, adjusted for the valuation impact of the exchange rate. The terms $UIP_{j,t}^{CHF}$ and $CIP_{j,t}^{CHF}$ captures deviations from the uncovered and covered interest rate parities. Specifically, $i_{j,t}$ and i_t^{CHF} are the money market interest rates in the local currency and the Swiss franc. ($S_{j,t}^{CHF}$ is the spot exchange rate, with $\Delta \ln\left(S_{j,t+1}^{CHF}\right)$ denoting the percent depreciation of the local currency between period t and $t+1$ (we discuss how to measure expected exchange rates below) $FR_{j,t+1}^{CHF}$ is the forward exchange rate. The deviations from UIP and CIP are then written as:

$$\begin{aligned} UIP_{j,t}^{CHF} &= i_{j,t} - i_t^{CHF} - \Delta \ln\left(S_{j,t+1}^{CHF}\right) \\ CIP_{j,t}^{CHF} &= i_{j,t} - i_t^{CHF} - \left(FR_{j,t+1}^{CHF} - S_{j,t+1}^{CHF}\right) / S_{j,t+1}^{CHF} \end{aligned}$$

Risk considerations enter in the form of the expected exchange rate variance and the expected covariance between the home country's exchange rate vis-a-vis the Swiss franc and vis-a-vis the other foreign currency. These can be interpreted as the influence of global financial risk factors on bank funding decisions. In robustness checks, we control for the role of the VIX index as a driver of financial risk sentiment and expected exchange rate volatility. All risk variables are interacted with the net positions in foreign currencies in line with theory. The final group of variables captures movements in loans and deposits in Swiss francs adjusted

for the direct valuation impact of exchange rate movements. In robustness checks, we also add loans and deposits in other foreign currencies. Finally, we include country fixed effects and an error term. The fixed effects capture cross country non-time varying differences in institutional and regulatory structures that matter for banks' choices of foreign currency funding. For example, countries with poorer access to domestic currency funding may choose more foreign currency funding overall. Countries with closer proximity to Switzerland (or the euro area) may have preferences for more Swiss franc (or euro) funding. The fixed effect would pick this up. We also estimate a version of 4) for other currencies. The specification simply corresponds to 4) with the CHF and FC labels switched.

While our theory implies a specification in deviations of levels from long-run steady state values, it assumes that banks face no costs of adjusting their balance sheet. In the presence of such costs, however, the adjustment of balance sheets could show a substantial inertia, making a level specification problematic. Moreover, we do not want to rely on estimates of long-run steady state level, and therefore estimate the panel regression in first differences.[5]. Since we do not have good measures of expected future exchange rate movements for banks, we assume that expected exchange rate changes equal to past exchange rate changes (adaptive expectations). Moreover, we include both the deviation from uncovered interest parity as suggested by our theory, and the deviation from covered interest parity.

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 collecting data from 20 participating central banks.[6] 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. Most, but not all, of these data included in the Monitor are publicly available through national data sources. The advantage of the Swiss Franc Lending Monitor is that the data series are pulled together in a cross-country comparable format. The Monitor contains quarterly data on various components of banks' balance sheet positions, aggregated at the country level. 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.

The Swiss Franc Monitor was initiated in 2009 and the sample starts in the first quarter of 2009 at the latest. Some participating countries, however, provide data for earlier quarters

[5] Of course in first differences country fixed effects cancel out

[6] Austria, Bulgaria, Czech Republic, Croatia, Denmark, Estonia, France, Germany, Greece, Hungary, Iceland, Italy, Latvia, Luxembourg, Poland, Romania, Serbia, Slovenia, Slovakia, and the United Kingdom.

as well. We use an unbalanced sample that starts in the first quarter of 2007.[7] This allows us to cover a part of the the pre-financial crisis period. We include 19 of the sample countries.[8] Since Estonia moves from having its own currency to joining the euro in 2011, we divide Estonia into two sample countries, namely EE1 which has data from before joining the euro, and EE2 which has data from the date of entry into the euro area. We hence effectively end up with a sample of 20 countries. Latvia, which joined the euro area in 2014, is only included in its pre-euro incarnation.

A the unique feature of the Monitor is its breakdown of balance sheet positions across currencies.[9] Specifically, all positions are divided between Swiss francs, other foreign currencies, and local currency. This provides exceptionally detailed information on developments in various subcategories of Swiss franc and other foreign currency denominated assets and liabilities. Other foreign currency positions are not broken further down into individual foreign currencies, however. In our empirical investigations, we take advantage of the fact that euro area countries are likely to predominantly have US dollars as the other foreign currency, while non-euro area countries are likely to have predominantly euros as the other foreign currency. 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. Moreover, we estimate the breakdown of other foreign currencies based on information on the currency weights of bank balance sheets of the sample countries.

Banks' assets are divided 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.[10] 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.[11] As we exclude domestic interbank positions, we define wholesale funding as the sum of deposits from foreign banks and non-banks. These include repo as well as interbank deposit. To some extent, these series may also include cross border retail deposits. We cannot separate those out, but assume that they are a small and relatively stable part of the series, and hence, will not strongly affect our results.

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

[8] We excluding Iceland due to insufficient data coverage.

[9] 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.

[10] 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.

[11] 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.

In the euro area, where banking has become more integrated, the extent to which this is the case may be more important than for non-euro area countries. Ideally, we would also add the outstanding amounts of own issues of debt securities in the given currency, but the data on these are unfortunately very incomplete.[12]

4.2 Some Stylized Facts on the Funding Currency Mix

The data suggests that the foreign currency funding mix is highly heterogenous across countries, both on the funding and on the lending side of bank balance sheets. We will focus on funding here, and note that in (Krogstrup and Tille [2015]), we use the same dataset but focus on bank lending behavior, and illustrate a number of stylized facts about the foreign currency mix of bank lending. We notably show that European banks use the Swiss franc to a much higher extent than other foreign currencies for domestic lending to households, and this is particularly the case in Eastern European countries. This fact reflects the prevalent use of the Swiss franc for mortgages in these countries. By contrast, lending to residents in other foreign currencies to a higher extend goes to non-financial companies, and we interpret this as related to the cross-border trade activities of the non-bank corporate firms. These features may have implications for the maturity and credit profile of lending across currencies, and hence for the funding of these positions.

Turning to funding, the left panel in Figure 1 depicts banks' wholesale funding, defined as cross border deposits from banks and non-banks, in percent of GDP divided on currencies, and shows that countries that are typically thought of as financial centers hold substantially greater amounts of wholesale funding. This partly reflects the higher overall size of the banking sectors in these countries. The right panel depicts the relative currency shares of this wholesale funding, with the countries sorted by the share of wholesale funding held in domestic currency. This sorting scheme neatly divides the sample countries into euro area countries that share their local currency, and hence have higher amounts of cross border wholesale funding denominated in their own currency, and other European countries with much lower shares of wholesale funding in local currency. Broadly, Figure 1 shows that whether or not a country is a financial center, and whether or not it is part of the euro area, matters structurally for its wholesale funding. We pay particular attention to these dimensions of the sample in the remainder of the paper.

The use of Swiss franc funding distinguishes itself from other foreign currencies by being to a higher degree wholesale. Figure 2 shows that the share of wholesale funding in total Swiss franc denominated liabilities tends to be higher than the corresponding share for other foreign currencies. Moreover, and not surprisingly, Swiss franc and other foreign currency liabilities are both to a much higher degree wholesale than domestic currency liabilities. For

[12] Some countries only report a total number of outstanding bank debt securities without providing the currency decomposition. Many countries do not provide data on debt securities at all.

other foreign currencies and domestic currency, residents' deposits are more prevalent than what is the case for Swiss francs. This also means that total Swiss franc liabilities are to a higher degree cross-border positions than the liabilities in other foreign currencies.

Importantly, the data shows that banks tend to be long the Swiss franc to a much higher extent than what is the case for other currencies (Yesin [2013] makes this point). Figure 3 illustrates the aggregate net currency mismatch in the banking sectors of the sample countries for Swiss franc positions and other foreign currency positions separately. It shows that European banks' assets in Swiss francs with very few exceptions substantially exceed liabilities in Swiss francs. This not the case for other foreign currencies. The model in Section 3 suggests that this feature may play an important role in the way in which banks' funding currency mix responds to developments in exchange markets.

In part, this currency mismatch may 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 indexed loans are often granted for mortgages. As mentioned above, the practise of granting foreign currency indexed mortgage loans is much less prevalent in other foreign currencies in European countries.[13] Swiss franc indexed mortgages have been popular doe to the low interest rate that the Swiss franc has traditionally offered. The transactions pertaining to such loans will be carried out in local currency, however, and no Swiss francs actually change hands when such loans are granted. This means that the granting of Swiss franc indexed mortgages does not give rise to the creation of matching off-shore Swiss franc deposits, but rather, to domestic currency deposits. A Swiss franc-indexed loan, however, gives rise to exactly the same currency exposure as an outright Swiss franc loan, and such loans are hence recorded as Swiss franc loans in the lending monitor. Further, anecdotal evidence suggests European banks often hedge such Swiss franc exposures in the currency swap market, as also discussed in Section 3.

Finally, the data shows that the use of the Swiss franc for wholesale funding has been moderately declining across the sample countries over time. In contrast, the time variation in the use of other foreign currencies has been more heterogenous, and depended on whether the country is a core or periphery country. We illustrate these time trends by the time fixed effects from panel regressions of the percentages of Swiss franc and other foreign currency wholesale funding respectively in total wholesale funding. The regressions (not shown) include time and country fixed effects and an error term and are estimated with simple OLS. We run these regression for the overall sample as well as for four sub samples, namely for core euro area countries, periphery euro area countries, core non-euro countries and periphery non-euro countries. The estimated time fixed effects, scaled to equal zero in the initial period, are presented in the left and right hand panels of Figure 4.

The left hand panel shows that the percentage of total wholesale funding that is de-

[13] One exception is Austria, which has had a substantial amount of outstanding mortgages granted in Yen.

nominated in Swiss francs has declined moderately in the sample countries since the global financial crisis. This moderate decline can be observed in all sub-samples, with the exception of the core non-euro countries (Denmark and the UK). The right hand panel shows that the percentage of wholesale funding that is denominated in other foreign currencies has remained relatively constant for the sample countries as a whole and for periphery countries, but has declined quite strongly for core countries. This strong decline in core countries reflects a shift toward increased use of domestic currency denominated cross border wholesale funding (not shown).

4.3 Adjusting bank positions for exchange rate valuation effects

To estimate the empirical specification in Section 3.2.2, we need the change in funding positions across currencies excluding changes due to exchange rate movements. The adjustment for valuation effects is complicated by the fact that we do not have the exact currency breakdown for other foreign currencies. We hence consider here how to adjust the data for such valuation effects. 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 active change in that position, $F_t^{c,j}$, 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:

$$L_t^{c,j} = L_{t-1}^{c,j} + F_t^{c,j} + L_{t-1}^{c,j} dln(S_t^{c,j})$$

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 $\dot{S}_t^{c,j} = dln(S_t^{c,j})$. 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):

$$\dot{l}_t^{c,CH} = f_t^{c,CH} + \dot{S}_t^{c,CH} \quad (5)$$

$$\dot{l}_t^{c,FX} = f_t^{c,FX} + \sum_j \varpi^{c,j} \dot{S}_t^{c,j} \quad (6)$$

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 active portfolio changes in CHF positions $f_t^{c,CH}$, we need

to estimates the these for positions in other foreign currency, $f_t^{c,FX}$. To do this, we rely on empirical estimates of the weights $\varpi^{c,j}$. The country specific estimates we use for the $\varpi^{c,j}$ are given in the appendix Table 1, and Appendix D provides country specific details on the selection of these currency weights.

We have relied on three sources for constructing these. 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. This source suggests that 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. The second source is the results from 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 (6). 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 $\varpi^{c,j}$. When the regression results provide a good fit of the composition across several currencies, 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 a third source, namely information on web sites of the European Central Bank and a number of the national central banks of the sample countries.

4.4 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.

4.4.1 Funding Costs

The first explanatory variable is the change in the deviation from uncovered interest parity. We compute these differentials using 3 month interbank deposit rates in the domestic and foreign currencies. Moreover, we assume that the expected appreciation of the foreign currency is equal to the current appreciation of that currency, and check robustness to assuming that expected exchange rate changes are zero.[14]

[14] 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.

The role of the uncovered interest parity differential derives from the model assumption that banks cover their foreign currency wholesale funding needs in the interbank market in that currency, and not in the foreign currency swap market. As noted in Section 3, banks can also fund themselves in the foreign currency swap market as well, and in the empirical specification, we allow for this by including the covered interest differential as a control variable.

During the larger part of the sample period, policy rates were at the zero lower bound, and monetary policy was conducted through alternative tools such as quantitative easing and the provision of swap lines with foreign central banks. 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. We capture the strains in the foreign currency funding markets, and their alleviation through central bank measures such as foreign currency swap lines, through the covered interest differential (insert references to papers making this link).

The explanatory variable is measured in terms of percentage changes over the quarter in question (the relative change between the end of the previous quarter and the end of the current quarter). We hence take the change across the quarter in funding costs as well. Due to high variation in the daily data on interest and exchange rates, however, we use the average of the interest and exchange rates of the last week of the quarter.

4.4.2 Exchange Rate Risk Developments

The theoretical model indicates that the appreciation, expected variances and expected covariances of exchange rates of foreign currencies matter for the use of foreign funding currencies.

Variances and covariances are based on weekly average exchange rates, but note that if these were instead based on daily data, it would not influence the results. The upper panels in Figure 5 depicts the quarterly averages of the Swiss franc and the US dollar nominal exchange rates and weekly variation against the euro. While the Swiss National Bank was actively managing the exchange rate during the larger part of the sample period, this was not 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 a floor vis-à-vis the euro, which required occasional foreign exchange interventions. During the floor period, Swiss franc remained largely stable against the euro, and it's variance was very low. The large peak in Swiss franc exchange rate variation in the third quarter of 2011 reflects intra-quarter variability in the months of July and August, which ended with the imposition of the exchange rate floor against the euro in September 2011. The peak in the first quarter of 2015 reflects the

[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]

Swiss National Bank's abandonment of the floor against the euro. We check the robustness of the results to this decision by including a dummy for that quarter. These peaks in weekly exchange rate variability was a shock to foreign banks' use of the Swiss franc and we hence want to include them in our regressions (i.e. we do not treat it as an outlier). For robustness, we control for dummies for those quarters.

The lower left panel in Figure 5 shows the covariance between the Swiss franc euro and the US dollar euro exchange rates (red line) and the covariance between Swiss franc US dollar and the euro US dollar exchange rates (blue line). These exchange rate covariations increase during periods of global financial uncertainty, as reflected by the VIX depicted in the right lower panel. We also control for the VIX as an alternative measure of global financial factors in the empirical specification, but note that due to the high correlation with exchange rate covariances, we do not include these two measures simultaneously.

5 Regressions and Results

Summary statistics for the regression variables for euro countries are displayed in Table, and those for non-euro countries in Table. To ease comparison, all explanatory variables in the form of variances and covariances are multiplied by 1000, and all rates of change are converted into yearly percentage equivalents (i.e. percent per annum). For example, we have computed the rates of exchange rate appreciation and the rates of valuation adjusted changes in deposits across the quarter as the relative quarterly change times 400. This makes these variables directly comparable to conventional interest rate notation. Poland is excluded from the regressions because of a lack of data on the currency composition of bank assets, which precludes the calculation of net exposures.

While we construct estimates of the split of the other foreign currencies across specific currencies (specifically the euro and the US dollar) in section 4.3, we do not have precise estimates of the time variation in these shares, and we hence cannot fine-tune our empirical specification across these two currencies. Instead, for the sub-sample of countries that are not in the euro area, we consider the euro to be the non-CHF foreign currency. For countries in the euro area, we instead consider the US dollar to be the main non-Swiss franc foreign currency.

The baseline regression variables and their descriptive statistics are given in Table 1 for non-euro area countries, and Table 2 for euro area countries. For notation, primary foreign funding currency is denoted by FC and the other foreign currency is denoted by OC. In the case of the euro area country sample, FC is the Swiss franc and OC is the US dollar, while for non-euro countries, the second foreign currency OC is the euro.

Following specification 4, 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 second quarter of 2015, and

is unbalanced.

Table 3 presents our baseline regression results. We split the sample between countries that are not members of the euro area (left panel) and countries that have the euro as their currency (right panel). For each panel we present the results for the (first difference) funding positions in Swiss franc and other foreign currencies, these being the euro for the left panel and the US dollar for the right panel.

We find that funding costs play some role, but in a contrasted way. The UIP deviation enters significantly and with the right sign for Swiss franc funding in non-euro countries, but is not significant in the other specifications. The CIP deviation matter for Swiss franc funding in euro area countries and for euro funding in the other countries. This suggests that funding activity in the relatively more sophisticated euro area financial markets operates mostly in combination with exchange rate swaps covering the exchange rate risk.

Exchange rate movements matters, with a future appreciation of the foreign currency raising its use in funding for non-euro area countries that are long in the foreign currency. This is line with our model as the appreciation raises the domestic currency value of the long position, which is offset by increasing the foreign currency funding liabilities. This is observed both for funding in Swiss franc and euro. Risk considerations have some effect for Swiss franc funding outside the euro area. The volume of Swiss franc funding is reduced when the exchange rate is more volatile, or when the Swiss franc moves more in step with the euro.

Finally, the movements in lending and deposit matter. Higher lending in a foreign currency raises the extent of wholesale funding in that currency, this effect being observed across the board, but especially outside the euro area. Additional deposits in euro also reduce the use of that currency for wholesale funding.

We refine our analysis by considering whether drivers differ across core and periphery countries. We do so by interacting all explanatory variables with a dummy that takes the value one for core countries, and zero otherwise.[17] The results are shown in Table 4. This matters for Swiss franc wholesale funding demand in non-core non-euro countries, but for all other specifications, the addition of the core dummy does not substantially change results.

Overall, our analysis shows a highly contrasted situation, as the drivers of foreign currency funding are quite heterogeneous across country groups, and across currencies. Among non-euro area countries, the funding activity in Swiss franc appears primarily driven by exchange rate movements and lending activity in that currency.

6 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

[17] Core countries are AT, GB, DK FR, DE, LU.

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.

References

Q. Farooq Akram, Dagfinn Rime, and Lucio Sarno. Arbitrage in the foreign exchange market: Turning on the microscope. *Journal of International Economics*, 76(2):237–253, December 2008. URL `https://ideas.repec.org/a/eee/inecon/v76y2008i2p237-253.html`.

Tobias Arian, Erkko Etula, and Tyler Muir. Financial intermediaries and the cross-section of asset returns. *forthcoming, The Journal of Finance*, 2014.

Raphael Auer and Sebastien Kraenzlin. International liquidity provision during the financial crisis: A view from Switzerland. *Federal Reserve Bank of St Louis Review*, pages 409–17, 2011.

Raphael Auer, Sebastien Kraenzlin, and David Liebeg. How do Austrian banks fund their Swiss franc exposure? *Austrian National Bank Financial stability report*, pages 54–61, 2012.

Stefan Avdjiev, Zsolt Kuti, and Elod Takats. The euro area crisis and cross-border lending to emerging markets. *Bank for International Settlements quarterly review*, pages 37–47, 2012.

Martin Brown and Ralph De Haas. Foreign banks in Emerging Europe. *Economic Policy*, pages 57–98, 2012.

Martin Brown and Helmut Stix. The euroization of bank deposits in Eastern Europe. *paper presented at the 59th panel meeting of economic policy*, 2014.

Martin Brown, Marcel Peter, and Simon Wehrmüller. Swiss franc lending in Europe. *SNB Mimeo*, 2009.

Valentina Bruno and Hyun Song Shin. Cross-border banking and global liquidity. BIS Working Papers 458, Bank for International Settlements, Aug 2014. URL `http://ideas.repec.org/p/bis/biswps/458.html`.

Nicola Cetorelli and Linda Goldberg. Global banks and international shock transmission: evidence from the crisis. *International Monetary Fund Economic Review*, 59:41–46, 2011.

Nicola Cetorelli and Linda Goldberg. Follow the money: Quantifying domestic effects of foreign bank shocks in the Great Recession. *American Economic Review Papers and Proceedings*, 2012.

Jens H.E. Christensen and Signe Krogstrup. Swiss unconventional monetary policy: lessons for the transmission of quantitative easing. Working Paper Series 2014-18, Federal Reserve Bank of San Francisco, Aug 2014. URL `http://ideas.repec.org/p/fip/fedfwp/2014-18.html`.

ECB. The international role of the euro. Technical report, The European Central Bank, 2014.

Ingo Fender and Patrick McGuire. Bank structure, funding risk and the transmission of shocks across countries: concepts and measurement. *BIS Quarterly Review*, September 2010. URL https://ideas.repec.org/a/bis/bisqtr/1009h.html.

Michael J. Fleming and Nicholas J. Klagge. The Federal Reserves foreign exchange swap lines. *Current Issues in Economics and Finance*, 16(4), April 2010.

Harald Hau and Helene Rey. Global portfolio rebalancing under the microscope. Technical report, National Bureau of Economic Research, 2008.

David S. Scharfstein Ivashina, Victoria and Jeremy C. Stein. Dollar Funding and the Lending Behavior of Global Banks. *Quarterly Journal of Economics*, 130(3):1241–1281, Aug 2015.

Victoria Ivashina, David S. Scharfstein, and Jeremy C. Stein. Dollar Funding and the Lending Behavior of Global Banks. NBER Working Papers 18528, National Bureau of Economic Research, Inc, November 2012. URL https://ideas.repec.org/p/nbr/nberwo/18528.html.

Andreas Kettemann and Signe Krogstrup. Portfolio balance effects of the Swiss National Banks bond purchase program. *Journal of Macroeconomics*, 40(C):132–149, 2014. URL http://ideas.repec.org/a/eee/jmacro/v40y2014icp132-149.html.

Signe Krogstrup and Cdric Tille. On the roles of different foreign currencies in European bank lending. CEPR Discussion Papers 10845, C.E.P.R. Discussion Papers, September 2015. URL https://ideas.repec.org/p/cpr/ceprdp/10845.html.

Robert McCauley, Patrick McGuire, and Vladyslav Sushko. Global dollar credit: links to US monetary policy and leverage. Working Paper 483, Bank for International Settlements, January 2015.

Gian-Maria Milesi-Ferretti and Cédric Tille. The great retrenchment: International capital flows during the global financial crisis. *Economic Policy*, 66:285–330, 2011.

Elod Takats. Was it credit supply? Cross-border bank lending to emerging market economies during the financial crisis. *Bank for International Settlements Quarterly Review*, pages 49–56, 2010.

Cdric Tille and Eric van Wincoop. International capital flows under dispersed private information. *Journal of International Economics*, 93(1):31–49, 2014a.

Cedric Tille and Eric van Wincoop. Solving DSGE portfolio choice models with dispersed private information. *Journal of Economic Dynamics and Control*, 40(C):1–24, 2014b.

Pinar Yesin. Foreign currency loans and systemic risk in Europe. *Federal Reserve Bank of St Louis Review*, pages 219–235, 2013.

Appendix

A Theoretical model

A.1 Bank equity

Equity is the residual value of loans minus deposits and wholesale funding. At period 2 equity is given by:

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

where we used the notation that $F_1^i = F_0^i \exp\left(f_1^i\right)$.

A.2 First-order conditions and approximations

The bank maximizes the expected utility of equity subject to the constraint that the overall level of wholesale funding is given:

$$E_1 \frac{(K_2)^{1-\gamma}}{1-\gamma} + \phi_0 \left[\sum_{i=dom,eur,chf} S_0^i F_0^i \exp\left(f_1^i + \nu_1^{S,i}\right) - \bar{F}_1\right]$$

The first-order conditions leads to a set of two portfolio Euler conditions (**??**) linking the expected discounted returns between funding in domestic currency and funding in foreign currency i.

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

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

In general, 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. In our case, only the second- and third-order components include terms that are not zero. We use the second-order component to compute the zero-order funding positions F_0^i, and the third-order component to compute the first-order funding positions f_1^i.

Specifically, the second-order components of the linear and quadratic terms are:

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

Combining these terms leads to (**??**).

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

$$\begin{aligned} linear_{i,1}(3) &= (K_0)^{-\gamma}\left(\tau_2^{q,i}\nu_2^{q,i} + \tau_2^{S,i}\nu_2^{S,i} - \frac{1}{2}\sigma_{fx}^2\nu_2^{\sigma,i} - \tau_2^{q,dom}\nu_2^{q,dom}\right) \\ quadratic_{i,1}(3) &= (K_0)^{-\gamma}\sigma_{fx}^2\nu_2^{\sigma,i} \\ &\quad -2\gamma(K_0)^{-\gamma-1}\left(\tau_2^{q,i} - \frac{1}{2}\sigma_{fx}^2\right)\sum_{k=eur,chf} Net_0^k\nu_1^{S,k} \\ &\quad -2\gamma(K_0)^{-\gamma-1}\left[Net_0^i\sigma_{fx}^2\nu_2^{\sigma,i} - Net_0^j\sigma_{fx}^2\frac{1}{2}\nu_2^{\rho}\right] \\ cubic_{i,1}(3) &= -3\gamma(K_0)^{-\gamma-1}\sigma_{fx}^2\sum_{k=eur,chf} Net_0^k\nu_1^{S,k} \\ &\quad -6\gamma(K_0)^{-\gamma-1}\left[\begin{array}{c} Net_0^i\nu_1^{S,i} + (1-\lambda)S_0^iC_0^i\left(\nu_1^{C,i} - \lambda\nu_1^{S,i}\right) \\ -S_0^iD_0^i\nu_1^{D,i} - S_0^iF_0^if_1^i \end{array}\right]\sigma_{fx}^2 \\ &\quad -6\gamma(-\gamma-1)(K_0)^{-\gamma-2} Net_0^i\nu_1^{S,i}\sigma_{fx}^2 \end{aligned}$$

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

B Data Sources and Definitions

The Swiss franc Lending Monitor contains end-of-month bank balance sheet positions. We match this by using end-of-month position of the relevant variables, notably exchange rates, unless otherwise noted below.

- 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, average rate of the last week of the quarter. 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 Implicit Swap Rates

A bank can obtain foreign currency funding directly by borrowing foreign currency at the foreign currency interest rate. It can also obtain foreign currency funding indirectly by borrowing domestic currency, at the domestic interest rate, and swapping these funds into foreign currency for the duration of the loan in the foreign exchange swap market. It buys foreign currency at the spot exchange rate, and simultaneously purchases a forward for the amount of

the loan that is to be repaid at maturity. We therefore calculate the implicit cost of borrowing in domestic currency at the domestic money market interest rate and swapping this loan into foreign currency for the duration of the loan as follows:

$$y^i_{j,swap} = y_i - \left(\frac{S^j_i + f^j_i/10000}{S^j_i} - 1 \right) \frac{360}{90} \tag{7}$$

where y is a three month interest rate, j is the foreign currency, i is the borrowing country, S is the spot exchange rate defined as domestic per foreign currency, and f is the three months forward premium. f is defined as the difference between the three months forward and the spot rate multiplied by 10000, and available in bloomberg. We refer to $y^i_{j,swap}$ as coutry i's implicit swap rate for currency j. All data are from bloomberg.

D 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 5 and 6.

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.

D.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/Banl or http://www.bundesbank.de/Redaktion/DE/Downloads/Statistiken/Banken_Und_Andere_Finanziell 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.

E Tables

	Mean	Maximum	Minimum	Std. Dev.	Obs
Growth in FC cross border deposits	7.69	533.01	-97.13	66.50	288
d(UIP vis-a-vis FC)	-0.21	65.42	-75.70	20.52	288
d(CIP vis-a-vis FC)	-0.02	5.52	-6.49	0.89	288
FC appreciation * NetFC	2.94	45.34	-16.51	8.89	288
OC appreciation * NetOC * NetFC	-0.11	7.52	-16.58	2.03	288
d(FC Variance) * NetFC	0.00	1.04	-1.03	0.21	288
d(Covariance, FC and OC) * NetOC	0.00	0.39	-0.20	0.04	288
Growth in FC loans	1.30	254.79	-86.54	24.98	288
Growth in FC domestic deposits	3.11	142.70	-65.83	21.30	288
Growth in OC cross border deposits	0.73	92.80	-25.28	11.53	288
d(UIP vis-a-vis OC)	0.09	56.75	-57.00	11.40	288
d(CIP vis-a-vis OC)	-0.13	5.53	-6.13	0.89	288
OC appreciation * NetOC	-0.16	11.25	-24.81	3.04	288
FC appreciation * NetFC * NetOC	-0.31	9.14	-25.10	2.85	288
d(OC Variance) * NetOC	0.00	0.20	-0.31	0.02	288
d(Covariance, FC and OC) * NetCHF	0.00	0.17	-0.32	0.02	288
Growth in OC loans	1.05	22.57	-34.59	5.99	288
Growth in OC domestic deposits	1.37	32.07	-79.39	7.82	288
Dummy_CORE (=1 for DK, GB)	0.20	1.00	0.00	0.40	288

Foreign currencies	FC=CHF, OC=EUR
Sample: Quarterly.	2007Q1 - 2015Q2
Countries: Non-euro Countries.	BG, CZ, DK, EE1, GB, HU, HR, LV, RO, RS

Table 1: Descriptive statistics for non-euro country baseline regression variable

	Mean	Maximum	Minimum	Std. Dev.	Obs
Growth in FC cross border deposits	1.55	417.34	-84.433	45.25	224
d(UIP vis-a-vis FC)	-0.27	51.77	-49.51	17.49	224
d(CIP vis-a-vis FC)	0.09	2.10	-0.56	0.49	224
FC appreciation * NetFC	2.63	46.51	-21.17	7.61	224
OC appreciation * NetOC * NetFC	0.06	12.87	-9.87	2.69	224
d(FC Variance) * NetFC	0.00	1.26	-1.23	0.21	224
d(Covariance, FC and OC) * NetOC	0.00	0.07	-0.06	0.01	224
Growth in FC loans	-0.28	140.48	-56.58	18.38	224
Growth in FC domestic deposits	3.25	175.00	-76.33	25.81	224
Growth in OC cross border deposits	-0.54	107.57	-47.64	15.30	222
d(UIP vis-a-vis OC)	-0.20	72.71	-50.94	21.39	222
d(CIP vis-a-vis OC)	0.01	0.57	-0.38	0.21	222
OC appreciation * NetOC	-0.19	20.91	-14.88	4.75	222
FC appreciation * NetFC * NetOC	-0.12	12.59	-9.65	2.03	222
d(OC Variance) * NetOC	0.00	0.16	-0.15	0.02	222
d(Covariance, FC and OC) * NetFC	0.00	0.07	-0.06	0.01	222
Growth in OC loans	1.62	201.86	-54.32	17.82	222
Growth in OC domestic deposits	0.88	65.90	-40.41	11.04	222
Dummy_CORE (=1 for AT, DE, FR, LU)	0.42	1.00	0.00	0.49	224

Foreign currencies	FC=CHF, OC=USD
Sample: Quarterly	2007Q1 - 2015Q2
Countries: Euro Countries	AT, DE, EE2, FR, GR, IT, LU, SI, SK,

Table 2: Descriptive statistics for euro country baseline regression variables

	Non-euro Countries		Euro Countries	
Dependent variable:	CHF funding growth	EUR funding growth	CHF funding growth	USD funding growth
Other foreign currency:	OC = EUR	OC = CHF	OC = USD	OC = CHF
Explanatory Variable	FC=CHF	FC=EUR	FC=CHF	FC=USD
UIP vis-a-vis FC	**0.45****	-0.01	0.15	0.04
CIP vis-a-vis FC	3.35	**2.53*****	**6.20****	-3.68
Expected FC appreciation * NetFC	**0.45****	**0.43****	-0.01	0.04
Expected OC appreciation * NetOC * NetFC	3.35	**-0.50***	0.35	**1.43*****
Change in FC variance * NetFC	**-0.66***	2.28	-12.22	-39.59
Change covariance FC, OC * NetOC	**-1.27***	-12.17	218.51	-123.18
Growth in FC loans	**41.98*****	**1.16*****	**0.29****	**0.13****
Growth in FC domestic deposits	6.34	**-0.19****	**-0.10****	**0.15***
Number of observations	288	288	224	222
Number of cross sections	10	10	9	9
R-Squared	0.11	0.33	0.04	0.1

Table 3: Baseline regression results

The table shows the results of regressing the quarterly valuation adjusted changes in wholesale funding in currency FC or OC, on various determinants. The sample runs from Q1 2007 to Q2 2015. Panel clustered standard errors are used for measuring significance. Asterisks * and ** indicate significance at the 5 percent and 1 percent levels, respectively.

	Non-euro Countries		Euro Countries	
Dependent variable:	CHF funding growth	EUR funding growth	CHF funding growth	USD funding growth
Other foreign currency:	OC = EUR	OC = CHF	OC = USD	OC = CHF
Explanatory Variable	FC=CHF	FC=EUR	FC=CHF	FC=USD
UIP vis-a-vis FC	0.2	0.002	0.325725	-0.01
CIP vis-a-vis FC	3.57	**2.74*** **	**7.59***	-1.84
FC appreciation * NetFC	**-0.85****	**0.47****	0.75	0.16
OC appreciation * NetOC * NetFC	**-1.61***	**-0.56***	1.88	**2.14*** **
Change in FC variance * NetFC	**32.40****	-31.34	**-29.09***	-7.57
Change in covariance, FC and OC * NetOC	8.54	24.08	194.66	-276.02
Growth in FC loans	**0.65*** **	**1.25*** **	**0.25***	**0.08****
Growth in FC domestic deposits	0.07	**-0.25****	-0.08	0.15
Dum_{Core}*UIP vis-a-vis FC	0.64	-0.03	**-0.64***	0.08
Dum_{Core}*CIP vis-a-vis FC	12.18	-2.77	**-7.84***	-6.88
Dum_{Core}*FC appreciation * NetFC	-0.38	12.57	**-1.48****	-0.07
Dum_{Core}*OC appreciation * NetOC * NetFC	236.92	-1.43	-2.08	**-1.51***
Dum_{Core}*Change in FC variance*NetFC	56.93	**4845.74*** **	18.01	-56.08
Dum_{Core}*Change in covariance, FC and OC * NetOC	-4292.74	**-6345.01*** **	-133.49	322.52
Dum_{Core}*Growth in FC loans	1.14	**-0.38***	**1.45*** **	**0.48*** **
Dum_{Core}*Growth in FC domestic deposits	-0.46	0.14	-0.18	-0.11
Number of observations	288	288	224	222
Number of cross sections	10	10	9	9
R-Squared	0.12	0.34	0.08	0.14

Table 4: Regression results allowing for effects in core countries to differ

The table shows the results of regressing the quarterly valuation adjusted changes in wholesale funding in currency FC or OC, on various determinants. The sample runs from Q1 2007 to Q2 2015. Panel clustered standard errors are used for measuring significance. Asterisks * and ** indicate significance at the 5 percent and 1 percent levels, respectively.

F Charts

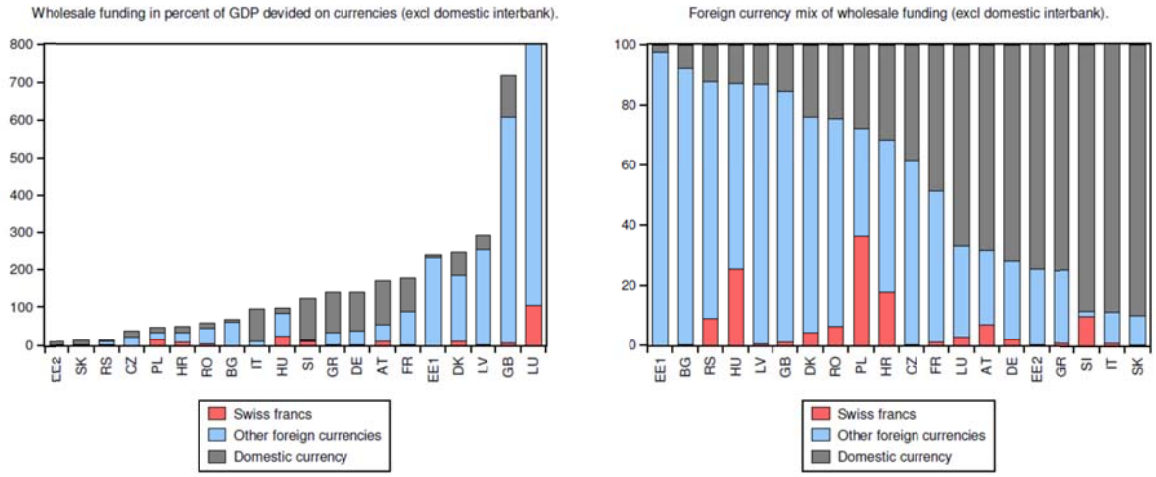


Figure 1: **Wholesale funding and currency mix, averages 2007-2015)**
Wholesale funding includes cross border deposit funding, including unsecured interbank deposits, deposits from foreign non-banks and repo, but does not include issues of own securities. The left hand panel reflects wholesale funding in percent of GDP divided on currencies, sorted by total wholesale funding to GDP. The bar for Luxembourg is is capped at 800% of GDP in order to make the bars for the other countries distinguishable, but Luxembourg has close to 4000% of wholesale funding to GDP. The right hand panel shows the shares of different currencies in banks' wholesale funding, sorted by the share of wholesale funding held in domestic currency. Source: SNB.

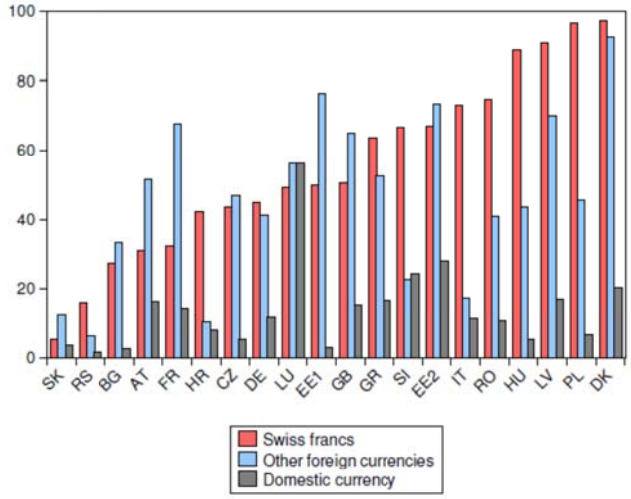


Figure 2: **Wholesale funding share of liabilities by currencies, averages 2007-2015)**
The Figure shows the share of total liabilities in a given currency which is wholesale funding in that currency, e.g. Swiss franc wholesale funding in percent of total Swiss franc liabilities. Wholesale funding includes cross border deposit funding, including unsecured interbank deposits, deposits from foreign non-banks and repo, but does not include issues of own securities. Source: SNB.

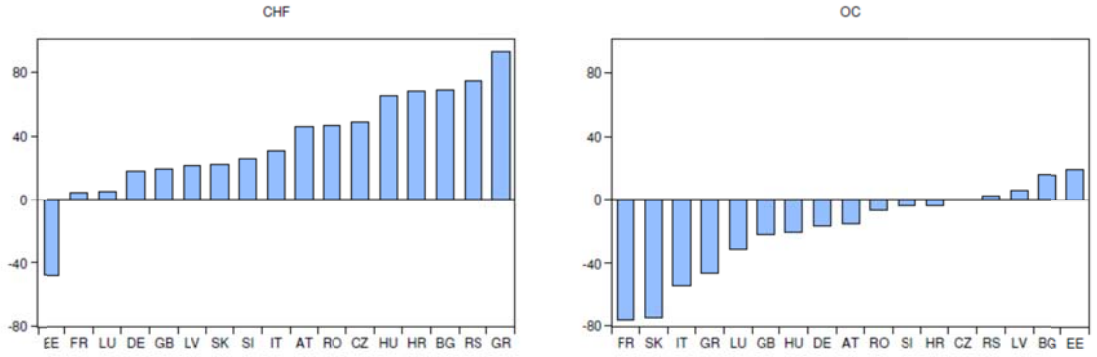


Figure 3: **Balance sheet mismatch, averages for 2007-2015**
Measured as total foreign currency assets in excess of total foreign currency liabilities, in percent of total foreign currency assets in the given currency. The left hand panels reflects on-balance sheet mismatches in Swiss francs whereas the right hand panel reflects those in other foreign currencies. Poland does not report on foreign currency assets, and is hence excluded. Source: SNB.

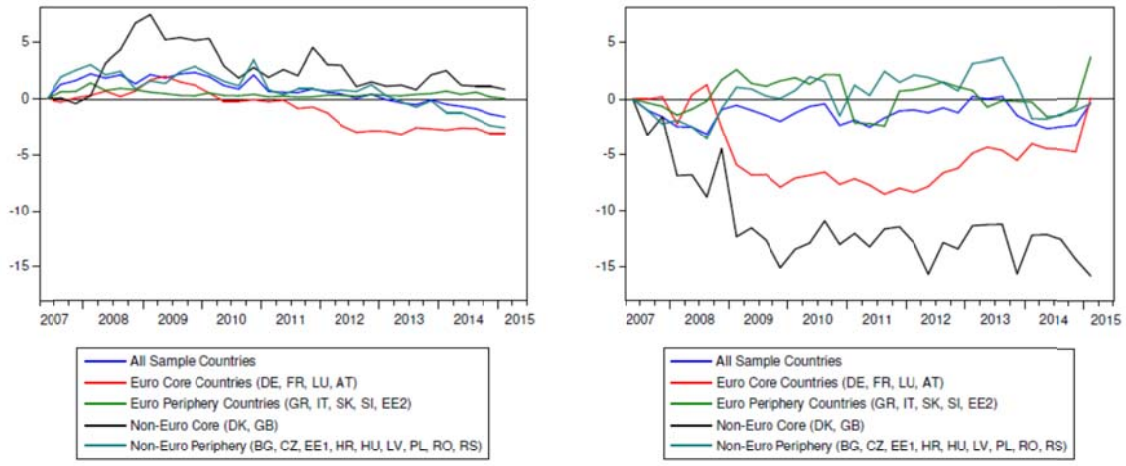
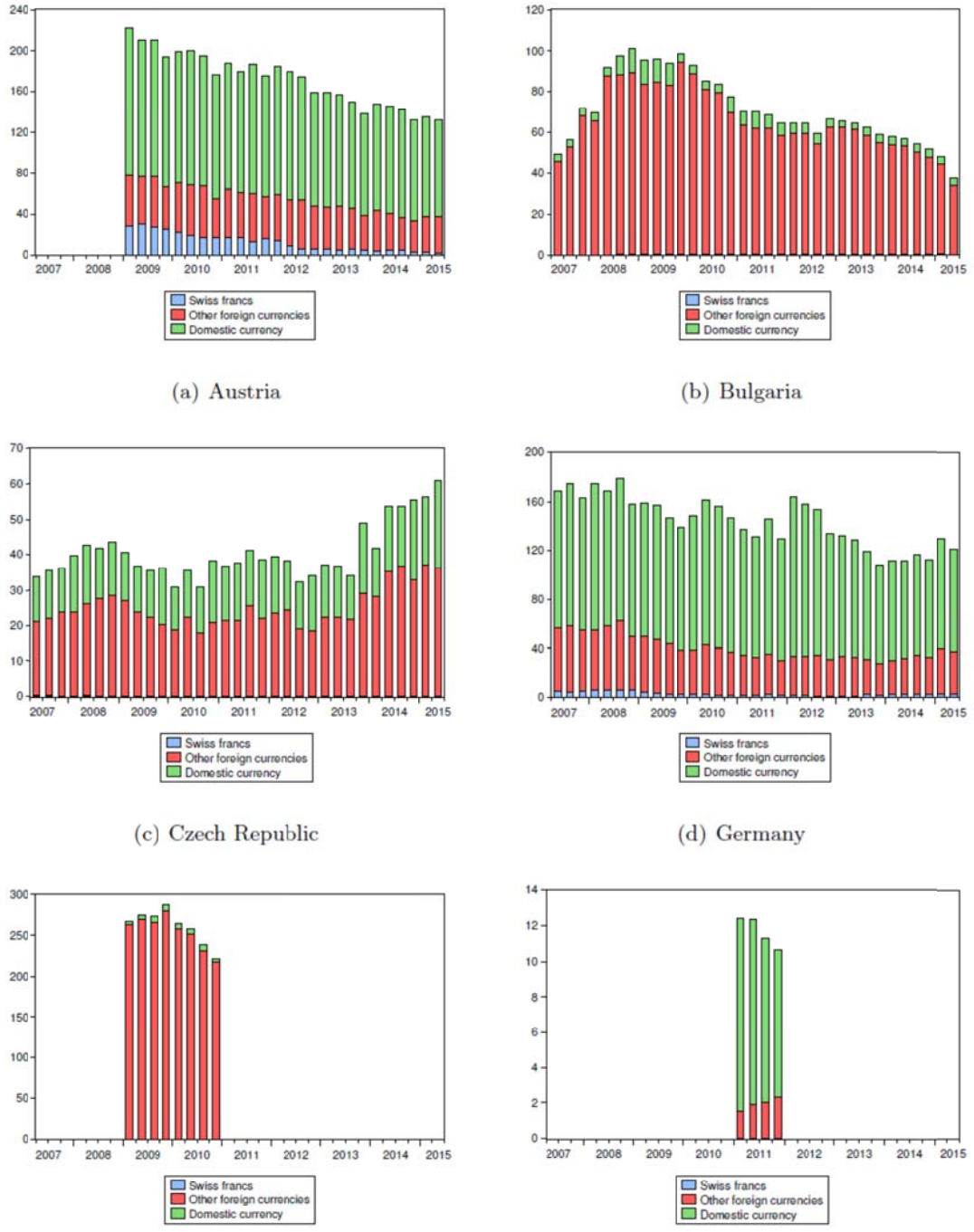


Figure 4: **Foreign currency composition of wholesale funding over time**
Quarterly, 2007Q2 to 2015Q2. The data depicts the value of the time fixed effects estimated from panel regressions on time and fixed effects of the percentage of wholesale funding that is denominated in Swiss francs (left panel) and in other foreign currencies (right panel) respectively in total wholesale funding. The unit on the vertical axis is percentage points. The time effects are scaled to equal zero in the initial period. The country fixed effects are not shown. The five lines reflect the time effects from the regression on whole sample (ALL) an different subsamples. Wholesale funding includes cross border deposit funding, including unsecured interbank deposits, deposits from foreign non-banks and repo, but does not include issues of own securities. Source: own estimations based on SNB Swiss Franc Lending Monitor.

Figure 5: **Swiss franc and US dollar exchange rates and variation against the euro, quarterly.**
Source: SNB.



(a) Austria

(b) Bulgaria

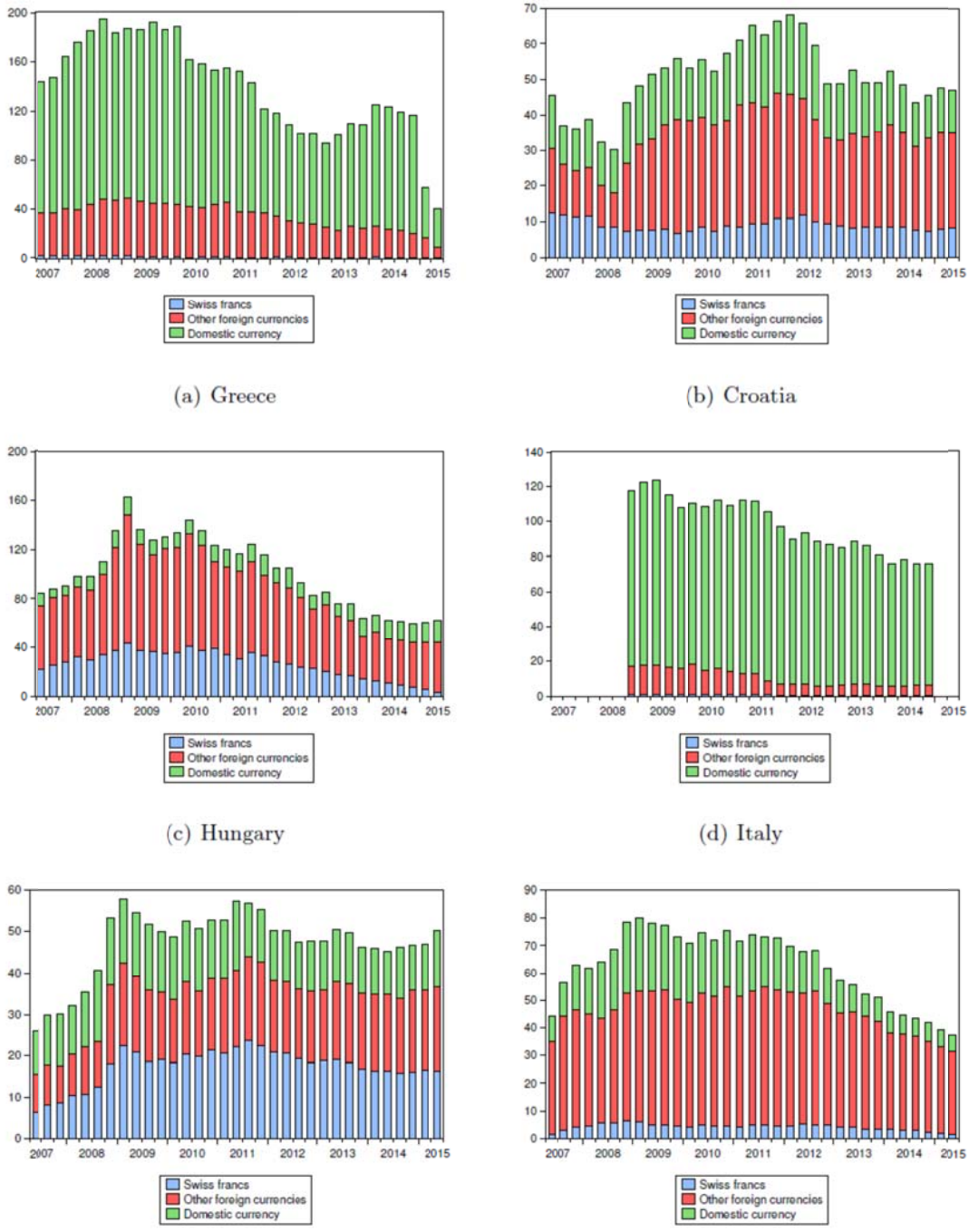
(c) Czech Republic

(d) Germany

(e) Estonia Pre Euro

(f) Estonia Post Euro

Figure 6: **Currency mix of wholesale funding in percent of GDP.**
The Figures show wholesale funding divided on Swiss francs, other foreign currencies and local currency, in percent of GDP. Wholesale funding includes cross border deposit funding, including unsecured interbank deposits, deposits from foreign non-banks and repo, but does not include issues of own securities. Source: The Swiss Franc Lending Monitor, SNB.

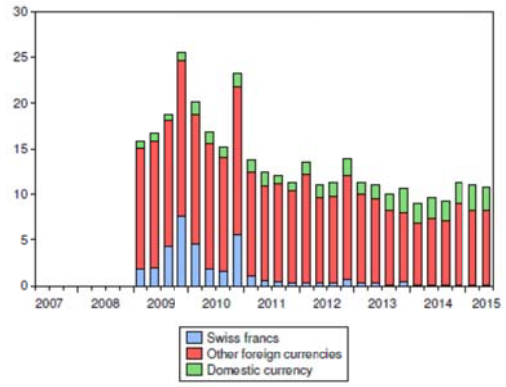


(a) Greece (b) Croatia

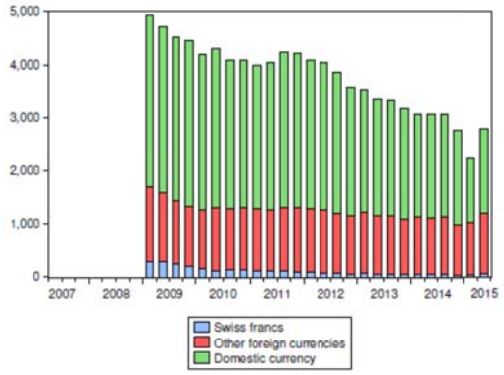
(c) Hungary (d) Italy

(e) Poland (f) Romania

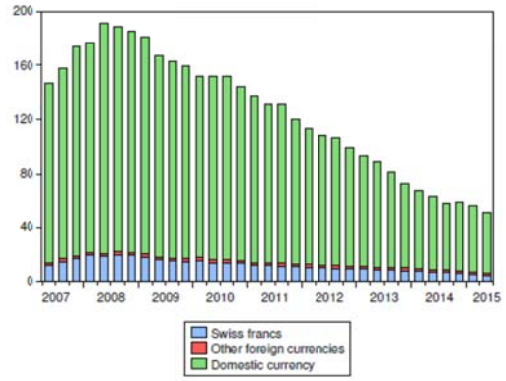
Figure 7: **Currency mix of wholesale funding in percent of GDP.**
The Figures show wholesale funding divided on Swiss francs, other foreign currencies and local currency, in percent of GDP. Wholesale funding includes cross border deposit funding, including unsecured interbank deposits, deposits from foreign non-banks and repo, but does not include issues of own securities. Source: The Swiss Franc Lending Monitor, SNB.



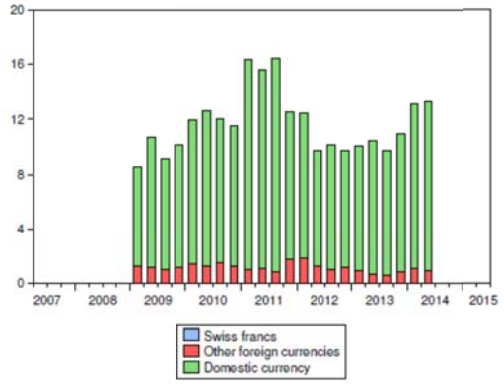
(a) Serbia



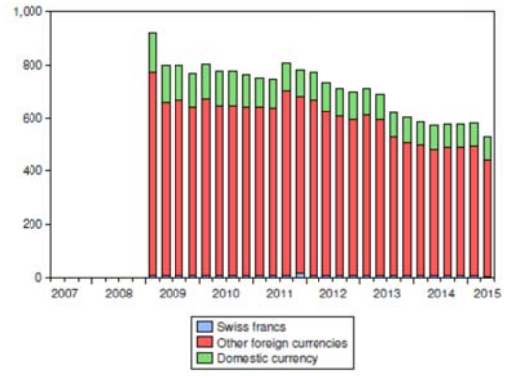
(b) Luxembourg



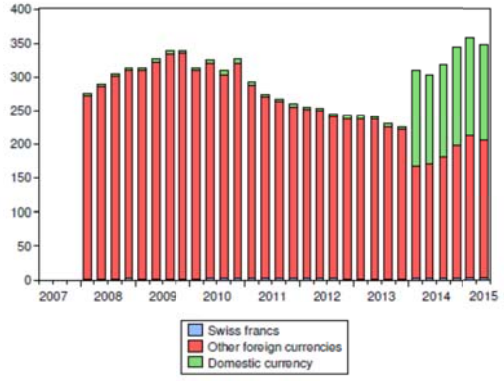
(c) Slovenia



(d) Slovakia

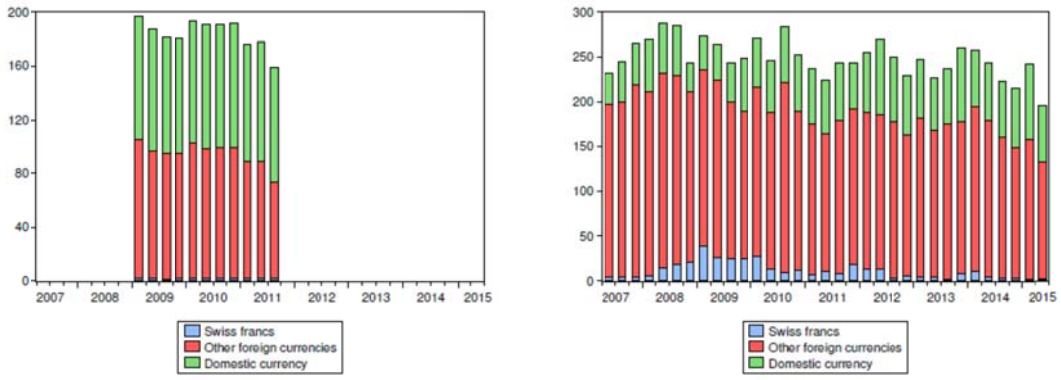


(e) United Kingdom



(f) Latvia

Figure 8: **Currency mix of wholesale funding in percent of GDP.**
The Figures show wholesale funding divided on Swiss francs, other foreign currencies and local currency, in percent of GDP. Wholesale funding includes cross border deposit funding, including unsecured interbank deposits, deposits from foreign non-banks and repo, but does not include issues of own securities. Source: The Swiss Franc Lending Monitor, SNB.



(a) France (b) Denmark

Figure 9: **Currency mix of wholesale funding in percent of GDP.**
The Figures show wholesale funding divided on Swiss francs, other foreign currencies and local currency, in percent of GDP. Wholesale funding includes cross border deposit funding, including unsecured interbank deposits, deposits from foreign non-banks and repo, but does not include issues of own securities. Source: The Swiss Franc Lending Monitor, SNB.