The impact of international swap lines on stock returns of banks in emerging markets

Alin Marius Andries[1]
Andreas M. Fischer[2]
Pinar Yesin[3]

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Abstract

This paper investigates the impact of international swap lines on stock returns using data from banks in emerging markets. The analysis first shows that swap lines by the Swiss National Bank (SNB) had a positive impact on bank stocks in Central and Eastern Europe. Next, the analysis highlights the importance of individual bank characteristics in identifying the impact effect of swap lines on bank stocks. The bank-level evidence suggests that stock prices of local and weaker capitalized banks responded strongly to SNB swap lines. This new evidence is consistent with the view that swap lines not only enhanced market liquidity but also reduced risks linked to financial stability.

Keywords: Swap lines, foreign currency loans, bank stocks, emerging markets.
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[1] Alexandru Ioan Cuza Uni. of Iasi, 22th Carol I Blvd, 700505, Iasi, Romania
telephone (+40 740) 317921
e-mail: alin.andries@uaic.ro
[2] Swiss National Bank, Postfach, 8022 Zurich, Switzerland
telephone (+41 44) 631 32 94
e-mail: andreas.fischer@snb.ch
[3] Swiss National Bank, Postfach, 8022 Zurich, Switzerland
telephone (+41 44) 631 39 69
e-mail: pinar.yesin@snb.ch

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1. Introduction

In response to the global financial crisis, international swap lines between central banks of larger economies and their counterparts in emerging market economies were introduced as a coordinated policy initiative. Empirical studies by Aizenman and Pasricha (2010), Moessner and Allen (2013), and Baba and Shim (2010) show supportive evidence that international swap lines (hereafter, swap lines) were coincident with reductions in CIP or CDS spreads. These country-level studies argue that swap lines prevented systematic risk and limited contagion during periods of market stress.

A shortcoming of the empirical literature on swap lines, however, is its narrow focus on country-level responses. Country-level data do not shed light on the channels through which swap lines impact banks, i.e., the beneficiaries of the foreign liquidity provision. The country-level studies assume that banks are homogenous.[1] We know very little how banks with different characteristics respond to swap lines.

The objective of this paper is to determine the impact of swap lines on stock returns using bank data from emerging markets. An event-study frame-

[1]For example, Goldberg et al. (2011) and Bruno and Shin (2014) acknowledge that European and Korean banks did not make equal use of liquidity provisions provided by swap lines.

work examines the response of stock prices for 47 Central and Eastern European (CEE) banks to swap lines between the Swiss National Bank (SNB) and the European Central Bank (ECB), the National Bank of Poland (NBP), and the Central Bank of Hungary (MNB). To identify the bank-specific response to swap lines, we focus on the importance of bank characteristics.[2] Information on bank characteristics includes the level of foreign currency exposure, the funding structure, the ownership type, and the capital structure.

The empirical results are presented for two levels of aggregation. We first replicate the country-level finding that stock returns of banks increased with SNB swap lines. This result is consistent with the view that swap lines with the SNB improved liquidity conditions in CEE between 2008 and 2010. In a second stage of the analysis, the importance of bank characteristics is examined. We show that the country-level approach used by the literature masks a richer set of bank-level findings.

The paper makes three contributions to the literature on unconventional measures and their impact on banks.[3] To our knowledge this is the first

[2]The experience in CEE before the financial crisis, particularly in Poland and Hungary, is overshadowed by the rapid growth of residential mortgage loans denominated in Swiss francs. The problem of currency mismatches became acute after the Swiss franc appreciated strongly during the financial crisis and many CEE banks were shutout from the interbank market for Swiss francs.

[3]Our paper is closest in spirit to Chodorow-Riech (2014) and Alfaro et al. (2014). The study by Chodorow-Riech (2014) investigates the impact of FOMC announcements on

study to examine the impact of swap lines on banks. We show stock prices of banks with a specific set of characteristics responded strongly to swap lines. This evidence, which expands the literature on liquidity provision in emerging markets, shows that stock prices of domestic and weaker capitalized banks responded strongly to SNB swap lines. [4]

A second contribution is to show that the success of swap lines is not dependent on currency choice. Swap lines are normally defined for exchange rates between the home currency and a major reserve currency (i.e., in U.S. dollar, euro, or yen). This was not the case for swap lines between the SNB and CEE central banks. These swap line agreements were between the euro and the Swiss franc.

A third contribution shows that gains from spillover effects through swap line agreements beyond national jurisdictions were limited. Only Hungarian and Polish banks benefited from swap lines between the SNB and the NBP and between the SNB and the MNB. The transmission of liquidity provision through swap lines does not follow the same cross border channels as liquidity shocks generated by other unconventional measures (i.e., quantitative

stock prices of financial firms. Similarly, the paper by Alfaro et al. (2014) examines the impact of Brazilian capital controls on stock prices of Brazilian firms.

[4]For the literature on swap lines and emerging markets see, Aizenman and Pasricha (2010), Baba and Shim (2010), and Bruno and Shin (2014).

easing). Studies by Fratzscher et al. (2013) and Bauer and Neely (2014) show that liquidity shocks arising from asset purchases in advanced countries can generate spillover effects for a range of emerging market economies.

The paper is organized as follows. Section 2 reviews the motivation for SNB swap lines with the ECB, the NBP, and the MNB. Section 3 presents the empirical methodology. Section 4 discusses the data. Section 5 presents the empirical results. Section 6 concludes.

2. SNB swap lines and CEE banks

Swiss franc and other foreign currency loans to the non-banking sector became extremely popular in CEE before the financial crisis.[5] Households and small firms increasingly borrowed in a lower-yielding foreign currency to finance their mortgages or business investments. The shaded columns in Figure 1 show the share of foreign currency loans as a percentage of total loans to the non-banking sector in select CEE countries as of 2009:Q1.[6] Figure 1 shows that at the height of the financial crisis, the majority of the outstanding loans to the non-banking sector in several CEE countries was denominated in

[5] Auer and Kraenzlin (2011), Beer et al. (2010), and Yesin (2013) discuss in detail Swiss franc lending in CEE.

[6] The date 2009:1 is the first available observation from the CHF Lending Monitor, an ongoing project of the Swiss National Bank with the aim to understand the scope of Swiss franc lending in Europe outside of Switzerland.

foreign currency. The same figure also illustrates that lending in Swiss francs was particularly popular in Hungary, Poland, Croatia, Serbia, and Romania. In the remaining countries, euro loans probably comprised the vast share of foreign currency loans.

As the financial crisis escalated so did the funding tensions in Swiss francs for many CEE banks. Most CEE banks lacked access to a Swiss franc-denominated deposit base or the domestic operations of the SNB (the SNB accepts non-domestic banks as counterparties). The interbank market for Swiss francs, which funded a large share of the CEE bank activities, was impaired. This situation of market stress reduced credit lines to CEE.

In this context, the SNB entered into temporary swap line agreements with several central banks between 2008 and 2010. Their objective was to improve the liquidity conditions for the Swiss franc in international financial markets. Table 1 lists the major swap line agreements involving the SNB. The most relevant agreements for this study are shaded grey in Table 1. These agreements were between the SNB and the ECB, the NBP, and the

MNB.[7]

The first agreement between the SNB and the ECB was a weekly swap line beginning on October 16, 2008. This swap line was euros for Swiss francs with no specified limit. The objective was to provide Swiss franc funding to banks in the euro area jurisdiction. When first announced, the swap line agreement was to last at least until January 2009.

A second swap line agreement between the SNB and the NBP, starting on November 17, 2008, was announced on November 7, 2008. The NBP joined the weekly EUR/CHF swap auctions between the SNB and the ECB. Under this agreement, the SNB provided the NBP with Swiss francs against euros, while the NBP provided Swiss francs to its counterparties and received Polish zloties. The agreement was to be in place as long as needed but at least until January 2009.

A third swap line agreement between the SNB and MNB was announced on January 28, 2009. The terms and conditions were similar to the previous agreement with the ECB and the NBP. The swap line agreements between

[7]An open issue is whether the SNB swaps were supported by ECB cooperation agreements with the NBP and MNB. These central bank cooperations were collateralized transactions that allowed the NBP and MNB to obtain euros. ECB (2014), which reviews the history of ECB swap line agreements with other central banks during financial crisis does not mention this.

the four central banks was prolongeed on January 16, 2009 and September 24, 2009. On January 18, 2010, it was communicated that the last EUR/CHF swap operation between the SNB, the ECB, the NBP, and the MNB would be on January 25, 2010.

A further swap line agreement designed to extend Swiss franc liquidity was the temporary reciprocal currency arrangements between the Federal Reserve (Fed), the ECB, the Bank of England (BoE), the Bank of Japan (BoJ), and the SNB. These agreements were announced on April 6, 2009 and were terminated on February 1, 2010. Although this swap line was not actively used by the SNB, it will be considered in the empirical analysis.

Figure 2 shows swap volumes between the euro and the Swiss franc for the three SNB swap agreements with the ECB, the NBP, and the MNP. The aggregate position is shown because the SNB did not publish separately volumes for the three central banks.[8] The figure shows a growing demand for Swiss francs with a peak volume of 40 billion CHF in May 2009. Thereafter, the volume drifts towards zero before the end of 2009.

3. The empirical setup

The analysis is conducted at two levels of aggregation. The first level begins

[8]CHF volume figures are not published by the ECB, the NBP, and the MNB.

with the country-level regressions used by Aizenman and Pasricha (2010) and Bruno and Shin (2014). The regression is used to test the hypothesis that swap lines improve liquidity conditions and this improvement is reflected in higher stock prices for banks:

$$\Delta p_{ijt} = \beta_1 SWAP_{jt}^{SNB|X} + other_t + \nu_j + \mu_t + \epsilon_{ijt}, \tag{1}$$

where Δp_{ijt} denotes the change in the ln stock price of a CEE bank i in country j at time t. The dummy variable, $SWAP_{jt}^{SNB|X}$, is +1 for the period when SNB swap lines with country X are active and 0 otherwise.[9] Because the SNB was involved in several swap line agreements, we are also interested in determining their impact on stock prices of CEE banks. The following swap line dummies are considered: SNB-ECB swap line, $SWAP_{jt}^{SNB|ECB}$; SNB-NBP swap line, $SWAP_{jt}^{SNB|NBP}$; SNB-MNB swapline, $SWAP_{jt}^{SNB|MNB}$; joint dummy NBP and MNB, $SWAP_{jt}^{SNB|CEE}$; the multilateral swap line between the Fed, the BoJ, the ECB, the BoE, and the SNB in USD, $SWAP_{jt}^{SNB|MULT1}$; and the multilateral swap line between the SNB, the ECB, the Fed, and the BoE in reciprocal currencies, $SWAP_{jt}^{SNB|MULT2}$. The periods are defined by their ac-

[9] Our variable of interest, $SWAP_{jt}^{SNB|X}$, is the interaction term (Date*Swap) used in Aizenman and Pasricha (2010) and Bruno and Shin (2014). Because the SNB was engaged in several (overlapping) swap line agreements, we focus on the interaction term and not on the date and country terms.

tive period listed in Table 1. The variable, $other_t$, captures (macroeconomic) control variables. These controls include the VIX uncertainty variable in t, the change in the ln EUR/CHF exchange rate in t, and the change in the ln stock market index for European banks in t. The regression equation also includes fixed (country j) and time (quarterly t) effects.

Our variable of interest is $SWAP_{jt}^{SNB|X}$ with the prior $\beta_1 > 0$. In other words, stock prices of CEE banks respond positively to news of a swap line agreement. A first test is to determine which swap lines mattered. Because central banks were concerned about stigma effects and published only aggregate swap volumes at best, the market was unable to determine which banks made use of swap lines. This forces us to define periods of swap line agreements with a dummy. This practice has been used in Aizenman and Pasricha (2010), Moessner and Allen (2013), and others. Thus in our analysis in section 5, a response effect of swap lines on bank stock prices cannot be interpreted as evidence that banks made use of the liquidity provisions. Rather the bank's stock price increased on the information that it had access to liquidity provisions. Hence, the timing of the swap dummies needs to be interpreted as defining periods of liquidity access when financial markets were under stress and not as a volume effect.

The evidence in Aizenman and Pasricha (2010), Moessner and Allen (2013), Baba and Shim (2010), Bruno and Shin (2014) and others show that CDS or interest rate spreads are reduced when swap dummies are interacted with country dummies for the beneficiary country in multi-country panel regressions. The key assumption is that banks in the beneficiary country respond uniformly to swap lines. Our objective is to relax this equality assumption and to allow for structural features of CEE banks. Below four propositions that condition on bank characteristics are discussed in terms of their stock price responses to news of a swap line.

Proposition # 1: *Banks with high levels of foreign currency loans benefit more from swap lines than do banks with low levels of foreign currency loans.*

The assumption is that banks with (long-term) foreign denominated assets are unable to refinance their (short-term) foreign currency liabilities. Because many financial markets for foreign currency (i.e., Libor, national interbank market) were impaired during the financial crisis, swap lines served the function of liquidity provision. Therefore, we expect stock prices of banks with high levels of foreign currency loans to respond positively to the introduction of swap lines.

Proposition # 2: *Banks engaged in foreign currency loans with a high deposit base in local currency are reliant on swap lines.*

This proposition says that a bank's funding structure matters. Under the assumption of no currency mismatches, banks with a high deposit base are better sheltered from liquidity shocks in the money market than banks reliant on the interbank market for there funding needs. However, the opposite holds if domestic deposits are in local currency and the bank's loans are in a foreign currency. In this case, the bank's currency mismatch is augmented by a duration mismatch. Under this proposition that swap lines serve the function of liquidity provision, stock prices of banks with a high deposit base in domestic currency should respond positively to the introduction of a swap line.

Proposition # 3: *Foreign owned banks are less reliant on swap lines.*

This proposition is consistent with Bruno and Shin (2014). The proposition says that foreign owned banks already enjoy access to secure foreign currency lines through their parent bank. This means stock prices of domestically owned banks should respond the strongest to the timing of swap lines. The country response of bank stocks depends on the market structure of bank ownership and their interconnectedness with foreign parent banks.

Proposition # 4: *Banks with a weak capital structure are reliant on swap lines.*

Swap lines act as a lifeline in that they allow (distressed) banks that suffer from counterparty risk time to find new (foreign denominated) liquidity. Banks with a higher capital base should be less reliant on swap lines. Here, we are saying that the swap line could take on a financial stability function in that they are providing liquidity for weakly capitalized banks.

To test these four propositions at the bank level, the baseline specification defined by equation (1) is extended to include information for bank i. The bank-level regression equation takes the following form:

$$\Delta p_{ijt} = \beta_1 SWAP_{jt}^{SNB|X} + \beta_2 BANK_{ijt}^{char} + \beta_3 BANK_{ijt}^{char} * SWAP_{jt}^{SNB|X} \quad (2)$$
$$+other_t + \nu_j + \mu_t + \epsilon_{ijt},$$

The variable, $BANK_{ijt}^{char}$, captures bank specific information for the CEE region: information on the bank's foreign currency exposure, funding structure, ownership type, and capital structure. Our test becomes the interaction term between the swap line dummy and bank specific information, $SWAP_{jt}^{SNB|X} * BANK_{ijt}^{char}$. If the interaction term is significant and positive, then this statistical evidence is consistent with the view that individual banks with particular characteristics benefitted from swap lines more than the country average. Such evidence also suggests that banks did not respond uniformly to signals of liquidity provision.

4. Data

The dataset comprises balance sheet information for 47 commercial banks operating in 15 CEE countries from January 3, 2005 to December 31, 2012.[10] The data set is constructed in the following manner. BankScope collects data on 462 commercial banks from CEE in 2012. From the 462 banks, only 92 have detailed information for at least 5 years and are publicly traded. Next, hand-collected information on FX risk for each bank for each year from the bank's annual reports and financial statements is available for 47 banks. Of these 47 banks, 18 are local (domestically owned) banks and 29 are foreign owned banks.[11] Appendix 1 reports the list of the banks included in our sample.

We group bank characteristics into four categories: the level of foreign currency exposure, the funding structure, ownership type (i.e., foreign or

[10]The countries are Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Hungary, Latvia, Lithuania, Macedonia, Montenegro, Poland, Romania, Serbia, Slovakia, Slovenia, and Ukraine.

[11]As in Claessens and van Horen (2014), we classify banks into foreign and local banks depending on whether 50% or more of the bank's stocks are owned by foreigners or by central, local governments or domestic private actors. Across CEE countries, foreign ownership in the banking sector has grown dramatically in the recent decade, and by 2008, foreign banks controlled around 80% of the assets in the regions banking industry. Western banks such as Raiffeisen Bank International, Erste Bank, UniCredit, Intesa, KBC, or regional banks such as OTP and NLB, are a dominant force in CEE (EIB, 2013). In our sample, 18 banks are subsidiaries of an International Banking Group with a large exposure to a region (at least 5 subsidiaries in CEE region).

domestic control), and the capital structure. Four measures of FX risk are used to test proposition 1: the share of assets in CHF measured as the ratio of assets in CHF to total assets; the share of assets in foreign currencies measured as the ratio of total assets in foreign currencies to total assets; the net position in CHF measured as the ratio of assets in CHF minus liabilities in CHF to total assets; and the net position in foreign currencies measured as the ratio of total assets in foreign currencies minus total liabilities in foreign currencies to total assets.

The second bank characteristic used to test proposition 2 considers the bank's funding structure. Following Demirguc-Kunt and Huizinga (2010), Ivashina and Scharfstein (2010), Altunbas et al. (2011) and Beltratti and Stulz (2012), the measure of funding structure is defined as total customer deposits divided by loans.

The third bank characteristic used to test proposition 3 is foreign ownership and international connectedness. Foreign ownership is defined as a dummy variable to be +1 if 50% or more of banks stocks are owned by foreigners (Claessens and van Horen, 2014), otherwise 0. international connectedness is defined by membership in a banking group. It is a dummy variable +1 if the bank is a subsidiary of an international banking group

with at least 5 subsidiaries in the CEE region, otherwise 0. This dummy measures the role of international connectedness without an explicit structure for ownership type.

The fourth bank characteristic to test proposition 4 assesses the capital structure of banks. As in Demirguc-Kunt et al. (2013), two measures of capital structure are used. the first variable is $CAP1_{ijt}$, which is the total capital ratio (the risk-adjusted regulatory capital ratio) calculated according to Basel rules as the sum of Tier 1 and Tier 2 capital divided by risk-adjusted assets and off-balance sheet exposures. The second variable is $CAP2_{ijt}$, which is defined as Tier 1 Ratio calculated as Tier 1 divided by risk-adjusted assets and off-balance sheet exposures.[12]

To isolate the impact of international swap lines on stock returns of CEE banks, three control variables are considered. The first variable is the VIX index of implied volatility in S&P500 index options. The VIX index reflects aggregate financial market volatility, as well as the price of risk of market volatility, see Adrian and Shin (2010). Higher market uncertainty should be negatively correlated with the return in bank stocks. The second control variable is the one-day return of the EUR/CHF exchange rate. A deprecia-

[12]Tier 1 capital comprises shareholder funds and perpetual, noncumulative preference shares.

tion in the Swiss franc should help support stock prices. The third control variable is the STOXX Europe 600 Banks index return. The coefficient of this variable is expected to be positively correlated with the return of share prices for individual banks. Appendix 2 reports the definitions and sources of all variables and Appendix 3 Panel B reports the descriptive statistics of variables used in our analysis.

5. Empirical Results

This section presents empirical results on the stock price response of CEE banks to swap line agreements. The results for two levels of aggregation are presented. The first subsection documents country-level responses to swap lines. The second subsection records bank-level responses to swap lines.

The sample is from January 1, 2005 to December 31, 2012. All regressions include the VIX uncertainty variable, the change in the ln EUR/CHF exchange rate, and the change in the ln European-wide banking stock index as controls. In addition, country and time effects are included in all regressions. The standard errors in all regressions control for country cluster effects.

The estimated coefficients of the control variables are consistent with their priors. The coefficient of the VIX variable is negative and highly significant.

In other words, bank stock prices increase with lower uncertainty. Similarly, the coefficient of the change in the *ln* EUR/CHF exchange rate is positive and significant. This is also consistent with the prior that a weaker Swiss franc is coincident with an increase in bank stock prices that are exposed to currency risk. The coefficient of the change in the *ln* European bank index is positive and significant in all regressions. This result says that there is strong co-movement between stock prices of European and CEE banks.

5.1 Country-level responses to SNB swap lines

The country-level responses to SNB swap lines yield three emprical findings. First, stock prices of Polish and Hungarian banks responded positively to SNB swap lines with the NBP and the MNB. This finding extends the country-level results of Bruno and Shin (2014) and others using CDS and interest rate spreads for a new asset class, namely stock prices. Second, the swap line between the SNB and the ECB had no impact for CEE banks in the euro area. This result highlights the fact that other countries in the euro area, i.e., Austria and Italy, had possibly a larger demand for Swiss francs than the CEE countries in the euro area, i.e., Slovenia and the Slovakia. Third, multilateral swap lines between the SNB and major central banks had no impact on stock prices of CEE banks. In other words, CEE banks

only benefitted from swap lines if their country's central bank had a swap line agreement with the SNB. This result suggests that CEE financial markets were highly segmented during periods of market stress and gains from spillover effects through swap line agreements beyond national jurisdictions were limited.

Table 2 presents regressions for equation 1 with four different dummy variables proxying different swap line agreements. Column 1 shows the (joint) swap dummy for Poland and Hungary, $SWAP_{jt}^{SNB|CEE}$, that captures periods when the SNB-NBP and the SNB-MNB swap lines were active. The coefficient of the swap line agreements is 0.0023. This coefficient says that stock prices of Polish and Hungarian banks increased on average 0.23% more than the CEE average during the period when the swap lines were active. The dummy, $SWAP_{jt}^{SNB|CEE}$, is statistically significant.

The dummy proxying the SNB-ECB swap line, $SWAP_{jt}^{SNB|ECB}$, is shown in column 2 of Table 2. The coefficient of the dummy is negative and significant only at the 10% level. This result says that stock returns of CEE banks in the ECB jurisdiction (i.e., Slovenia and Slovakia) did not benefit from liquidity provisions in Swiss francs. This result is possibly explained by the fact that CEE countries in the euro area have relatively small volumes

of Swiss franc denominated loans compared to Poland and Hungary.

Columns 3 and 4 test the Hungarian and Polish swap line agreements separately. They show that both dummy variables are positive and statistically significant. The coefficients are 0.0029 for Hungary and 0.0020 for Poland. This response effect for swap lines is roughly ten times larger than the response effect for VIX uncertainty.

Next, results from robustness tests of the joint dummy for SNB-MNB and SNB-NBP swap lines, $SWAP_{jt}^{SNB|CEE}$, are shown in Table 3. The coefficient of the variable of interest, $SWAP_{jt}^{SNB|CEE}$, is stable and significant for different samples. For comparative purposes, Column 1 presents the regression from the previous Table for the full sample. Column 2 shows there is no change in the coefficient after the Lehman shock. Similarly, the regression for the shortened sample covering the Lehman shock to the Euro crisis in May 2010 shows that the coefficient for $SWAP_{jt}^{SNB|CEE}$ remains stable.

Table 4 repeats the same exercise for different sample periods but now separates the $SWAP_{jt}^{SNB|CEE}$ dummy into the SNB-NBP swap line, $SWAP_{jt}^{SNB|NBP}$, and the SNB-MNB swap line, $SWAP_{jt}^{SNB|MNB}$. These regressions show that Polish and Hungarian banks benefitted from swap lines with the SNB. Although the empirical results suggest that Hungarian banks responded more

strongly to swap lines than Polish banks, this result needs to be interpreted with caution. The number of Hungarian banks (i.e., 2 banks) in our sample is considerably smaller than the number of Polish banks (10 banks). Because of this difference in the number of banks, it is our preference to work with $SWAP_{jt}^{SNB|CEE}$ rather than the individual country dummies for the SNB-MNB and SNB-NBP swap lines.

Next, we test the robustness of $SWAP_{jt}^{SNB|CEE}$ against other SNB swap lines with major central banks. Table 5 shows regressions with $SWAP_{jt}^{SNB|CEE}$ along with $SWAP_{jt}^{SNB|ECB}$ in EUR/CHF, $SWAP_{jt}^{SNB|MULT1}$ in USD/CHF, and $SWAP_{jt}^{SNB|MULT2}$ in various currencies. The regressions show that $SWAP_{jt}^{SNB|CEE}$ remains positive and significant, whereas the coefficients of the two multilateral swap lines are much smaller and in two cases negative. Further, the statistical significance is not established. We interpret these country-level results as follows: only the SNB-MNB and the SNB-NBP swap lines mattered for CEE banks.

In the next subsection, the specification in column 1 in Table 2 is treated as the baseline. To test the four propositions outlined in section 3, bank specific information together with its interaction with the swap dummy is added to the baseline specification.

5.2 Bank-level responses to SNB swap lines

This subsection presents evidence that the stock price of Hungarian and Polish banks with specific characteristics responded more strongly than the average to a swap line agreement defined by $SWAP_{jt}^{SNB|CEE}$. The bank characteristics are motivated by the four propositions discussed in section 3. They include information on the bank's foreign currency exposure, funding structure, ownership type, and capital structure. The evidence shows that ownership type and capital structure matter.

Table 6 presents regressions that capture information on CEE banks's currency exposure. Column 1 records information on the bank's share of CHF assets to total assets, whereas column 2 considers foreign assets to total assets. Columns 3 and 4 consider their respective net positions. The results in three out of four cases show that stock prices of CEE banks with a high foreign currency exposure responded negatively to swap line agreements. The four measures capturing foreign currency exposure are however always statistically insignificant.

Next, the interaction term of foreign currency exposure with $SWAP_{jt}^{SNB|CEE}$ is considered. Here, total foreign currency assets to total assets shown in column 2 is of interest. The coefficient of the interaction term is 0.0013 and

statistically significant. This says that the stock price of Hungarian and Polish banks with a high foreign currency exposure in their asset position responded positively to swap line agreements. Because of the mixed results for different measures of currency exposure, we interpret the evidence in Table 6 as being weakly consistent (at best) with proposition 1.

Table 7 presents information on the stock price response to information on a bank's funding structure. Funding structure is proxied by the ratio of customer deposits to total loans. Proposition 2 says that the stock price of banks with a high level of costumer deposits in domestic currency will respond positively to a swap line agreement. The ratio of customer deposits to total loans is negative and close to zero. The interaction term with the swap line agreement however is positive with a coefficient of 0.0001. This result says that stock prices of Hungarian and Polish banks with a funding structure that is highly reliant on costumer deposits reacted positively to news of a swap line agreement. Although the funding structure of customer deposits is statistically significant, the response effect is small.

Regressions that test the importance of ownership structure are presented in Table 8. The evidence is consistent with proposition 3 and Bruno and Shin (2014). The proposition says that foreign owned CEE banks enjoy access to

foreign exchange through the parent bank, whereas domestically owned banks do not. Therefore, the stock price of local banks should respond positively to news of a swap line. Column 1 introduces a foreign ownership dummy (+1 when more than 50% is foreign owned) and the interaction term to the baseline specification. The coefficient of the foreign ownership dummy is 0.0003. This says that the stock price of foreign owned CEE banks was on average higher than local CEE banks. This term however is statistically insignificant. Next, the coefficient of the foreign ownership dummy interacted with the swap dummy is -0.001 and is statistically significant. This result says that stock prices of local banks in Hungary and Poland increased more than the average Hungarian and Polish bank.

An alternative form of interconnectedness, i.e., member of banking group is considered in column 2 of Table 8. The dummy, banking group, is +1 when a bank is part of a banking group with subsidiaries in at least five countries in the CEE region. Note, this form of organizational structure does not imply foreign ownership and therefore access to foreign exchange. The results for bank group show that the coefficient of the dummy is zero and insignificant. However, the coefficient of the interaction term is 0.0004 and significant. Therefore, information from stock prices signals the view that

banking groups in CEE benefitted from SNB swap lines. We interpret this result as saying that international banking groups with a high exposure to this region are unable to provide liquidity to their subsidiaries during periods of stress.

Table 9 presents evidence in favor of the view that swap lines helped CEE banks with a weak capital structure. Column 1 adds the total capital ratio of banks (i.e., $CAP1$) and their interaction term ($SWAP_{jt}^{SNB|CEE} * CAP1$) to the baseline regression. The coefficient for $CAP1$ is zero and insignificant, yet the coefficient of the interaction term is -0.0002 and is weakly significant at the 10% level. This says that the stock price of Polish and Hungarian banks with a higher capital ratio did not increase as much as those with a low capital ratio. Next, the regression with Tier 1 capital ($CAP2$) is presented in column 2. Again, the coefficient of the capital structure term, $CAP2$, is zero and statistically insignificant. However, the interaction term, $SWAP_{jt}^{SNB|CEE} * CAP2$ is -0.0001 and statistically significant. From this evidence, we conclude that weaker capitalized banks responded more strongly to the timing of a swap line agreement.

6. Conclusions

The strong response of CEE bank stocks to swap lines suggests that this unconventional form of liquidity provision impacted a broader range of financial assets (i.e., interest rate spreads, CDS rates, or exchange rates) than has been previously examined. The analysis for bank stocks reconfirms findings in previous studies that gains from spillover effects through swap line agreements outside national jurisdictions were limited. This empirical finding reenforces the desire of emerging market economies to sign international swap lines with central banks of major currencies.

The analysis of bank stocks also allow us to go one level deeper and to determine whether swap line actions triggered asymmetric response effects at the firm level. The literature has until now assumed that financial assets respond uniformly to swap lines. The bank-level analysis suggests that the effectiveness of international swap lines is also partially dependent on the structure of a country's banking system. Stock prices of local and weakly capitalized banks responded the strongest to swap line agreements. This new evidence is consistent with the view that swap lines were not only important in providing liquidity but also took on functions linked to financial stability.

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Appendix 1: List of Eastern European Banks

Bank name	Bank code (BankScope)	Host country	Total assets (2008 – Th. EUR)	Ownership
Hypo Alpe-Adria-Bank a.d. Banja Luka	29065	Bosnia and Herzegovina	978,876.44	Foreign
Intesa Sanpaolo Banka d.d. Bosna i Hercegovina	46742	Bosnia and Herzegovina	517,200.00	Foreign
NLB Banka d.d.	45854	Bosnia and Herzegovina	405,662.35	Foreign
Sparkasse Bank dd	40547	Bosnia and Herzegovina	269,095.15	Foreign
UniCredit Bank dd	46705	Bosnia and Herzegovina	1,687,737.40	Foreign
Corporate Commercial Bank AD	15330	Bulgaria	1,090,747.80	Domestic
First Investment Bank AD	43151	Bulgaria	2,212,054.60	Domestic
Erste & Steierm%‰rkische Bank dd	31492	Croatia	6,393,708.50	Foreign
Hrvatska Postanska Bank DD	27044	Croatia	2,040,052.10	Domestic
Jadranska Banka dd	47953	Croatia	328,089.76	Domestic
Podravska Banka	47433	Croatia	387,993.32	Domestic
Privredna Banka Zagreb d.d-Privredna Banka Zagreb Group	31139	Croatia	9,927,293.80	Foreign
Zagrebacka Banka dd	33081	Croatia	14,500,759.00	Foreign
Komercni Banka	42320	Czech Republic	25,965,373.00	Foreign
FHB Mortgage Bank Plc-FHB Jelzalogbank Nyrt.	18740	Hungary	2,636,629.20	Domestic
OTP Bank Plc	44850	Hungary	35,821,287.00	Domestic
AS DNB Banka	33110	Latvia	3,179,184.50	Foreign
AB DNB Bankas	38058	Lithuania	4,092,425.00	Foreign
Siauliu Bankas	38681	Lithuania	609,742.79	Domestic
Komercijalna Banka A.D. Skopje	35919	Macedonia (FYROM)	908,878.90	Domestic
Stopanska Banka a.d. Skopje	30961	Macedonia (FYROM)	980,648.13	Foreign
Stopanska Banka AD, Bitola	45348	Macedonia (FYROM)	111,765.28	Domestic
TTK Banka AD Skopje	25280	Macedonia (FYROM)	101,506.88	Domestic
Hipotekarna Banka ad Podgorica	28971	Montenegro	74,700.00	Domestic
Bank BPH SA	31077	Poland	8,898,175.80	Foreign
Bank Handlowy w Warszawie S.A.	30746	Poland	10,322,951.00	Foreign
Bank Millennium	45307	Poland	11,427,851.00	Foreign
Bank Polska Kasa Opieki SA-Bank Pekao SA	31008	Poland	32,009,609.00	Foreign
Bank Zachodni WBK S.A.	32473	Poland	13,933,606.00	Foreign
BNP Paribas Bank Polska SA	11560	Poland	4,824,532.60	Foreign
ING Bank Slaski S.A. - Capital Group	48129	Poland	16,887,914.00	Foreign
Kredyt Bank SA	48171	Poland	9,396,294.20	Foreign
Nordea Bank Polska SA	48321	Poland	3,820,411.30	Foreign
Powszechna Kasa Oszczednosci Bank Polski SA - PKO BP SA	33088	Poland	32,663,480.00	Domestic
BRD-Groupe Societe Generale SA	36742	Romania	12,909,561.00	Foreign
Transilvania Bank-Banca Transilvania SA	44741	Romania	4,347,681.30	Domestic
AIK Banka ad Nis	16829	Serbia	953,061.25	Domestic
Komercijalna Banka A.D. Beograd	12565	Serbia	1,951,867.50	Domestic
Vseobecna Uverova Banka a.s.	35884	Slovakia	11,232,300.00	Foreign
OTP Banka Slovensko, as	38552	Slovakia	1,620,900.00	Foreign
Prima banka Slovensko a.s.	44132	Slovakia	2,715,200.00	Foreign
Sberbank Slovensko, as	42553	Slovakia	1,529,900.00	Foreign
Tatra Banka a.s.	37500	Slovakia	10,551,100.00	Foreign
Abanka Vipa dd	35837	Slovenia	3,883,000.00	Domestic
Nova Kreditna Banka Maribor d.d.	31186	Slovenia	5,489,900.00	Domestic
Joint-Stock Commercial Bank for Social Development - Ukrsotsbank	46068	Ukraine	4,607,361.40	Foreign
Raiffeisen Bank Aval	46840	Ukraine	6,314,330.10	Foreign

Appendix 2 Definition of all variables

Variable	Definition	Source
Bank performance	Daily stock return calculated as $\Delta p_{i,j,t} = \ln(P_{i,j,t} - P_{i,j,t-1})$, where $P_{i,j,t}$ denotes the daily stock price for bank i in country j for day t	Thomson Reuters
SNB-CEE	A dummy variable taking a one if the bank operates in Hungary for period 28 January 2009–25 January 2010 or in Poland for period 7 November 2008–25 January 2010	SNB press releases
SNB-ECB	A dummy variable taking a one if the bank operates in any country member of Euro zone for period 16 October 2008–25 January 2010;	SNB press releases
SNB-MNB	A dummy variable taking a one if the bank operates in Hungary for period 28 January 2009–25 January 2010;	SNB press releases
SNB-NBP	A dummy variable taking a one if the bank operates in Poland for period 7 November 2008–25 January 2010	SNB press releases
SNB-MULT1	A dummy variable taking a one if SNB has an Dollar Liquidity Swap Lines with FED or other banks (12 December 2007–1 February 2010; and May 2010 – 31 December 2012)	SNB press releases
SNB-MULT2	A dummy variable taking a one if SNB has an CHF Liquidity Swap Lines with other central banks (6 April 2009 – 1 February 2010; and 30 November 2011 – 31 December 2012)	SNB press releases
Share of assets in CHF	Assets in CHF/ Total assets	Annual Reports
Share of assets in foreign currencies	Total assets in foreign currencies/ Total assets	Annual Reports
Net position in CHF	(Assets in CHF – Liabilities in CHF)/Total assets	Annual Reports
Net position in foreign currencies	(Total assets in foreign currencies – Total liabilities in foreign currencies)/Total assets	Annual Reports
Customer deposits	Total Customer Deposits / Loans	Bureau van Dijk – BankScope
Foreign ownership	A dummy variable taking a one if 50% or more of banks' shares are owned by foreigners	Bureau van Dijk – BankScope
Member of Banking group	A dummy variable taking a one if the bank is a subsidiary of a International banking group with at least 5 subsidiaries in CEE region	Annual Reports
CAP1	Total capital Ratio	Bureau van Dijk – BankScope
CAP2	Tier 1 Ratio	Bureau van Dijk – BankScope
VIX	VIX measures market expectation of near term volatility conveyed by stock index option prices	Federal Reserve Economic Data
Exchange rate (CHF/EUR) return	Swiss franc/EUR exchange rate return	Thomson Reuters
European banking systems performance	Measured using STOXX® Europe 600 Banks index return	Thomson Reuters

Appendix 3 Summary statistics

Panel A – Stock returns of banks

Year	Daily stock return (%, average)	Annual stock return (%, average)
2005	0.0676	14.7881
2006	0.0380	7.8019
2007	0.0472	11.9458
2008	-0.2886	-68.0292
2009	0.0443	11.8574
2010	-0.0151	-4.0578
2011	-0.1029	-29.2377
2012	-0.0382	-10.8925
Total	-0.0421	-10.8691

Panel B - Descriptive statistics of variables

Variables	Obs	Mean	Std. Dev.	Min	Max
Bank performance	76139	-0.000421	0.022518	-0.095676	0.088138
Share of assets in CHF	37036	0.117977	0.134972	0.000044	0.444116
Share of assets in foreign currencies	90228	0.390658	0.226975	0.007891	0.881546
Net position in CHF	37036	0.058069	0.097853	-0.021027	0.440416
Net position in foreign currencies	91791	0.028686	0.105065	-0.359737	0.541679
Customer deposits (%)	95961	1.592592	8.127242	0.301701	155.545000
CAP1 (Total capital Ratio (%))	84489	15.031540	5.139137	8.630000	41.550000
CAP2 (Tier 1 Ratio (%))	58425	13.866860	6.170360	5.510000	41.740000
VIX	94611	21.499380	10.614510	9.890000	80.860000
Exchange rate (CHF/EUR) return	95221	-0.000010	0.007196	-0.032501	0.246332
European banking systems performance	98042	-0.000172	0.020220	-0.103924	0.174581

Figure 1: Share of foreign currency loans as a percentage of total loans in the non banking sector in Eastern Europe as of 2009:Q1.

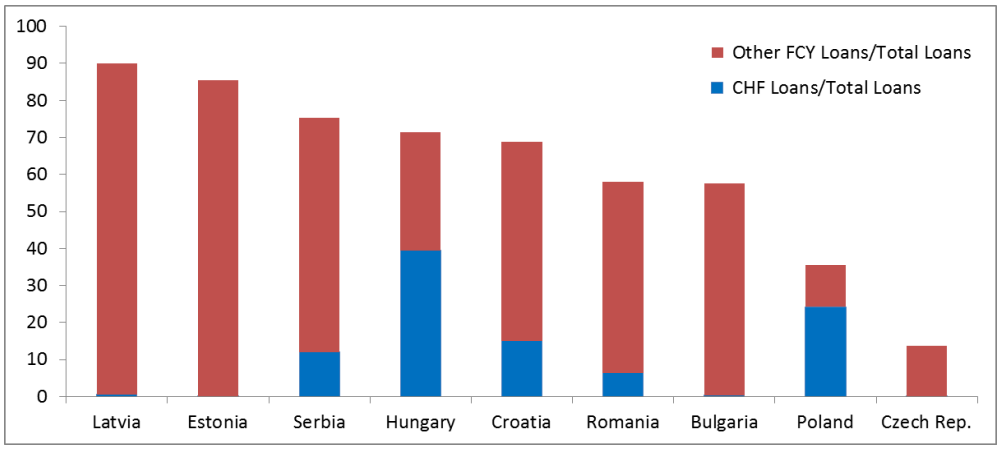
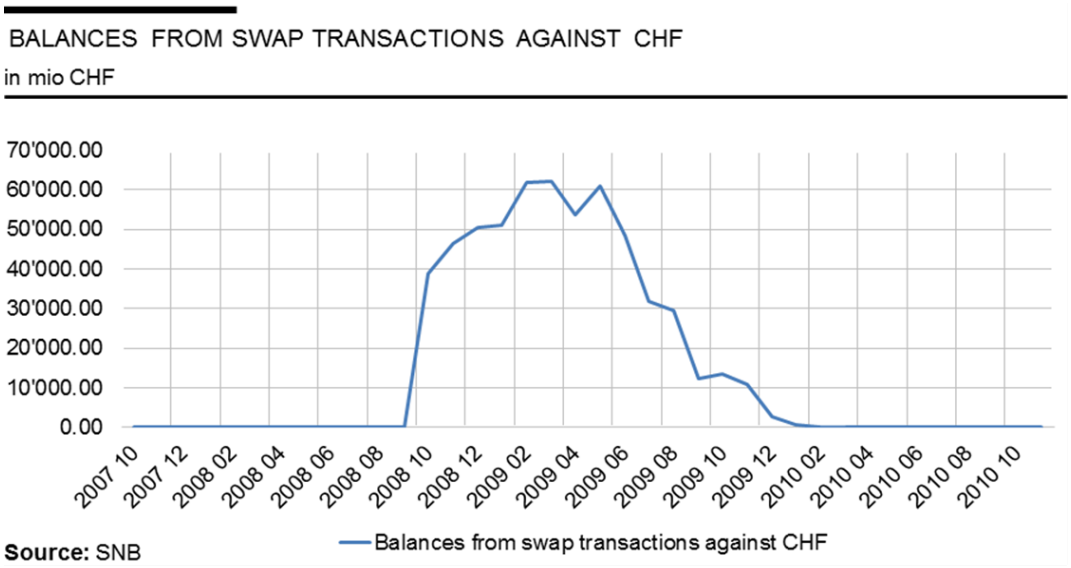


Figure 2



Source: SNB

Table 1: Timeline of Events (Central Banks' Liquidity Measures)

Date	Event	Notes	Swap line limit	Term	In place until	Dummy variable in the empirical analysis
2007						
12 December	The SNB announces USD repo auctions	The SNB announces a six-month CHF/USD swap agreement with the Federal Reserve in order to provide USD repo auctions with its counterparties.	USD 4 billion	28 days	6 months	$SWAP^{SNB|MULTI}$
2008						
11 March	The USD/CHF swap lines are increased		USD 6 billion	28 days		
2 May	The USD/CHF swap lines are increased	Also the frequency of USD repo auctions is increased to every 2 weeks.	USD 12 billion	28 days		
30 July	The SNB announces extended-term USD repo auctions		USD 12 billion	28-days or 84 days		
18 September	The SNB announces overnight USD repo auctions. USD/CHF swap lines are also increased.		USD 27 billion	Overnight, 28-days and 84 days		
26 September	The SNB announces 7 day USD repo auctions. USD/CHF swap lines are also increased.		USD 30 billion	Overnight, 7 days, 28 days and 84 days		
29 September	USD/CHF swap lines are increased	Joint announcement of the Federal Reserve, ECB, SNB, BoC, BoE, BoJ, Danmarks Nationalbank, Norges Bank, RBA, and Sveriges Riksbank.	USD 60 billion	Overnight, 7 days, 28 days and 84 days	April 30, 2009	
13 October	USD/CHF swap lines are increased to accommodate whatever quantity of USD funding is demanded.	Joint announcement of the ECB, BoE, BoJ, SNB and the Federal Reserve	No limit	7 days, 28 days and 84 days		
15 October	The SNB and ECB announce the establishment of weekly EUR/CHF swap operations.	In place as long as needed, but at least until January 2009	No pre-specified limit		January 2009	$SWAP^{SNB|ECB}$
7 November	The Swiss National Bank and Narodowy Bank Polski announce the establishment of weekly EUR/CHF swap operations.	Starting on 17 November 2008, the NBP will join the weekly EUR/CHF foreign exchange swap operations of the SNB and the Eurosystem. Under this arrangement, the SNB will provide the NBP with Swiss francs against euro, while the NBP will provide the Swiss francs to its counterparties against Polish zloty. In place as long as needed, but at least until January 2009.	No pre-specified limit	7 days Longer term transactions may be offered from time to time	January 2009	$SWAP^{SNB|NBP}$
19 December	USD repo auction schedule is announced for the first quarter of 2009	Joint announcement of the SNB, BoE, ECB, BoJ, and the Federal Reserve.	No limit	7 days, 28 days, 84 days		

Table 1: ***Continued Timeline of Events (Central Banks' Liquidity Measures)***

2009						
16 January	The SNB, the ECB and the NBP announce the continuation of EUR/CHF swap operations	The goal is to support further improvements in the short-term Swiss franc money markets	No pre-specified limit	7 days	30 April 2009	
28 January	The SNB and Magyar Nemzeti Bank announce the establishment of weekly EUR/CHF swap operations.	The SNB will provide the MNB with Swiss francs against euro.	No pre-specified limit	7 days	30 April 2009	$SWAP^{SNB|MNB}$
6 April	The Bank of England, the ECB, the US Federal Reserve, the Bank of Japan and the SNB announce swap arrangements	The new swap line mirrors the existing arrangement that enables the SNB to draw US dollars against Swiss francs. The Fed can draw Swiss franc liquidity against US dollars when needed.	CHF 40 billion		30 October 2009	$SWAP^{SNB|MULT2}$
25 June	The SNB, the ECB, the Narodowy Bank Polski and the Magyar Nemzeti Bank jointly announce the continuation of the EUR/CHF swap operations		No pre-specified limit	7 days	31 October 2009	
25 June	The temporary reciprocal currency arrangements (swap lines) between the Federal Reserve and other central banks, including the Swiss National Bank, have been extended through 1 February 2010.	Bank of England, European Central Bank, Federal Reserve System, Bank of Japan.			1 February 2010	
24 September	The SNB, the ECB, the Narodowy Bank Polski and the Magyar Nemzeti Bank jointly announce the continuation of the EUR/CHF swap operations		No pre-specified limit	7 days	31 January 2010	
2010						
18 January	The SNB, the ECB, the Narodowy Bank Polski and the Magyar Nemzeti Bank announce the discontinuation of the EUR/CHF swaps operations	Demand for liquidity provided by this type of operation has declined, and conditions in the Swiss franc funding market have improved. The last swap operation will therefore be conducted on 25 January2010. Banks domiciled in Switzerland and abroad continue to have access to Swiss franc liquidity via the Swiss franc repo system and the interbank market.				
27 January	The SNB confirms the expiration, on 1 February 2010, of its temporary reciprocal currency arrangements (swap lines) with the US Federal Reserve.	In this context, the SNB, in agreement with the Federal Reserve, the European Central Bank, the Bank of England and the Bank of Japan, will discontinue its US dollar repo operations with effect from 31 January 2010.				

Source: SNB press releases

Table 2: Estimating impact of the SNB swap on Hungarian and Polish banks

This table reports the results of regressions that examine the impact of the SNB swap on Hungarian and Polish banks. We estimate alternative versions of the following regression specification:

$$\Delta p_{i,j,t} = \beta_1 \times SWAP_{jt}^{SNB|X} + other_t + \nu_j + \mu_t + \varepsilon_{i,j,t}$$

where $\Delta p_{i,j,t}$ denotes the bank performance measured as the change in the ln share price of a CEE bank i in country j at time t; the dummy variable, $SWAP_{jt}^{SNB|X}$, is +1 for the period when the swap lines with country or group X are active and 0 otherwise and denotes one of the alternative dummy swap lines: SNB-CEE ($SWAP_{jt}^{SNB|CEE}$) – is a dummy variable taking a one if the bank operates in Hungary for period 28 January 2009–25 January 2010 or in Poland for period 7 November 2008–25 January 2010, SNB-ECB swap line ($SWAP_{jt}^{SNB|ECB}$) – is a dummy variable taking a one if the bank operates in any country member of Euro zone for period 16 October 2008–25 January 2010, SNB-MNB swap line ($SWAP_{jt}^{SNB|MNB}$) – is a dummy variable taking a one if the bank operates in Hungary for period 28 January 2009–25 January 2010, and SNB-NBP swap line ($SWAP_{jt}^{SNB|NBP}$) is a dummy variable taking a one if the bank operates in Poland for period 7 November 2008–25 January 2010; the variable $other_t$ captures (macroeconomic) control variables and include *VIX* – to control for investor sentiment and market volatility; *Exchange rate (CHF/EUR) return* – to control for movements on FX markets; *European banking systems performance* (STOXX® Europe 600 Banks index return) – to control for European banking system overall performance. We include country fixed effects ν_j and time (quarter) fixed effects μ_t in all specifications to control for omitted variables. Standard errors are reported in brackets and account for clustering at the country level. We use ***, **, and * to denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent: Bank performance	Model 1	Model 2	Model 3	Model 4
SNB-CEE	0.0023***			
	(0.00)			
SNB-ECB		-0.0009*		
		(0.00)		
SNB-MNB			0.0029***	
			(0.00)	
SNB-NBP				0.0020***
				(0.00)
VIX	-0.0002***	-0.0002***	-0.0002***	-0.0002***
	(0.00)	(0.00)	(0.00)	(0.00)
Exchange rate	0.0722***	0.0725***	0.0724***	0.0722***
(CHF/EUR) return	(0.01)	(0.01)	(0.01)	(0.01)
European banking	0.1793***	0.1791***	0.1792***	0.1792***
systems performance	(0.06)	(0.06)	(0.06)	(0.06)
Constant	0.0025***	0.0025***	0.0025***	0.0025***
	(0.00)	(0.00)	(0.00)	(0.00)
Country FE	YES	YES	YES	YES
Time (Quarter) FE	YES	YES	YES	YES
R-squared	0.0405	0.0402	0.0402	0.0404
N. of cases	72028	72028	72028	72028
Mean of dependent variable	-.0004213	-.0004213	-.0004213	-.0004213

Table 3 Robustness checks with different sample periods (Hungary and Poland together)

This table reports the results of regressions that examine the impact of the SNB swap on Hungarian and Polish banks using different sample periods. We estimate alternative versions of the following regression specification:

$$\Delta p_{i,j,t} = \beta_1 \times SWAP_{jt}^{SNB|CEE} + other_t + \nu_j + \mu_t + \varepsilon_{i,j,t}$$

where $\Delta p_{i,j,t}$ denotes the bank performance measured as the change in the ln share price of a CEE bank i in country j at time t; the dummy variable, SNB-CEE ($SWAP_{jt}^{SNB|CEE}$) – is a dummy variable taking a one if the bank operates in Hungary for period 28 January 2009–25 January 2010 or in Poland for period 7 November 2008–25 January 2010; the variable $other_t$ captures (macroeconomic) control variables and include *VIX* – to control for investor sentiment and market volatility; *Exchange rate (CHF/EUR) return* – to control for movements on FX markets; *European banking systems performance* (STOXX® Europe 600 Banks index return) – to control for European banking system overall performance. In Model 2 we report estimates for the period after 15 September 2008 - Lehman Brothers files for bankruptcy. In Model 3 we report estimates for the period after 15 September 2008 - Lehman Brothers files for bankruptcy until 23 April 2010 - Greece officially requests financial support from the euro area countries and the IMF. We include country fixed effects ν_j and time (quarter) fixed effects μ_t in all specifications to control for omitted variables; and $\varepsilon_{i,j,t}$ is the error term. Standard errors are reported in brackets and account for clustering at the country level. We use ***, **, and * to denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent: Bank performance	Model 1 Full sample	Model 2 After 15 sep 2008	Model 3 Between 15 sep 2008 and 23 apr 2010
SNB-CEE	0.0023***	0.0023***	0.0023***
	(0.00)	(0.00)	(0.00)
VIX	-0.0002***	-0.0002***	-0.0002***
	(0.00)	(0.00)	(0.00)
Exchange rate	0.0722***	0.0877***	0.2219***
(CHF/EUR) return	(0.01)	(0.03)	(0.07)
European banking	0.1793***	0.1710***	0.1914***
systems performance	(0.06)	(0.06)	(0.06)
Constant	0.0025***	0.0072***	0.0070**
	(0.00)	(0.00)	(0.00)
Country FE	YES	YES	YES
Time (Quarter) FE	YES	YES	YES
R-squared	0.0405	0.0461	0.0683
N. of cases	72028	48485	17123
Mean of dependent variable	-.0004213	-.000554	-.0004105

Table 4 Robustness checks with different sample periods (Hungary and Poland separately)

This table reports the results of regressions that examine the impact of the SNB swap on Hungarian and Polish banks using different sample periods. We estimate alternative versions of the following regression specification:

$$\Delta p_{i,j,t} = \beta_1 \times SWAP_{jt}^{SNB|X} + other_t + \nu_j + \mu_t + \varepsilon_{i,j,t}$$

where $\Delta p_{i,j,t}$ denotes the bank performance measured as the change in the ln share price of a CEE bank i in country j at time t; the dummy variable, $SWAP_{jt}^{SNB|X}$, is +1 for the period when the swap lines with country or group X are active and 0 otherwise and denotes one of the alternative dummy swap lines: SNB-MNB swap line ($SWAP_{jt}^{SNB|MNB}$) – is a dummy variable taking a one if the bank operates in Hungary for period 28 January 2009–25 January 2010, and SNB-NBP swap line ($SWAP_{jt}^{SNB|NBP}$) is a dummy variable taking a one if the bank operates in Poland for period 7 November 2008–25 January 2010. the variable $other_t$ captures (macroeconomic) control variables and include VIX – to control for investor sentiment and market volatility; Exchange rate (CHF/EUR) return – to control for movements on FX markets; European banking systems performance (STOXX® Europe 600 Banks index return) – to control for European banking system overall performance. In Model 2 we report estimates for the period after 15 September 2008 - Lehman Brothers files for bankruptcy. In Model 3 we report estimates for the period after 15 September 2008 - Lehman Brothers files for bankruptcy until 23 April 2010 - Greece officially requests financial support from the euro area countries and the IMF. We include country fixed effects ν_j and time (quarter) fixed effects μ_t in all specifications to control for omitted variables; and $\varepsilon_{i,j,t}$ is the error term. Standard errors are reported in brackets and account for clustering at the country level. We use ***, **, and * to denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent: Bank performance	Model 1 Full sample	Model 2 After 15 sep 2008	Model 3 Between 15 Sep 2008 and 23 Apr 2010
SNB-MNB	0.0034***	0.0034***	0.0035***
	(0.00)	(0.00)	(0.00)
SNB-NBP	0.0021***	0.0021***	0.0023***
	(0.00)	(0.00)	(0.00)
VIX	-0.0002***	-0.0002***	-0.0002***
	(0.00)	(0.00)	(0.00)
Exchange rate	0.0722***	0.0877***	0.2219***
(CHF/EUR) return	(0.01)	(0.03)	(0.07)
European banking	0.1792***	0.1710***	0.1914***
systems performance	(0.06)	(0.06)	(0.06)
Constant	0.0025***	0.0073***	0.0070**
	(0.00)	(0.00)	(0.00)
Country FE	YES	YES	YES
Time (Quarter) FE	YES	YES	YES
R-squared	0.0405	0.0462	0.0683
N. of cases	72028	48485	17123
Mean of dependent variable	-.0004213	-.000554	-.0004105

Table 5 Controlling for the other major central banks' swap agreements

This table reports the results of regressions that examine the impact of the SNB swap on Hungarian and Polish banks controlling for the other major central banks' swap agreements. We estimate alternative versions of the following regression specification:

$$\Delta p_{i,j,t} = \beta_1 \times SWAP_{jt}^{SNB|CEE} + \beta_2 \times SWAP_{jt}^{SNB|X} + \text{other}_t + \nu_j + \mu_t + \varepsilon_{i,j,t}$$

where $\Delta p_{i,j,t}$ denotes the bank performance measured as the change in the ln share price of a CEE bank i in country j at time t; the dummy variable, SNB-CEE ($SWAP_{jt}^{SNB|CEE}$) – is a dummy variable taking a one if the bank operates in Hungary for period 28 January 2009–25 January 2010 or in Poland for period 7 November 2008–25 January 2010; $SWAP_{jt}^{SNB|X}$, is +1 for the period when the swap lines with country or group X are active and 0 otherwise and denotes one of the alternative dummy swap lines: SNB-ECB ($SWAP_{jt}^{SNB|ECB}$) – a dummy variable taking a one if SNB has an Liquidity Swap with ECB (16 October 2008–25 January 2010); SNB-MULT1 (($SWAP_{jt}^{SNB|MULT1}$) – a dummy variable taking a one if SNB has an Dollar Liquidity Swap Lines with FED or other banks (12 December 2007–1 February 2010; and May 2010 – 31 December 2012); and SNB-MULT2 ($SWAP_{jt}^{SNB|MULT2}$) - a dummy variable taking a one if SNB has an CHF Liquidity Swap Lines with other central banks (6 April 2009 – 1 February 2010; and 30 November 2011 – 31 December 2012); the variable other_t captures (macroeconomic) control variables and include VIX – to control for investor sentiment and market volatility; Exchange rate (CHF/EUR) return – to control for movements on FX markets; European banking systems performance (STOXX® Europe 600 Banks index return) – to control for European banking system overall performance. We include country fixed effects ν_j and time (quarter) fixed effects μ_t in all specifications to control for omitted variables; and $\varepsilon_{i,j,t}$ is the error term. Standard errors are reported in brackets and account for clustering at the country level. We use ***, **, and * to denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent: Bank performance	Model 1	Model 2	Model 3	Model 4
SNB-CEE	0.0023***	0.0023***	0.0023***	0.0023***
	(0.00)	(0.00)	(0.00)	(0.00)
SNB-ECB	-0.0002	-0.0002		
	(0.00)	(0.00)		
SNB-MULT1	0.0008		0.0004	
	(0.00)		(0.00)	
SNB-MULT2	-0.0007***			-0.0004
	(0.00)			(0.00)
VIX	-0.0002***	-0.0002***	-0.0002***	-0.0002***
	(0.00)	(0.00)	(0.00)	(0.00)
Exchange rate	0.0726***	0.0722***	0.0724***	0.0722***
(CHF/EUR) return	(0.01)	(0.01)	(0.01)	(0.01)
European banking	0.1788***	0.1793***	0.1791***	0.1791***
systems performance	(0.06)	(0.06)	(0.06)	(0.06)
Constant	0.0027***	0.0025***	0.0026***	0.0026***
	(0.00)	(0.00)	(0.00)	(0.00)
Country FE	YES	YES	YES	YES
Time (Quarter) FE	YES	YES	YES	YES
R-squared	0.0405	0.0405	0.0405	0.0405
N. of cases	72028	72028	72028	72028
Mean of dependent variable	-.0004213	-.0004213	-.0004213	-.0004213

Table 6 Controlling for the level of foreign currency exposure (FX)

This table reports the results of regressions that examine the impact of the SNB swap on Hungarian and Polish banks controlling for the level of foreign currency exposure. We estimate alternative versions of the following regression specification:

$$\Delta p_{i,j,t} = \beta_1 \times SWAP_{jt}^{SNB|CEE} + \beta_2 \times FX_{i,j,t} + \beta_3 \times SWAP_{jt}^{SNB|CEE} * FX_{i,j,t} + other_t + \nu_j + \mu_t + \varepsilon_{i,j,t}$$

where $\Delta p_{i,j,t}$ denotes the bank performance measured as the change in the ln share price of a CEE bank i in country j at time t; the dummy variable, SNB-CEE ($SWAP_{jt}^{SNB|CEE}$) – is a dummy variable taking a one if the bank operates in Hungary for period 28 January 2009–25 January 2010 or in Poland for period 7 November 2008–25 January 2010; FX denotes one of the alternative measure for the level of foreign currency exposure: *Share of assets in CHF* = (Assets in CHF/ Total assets); *Share of assets in foreign currencies* = (Total assets in foreign currencies/ Total assets); *Net position in CHF* = [(Assets in CHF – Liabilities in CHF)/Total assets]; *Net position in foreign currencies* = [(Total assets in foreign currencies – Total liabilities in foreign currencies)/Total assets]; $SWAP_{jt}^{SNB|CEE} * FX_{i,j,t}$ denotes the interaction between SNB-CEE *swap variable* and *FX variables;* the variable $other_t$ captures (macroeconomic) control variables and include *VIX* – to control for investor sentiment and market volatility; *Exchange rate (CHF/EUR) return* – to control for movements on FX markets; *European banking systems performance* (STOXX® Europe 600 Banks index return) – to control for European banking system overall performance. We include country fixed effects ν_j and time (quarter) fixed effects μ_t in all specifications to control for omitted variables; and $\varepsilon_{i,j,t}$ is the error term. Standard errors are reported in brackets and account for clustering at the country level. We use ***, **, and * to denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent: Bank performance	Model 1	Model 2	Model 3	Model 4
SNB-CEE	0.0031***	0.0018***	0.0029***	0.0023***
	(0.00)	(0.00)	(0.00)	(0.00)
Share of assets in CHF	-0.0000			
	(0.00)			
SNB-CEE * Share of assets in CHF	-0.0011			
	(0.00)			
Share of assets in foreign currencies		-0.0002		
		(0.00)		
SNB-CEE * Share of assets in foreign currencies		0.0013***		
		(0.00)		
Net position in CHF			-0.0005	
			(0.00)	
SNB-CEE * Net position in CHF			-0.0001	
			(0.00)	
Net position in foreign currencies				0.0006
				(0.00)
SNB-CEE * Net position in foreign currencies				-0.0003
				(0.00)
VIX	-0.0002***	-0.0002***	-0.0002***	-0.0002***
	(0.00)	(0.00)	(0.00)	(0.00)
Exchange rate (CHF/EUR) return	0.0799***	0.0710***	0.0799***	0.0710***
	(0.01)	(0.01)	(0.01)	(0.01)
European banking systems performance	0.2688***	0.1796***	0.2688***	0.1796***
	(0.07)	(0.06)	(0.07)	(0.06)
Constant	0.0024***	0.0026***	0.0024***	0.0024***
	(0.00)	(0.00)	(0.00)	(0.00)
Country FE	YES	YES	YES	YES
Time (Quarter) FE	YES	YES	YES	YES
R-squared	0.0766	0.0401	0.0766	0.0401
N. of cases	32801	69557	32801	69557
Mean of dependent variable	-.0004213	-.0004213	-.0004213	-.0004213

Table 7 Controlling for funding structure

This table reports the results of regressions that examine the impact of the SNB swap on Hungarian and Polish banks controlling for funding structure. We estimate alternative versions of the following regression specification:

$$\Delta p_{i,j,t} = \beta_1 \times SWAP_{jt}^{SNB|CEE} + \beta_2 \times Fund\_struct_{i,j,t} + \beta_3 \times SWAP_{jt}^{SNB|CEE} * Fund\_struct_{i,j,t} + other_t + \nu_j + \mu_t + \varepsilon_{i,j,t}$$

where $\Delta p_{i,j,t}$ denotes the bank performance measured as the change in the ln share price of a CEE bank i in country j at time t; the dummy variable, SNB-CEE ($SWAP_{jt}^{SNB|CEE}$) – is a dummy variable taking a one if the bank operates in Hungary for period 28 January 2009–25 January 2010 or in Poland for period 7 November 2008–25 January 2010; $Fund\_struct$ measured using *Customer deposits* = (Total Customer Deposits / Loans); $SWAP_{jt}^{SNB|CEE} * Fund\_struct_{i,c,t}$ denotes the interaction between SNB-CEE *swap variable* and *Funding structure variables;* the variable $other_t$ captures (macroeconomic) control variables and include *VIX* – to control for investor sentiment and market volatility; *Exchange rate (CHF/EUR) return* – to control for movements on FX markets; *European banking systems performance* (STOXX® Europe 600 Banks index return) – to control for European banking system overall performance. We include country fixed effects ν_j and time (quarter) fixed effects μ_t in all specifications to control for omitted variables; and $\varepsilon_{i,j,t}$ is the error term. Standard errors are reported in brackets and account for clustering at the country level. We use ***, **, and * to denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent: Bank performance	Model 1
SNB-CEE	0.0021***
	(0.00)
Customer deposits	-0.0000***
	(0.00)
SNB-CEE * Customer deposits	0.0001***
	(0.00)
VIX	-0.0002***
	(0.00)
Exchange rate (CHF/EUR) return	0.0727***
	(0.01)
European banking systems performance	0.1794***
	(0.06)
Constant	0.0025***
	(0.00)
Country FE	YES
Time (Quarter) FE	YES
R-squared	0.0408
N. of cases	72028
Mean of dependent variable	-.0004213

Table 8 Controlling for degree of ownership structure

This table reports the results of regressions that examine the impact of the SNB swap on Hungarian and Polish banks controlling for degree of international connectedness. We estimate alternative versions of the following regression specification:

$$\Delta p_{i,j,t} = \beta_1 \times SWAP_{jt}^{SNB|CEE} + \beta_2 \times Connect_{i,j,t} + \beta_3 \times SWAP_{jt}^{SNB|CEE} * Connect_{i,j,t} + \text{other}_t + \nu_j + \mu_t + \varepsilon_{i,j,t}$$

where $\Delta p_{i,j,t}$ denotes the bank performance measured as the change in the ln share price of a CEE bank i in country j at time t; the dummy variable SNB-CEE ($SWAP_{jt}^{SNB|CEE}$) – is a dummy variable taking a one if the bank operates in Hungary for period 28 January 2009–25 January 2010 or in Poland for period 7 November 2008–25 January 2010; $Connect$ denotes one of the alternative measure for degree of international connectedness: *Foreign ownership* is a dummy variable taking a one if 50% or more of banks' shares are owned by foreigners; *Member of Banking group* is a dummy variable taking a one if the bank is a subsidiary of a International banking group with at least 5 subsidiaries in CEE region; $SWAP_{jt}^{SNB|CEE} * Connect_{i,j,t}$ denotes the interaction between SNB-CEE *swap variable* and *Degree of international connectedness variables;* the variable $other_t$ captures (macroeconomic) control variables and include *VIX* – to control for investor sentiment and market volatility; *Exchange rate (CHF/EUR) return* – to control for movements on FX markets; *European banking systems performance* (STOXX® Europe 600 Banks index return) – to control for European banking system overall performance. We include country fixed effects ν_j and time (quarter) fixed effects μ_t in all specifications to control for omitted variables; and $\varepsilon_{i,j,t}$ is the error term. Standard errors are reported in brackets and account for clustering at the country level. We use ***, **, and * to denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent: Bank performance	Model 1	Model 2
SNB-CEE	0.0030***	0.0022***
	(0.00)	(0.00)
Foreign ownership	0.0003	
	(0.00)	
SNB-CEE * Foreign ownership	-0.0010*	
	(0.00)	
Member of Banking group		0.0001
		(0.00)
SNB-CEE * Member of Banking group		0.0004**
		(0.00)
VIX	-0.0002***	-0.0002***
	(0.00)	(0.00)
Exchange rate (CHF/EUR) return	0.0722***	0.0722***
	(0.01)	(0.01)
European banking systems performance	0.1793***	0.1793***
	(0.06)	(0.06)
Constant	0.0023***	0.0025***
	(0.00)	(0.00)
Country FE	YES	YES
Time (Quarter) FE	YES	YES
R-squared	0.0405	0.0405
N. of cases	72028	72028
Mean of dependent variable	-.0004213	-.0004213

Table 9 Controlling for capital structure

This table reports the results of regressions that examine the impact of the SNB swap on Hungarian and Polish banks controlling for capital structure. We estimate alternative versions of the following regression specification:

$$\Delta p_{i,j,t} = \beta_1 \times SWAP_{jt}^{SNB|CEE} + \beta_2 \times CAP_{i,j,t} + \beta_3 \times SWAP_{jt}^{SNB|CEE} * CAP_{i,j,t} + \text{other}_t + \nu_j + \mu_t + \varepsilon_{i,j,t}$$

where $\Delta p_{i,j,t}$ denotes the bank performance measured as the change in the ln share price of a CEE bank i in country j at time t; the dummy variable SNB-CEE ($SWAP_{jt}^{SNB|CEE}$) – is a dummy variable taking a one if the bank operates in Hungary for period 28 January 2009–25 January 2010 or in Poland for period 7 November 2008–25 January 2010; CAP denotes one of the alternative capital structure measure: *CAP1* = Total capital Ratio; *CAP2* = Tier 1 Ratio;; $SWAP_{jt}^{SNB|CEE} * CAP_{i,j,t}$ denotes the interaction between SNB-CEE *swap variable* and *Capital structure variables;* the variable $other_t$ captures (macroeconomic) control variables and include *VIX* – to control for investor sentiment and market volatility; *Exchange rate (CHF/EUR) return* – to control for movements on FX markets; *European banking systems performance* (STOXX® Europe 600 Banks index return) – to control for European banking system overall performance. We include country fixed effects ν_j and time (quarter) fixed effects μ_t in all specifications to control for omitted variables; and $\varepsilon_{i,j,t}$ is the error term. Standard errors are reported in brackets and account for clustering at the country level. We use ***, **, and * to denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent: Bank performance	Model 1	Model 2
SNB-CEE	0.0045***	0.0038***
	(0.00)	(0.00)
CAP1	0.0000	
	(0.00)	
SNB-CEE * CAP1	-0.0002*	
	(0.00)	
CAP2		0.0000
		(0.00)
SNB-CEE * CAP2		-0.0001**
		(0.00)
VIX	-0.0002***	-0.0002***
	(0.00)	(0.00)
Exchange rate (CHF/EUR) return	0.0706***	0.0803***
	(0.01)	(0.02)
European banking systems performance	0.1912***	0.2311***
	(0.06)	(0.06)
Constant	0.0024***	0.0030***
	(0.00)	(0.00)
Country FE	YES	YES
Time (Quarter) FE	YES	YES
R-squared	0.0441	0.0705
N. of cases	72028	72028
Mean of dependent variable	-.0004213	-.0004213