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Did the exchange rate interventions enhance inflation in Switzerland?

Libor Židek and Magdalena Šuterová

Abstract

For nearly five years, the Swiss National Bank intervened against the Swiss franc to prevent increase of deflation pressures. An unexpected switch in monetary policy was made in January 2015, and the regime was abandoned. In this paper, the authors examine the exchange rate influence on the inflation in Switzerland, separately for the pre-crisis and the intervention period. Using autoregressive models, they quantify the extent of pass-through of an exchange rate shock to different price indices. The results suggest that the exchange rate interventions did indeed enhance the exchange rate pass-through into inflation. Despite the effect's moderate influence, the decline was not immediate. The authors additionally analysed long-term exchange rate pass-through. The examination reveals that the long-term behaviour arises rather from the intervention than from the pre-crisis period. The exchange rate effect on inflation was thus in a better accordance with theory during the intervention period. As such, currency depreciation did have a positive effect on inflation in Switzerland.

JEL C32 E31 E52

Keywords Swiss National Bank; exchange rate interventions; exchange rate pass-through; SVAR

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Introduction

During the economic slowdown in 2009, central banks in many industrialized countries supported the economies by providing more favourable monetary conditions. Their measures were intended to help reach the inflation targets. The Swiss National Bank (SNB) was no different. Nevertheless, its challenge was hardened due to the strong franc. The bank reached the zero lower bound in March 2009. These circumstances made the SNB adopt non-standard measures, which consisted of affecting the exchange rate vis-à-vis the euro. At first, the bank occasionally intervened at the foreign exchange market when it deemed necessary (SNB 2009). After more than two years, in September 2011, it set the minimum exchange rate at CHF 1.2 per euro (SNB 2011). This regime lasted till January 2015.

The aim of this paper is to evaluate the effect of Swiss National Bank's exchange rate interventions on inflation. We examine the transmission of the exchange rate shock to prices using vector autoregressive models. The extent of the exchange rate effect on inflation is often referred to as the exchange rate pass-through (ERPT). We use the Cholesky decomposition to obtain structural identification of the model, from which the ERPT is estimated via impulse response functions. We estimate the extent of the pass-through over a long-term period from 2000 to 2016. Then we divide the sample into two equal parts corresponding to the periods before and after the interventions. By estimating the model on both samples, we determine in which period the ERPT was inflationary. In addition, we compare short-run and long-run results to reveal in which period the short-run ERPT match, and thus influence, the long-run ERPT.

The paper is organized as follows. In section 1, we give account of existing literature concerning the issue of exchange rate pass-through. The economic model and the applied econometric approach are discussed in section 2. Exchange rate pass-through evaluation is then conducted in section 3. Finally, section 4 presents the conclusion of the research.

1 Theoretical background

Relationship between the exchange rate and price level is one of the classical topics in macroeconomics. Literature evaluating this relationship in Switzerland in general is scarce though, and there is no literature concerning the intervention period itself. However, there are several studies that aim to explain the impact of the exchange rate on inflation. The pass-through of exchange rate shock into prices is theoretically expected to be equal to one. That is, one-percent shock in the rate of exchange is supposed to cause a one-percent change in prices. The ERPT is then complete. However, this is not the case; the empirical pass-through is predominantly uncomplete and the studies generally seek to clarify why.

One of the first ERPT studies is Mann's (1986), who tracks the importers' and exporters' reaction to the exchange rate volatility. The author concludes that the higher the exchange rate volatility, the more they tend to adjust their profit margins rather than the prices. In other words, importers and exporters keep the final price in the market's currency and not the profit margin in their domestic currency. As a result, the exchange rate impact on prices diminishes. Krugman (1986) provides similar results. The pass-through of a shock in the exchange-rate should be more notable when the volatility is low, i.e., when the exchange rate is rather stable. In such situations, the shocks are unexpected. Therefore, the economic subjects are likely to adjust their prices to the rate of exchange they expect to remain relatively stable on the new level.

As a classic among research into the relationship between the exchange rate and inflation is regarded McCarthy's study (2000). The author considered the exchange rate to affect the prices along the distribution chain, that is, from the importer prices via producer prices to the consumer prices. Data for nine industrialized economies including Switzerland between 1976–1998 were used. He found virtually no exchange rate pass-through into inflation for Switzerland. The same approach, but with the dismissal of the

producer prices, was used by Stulz (2007). He found incomplete exchange rate pass-through into consumers' prices in Switzerland. Identical results were also obtained by Herger (2015). The studies also prove that the pass-through weakens along the distribution chain up to consumers. This is not surprising; all importers are affected by the rate of exchange. The same is not necessarily true for all other branches, though.

Explanation for the incomplete pass-through can be found in papers by Taylor (2000), Gagnon and Ihrig (2004), and Devereux (2008), who claim that the ERPT and inflation are directly proportionate. The reason is intelligible – the inflation in the 70s and 80s was managed as more central banks switched their monetary policy regimes towards inflation targeting. According to the authors, the pass-through weakened simultaneously, because economic subjects expect the central bank to maintain stable inflation. Bailliu and Bouakez (2004) conclude similarly. Firms are thus reluctant to increase prices, even in response to the exchange rate shock, worrying the loss of competitiveness. Alan Greenspan mentioned the same idea earlier, saying: “Because neither business firms nor their competitors can currently count any longer on a general inflationary tendency to validate decisions to raise their own prices, each company feels compelled to concentrate on efforts to hold down costs. [...] This contrasts with our experiences through the 1970s and 1980s, when firms apparently found it easier and more profitable to seek relief from rising nominal labour costs through price increases than through cost-reducing capital investments” (Greenspan 1999).

The studies apparently complement each other. There are three general hypotheses emerging; the first, the pass-through is larger if the exchange rate is generally stable. The second, the pass-through gradually weakens along the distribution chain. And the third, the exchange rate pass-through is weak in an economy with low inflation and low inflation expectations.

2 Empirical model

Our paper's goal is to estimate the success of exchange rate monetary policy in Switzerland. For that, we utilize the idea of exchange rate pass-through into different price aggregates. We estimate the transmission of the exchange rate shock to prices using the SVAR model. The methodology suggested by McCarthy (2000) is used, and is adjusted to fit the Swiss economy more accurately.

To begin with, we identify our model as a reduced form of the VAR system with six endogenous and one exogenous variable. The estimated residuals are then transformed into structural form using Cholesky decomposition. The basic model is set as:

$$x_t = f(OIL_t, Y_t, INR_t, EXR_t, IPI_t, PPI_t, CPI_t),$$

where OIL_t represents changes in natural logarithm of oil price, Y_t denotes production gap obtained from natural logarithm of GDP via Hodrick-Prescott filter, INR_t stands for changes in the interest rate, EXR_t is the percent change in the rate of exchange, and IPI_t, PPI_t, CPI_t are the percent changes in importer, producer and consumer price indices, respectively.

Oil price stands for external supply shock. Adding the supply shock allows the model to differentiate between volatility in the foreign currency price and the foreign commodity price. The price of Brent oil is used as it is common in Europe. The data are available from the U.S. Energy Information Administration (2017) and were transformed into changes in natural logarithm. To capture demand shock, which should naturally lead to inflation, the model contains production gap. It was obtained as a cyclical component of GDP logarithm provided by the State Secretariat for Economic Affairs (2017). First differences in three-month LIBOR are used for the interest rate variable, as 3M LIBOR is the leading indicator for the SNB's monetary policy decisions.² The model is therefore able to isolate the conventional monetary

² The Swiss National Bank's monetary policy decisions are based on the three-month LIBOR for the Swiss franc. The bank publishes the value of the 3M LIBOR, which should, in the

policy tool influence. The data are provided by the SNB's data portal (2017). Nominal rate of exchange in direct quote (CHF per EUR) was obtained from the European Central Bank (2017). We use percent changes of the variable, and bilateral exchange rate was chosen because the commitment was realized explicitly towards the euro. Nevertheless, using the nominal effective exchange rate (not in this study) provides similar results. For inflation, percent changes in the importer, producer and consumer price are incorporated into the model. These were also used by McCarthy (2000). Our approach reflects the idea of the exchange rate shock passing through the distribution chain, represented with the appropriate price indices. All three indices were provided by the Federal Statistical Office (2017).

Variable ordering is based on economic intuition. The price indices are ordered along the production chain so that cost changes can be reflected. Thus, the IPI is prior to the PPI, and these are followed by the CPI. Exchange rate always affects importers' costs; therefore, it precedes the indices. The rate of exchange is influenced via the interest rate differential, interest rate is thus prior to exchange rate. GDP precedes interest rate because the latter reacts to the situation in the economy. And finally, oil price is exogenous as the world price of oil cannot be expected to react to issues in one small economy.

Data used in this paper are quarterly. The whole period of inflation targeting in Switzerland up to now is covered, that is, 2000:1–2016:4. GDP and price indices were seasonally adjusted using the X-12-ARIMA procedure. Dickey-Fuller tests proved the presence of unit roots in all variables. To remove the unit roots, the variables were transformed as was described previously. The transformations led to stationary variables in the whole sample and in the sample 2009:1–2016:4. As for the sample 2000–2008, the interest rate changes and percent changes in the PPI were not stationary even

bank's opinion, lead to the desired rate of inflation. Nevertheless, the bank is never able to directly affect LIBOR, as it is a market rate. Thus, the published rate is complemented with a half-a-percent interval to each side, within which the bank tolerates the rate to fluctuate (SNB, 2017).

after the transformation. Nevertheless, the interest rate was stationary in levels and is used as such for the period in question. Percent changes of the PPI were tested by an additional KPSS test, which did not prove the unit root to be present. Different results can be explained by the potentiality of a structural break in the data. Moreover, the Dickey-Fuller test did not reject the null at the 0.09 significance level. For reasons given, the PPI is used with no further transformation.

Our model estimates a shock at each stage for each variable which cannot be explained by shocks in previous variables or by lagged variable itself. These shocks are used for modelling the impulse-response functions. Thus, the impulse-responses express the reaction of the variable of interest (the price index) on a shock in another variable (the rate of exchange). The exchange rate was in direct quote and in percent changes. Currency depreciation in direct quote means increase. Therefore, a unity shock in exchange rate, which defines the impulse-response function, is interpretable as a one-percent depreciation. The price indices were also used in percent changes, the model thus provides estimates of inflation growth as a response to one-percent currency depreciation. Complete exchange rate pass-through is defined as one-percent inflation growth, which is found as number one on the impulse-response function's vertical axis. The horizontal axis represents number of periods for which the function is defined. We follow the SNB's approximation of monetary policy time horizon, which is three years or twelve periods for quarterly data. The results are further supported by forecast error variance decomposition to show the importance of the rate of exchange for the prices.

Lag length test indicated one lag to be appropriate, based on the Schwarz information criterion. To keep comparability, the same lag length is used for the whole sample, as well as for the two subsamples.

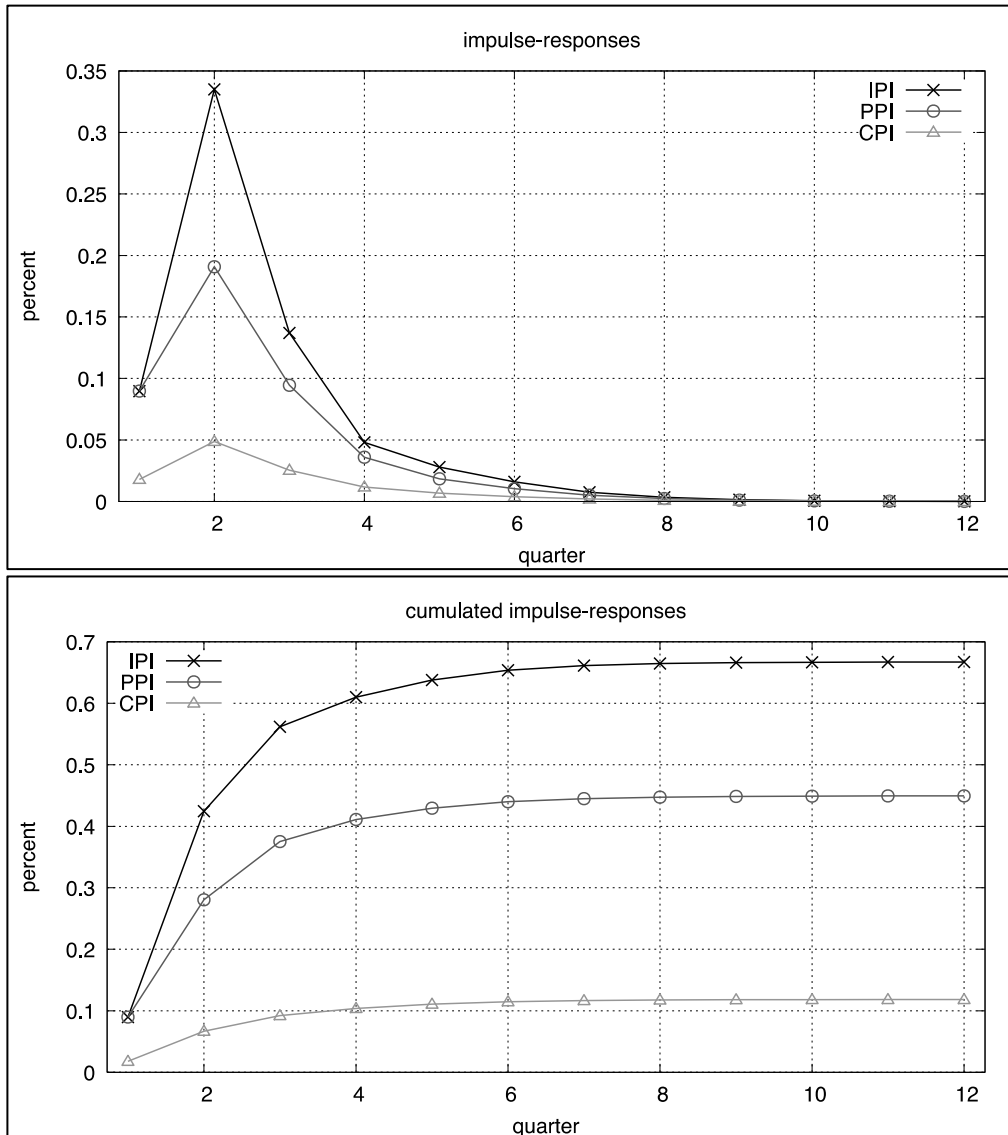
3 Evaluation of the exchange rate pass-through in Switzerland

In this chapter we perform empirical tests of the model explained in the previous section. Our model is first estimated for the whole period, i.e. 2000:1–2016:4, to obtain the long-term ERPT. We then divide our sample into equal parts, where the second part's first observation is 2009:1. Therefore, we can estimate our model for periods without and with the exchange rate interventions separately. Comparison of results allows us to see in which period the prices were affected by the rate of exchange, as well as in which period the effect was more convincing.

3.1 Exchange rate pass-through in 2000–2016

The exchange rate pass-through is, as was mentioned, first estimated for the full sample. Figure 1 shows the impulse-responses of all three price indices to a one-percent exchange rate depreciation. The lower panel of the figure shows the cumulated values of the upper panel, i.e. the total effect of the depreciation. In the long-run, the ERPT behaves in accordance with theory – it gradually weakens along the production chain and the curves show the same pattern. After approximately two years, importer prices grow by 0.67 percent, producer prices by 0.45 percent and consumer prices by 0.12 percent.

Figure 1: Price indices' impulse-responses, 2000:1–2016:4



Source: authors' own computation

With regard to the importer prices, Stulz (2007) finds slightly weaker pass-through in Switzerland for the years 1976–2004. Similarly, Campa and Goldberg (2002) estimate the ERPT for the years 1975–1999 and their results correspond to the findings of this study. McCarthy (2000) compares the pass-through into importer prices among nine industrialized economies including Switzerland between 1976 and 1998. As he points out, the ERPT in Switzerland was “surprisingly small”. All in all, we can conclude the pass-through to importer prices as incomplete. There are several interpretations

why it should be so. First, as was mentioned in the introduction section, companies want to keep their competitiveness. Therefore, in a low-inflation environment, they do not raise their prices even in response to the exchange rate shock. Another explanation for the pass-through to be incomplete is price stickiness, particularly if the prices are calculated in domestic currency. The exchange rate change effects on inflation are then nullified within producers' costs and revenues. Finally, the third reason we can account for is, as McCallum and Nelson (1998) suggest, the fact that the importers add factors of production other than just the imported goods itself. They certainly do so in case of their labour or transport. Their final prices thus do not necessarily have to be fully affected by the changes in the rate of exchange.

The pass-through into producer prices is quite strong; the producer price index response by some two thirds of the importers' response. Interestingly enough, the pass-through into producer prices does not decline as quickly and after four periods it is almost the same as pass-through of exchange rate into importer prices; apparently, the adjustment process takes longer. The pass-through into producer prices is, as well as in the case of importer prices, incomplete but still positive and thus in accordance with theory.

Although consumer price index reaction is much weaker than the reaction of preceding indices, the reaction is positive and cumulated growth of consumer inflation is 0.12 percent. The most convincing explanation of weak pass-through is simply the fact that prices directly affected by the rate of exchange account only for a small portion of the consumer basket. Bachetta and Wincoop (2002) claim that domestic firms prefer to price in domestic currency, and as a result the pass-through to consumer prices is virtually zero, which is likewise affirmed by Burstein and Gopinath (2013). The more of the final goods are domestically produced, the more likely the firm is to price in domestic currency. Such postulate is, with no doubt, acceptable and explains

the negligible pass-through in the case of the CPI; the consumer basket always contains such commodities.

Variance decomposition, as presented in Table 1, illustrates how important the shocks in each variable are for another variable to change. Unlike the impulse-response functions, the variance decomposition separates the individual contributions. Results in Table 1 are for the twelfth period – in accordance with the SNB’s three-year-long monetary policy time horizon. Note that the exchange rate is more important for the PPI than for the IPI. Nevertheless, such results do not oppose those from impulse-responses, because the indices variability matters. As the standard deviation of the PPI is smaller than that of the IPI (1.43 vs. 0.57), the total change of the PPI does not exceed the IPI despite being influenced more. As for the CPI, the direct effect of exchange rate error on the consumer prices is minimal. The IPI and the PPI combined account for some one quarter of the CPI change, though. The CPI is therefore influenced by the exchange rate through the preceding indices, which is exactly the exchange-rate pass through principle.

Table 1: Forecast error variance decomposition, 2000–2016

	ε^{GDP}	ε^{LIBOR}	$\varepsilon^{CHF/EUR}$	ε^{IPI}	ε^{PPI}	ε^{CPI}
ΔGDP	79.4	14.6	0.8	2.6	0.7	1.8
$\Delta LIBOR$	13.6	78.7	0.1	0.1	0.2	7.2
$\Delta CHF/EUR$	3.5	9.5	79.9	3.2	3.0	0.9
ΔIPI	10.9	22.1	17.0	43.8	3.7	2.4
ΔPPI	13.9	12.1	24.9	6.6	40.1	2.4
ΔCPI	5.8	3.8	5.8	10.2	13.3	61.1

Source: authors’ own computation

The full sample estimation shows the long run pass-through behaviour tendency. Later it is compared with subsamples results, to see which period affected the long run more. Therefore, results presented in this subchapter are the ‘full sample results’ mentioned later in the text.

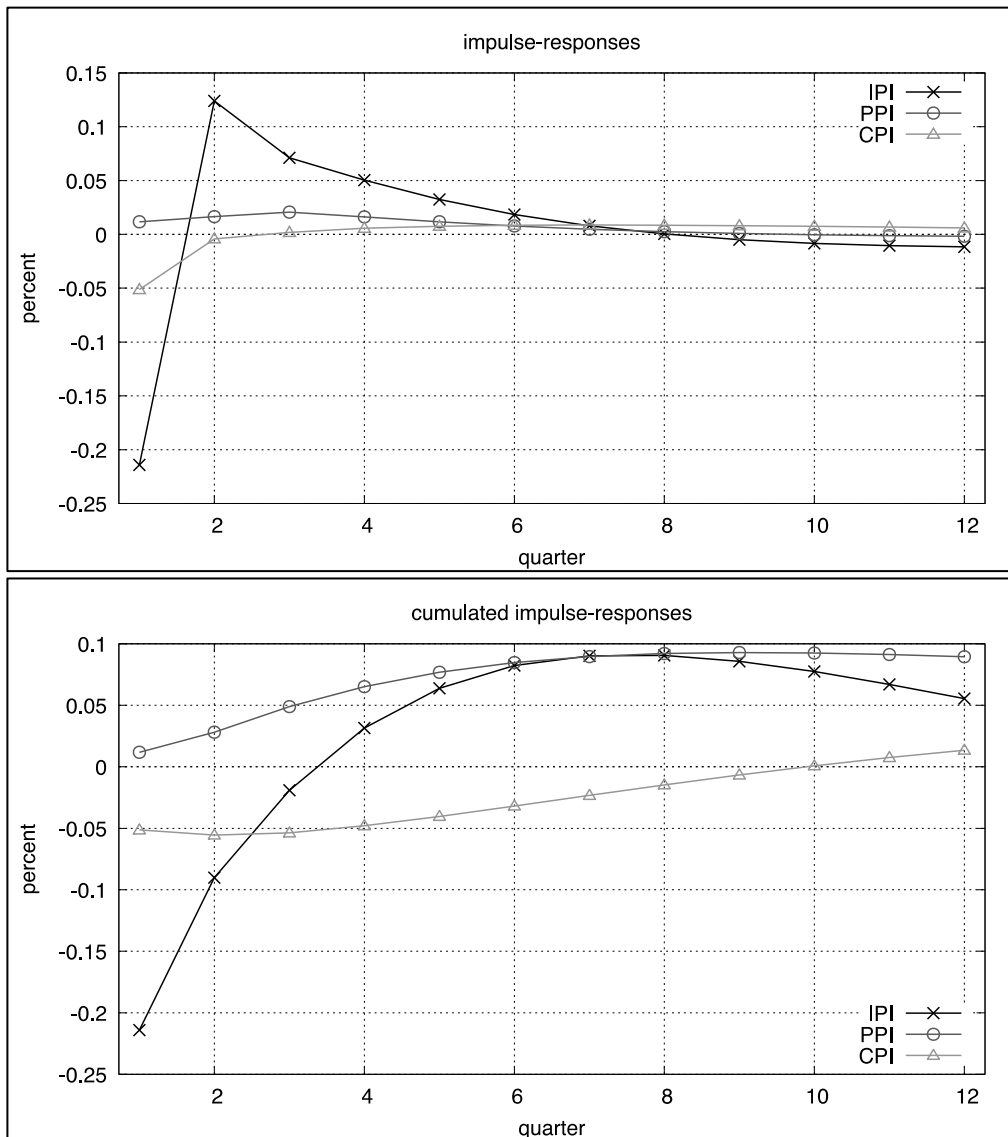
3.2 Exchange rate pass-through in 2000–2008

The first subsample provides for an estimation of the extent of pass-through before the exchange rate’s adjustment by the central bank separately. The relevant period is 2000:1–2008:4. Model and methodology are identical to the

full sample. The impulse-responses in Figure 2 were obtained from the sample 2000:1–2008:4. The results obviously differ from those for the full sample. Surprisingly, the importers price index decreased in the first period, causing the imported inflation to lower after the exchange rate depreciation. There are no other empirical studies finding negative ERPT in Switzerland for the given period. The cumulated pass-through is positive though, with peak after approximately twenty months, reaching the almost 0.1 % maximum. The pass-through is apparently much weaker than in the full sample. Herger (2015) tracks the pass-through for the years 1999–2010, his sample thus extends ours by two years, taking into account the beginning of the intervention. According to him, the pass-through reached only 0.3-percent growth in importer prices. The evidence of incomplete and weak pass-through is obvious. Moreover, the cumulated curve shows somehow hump-shaped pattern, similarly as in Stulz’s (2007) study. We conclude the pass-through into importer prices to be non-permanent.

Producers price index reaches its maximum after twenty months as well. The same values of the IPI and the PPI at the peak are worth noticing. Also, the exchange rate pass-through into the PPI being stronger than into the IPI, together with the negative ERPT into the CPI, does not follow the theoretical mechanism. All in all, the pass-through in the years 2000–2008 is weak and not in accordance with expectations.

Figure 2: Price indices' impulse-responses, 2000:1–2008:4



Source: authors' own computation

Comparison with the full sample yields clear conclusion. The ERPT before the beginning of the intervention period was minor. Stulz (2007) tested subsamples as well and found the ERPT in 1976–1993 to be stronger than in 1993–2004. Also, he found that the growth in prices remains longer in the first period. In his study, the latter period partly covers the first period in this paper. The results are consistent. We can assume that before the crisis, when the inflation was low and stable, the exchange rate shocks were considered as mere deviations from the trend. As such, they were not a reason to adjust

prices. In other words, the exchange rate could be expected to stick to the trend. Weak ERPT explained by low and stable inflation is in conformity with other authors' conclusions cited in the introduction (e.g. Gagnon and Ihrig 2004, Bailliu and Bouakez 2004 and Taylor 2000).

Forecast error variance decomposition for the period 2000–2008 is shown in Table 2. The consumers price index is influenced by other indices to a large extent. On the other hand, the exchange rate only moderately affects all variables but itself. Thus, based on both the impulse-responses and variance decomposition, the exchange rate pass through is not very convincing for the pre-crisis period.

Table 2: Forecast error variance decomposition, 2000–2008

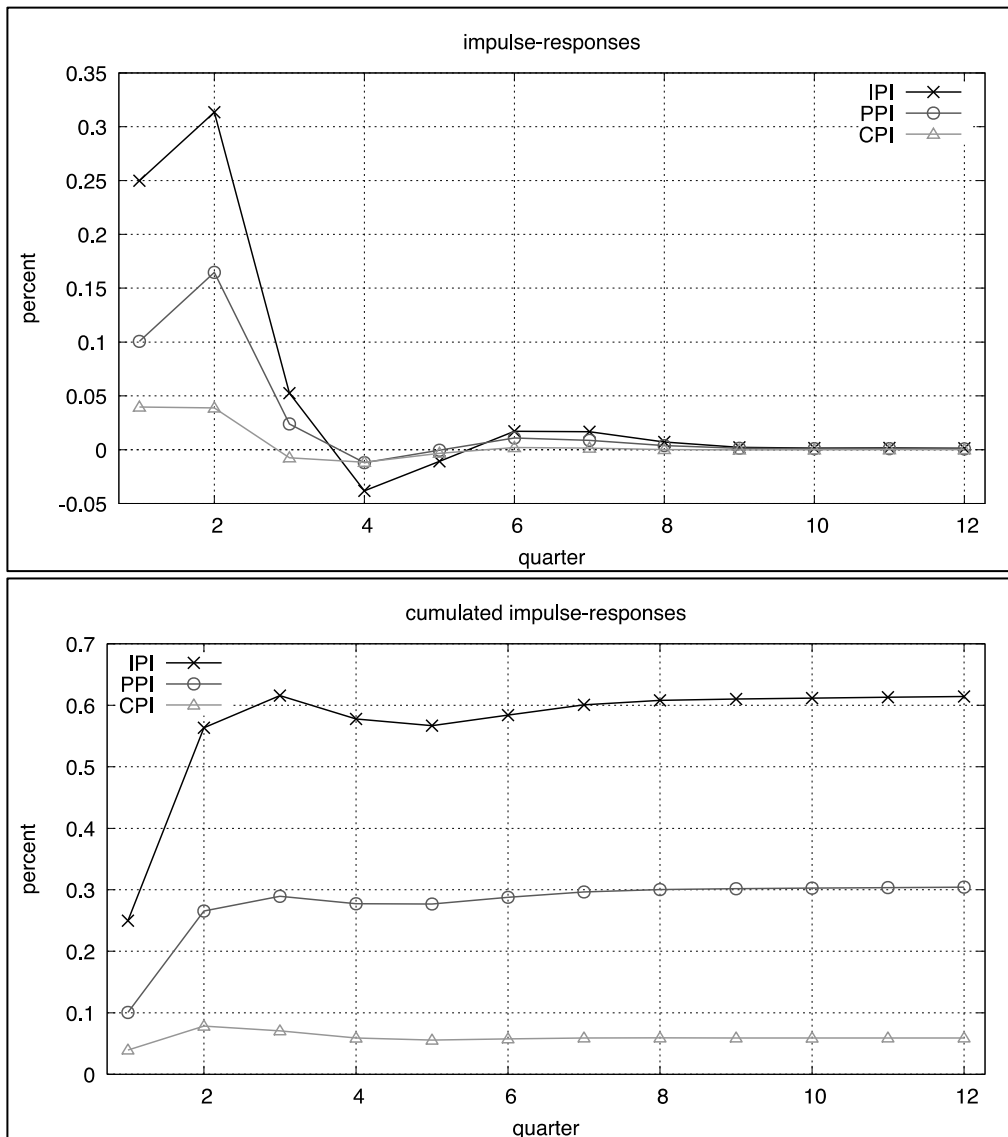
	ε^{GDP}	ε^{LIBOR}	$\varepsilon^{CHF/EUR}$	ε^{IPI}	ε^{PPI}	ε^{CPI}
ΔGDP	87.6	2.5	3.7	1.0	1.6	3.7
$LIBOR$	37.3	27.3	5.8	13.7	4.4	11.4
$\Delta CHF/EUR$	10.7	8.3	71.1	3.8	1.7	4.4
ΔIPI	15.5	4.9	11.5	60.1	4.3	3.7
ΔPPI	28.3	0.4	1.0	5.6	64.1	0.7
ΔCPI	10.7	5.1	6.6	18.5	22.1	36.9

Source: authors' own computation

3.3 Exchange rate pass-through in 2009–2016

As the last step, we estimate the exchange rate pass-through for the period when the interventions were conducted. In Figure 3 we can see impulse-responses for the time given. Similarly to the results for the full sample, and oppositely to the results for the pre-crisis period, the ERPT is positive. The curves are alike, and they exceed the values observed for the pre-crisis sample. Importers prices tend to grow immediately, reaching the cumulated growth by 0.6 percent. The pass-through also corresponds more to the full sample. After the interventions began, the ERPT into importers prices is stronger and more influential in the long run.

Figure 3: Price indices' impulse-responses, 2009:1–2016:4



Source: authors' own computation

Regarding the producers price index, they grow by some half the importer prices growth; the same pattern was observed also in the full sample. In the pre-crisis sample, even though the growth in the IPI and the PPI was equal, the maximum was only 0.1 percent. In this case, the producers price index reaction to the exchange rate depreciation increased and reached 0.3 percent. After the beginning of the interventions, the ERPT is stronger and more convincing.

Consumers prices reaction, although being the weakest, is promising in comparison with the pre-crisis sample. The positive responses are not neutralized and the overall effect of the exchange rate depreciation is slightly inflationary. Just as the preceding indices, the CPI reaction corresponds to the full sample rather than to the 2000–2008 sample. Hence, the conclusion remains – after the SNB started to adjust the rate of exchange, its influence on prices extended.

Stronger ERPT is consistent with studies mentioned above. According to Svensson (2000), the success of interventions lies in the inflation expectations. The factual exchange rate fix enhances inflationary pressures via imported goods. At the same time, the subjects expect the interventions to last only until the inflation goal is reached. However, the duration is conditioned; the interventions do not stop until the central bank reaches its inflation goal. Expecting the rate of exchange to be floating again means expecting the inflation to rise, which connects the two. And, as Mann (1986) pointed out, stable rate of exchange enhances the ERPT because the subjects assume the stability to last and they adjust their prices adequately.

As Table 3 indicates, the role of the exchange rate rose in comparison to the pre-crisis period. The results also match the full sample better, and thus the impulse-responses and variance decomposition support each other. The importers and producers prices depend on the exchange rate to a large extent. The dependence of consumers prices, the most important for the central bank, slightly rose as well. The exchange rate thus determined the CPI inflation more; it caused inflationary pressures during the interventions.

Table 3: Forecast error variance decomposition, 2000–2008

	ε^{gap}	ε^{LIBOR}	$\varepsilon^{CHF/EUR}$	ε^{IPI}	ε^{PPI}	ε^{CPI}
<i>gap</i>	71.8	20.4	1.4	1.0	0.0	5.3
$\Delta LIBOR$	12.1	80.0	1.8	0.4	0.5	5.1
$\Delta CHF/EUR$	13.2	15.3	43.4	4.2	8.6	15.3
ΔIPI	11.4	24.5	18.7	24.9	5.7	14.8
ΔPPI	7.4	31.1	19.6	9.2	21.1	11.7
ΔCPI	21.2	7.6	8.0	2.9	1.3	59.0

Source: authors' own computation

4 Conclusion

In our study, we analysed the impact of the SNB's interventions on inflation. Three expectations resulted from other authors' studies. First, the exchange rate effect should diminish along the distribution chain. It should also be stronger in an economy where both inflation and inflation expectations are higher. And third, the pass-through rather occurs when the exchange rate is generally stable.

The exchange rate pass-through was convincing in the long run. It did decrease gradually along the distribution chain, being the strongest immediately after the shock. Also, it was positive, which in terms of our model means inflation growth as a currency depreciation consequence. In the pre-crisis period, the pass-through was neither in accordance with theory, nor with the long-term behaviour. Namely the producers price index responded unexpectedly. After the beginning of the crisis and the exchange rate interventions, the ERPT changed considerably. It corresponds to the theoretical mechanism and thus was suitable to fulfil the goal of the non-standard monetary policy measure. We can find the explanation in the inflation expectations, where the factual exchange rate depreciation could act as a signal for the prices to rise.

Stronger pass-through in an environment with higher inflation was expected to occur rather in the pre-crisis period. The Swiss National Bank was successful in reaching its main goal most of the time before the crisis. After 2009, the inflation dropped and remained at historically low values; so could the inflation expectations. Nevertheless, our study shows that the shocks were more influential during the interventions. The phenomena can as well be explained by inflation expectations. More precisely, switches in the expectations caused an easier transmission of exchange rate shocks into the prices.

Generally stable exchange rate enhancing the pass-through into prices can be neither proved nor dismissed. During the intervention period, the

exchange rate was firstly very volatile and only after the commitment did the rate keep its value. Also, disagreements about the intervention in the sense of its stabilising or destabilising effect on the exchange rate exist.

Overall, the empirical results presented in our study show that the exchange rate intervention is a convenient unconventional monetary policy tool. The shock in the rate of exchange caused inflationary pressures and its role was enhanced. We therefore conclude that the measure was appropriate and well chosen.

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