Causes and consequences of long-run currency appreciation: The Swiss case

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The econometric analysis of a panel of currencies after the transition to flexible exchange rates indicates that the real exchange rate of the Swiss franc against six major currencies is trend stationary and that the elasticity of the nominal exchange rate with respect to the relative price level is close to 1. Moreover, the dollar and pound real exchange rates appear unrelated to the GDP share of the Swiss financial sector over the years 1916-2010. This confirms previous findings for the pound and dollar for a currency panel during the flexible exchange rate period, namely, that the real appreciation of the Swiss franc in the flexible exchange rate period appears to be a "real" phenomenon not related to monetary and financial developments, and it mainly creates a risk for the stock of Swiss net foreign assets.

JEL codes: N23
Key words: Swiss franc, real and nominal appreciation, deterministic trend, PPP, net foreign assets, currency mismatch

1 Introduction

The Swiss franc is usually seen as a relatively weak currency in the 19th century, up to World War I. Our analysis of the deviations from metallic parities of the Swiss franc in its first 60 years of existence correct this view to a certain extent (Baltensperger and Kugler, 2017, 180-189). According to this measure, the franc appears to be only consistently undervalued against firmly established currencies with a long history of stability (the pound and Dutch guilder), whereas we note a mixed pattern for the strength of the Swiss franc against the mark, the French franc and the Italian lira. Judged against this background, the Swiss franc was apparently a relatively "normal" currency in the 19th century, with periods of strength and weakness interchanging. In the periods after World War I, however, the Swiss franc experienced a strong real and nominal trend appreciation against both the pound and the dollar, the only two other major currencies which survived the political and economic disasters of the 20th century (Baltensperger and Kugler, 2017, 189-199). The real appreciation of the franc followed a stable deterministic trend with an appreciation rate of nearly 1% per year, presumably caused by the Balassa effect. Removing the real trend from the nominal exchange rate shows a strong equilibrium appreciation of the Swiss franc caused by inflation

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differentials, in particular after World War II. We see an acceleration of this development in the Bretton Woods years and its continuation after the transition to flexible exchange rates. A similar pattern of real and nominal appreciation of the Swiss franc also occurred against the euro and the previous currencies of the Eurozone countries, with a trend real appreciation of slightly less than half a percentage point since 1978.

This paper provides some additional results on the causes of the nominal and real appreciation of the Swiss franc during the 20th century. Instead of analyzing data on just one currency over nearly 100 years with major breaks in the international monetary system, we consider a panel of currencies after the transition to flexible exchange rates in 1971/72. Thus, we enlarge our sample of 43 years (1973-2016) by including a cross-sectional dimension covering seven currencies (the US dollar, Canadian dollar, pound, mark/euro, Swedish krona, Danish krone and yen). This analysis allows us to shed more light on an often-heard explanation for the real appreciation of the Swiss Franc, namely, the high stability orientation of Swiss monetary policy. Moreover, we briefly address the question of the importance of the Swiss financial sector for the real appreciation using the "long" time series for the pound and dollar. Finally, we take a brief look at the consequences of the real appreciation for Swiss economy.

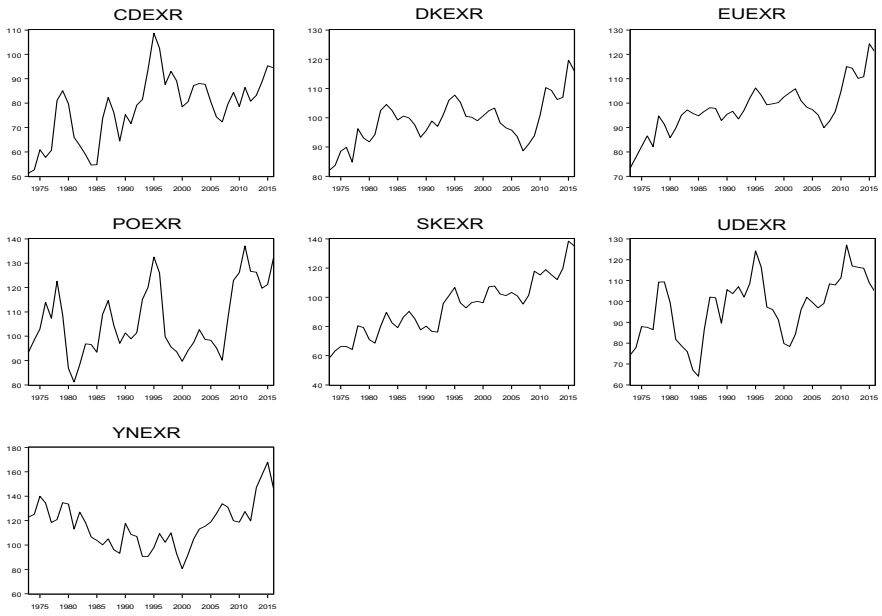
The paper is organized as follows. Section 2 presents single and panel unit root tests for the real exchange rates, including a deterministic trend. The results of deterministic cointegration estimates and tests are presented in Section 3 in a single equation as well as a panel framework. In this context, we are particularly interested in the hypothesis that the elasticity of the exchange rate with respect to the relative price level is 1 when we take into account a deterministic time trend for the real exchange rate. This provides evidence for whether the real appreciation of the Franc is a "real" phenomenon not related to the relatively high degree of monetary and price stability in Switzerland. In Section 4 we go briefly back to the one-time series dimension for the pound and the dollar and test whether the appreciation of the Swiss franc is related to the development of the importance of the Swiss financial sector. The consequences of the real appreciation of the franc for the Swiss economy are briefly considered in Section 5. Section 6 concludes.

2 Unit root tests for the real Swiss franc exchange rate

Figure 1 displays the annual development of the real exchange rate index of the Swiss franc against seven currencies (January 1999 = 100, CPI based). Before turning to the econometric analysis of these data, we have to mention that we consider the exchange rate index in the usual way, with an increase denoting an appreciation of the Swiss franc.

Figure 1 clearly shows the real appreciation trend of the Swiss franc against the Canadian dollar (CD), the Danish krone (DK), the mark/euro (EU), the pound (PO), the Swedish krona (SK) and the US dollar (UD). The yen (YN) is the only exception – in this case, there is no visible trend. The crucial question is whether this trend is a random walk with drift or a deterministic linear trend, as was shown to be the case for the dollar and the pound using annual data since 1916. In the former case, we have no long-run anchor for the real exchange rate, while in the latter case we have reversion to a linear deterministic trend. Figure 1 suggests that appreciation was particularly strong during the first two of years of the flexible exchange rate period. This is plausibly caused by a "repressed" appreciation during the late Bretton Woods years and the transition to flexible rates.

Figure 1: Real Swiss franc exchange rate, 1973-2016



Data source: https://data.snb.ch/de/topics/ziredev#!/cube/devlanda.

Table 1 reports the results of the application of the Phillips–Perron (PP) unit root test and the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) stationarity test. In most cases, we see inconclusive results – neither the unit root nor the stationarity hypothesis can be clearly rejected. For the Swedish krona, the unit root hypothesis can be rejected with a marginal significance level of 2.4%, while the stationarity hypothesis for the deviation from a deterministic trend cannot be rejected at any reasonable significance level (KPSS=0.0684). The yen provides the opposite pattern of results: we can clearly reject the stationarity hypothesis, but the unit root hypothesis seems to be well in line with the data (marginal significance level of 72.8%).

The non-rejection of both null hypotheses for most cases points to a lack of power of the statistical tests given the relatively short time series. This conjecture is confirmed by the application of a panel unit root test with all exchange rates except the yen: the W-statistic of Im, Pesaran and Shin (2003), allowing for individual unit root processes of the members of the panel, is -3.676, which clearly rejects the unit root hypothesis with a marginal significance level of 0.0001.[2]

Table 1: Unit root and stationarity test results, deterministic trend included

Exchange rate	PP test	KPSS test
Canadian dollar	-2.907	0.1220*
	(0.1705)	
Danish krone	2.558	0.1019
	(0.3007)	
Mark/euro	-3.272*	0.1180
	(.0.0999)	
Pound	-2.688	0.0872
	(0.2465)	
Swedish krona	-3.828**	0.0684
	(0.0244	
UD dollar	-2.874	0.0479
	(0.1808)	
Yen	-1.713	0.2086**
	(0.7283)	

Notes: Marginal significance in parentheses, *, **, *** indicates significance at the 10%, 5% and 1% levels, respectively.

2 The alternative Fisher ADF and PP test rejects the unit root hypothesis with a marginal significance level of 0.0005 and 0.0196, respectively.

3 Cointegration estimates of the PPP relationship with deterministic trend

In this section, we estimate the purchasing power parity (PPP) relationship for the exchange rate of the Swiss franc against the six currencies for which we found a trend stationary behavior of the real exchange rate. To this end, we regress the log of the nominal exchange rate index on the log of the relative consumer price index (CPI) (calculated as the ratio of the nominal to the real index). The results obtained by the application of fully modified ordinary least squares (FMOLS) using annual data from 1973-2016 are given in Table 2.

Table 2: Fully modified OLS cointegration estimates and tests for the Swiss franc,1973-2016

$$y_t = b_0 + b_1 x_t + b_2 t + \varepsilon_t$$

y: log exchange rate; ***x***: log relative CPI

Exchange rate	b_1	b_2	R^2	DW	Phillips-Ouliaris test	Hansen test
Canadian dollar	1.136***	0.00668	0.8304	0.6178	-3.022	0.2835
	(0.3912)	(0.00614)				
Danish krona	1.373***	0.00214	0.9483	0.6649	-2.608	0.0245
	(0.2270)	(0.00213)				
Mark/euro	1.466***	0.00636***	0.8850	0.2771	-3.489	0.6825*
	(0.2104)	(0.001629)				
Pound	0.908***	0.00727	0.8937	0.5435	-2.915	0.2175
	(0.2578)	(0.00523)				
Swedish krona	1.096***	0.01366***	0.9718	1.0992	-3.971*	0.2635
	(0.1058)	(0.00233)				
US dollar	0.7102	0.01180	0.8200	0.5846	-3.003	0.2031
	(0.5466)	(0.00895)				

Notes: Newey-West standard errors in parentheses. *, **, *** indicates significance at the 10%, 5% and 1% levels, respectively.

Again, the results are somewhat inconclusive for the single equation estimates. In most cases, the Phillips-Ouliaris test does not reject the "no cointegration" hypothesis, and neither does the Hansen (1992) parameter instability test (null hypothesis of cointegration). There are two exceptions to this pattern: for the mark/euro (Swedish krona) the null of no cointegration (cointegration) is marginally rejected at the 10% level. However, we note that the slope coefficient is relatively

close to one in all cases and statistically not significantly different from one.[3] The deterministic trend coefficient estimates are between 0.002 and 0.014, but only in two cases are they highly statistically significantly different from zero (mark/euro and Swedish krona).

Given this pattern of results, we now consider a panel cointegration framework. We assume the relative price level elasticity of the exchange rate is the same for all currencies, but allow for a different intercept and deterministic trend coefficient. The corresponding results are provided in Table 3.

Table 3: Panel PPP cointegration estimates and tests for the Swiss franc,1973-2016

$$y_t = b_0 + b_1 x_t + b_2 t + \varepsilon_t$$

y: log exchange rate; ***x***: log relative CPI

Exchange rate	b_1	b_2	**Pedroni Panel PP test**	**Phillips-Ouliaris test**
Canadian dollar	1.051***	0.00860***	-2.206**	-5.876***
	(0.0630)	(0.00158)	(0.0137)	(0.0000)
Danish krona	1.051***	0.00290*		
	(0.0630)	(0.00162)		
Mark/euro	1.051***	0.00753***		
	(0.0630)	(0.00128)		
Pound	1.051***	0.00299		
	(0.0630)	(0.00198)		
Swedish krona	1.051***	0.01393***		
	(0.0630)	(0.00181)		
US dollar	1.051***	0.00598***		
	(0.0630)	(0.00163)		

Notes: *, **, *** indicates significance at the 10%, 5% and 1% levels, respectively.

First of all, we note that the null of no cointegration is rejected at least at the 5% level by the Pedroni (1999) panel PP test as well as by the Kao (1999) panel ADF test. Therefore, the estimates should be reliable and do not suffer from a spurious regression problem. The estimated PPP coefficient is 1.05 and statistically not significantly different from the theoretically expected value of 1. The time trend estimate lies between 0.003 and 0.014 and is statistically significant with one exception. Thus, this analysis confirms our finding for the "long" time series for the pound and dollar that the real appreciation of the Swiss franc in the flexible exchange rate period appears to be a "real" trend phenomenon not related to the

3 For an outline of FMOLS estimation and cointegration and unit root tests the reader is referred to Hamilton (1994, 571-629).

different inflation experiences of the countries considered, which led to a nominal appreciation according to the PPP hypothesis.

Table 4 reports the estimates of the real appreciation coefficient b_2 under the restriction that the PPP coefficient b_1 is 1.

Table 4: Restricted OLS PPP cointegration estimates for the Swiss franc,1973-2016

$$y_t = b_0 + x_t + b_2 t + \varepsilon_t$$

y: log exchange rate; ***x***: log relative CPI

Exchange rate	b_2	R^2	**DW**
Canadian dollar	0.00936*** (0.00222)	0.8495	0.5841
Danish krona	0.00372*** (0.00134)	0.9483	0.4619
Mark/euro	0.00769*** (0.001629)	0.8281	0.4634
Pound	0.00423** (0.00215)	0.9119	0.5483
Swedish krona	0.0149*** (0.00106)	0.9740	1.043
US dollar	0.00680*** (0.002040)	0.8291	0.5671

Notes: Newey-West standard errors in parentheses. *, **, *** indicates significance at the 10%, 5% and 1% levels, respectively.

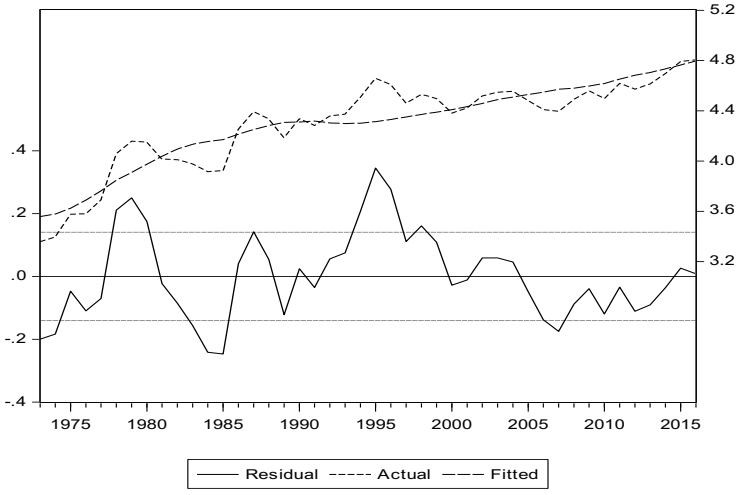
According to Table 4, all real appreciation coefficients are statistically significantly positive and are between approximately 0.004 and 0.015. Moreover, the hypothesis that all the coefficients, except that for the Swedish krona, are equal cannot be rejected at the 10% level.[4] The assumption that the coefficient b_2 is equal results in a joint estimate of 0.064 and a standard error of 0.00060. This result has an interesting implication. Taken at face value, it means that the long-run real exchange rates between the currencies of Canada, Denmark, Germany, the United Kingdom and the United States remained constant since 1973, whereas Sweden experienced a strong real trend depreciation not only against the Swiss franc, but also to a lesser extent against all other five currencies.

4 The test statistic, which is x^2 distributed with four degrees of freedom under the hypothesis of equality, is 1.727 with a marginal significance level of 0.786.

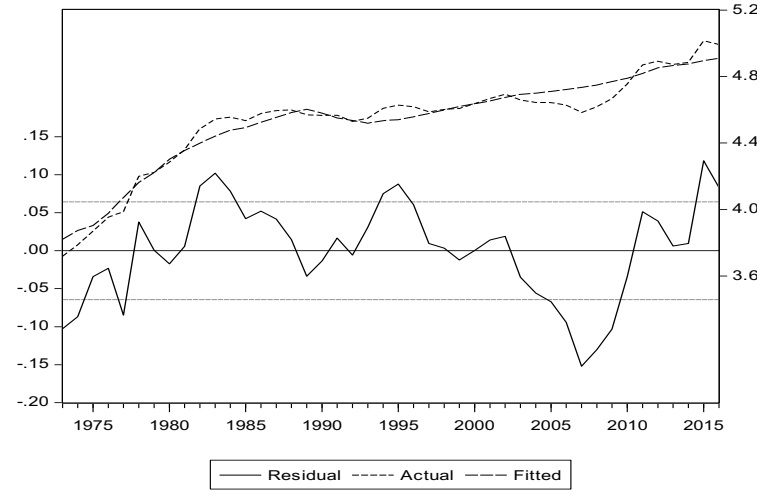
Figure 2 visualizes the PPP relationship using restricted estimates with unit elasticity. We see persistent deviations from the long-run equilibrium. However, they appear stationary (to the eye and the econometric tests). Indeed, the AR(1) coefficient of the regression residual lies between 0.7 and 0.8 and is clearly below 1.

Figure 2: Fitted values and residuals from trend-corrected PPP model, Swiss Franc, 1971-2016

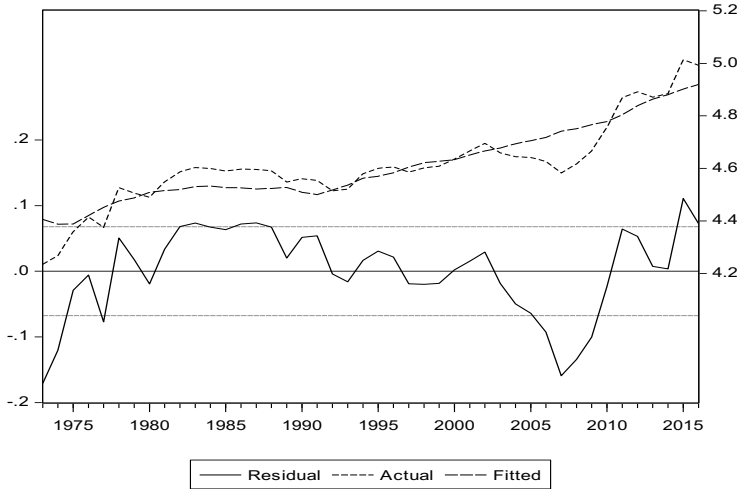
Canadian dollar



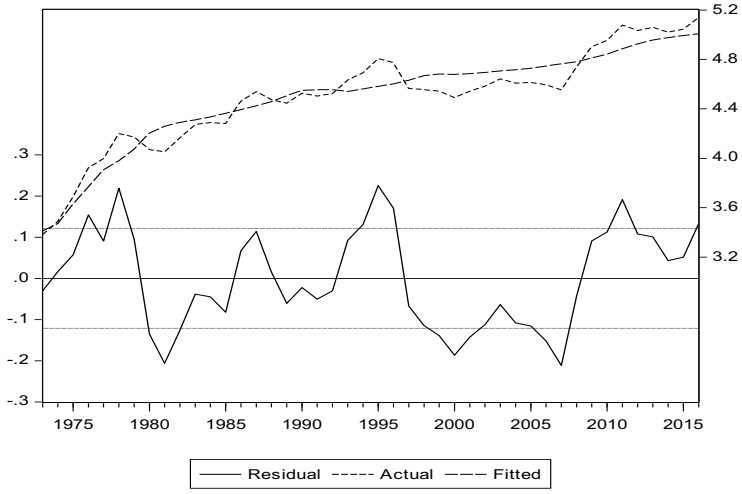
Danish krone



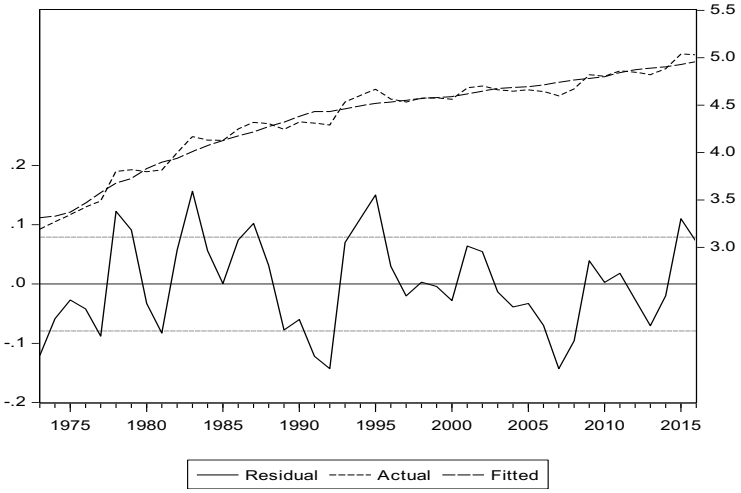
Mark/euro



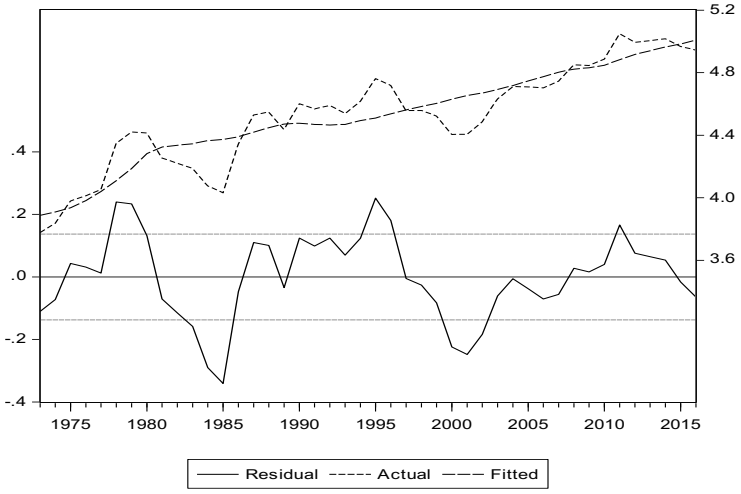
Pound



Swedish krona



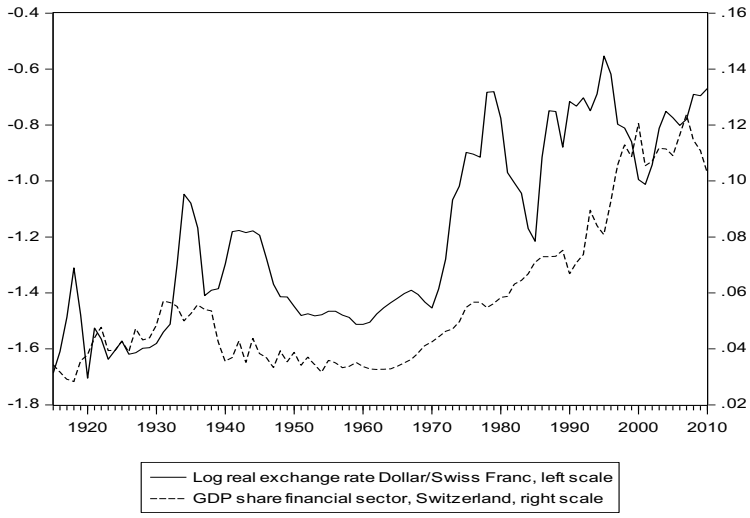
US dollar



4 The real franc exchange rate and Switzerland's financial sector

In this section, we return to the perspective of the "long" time series for the pound and US dollar over the period 1916-2010. We use these data to provide some empirical evidence on the often-expressed view that the strength of the Swiss franc is strongly linked to the importance of the Swiss financial sector. In Figure 3 we plot the log of the real dollar/franc exchange rate and the share of the financial sector in Swiss GDP. We note a positive correlation between the two series. However, this could be a completely spurious phenomenon. Table 5 reports the FMOLS estimates and tests for the dollar and the pound, including the share of the financial sector as an additional regressor besides the trend for the real exchange rate.

Figure 3: Real dollar exchange rate and the financial sector, 1916-2010



Data source: GDP share of financial sector: Swiss economic and social history data base, Table Q17a, Q18a, Q18b). http://www.fsw.uzh.ch/hstat/nls_rev/overview.php

Table 5: FMOLS PPP cointegration estimates and tests for the Swiss franc,1973-2016

$$y_t - x_t = b_0 + b_1 z_t + b_2 t + \varepsilon_t$$

y: log exchange rate; ***x***: log relative CPI; ***z***: GDP share of Swiss financial sector

Exchange rate	b_1	b_2	R^2	DW	Phillips-Ouliaris test	Hansen test
Pound	0.9865	0.09049***	0.7998	0.4001	-3.5681	1.8953***
	(1.3737)	(0.001297)				
Dollar	4.5949**	0.006232***	0.7186	0.3504	-3.3002	0.6097*
	(1.8920)	(0.00895)				

Notes: Newey-West standard errors in parentheses. *, **, *** indicates significance at the 10%, 5% and 1% levels, respectively.

The results are clearly not in favor of the financial sector importance hypothesis for the strength of the Swiss franc. The null hypothesis of no cointegration cannot be rejected at the 10% level, while the hypothesis of cointegration is rejected at least at the 10% level with a marginal significance of 0.0533. Even when we are willing to assume cointegration for the dollar equation, the coefficient of the financial sector share is statistically significant at the 5% level but the trend remains the dominating determinant of the real exchange rate. In order to illustrate the order of magnitudes consider the increase of the GDP share of the financial sector from 1930 to 2010 of around 0.05, or 5%. According to Table 5, this would be associated with a real appreciation of the Swiss franc against the dollar of 0.2295, or approximately 23%. The trend component, however, leads over 80 years to an increase in the exchange rate of 65.3% (1.0062).[80] Moreover, when we estimate the error correction model associated with the cointegrating relationship, we see that the GDP share of the financial sector is not weakly exogenous and the cointegrating relationship as a causal interpretation running from the GDP share of the financial sector to the real exchange rate is not warranted.[5]

5 The real exchange rate as well as the financial sector GDP share adjusts in response to deviations from the long-run equilibrium.

5 Consequences of the real appreciation of the franc for the Swiss economy

In evaluating the consequences of the franc's real appreciation for the Swiss economy, it is important to emphasize that it is not a monetary or financial phenomenon. The evidence presented in Baltensperger and Kugler (2017, 180-189) and in this paper clearly support a "real" explanation for the real appreciation of the franc. Moreover, the rapidly increasing success of Swiss goods-exporting industries in the last 100 years contributing to permanently high current account surpluses[6] is an additional clear argument against a monetary or financial explanation for the Swiss franc appreciation.

In our book , we favored the Balassa effect as an explanation for the real appreciation of the franc. However, we note that the pattern of trend real appreciation found for the currency panel and the years 1973-2016 may not be so easily interpreted as the Balassa effect. Moreover, recent empirical studies using productivity data shed some doubt on the results of the earlier corresponding studies supporting the Balassa effect (Fazio, MacDonald and McAdam, 2007; Gubler and Sax, 2017; Ricci and Milesi-Feretti, 2013). Besides supply effects (as in the Balassa effect), demand effects may be important for explaining the real exchange rate (a relative price). When we look at the structure of Swiss goods exports, we see a clear domination of the chemical and pharmaceutical industry emerging over the last 30 years.[7] These goods are characterized by a low price and a high income elasticity of demand, which provide room for real appreciation in a growing world economy. This interpretation is in line with the empirical result of Weder and Sax (2009) that improvements in the terms of trade are the most important determinant of the real appreciation of the Swiss franc.

Therefore, we can conclude that trend real appreciation was not a major problem restricting the growth of the Swiss economy. However, that does not mean that a tremendous short-run (not trend) appreciation, as witnessed in 2010/11 or earlier in 1978, did not create severe problems for the Swiss economy, with the danger of permanent losses in production of internationally traded goods. Under such conditions, interventions of Swiss National Bank to dampen the appreciation of the franc are clearly warranted.

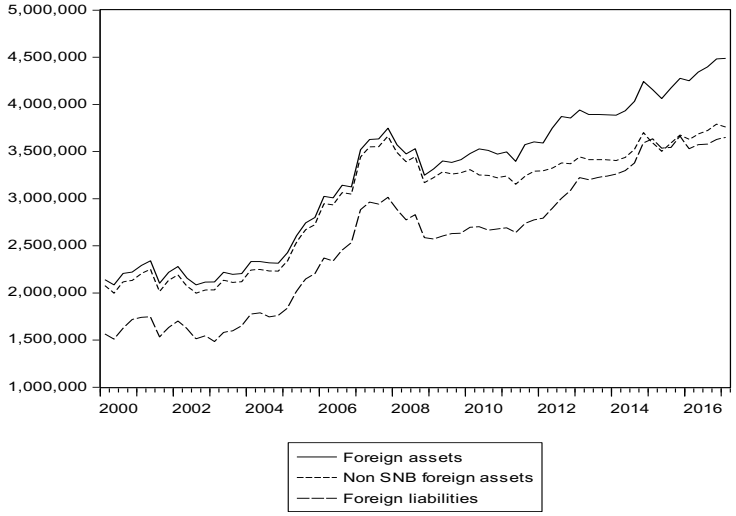
There is, however, a financial consequence of the real appreciation of the Swiss franc which has not received a lot of public attention so far (Baltensperger and Kugler, 2017, 212-215). As a consequence of the permanently large current

6 Compare Baltensperger and Kugler (2017, 210-212).

7 The nominal export share of the chemical and pharmaceutical industry increased from about 25 % in 1988 to nearly 50 % in 2017 (data source: https://data.snb.ch/de/topics/aube#!/cube/ausshawarm).

account surplus, Switzerland has a huge stock of net and gross foreign assets. Gross foreign assets are much larger then net foreign assets as Switzerland, as an important financial center, has a sizable stock of foreign liabilities. Figure 4 shows the development of Swiss foreign assets (total and non-SNB owned) and total liabilities since 2000. We observe a tremendous growth of assets leading to a level which was twice as large in 2016 compared to 2000, and nearly seven times GDP. Up to 2009, this growth was mainly driven by the private sector's accumulation of foreign assets. Since then, however, non-SNB foreign assets have grown relatively weakly and the growth in foreign assets has been dominated by a tremendous accumulation of central bank international reserves, which reached a level of approximately CHF700 billion at the end of 2016. Therefore, the private sector substituted foreign assets by domestic (Swiss franc) assets created by the central bank. Foreign liabilities grew at nearly the same pace and recently reached a level more than five times GDP. The strong growth of these gross figures is caused by the tremendous expansion of the financial sector up to the crisis of 2007-09 and conforms with the "excess financial elasticity" hypothesis of Borio, Shin and James (2014).

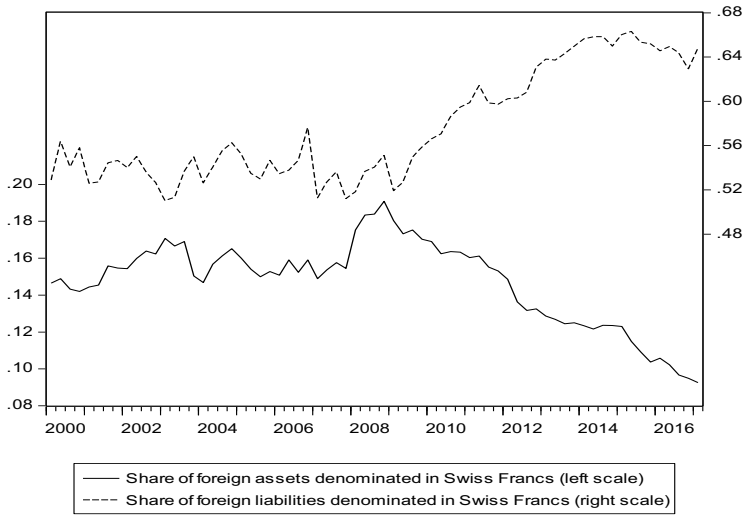
Figure 4: Swiss foreign assets and liabilities, 2000Q1-2017Q1 (CHF millions)



Data source: https://data.snb.ch/de/topics/aube#!/cube/auvekomq

Most interesting is the currency composition of Swiss foreign assets and liabilities. Figure 5 displays the shares of Swiss franc-denominated assets and liabilities. The share of these assets increased slightly from 15% in 2000 to 18% in 2008. Since then, we note a decrease to slightly more than 9% in 2016. Interestingly, we see that the franc share in foreign liabilities was always substantially larger and remained close to 55% until 2008. From then onwards, we see a tremendous increase of this share to around 65% since 2014. This development is probably caused by the increasing attractiveness of the Swiss franc as a safe haven currency in the recent crises. In addition, at the zero lower bound of short-term interest rates, the trend appreciation of the Swiss franc makes it internationally interesting from a rate-of-return perspective, in contrast to the periods of substantially lower Swiss interest rates in the past. These conditions mean that we have a currency mismatch between foreign assets and liabilities, which increased strongly since the recent financial crisis. This has the implication that the Swiss economy bears a large and increasing exchange rate risk.

Figure 5: Swiss franc share in foreign assets and liabilities, 2000Q1-2017Q1

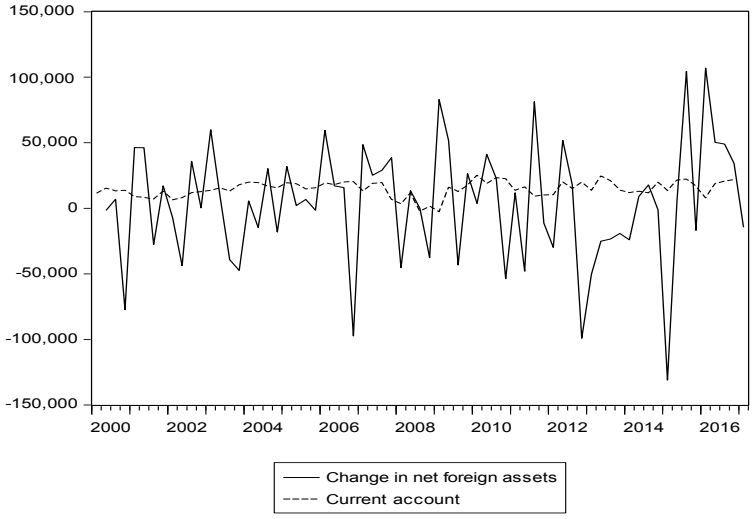


Data source: https://data.snb.ch/de/topics/aube#!/cube/auvercurrq

Figure 6 displays the quarterly change in net foreign assets and the current account since 2000. We see that the current account is always positive and much less volatile than the change in net foreign assets, which is often strongly negative. The volatility of the change in net foreign assets has tended to increase since the recent financial and government finance crisis. This phenomenon is created by

valuation effects on the very large stocks of gross foreign assets and liabilities. Given the increasing currency mismatch since 2008, the development of the Swiss franc exchange rate is an increasingly important determinant of the change in net foreign assets. For instance, the strong appreciation of the Swiss franc from the beginning of 2011 to the end of 2015 led to a reduction of net Swiss foreign assets from CHF805 billion to CHF613 billion, although the current account was always in surplus. Such negative shocks to net foreign assets do not appear to be a transitory phenomenon, at least in the last 17 years – the mean quarterly difference between change in net foreign assets (4,157 million CHF) and current account (CHF14,826 million) is CHF-10,668 million, and this value is statistically marginally significant at the 5% level (z-value -1.961 taking into account autocorrelation and heteroscedasticity). Thus it appears that the Swiss economy generated persistent current account surpluses which are then partly lost by foreign investment and the creation of foreign liabilities. This sheds some doubt on the effectiveness of the management of the large stocks of Swiss gross foreign assets and liabilities.

Figure 6: Swiss net foreign assets and current account, 2000Q1-2017Q1 (CHF millions)



Data source: https://data.snb.ch/de/topics/aube#!/cube/auvekomq, https://data.snb.ch/de/topics/aube#!/cube/bopoverq

6 Conclusions

The main findings of this paper are as follows. First the econometric analysis of a panel of currencies after the transition to flexible exchange rates (1973-2016) indicates that the real exchange rate of the Swiss franc against US dollar, Canadian dollar, pound, mark/euro, Swedish krona and Danish krone is trend stationary, but this does not hold for the yen. Second, the price elasticity of the nominal exchange rate with respect to the relative price level is close to, and not significantly different, from 1. Thus, our analysis confirms our finding (Baltensperger and Kugler, 2017) for the "long" time series for the pound and US dollar over the years 1916-2010 that the real appreciation of the Swiss Franc in the flexible exchange rate period appears to be a "real" phenomenon not related to the different inflation experience of the countries considered, which led to a nominal appreciation according to the PPP hypothesis. Third, the real trend appreciation appears to be equal for most currencies and is jointly estimated to be 0.64% per year. Thus, it appears that the rate of trend real appreciation is lower for the pound and dollar than its estimate using the long time series. For the Swedish krona we get a different and surprisingly high rate of real appreciation of 1.5% per year. Fourth, the inclusion of the share of the financial sector in GDP as a long-run determinant of the real exchange rate of the franc against the pound and dollar in a cointegration regression provides no evidence for the often-expressed view that the strength of the Swiss financial sector is a major cause of the real appreciation of the franc. In our book, we favored the Balassa effect as an explanation for the real appreciation of the franc. However, we note that the pattern of trend real appreciation reported in this paper may not be so easily interpreted as the Balassa effect. Moreover, recent empirical studies shed some doubt on the results of the earlier studies supporting the Balassa effect. Besides supply effects, the low price and high income elasticity of the international demand for Swiss tradable goods (in particular, pharmaceuticals) may be an important real determinant of the real appreciation of the franc. Whatever the real source of Swiss franc appreciation, we conclude that it is not the price stability orientation of Swiss monetary policy or the strong development of the financial sector which harmed the development of the Swiss production of tradable goods. The latter view is, in addition, very difficult to reconcile with the fact that Switzerland has a persistent and growing large trade and current account surplus since World War I.

The main problem of the "strong" franc appears to be that it creates a large and increasing currency mismatch risk for Swiss net foreign assets, as 90% of these assets are now denominated in foreign currencies whereas nearly two-thirds of the liabilities are in Swiss Francs. Moreover, the fact that the average increase in net foreign assets since 2000 was much less than the average current account

surplus sheds some doubt on the effectiveness of the management of the large stocks of Swiss gross foreign assets and liabilities.

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