Forex intervention and reserve management in Switzerland and Israel since the financial crisis: Comparison and policy lessons

Alex Cukierman[1]

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1. Introduction

Switzerland and Israel are two small open economies whose central banks intervene in the foreign exchange (forex) market since the outbreak of the global financial crisis (GFC). This paper compares the appreciation pressures on the currencies of the two countries, documents the similarities and differences between their methods of interventions and discusses their consequences for the size of forex reserve accumulation and their management. It is argued that the differences in methods of intervention and in the magnitude of reserve accumulation should be understood within the larger context of differences in the monetary policies of the Swiss National Bank (SNB) and of the Bank of Israel (BOI). [2] Those differences are caused, in turn, by structural differences in inflation, growth, openness, and safe haven considerations between the two economies.

In both countries there are periods of discretionary interventions in which the central bank (CB) intervenes without preannouncing or committing to such policy in advance as well as periods of relatively "strong interventions" in which the CB commits to either maintain an exchange rate (ER) floor vis-à-vis the currency of a major trading partner (the Euro between 2011 and 2014 in Switzerland) or to buy preannounced relatively large quantities of forex per period (Israel 2008-2009). Following a comparison of the effectiveness of strong and discretionary interventions in the two countries the paper discusses the pros and cons of forex interventions by small open economies faced with large trading partners whose policy rates are at or below the ZLB and who engage in large scale asset purchases.

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[2] In particular, the SNB policy rate hit the zero lower bound (ZLB) as early as 2011 when the Israeli policy rate was still in the neighborhood of three percent.

Sustained periods of intervention lead to large reserve accumulations that ultimately raise questions about potential costs of large reserves. The paper critically examines conventional views about such costs, the related accounting methods used to quantify them and proposes institutional changes designed to ameliorate the tradeoff between leaning against appreciations and "excessive" reserve accumulation. In this context the experience of Switzerland and of the Norwegian sovereign wealth fund is particularly relevant for Israel.

The paper's organization follows. Section 2 compares the evolution of the nominal and effective exchange rates and the accumulation of forex reserves in Switzerland and Israel over the 2006-2016 period with particular attention to the periods of strong intervention. An important difference between the intervention policy of the BOI and that of the SNB is that it is sterilized in the first case and unsterilized in the second. Section 3 discusses the reasons for this and other differences within the broader context of monetary policy with particular emphasis on the differences in inflation, real growth, distance from the ZLB and potency of the safe haven motive. This is followed, in section 4, by a survey of existing evidence on the effectiveness of interventions in ironing out fluctuations and slowing down appreciations in nominal and effective ER in the two countries during discretionary as well as strong intervention periods. The section also briefly surveys the little existing evidence on the impact of the effective ER on exports in Israel.

Section 5 discusses the pros and cons of direct interventions in forex markets. An inevitable consequence of sustained periods of intervention is the accumulation of forex reserves beyond what is considered necessary for the precautionary needs of a country. Both Switzerland and Israel have reached this state already during the early phases of the GFC. This induced policymakers in both countries to gravitate toward the belief that there is a tradeoff between using forex interventions to lean against appreciations and "excessive" reserve accumulation. Section 6 critically examines the bases for this view including, in particular, the practice of measuring the costs of intervention in domestic currency in conjunction with the traditionally conservative investment policies of central banks. Drawing on the return experience of the Norwegian sovereign wealth fund (SWF) section 6 argues that, when it exists, this tradeoff can be ameliorated by raising the fraction of reserves that is invested less conservatively.[3] The section discusses some of the possible institutional changes required to move in this direction while maintaining safeguards needed to assure that income from reserves is used only or mainly for long term purposes to be defined by law. This is followed by concluding remarks

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[3] The fraction of funds invested in equities by the Norwegian SWF has traditionally been sixty percent followed by twenty percent in Switzerland and less than ten percent in Israel.

2. Forex intervention and reserves during the global financial crisis in Switzerland and Israel: Basic Facts

The Bank of Israel (BOI) renewed foreign exchange (forex) intervention after a prolonged period of absence from this market in March 2008. The Bank's direct entry into the market was preceded by an announcement that, until further notice, it will purchase 25 million $ worth of forex per day. In August 2008 the Bank raised daily purchases to 100 million $ and maintained this rate until July 2009. Since August 2009 preannounced fixed purchases amounts were replaced by the purchase of, unspecified in advance, discretionary amounts. Between the third quarter of 2011 and the second quarter of 2013 the Bank did not intervene. Thereafter it renewed unspecified in advance, variable intervention.[4]

During 2008 and 2009 participation of the Swiss National Bank (SNB) in the forex market was limited to short term currency swaps between the Swiss Franc (CHF) on one hand and the $ and the Euro, on the other. Unlike the BOI the SNB does not publish systematic accounts of the volume of its interventions in the forex market. But it does occasionally reveal data about relatively important amounts of interventions. The first such acknowledgment notes a purchase of around 31 billion CHF of forex during the first quarter of 2010.[5] During 2011 the SNB took deliberate actions to increase liquidity and the volume of banks' sight deposits in order to stem the appreciation of the CHF.

On September 6 of the same year the SNB announced that it will prevent any appreciation of the CHF below 1.2 EUR/CHF by means of forex interventions. It stated that it will enforce this minimum rate with the utmost determination and is prepared to buy foreign currency in unlimited quantities.[6] This statement was frequently reiterated following quarterly meetings of the Bank's Governing Board till the discontinuation of this policy in January 2015 when the European Central Bank (ECB) substantially expanded financial asset purchases and moved the rate on its deposit facility into negative territory. Figure 1a below suggests that the preannounced nominal floor was tightly adhered to during the (roughly) three years between September 2011 and January 2015.[7]

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[4] Further details appear in Figure 1 and the adjoining discussion in Ribon (2017). A relatively small amount of purchases designed to offset the potential impact of gas discovery on the exchange rate was preannounced during the second quarter of 2013 and consistently implemented thereafter. The average monthly intervention over months with non zero interventions during the variable intervention period was 830 millions.$. This figure is substantially lower than the monthly intervention during the preannounced fixed intervention period.

[5] Chronicle of monetary events, SNB 103rd Annual Report (2010), p. 196.

[6] Chronicle of monetary events, SNB 104th Annual Report (2011), p. 201.

[7] The maximal monthly increase in forex reserves was 92 billion CHF. It occurred just prior to the enactment of the 1.2 floor against the Euro in September 2011. Interestingly part of this increase was reversed one month later. But even after this reversal the cummulative increase in forex reserves between August and October 2011 amounted to 73 billion Swiss Francs. By contrast the maximal monthly increase in forex reserves at the BOI was smaller by several orders of magnitudes. This maximum was around 4 billion $ and it occurred at the beginning of the transition to the discretionary intervention period. An

From that point in time and on the SNB intervened "as necessary" without committing in advance to either a quantity of forex purchases or a given nominal exchange rate. Somewhat uncharacteristically the SNB acknowledged forex intervention after Brexit and reported in its 2016 report that total forex intervention during this year amounted to 67.1 billion CHF.

Figure 1a shows indices for the evolution of the nominal Shekel to US dollar rate (USD/ILS) and the Swiss Franc to Euro rate (EUR/CHF) from the beginning of 2006 till the beginning of 2017. By convention decreases in the indices indicate an appreciation of the domestic currency.[8] In order to facilitate comparison of percentage rates of appreciation across the two countries both exchange rate indices are normalized to a common base of 100 in January 2006. Using similar conventions Figure 1b shows the evolution of effective nominal exchange rate in the two countries over the same period. The vertical red lines in the two figures indicate the period during which the preannounced floor on the EUR/CHF rate was in effect.

The figures show that during the decade starting in 2006 the domestic currencies and the effective exchange rates of both countries were subject to similar persistent trends of appreciation. Over the entire period this trend is somewhat stronger for the Swiss nominal exchange rate and virtually identical for the effective nominal exchange rates of both countries.[9] The figures suggest that the period of large preannounced fixed Israeli interventions that started in March 2008 was preceded by unusually large appreciations in both the nominal and the effective rates of exchange of the Shekel. Similarly, the September 2011 SNB commitment to prevent appreciation of the CHF beyond 1.2 CHF to one Euro was preceded by relatively swift and large appreciations in both the nominal and effective exchange rates of the Swiss currency.

When implemented forex interventions by both the SNB and the BOI slow down the general appreciation trends in Switzerland and Israel. Independently of whether the central bank (CB) commits to purchase some amounts of forex or to a particular exchange rate, the general trend toward appreciation forced both CBs to increase foreign exchange reserves. When Israeli intervention was renewed in March 2008 its main objective was to raise Israel's forex reserves that were deemed insufficient at the time in view of Israel's forex obligations and its geopolitical situation. But, as those reserves grew rapidly during 2008 and 2009 it became apparent that the main, longer term, objective of intervention is the preservation of competitiveness in a world characterized by a shrinking volume of trade and extremely low interest rates.[10] Maintenance of

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important reason for this difference is the much stronger safehaven demand for the Swiss Franc relatively to such a demand for the Israeli Shekel.

[8] This corresponds to the convention that specifies the USD/ILS rate as the number of ILS per USD and the EUR/CHF as the number of CHF per one EUR.

[9] In spite of this, the cumulative rate of appreciation of the **real** effective exchange rate (not shown) of the Swiss Franc is somewhat smaller than that of the Israeli Shekel. As documented later this is due to the fact that Swiss inflation was generally lower than that of Israel over the sample period.

[10] When Israeli intervention was renewed there was no tradeoff between preservation of competitiveness and "excessive" buildup of forex reserves since those reserves were initially too low. During this initial period intervention was particularly beneficial since it helped to preserve competitiveness on international market while replenishing forex reserves at a relatively low price of foreign exchange. It is argued later that, under appropriate reform of institutions, the "tradeoff" that emerged later can be largely mitigated.

Figure 1a: Switzerland versus Israel - Comparison of nominal exchange rates, Jan 2006=100.0
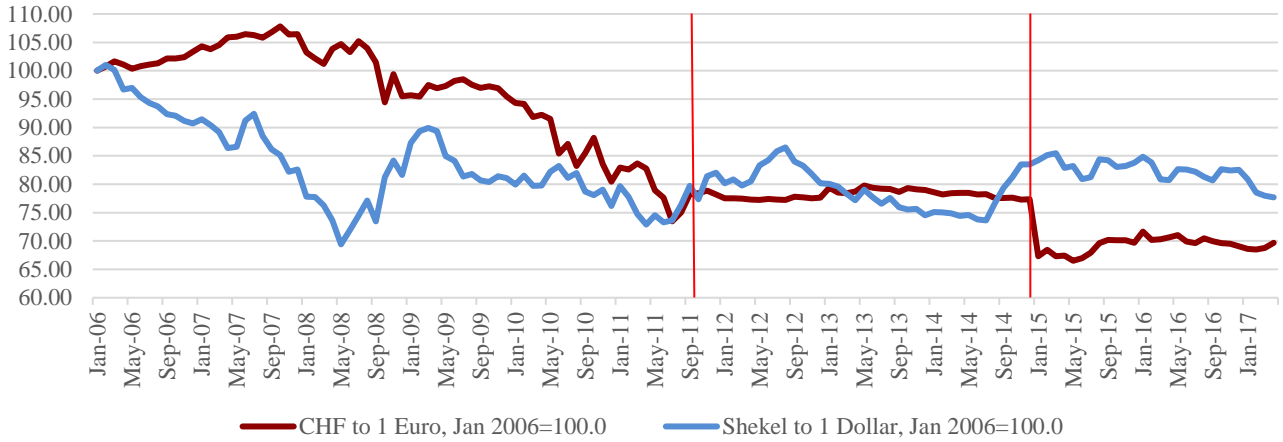
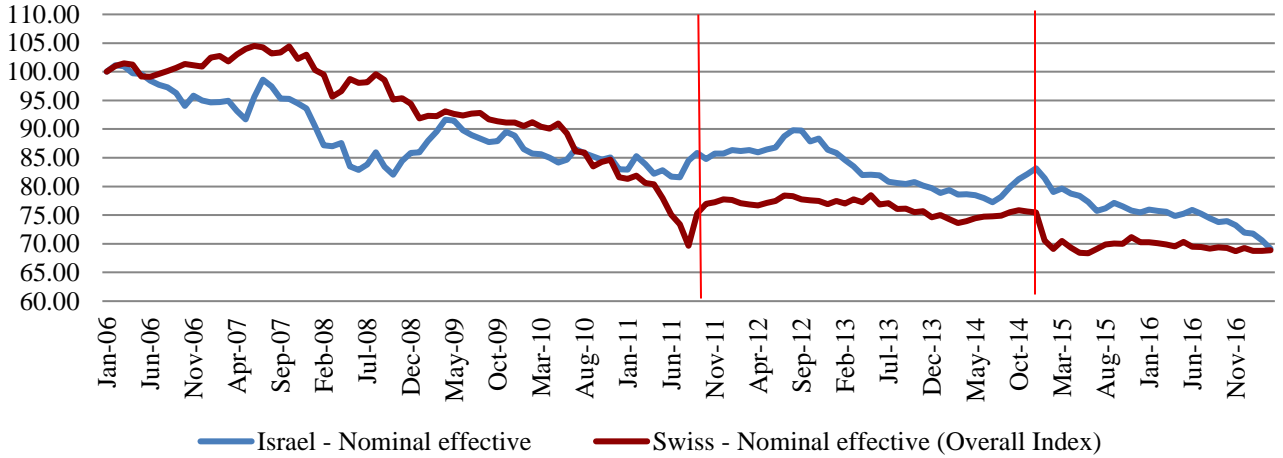— CHF to 1 Euro, Jan 2006=100.0   — Shekel to 1 Dollar, Jan 2006=100.0

Figure 1b: Switzerland versus Israel - Comparison of nominal effective exchange rates, Jan 2006=100.0

— Israel - Nominal effective   — Swiss - Nominal effective (Overall Index)

Competitiveness and a high level of economic activity under similar world circumstances was the major motive for forex intervention by the SNB throughout the entire period.

Fig 2 presents the evolution of forex reserves in Switzerland and Israel as a share of GDP between 2006 and 2016. The vertical blue lines show the period of Israel's relatively strong quantitative intervention (2008-end of Q1 till 2009-beginning of Q3) and the vertical red lines show the period of Swiss determined commitment to an exchange rate floor on the EUR/CHF exchange rate. Examination of the changes in the GDP share of reserves over those two periods reveals that, in both Switzerland and Israel this share roughly doubled between the beginning and the end of the relatively strong respective intervention periods (from 41% at the end of the third quarter of 2011 to 79% at the end of the first quarter of 2015 in Switzerland and from 14% at the end of the first quarter of 2008 to 27% at the end of the third quarter of 2009 in Israel). In view of the difference in the form of strong commitment between Switzerland and Israel (an exchange rate floor in the first case and preannounced fixed forex purchases in the second) this similarity is striking.

At the beginning of 2006 the Israeli GDP share of forex reserves was twice that of Switzerland. This pre-crisis difference was due to the particular geopolitical situation of Israel along with the fact that Switzerland is an important financial center that (unlike Israel) does not need large amounts of forex reserves during normal times. As the global GFC entered its post-Lehman acute phase the SNB reduced the policy rate to 0.25 during the last quarter of 2008 and started to engage in undisclosed amounts of forex intervention. Those policy measures were aimed at maintaining competitiveness and economic activity as well as to offset the deflationary tendencies that engulfed Switzerland and other developed economies after the collapse of Lehman Brothers.

Essentially Switzerland reached the vicinity of the zero lower bound (ZLB) already at the end of 2008 and, following the lead of the Fed, engaged in quantitative easing (QE). Since the share of trade in Switzerland is substantially larger than that of the US the bulk of those QE operations took the form of purchases of foreign exchange denominated assets that resulted in swift increases in forex reserves. As a consequence, and as shown in Figure 2, between the beginning of 2009 and the second quarter of 2010 the share of reserves to GDP increased from less than ten percent to over thirty percent. By that time, the share of Swiss reserves had become larger than that of Israel for the first time. It is noteworthy that this occurred prior to the SNB commitment to defend a 1.2 floor for the EUR/CHF rate and in spite of a doubling of the Israeli GDP share of reserves between March 2008 and the end of the third quarter of 2009.

As recounted earlier the commitment to a floor led to a further doubling of the share of Swiss reserves (to 70% of GDP at the end of the first quarter of 2015) Continuation of largely undisclosed amounts of intervention since then increased this share to the size of GDP by the end of 2016. By contrast, after reaching 30 percent of GDP during 2010 the Israeli GDP share of forex reserves remained stable in the vicinity of this figure to this day. The stability in the Israeli share was achieved in spite of non-negligible additional purchases of forex by the BOI for the following two reasons: A

Figure 2: Switzerland vs Israel - Forex reserves as a share of GDP

Ratio of Forex Reserves to GDP - Switzerland Ratio of Forex Reserves to GDP - Israel
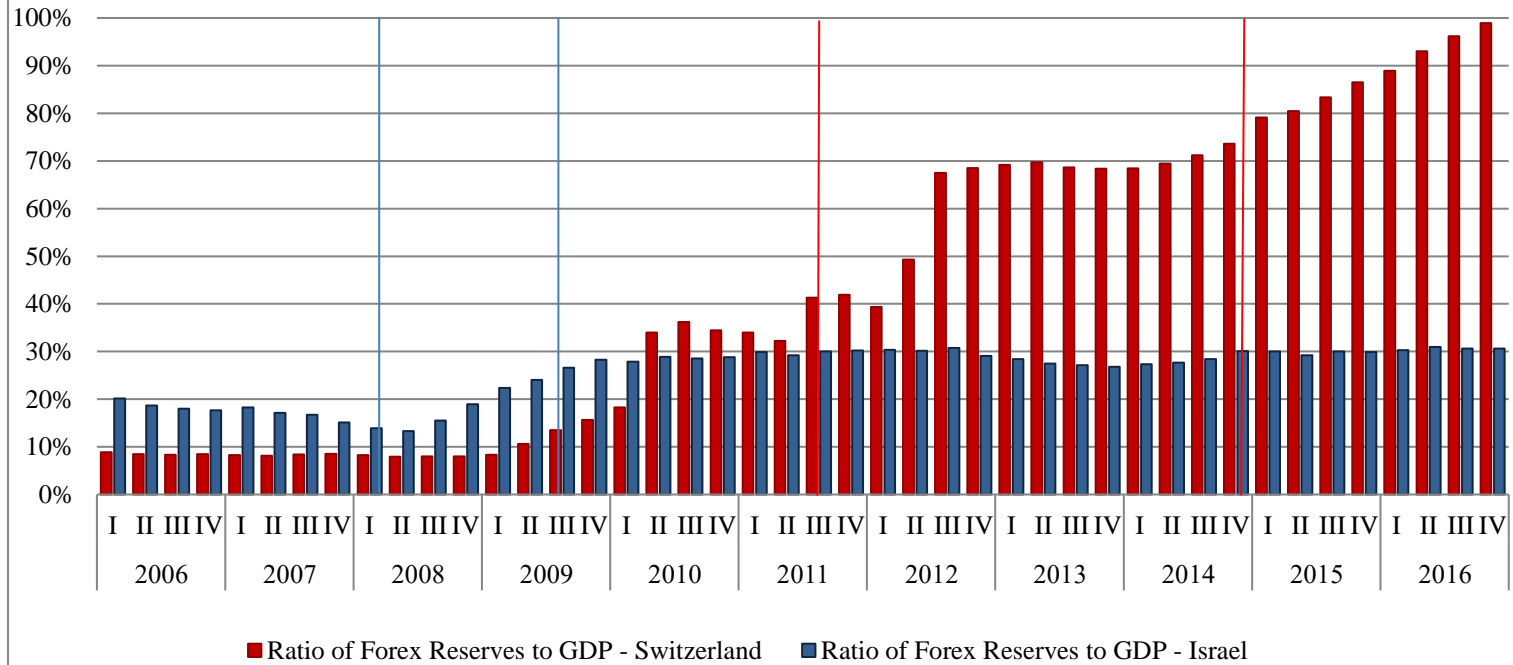
Sources:
Switzerland: St. Louis Federal Reserve and SNB Data Portal.
Israel: BOI Statistics Portal

robust rate of real growth that was uniformly larger than that of the Swiss economy since the outbreak of the financial crisis (Figure 3) and a general trend toward appreciation of the ILS.

The accumulation of forex reserves by the SNB and the BOI forced both banks to devote more resources to the management of those reserves and to gradually increase the share of equity investment. Due to it's substantially higher accumulation of reserves the SNB had to create a large new division that handles the investment of those reserves. It also was one of the first CB's to expand the investment of reserves into stocks. Those and related issues are discussed later in the section on the potential consequences of "excessive" reserve accumulation.

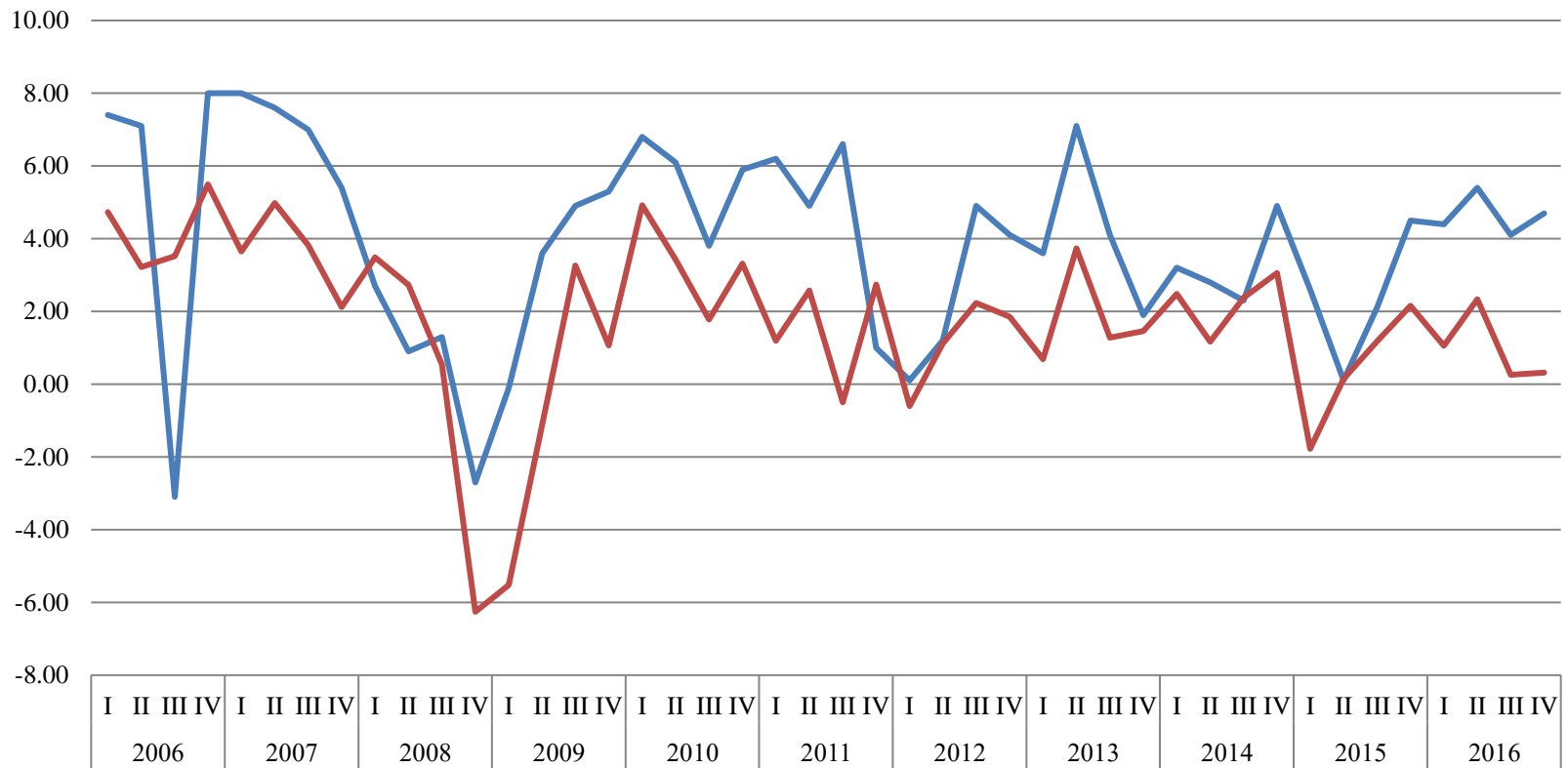## 3. Forex interventions and monetary policy – Switzerland versus Israel

An important difference between the Israeli and Swiss forex interventions is that in the first case such interventions were sterilized whereas, from some point in time and on, Swiss interventions were not sterilized at all. Understanding the reasons for this and related differences requires a broader look at the differences in the monetary policies of the two banks and of the motives underlying those differences.[11] Figure 4 displays the behavior of the monetary policy rates of the SNB and of the BOI over the 2006-2016 period. Both rates decrease sharply following the downfall of Lehman's Brothers during the second half of 2008. But their subsequent behavior differs. The Swiss policy rate drops to 0.25 already during the second quarter of 2008, stays there for over a year, drops to zero during the last quarter of 2011 and finally deeps into negative territory.[12] The current negative rate of -0.75 has been in effect since the second quarter of 2015.

By contrast, after dropping to a temporary minimum of 0.5 during the second quarter of 2009, the BOI policy rate resumes an upward trend reaching a local maximum of 3.25 percent during the third quarter of 2011. From that point and on the BOI rate gradually declines reaching the current floor of 0.1 during the second quarter of 2015. The broad picture that emerges from Figure 4 is that the BOI rate has been uniformly higher than that of the SNB and that the latter engaged in rate cutting substantially earlier than the BOI. Two important factors that explain those policy differences are the differences in inflation and in real growth rates between Switzerland and Israel. Figure 5 shows that during the bulk of the 2006-2016 period Israeli inflation was higher than its Swiss counterpart and Figure 3 shows that it also grew more vigorously over the financial crisis. Since it had both lower inflation and lower economic activity, the SNB chose to set lower policy rates than its Israeli counterpart and did that substantially earlier. Obviously this difference in policy stances is consistent with standard inflation targeting (IT).

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[11] Over the 2006 - 2016 period the correlation between the ratio of forex reserves to GDP and the ratio of the monetary base to GDP was 0.98 in Switzerland and 0.85 n Israel.

[12] Actually the drop of the Swiss policy rate to 0.25 preceded similar drops in the policy rates of the US, the UK and Japan by one or two quarters. Details appear in Figure 1.1 of Bean et.al. (2015).

Figure 3: Switzerland versus Israel - Quarterly changes in GDP at yearly rates (percentages)

Sources:
Switzerland - SNB data portal - https://data.snb.ch/en

Figure 4: Israeli and Swiss policy rates

Sources:
Swiss-https://ieconomics.com/switzerland-interest-rate
Israel- BOI Statistics portal
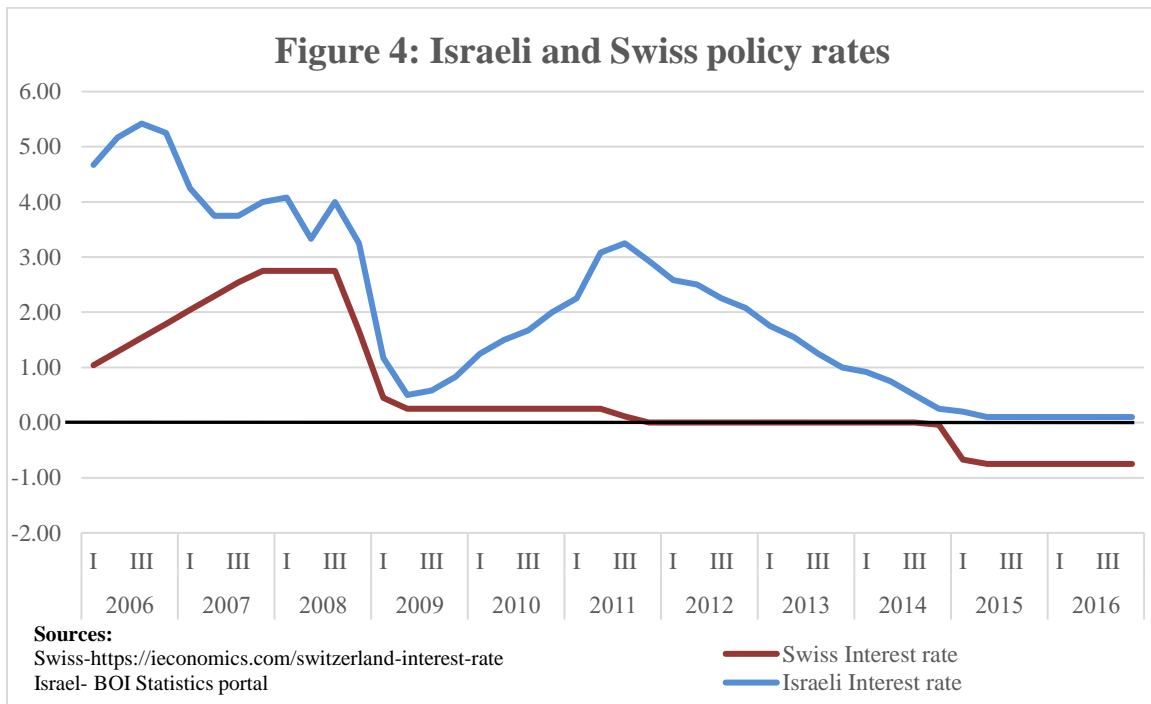
— Swiss Interest rate
— Israeli Interest rate

Figure 6 shows the GDP shares of monetary bases in Israel and Switzerland.[13] Comparing the evolution of those shares with those of forex reserves in Figure 2 suggests that, by and large, the BOI sterilizes the impact of forex interventions on the base while the SNB does not. Essentially since the end of 2008, after its policy rate drops to 0.25, the SNB engages in QE operations similar to those initiated by the Fed around the same time. However, unlike the relatively insular Fed whose QE operations were aimed mainly at domestic assets, the SNB bought mostly foreign assets. As a consequence the bulk of the SNB QE operations took the form of increases in forex reserves alongside the increase in the monetary base. This policy difference is traceable to the high degree of openness of the Swiss economy along with the fact that the CHF is a safe haven currency.

The positive correlation between the monetary base and forex reserves is particularly striking since the fourth quarter of 2011, when the Swiss policy rate hit the zero lower bound (ZLB) and ultimately deeps into the negative range (until that time the correlation between the shares is 0.64. From the last quarter of 2011 and on the correlation is 0.98). Due to both low growth and inflation this policy of non-sterilized interventions was probably consistent with the SNB objectives of the time. However it bears pointing out that engaging in sterilized forex interventions may not even be feasible when the policy rate is in negative territory. The reason is that, in order to engage in sterilization, the CB has to entice banks and the public to hold funds in the CB or to buy CB obligations (SNB debt certificates in Switzerland and "Makam" in Israel). This requires paying at least a small positive rate which is not feasible when the policy rate is in negative territory.

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[13] As in Figure 2 the vertical blue and red lines denote respectively the periods of relatively strong intervention in Israel and Switzerland.

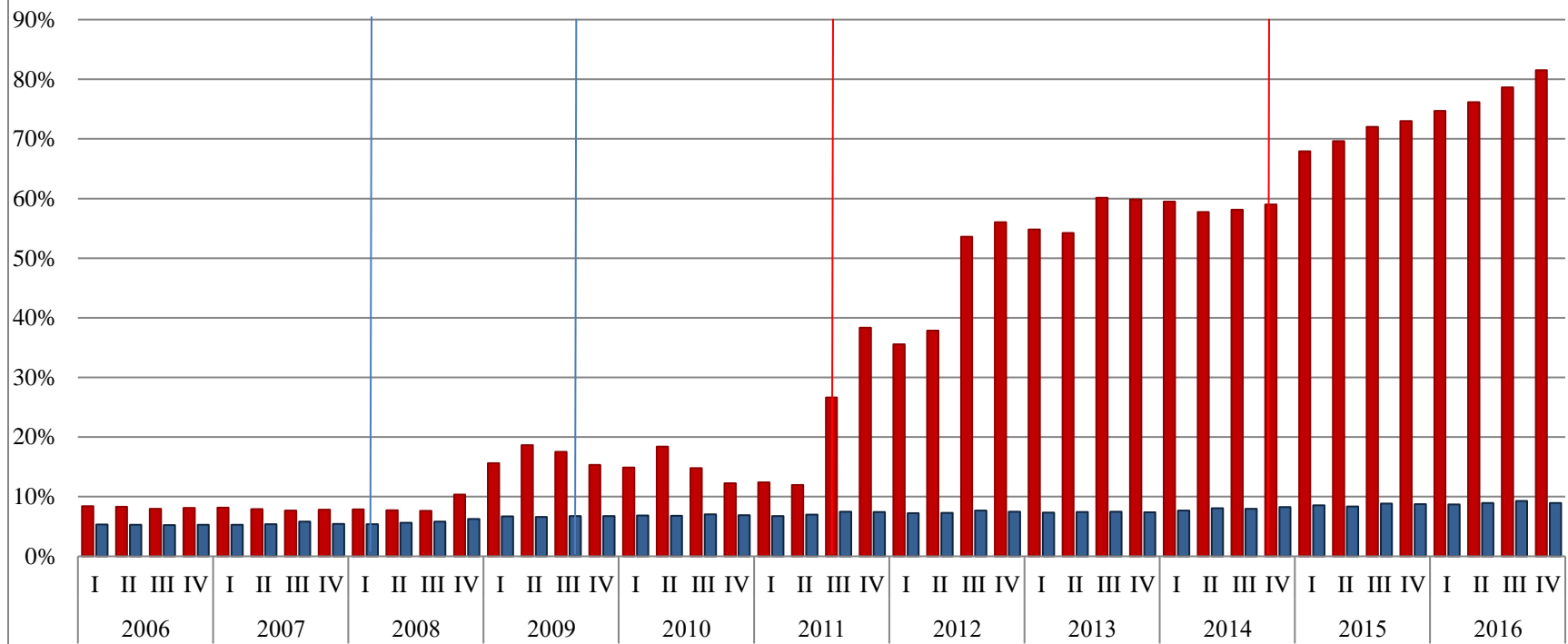**Figure 5 : Israeli and Swiss Inflation (monthly, year on year)**
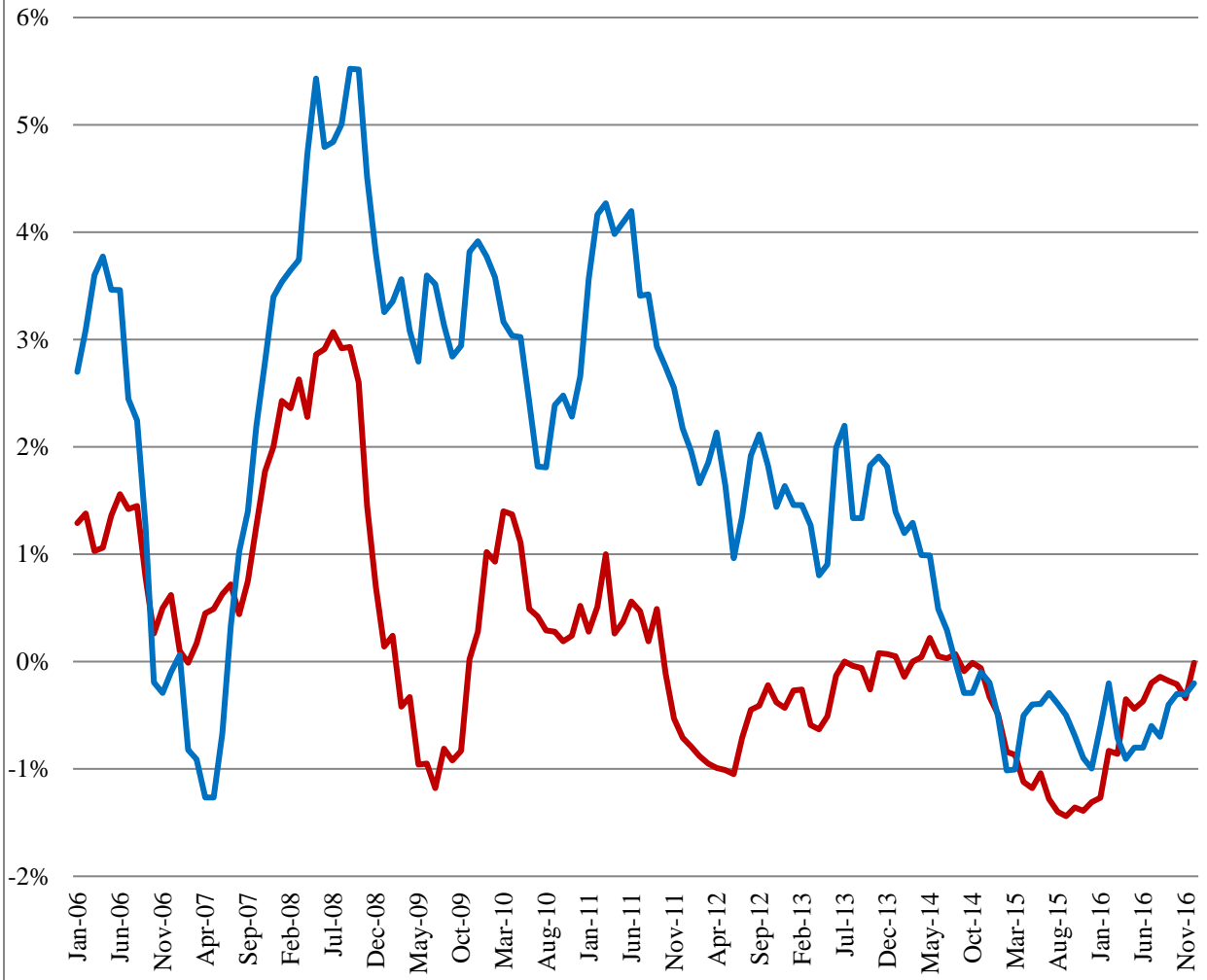
Sources:
Swiss Inflation - Inflation.eu
Israeli Inflation - BOI statistic portal

Swiss Inflation   Israeli Inflation

Figure 6: Switzerland versus Israel: Monetary base as a share of GDP - h/GDP

Sources:
Switzerland - St. Louis Federal Reserve Data Base and SNB Data Portal
Israel - BOI Statistics Portal

■ h/GDP - Switzerland   ■ h/GDP - Israel

4. Some evidence on the effectiveness of intervention in Israel and Switzerland

Once forex reserves cross a certain threshold the main reasons for intervention are to iron out short term fluctuations in the exchange rate (ER) and to slow down persistent, but ultimately reversible, appreciations due mainly to capital flows. For both countries this sections presents some modest results on the effectiveness of strong interventions in achieving the first objective and surveys existing evidence on the effectiveness of intervention in slowing down appreciations. The first objective is grounded in the view that, due to risk aversion, exporters prefer stable nominal, (as well as effective and real exchange rates) to variable ER.

The ultimate justification for the second objective relies on the existence of fixed exit and entry costs for exporting enterprises. If it is ultimately expected to be reversed, there is a case for leaning against an appreciation of the ER even if it is expected to persist for several years. By partially neutralizing such appreciations the CB saves the additional fixed costs that would have to be incurred by private enterprises to rebuild their production and marketing lines after exiting during periods of strength of the domestic currency. The persistent expansionary monetary policies of the Fed and of the ECB provide a fitting example of such a case. Although they persist such policies are ultimately expected to be reversed.

Table 1 presents evidence on fluctuations in the nominal, effective and real ER in Switzerland and Israel during periods of strong intervention and other periods. The "other periods" are split further into periods prior and after periods of strong interventions. For Switzerland the nominal ER is the EUR/CHF rate and for Israel it is the USD/ILS rate.

Table 1: Standard Deviations of exchange rates by exchange rate (ER) types and intervention periods - Switzerland versus Israel*					
Type of Exchange rate	Country	Strong Intervention (1)	No Strong Intervention (2)	Prior to Strong Intervention period (3)	After Strong Intervention period (4)
Nominal ER	Switzerland	0.01	0.22	0.14	0.02
	Israel	0.31	0.28	0.31	0.16
Nominal Effective ER	Switzerland	1.33	13.14	8.65	0.71
	Israel	3.11	7.55	3.64	4.97
Real Effective ER	Switzerland	1.34	7.77	6.69	1.17
	Israel	2.70	6.48	2.81	3.05

*Strong intervention periods are identified as October 2011-December 2014 for Switzerland and April 2008-July 2009 for Israel.
Source: Author's calculations

The Swiss era of strong intervention is taken to be the period over which the SNB was committed to maintain a floor of 1.2 CHF to the Euro and for Israel it is the period of relatively large scale preannounced forex purchases by the BOI (precise dates appear at the bottom of Table 1). Comparison of columns (1) and (2) in Table 1 suggests that fluctuations in the nominal effective and real ERs have been significantly reduced during periods of strong intervention in both Switzerland and Israel. Fluctuations in the EUR/CHF nominal rate were almost completely eliminated during the SNB commitment to the 1.2 floor.

By contrast fluctuations in the nominal USD/ILS rate did not change much during the period of large scale preannounced forex purchases. Obviously, part of this difference is due to the fact that the SNB committed to an ER target while the BOI committed to purchasing prespecified but limited amounts of forex. Another part of the difference is due to the fact that, although both CBs ultimately target effective rates, the correlation between the USD/ILS rate and the Israeli effective ER is weaker than that between the EUR/CHF and the Swiss effective ER. It is remarkable that, in contrast to Israel, Swiss fluctuations in all three types of ERs are lower in the post strong intervention period than prior to it.

The general conclusion from the table is that, for both countries, strong interventions managed to dampen fluctuations in both nominal and real effective ERs. This dampening effect lasted even after the removal of strong intervention in Switzerland but not in Israel. This difference is probably due to continued non-negligible verbal intervention by the SNB even after the removal of the 1.2 floor in combination with memories of its strong determination to defend the floor as long as there were no dramatic changes in the monetary policy of its main trading partners.

I turn next to a brief survey of existing evidence on the effectiveness, for Israel and Switzerland, of intervention in slowing down appreciation of the nominal ER in order to ultimately reduce the potential adverse effect of appreciation on exports, economic activity and employment. Economic theory suggests that the impact of intervention on this ultimate objective can be decomposed into the following three stages: (i) the impact of intervention on the nominal ER, (ii) the impact of the nominal ER on the effective and real ERs, (iii) the impact of the effective and real ERs on exports and real activity. Most of the existing evidence focuses on the first link.

Using a five endogenous variables Bayesian vector auto regression (VAR) framework estimated **prior to** the Israeli strong intervention period Sorezcky (2015) constructs an estimate of the USD/ILS ER during that period **in the absence of intervention** and compares it to the actual exchange rate during that period. The difference between those two time paths yields an estimate of the effect of forex intervention.[14] He finds that, following a modest excess depreciation of about 1.7 percent between March and June 2008 (during which the daily purchases were only 25 million USD per day), the difference between actual and predicted values of the USD/ILS ER

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[14] The remaining four BVAR endogenous variables in addition to the USD/ILS rate are CPI inflation, an index of the rate of change in business sector product, the BOI interest rate and one year ahead inflationary expectations derived from the difference between the yields to maturity of non-indexed and indexed bonds. The paper also conducts a number of sensitivity tests the most important of which is designed to separate the effect of intervention from the panic that induced a rush to the USD following the collapse of Lehman Brothers in September 2008.

widens gradually after the beginning of purchases at a daily rate of 100 million USD per day in August 2008. This difference reaches a maximum of 11.4% in November 2011 and then gradually fades away toward zero about a month prior to the end of the strong intervention period in July 2009.

During the Israeli strong intervention period the amounts of monthly intervention were preannounced in advance. Since September 2009 the BOI switched to discretionary occasional interventions without exante preannouncements of amounts to be purchased. This period includes months with positive intervention volumes as well as months with zero intervention. Using monthly data between September 2009 and December 2015 Ribon (2017) reports the following empirical results for this period: (i) The average intervention level in months with positive intervention was 830 million $ per month. (ii) On average the nominal effective ER in months with positive intervention is more depreciated by 0.6 percent in comparison to months without any intervention. (iii) When the probability of intervention is endogenized this differential impact rises from 0.6 percent to at least 1.1 percent. (iv) Intervention is more effective when interest rate policy is relatively more expansionary, as was the case from 2013 and on. But the study is largely silent about the length of time over which a given intervention affects the ER.

Those results are obtained by estimating a two stages limited information maximum likelihood (LIML) regression in which the dependent variable is the first difference in the log of the effective nominal ER. In addition to the level of intervention and the interest rates differentials between the BOI rate and that of the Fed the set of regressors includes a USD currency basket ER, an index of five years Israel CDS, a measure of foreign direct investment (FDI) inflows, an index of world stock market prices and an average three months lagged value of the current account surplus. One difficulty with isolating the net effect of intervention on the effective ER is that the more appreciated is the ER the higher is the likelihood that the CB will intervene. This confounds the impact of the ER on intervention with the impact of intervention on the ER. The two stages estimation is used in order to isolate the second effect and is implemented by first estimating an intervention function for the BOI.[15]

As we saw in the previous section strong intervention in Switzerland took the form of a commitment to an ER floor with respect to the Euro rather than to preannounced forex purchases as was the case during the Israeli strong intervention period. The SNB commitment to a floor was in effect between September 2011 and January 2015. Prior to this period and after it the SNB engaged in discretionary forex purchases similar to those conducted by the BOI after July 2009. During the strong intervention period the SNB repeatedly made strong statements about its "utmost determination" to defend the floor, and when necessary backed it up with massive forex interventions.[16]

Kugler (2017) estimates a bivariate VAR between the rate of change in a measure of intervention and the rate of change in the EUR/CHF rate. Since the SNB does not publish intervention figures he uses weekly data on the Bank's sight deposits as a proxy for intervention.[17] The estimates reveal the existence of two ways positive causality between sight deposits and the ER during the periods of discretionary interventions (prior

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[15] Interestingly, a higher level of accumulated reserves reduces the likelihood that the BOI will intervene.
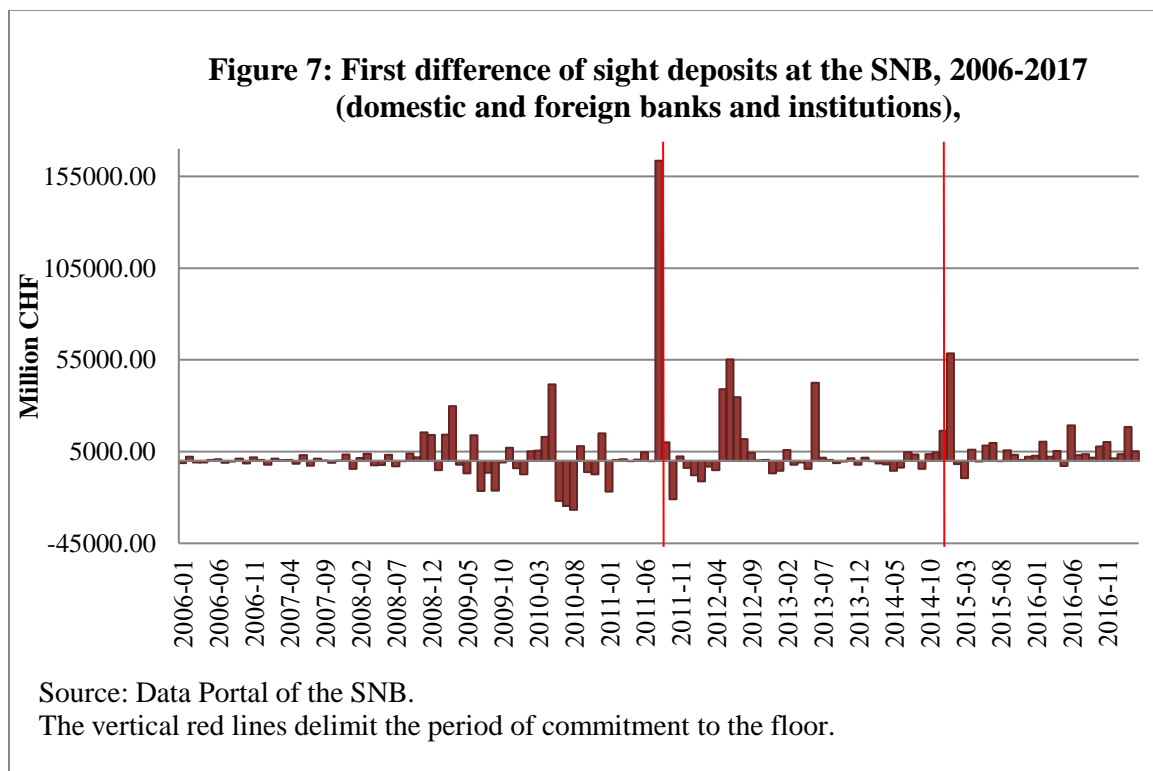
[16] One of many such statements is reported on page 214 of the 105th SNB Annual Report (2012).

[17] Sight deposits at the SNB constitute a major component of the monetary base.

to September 2011 and after January 2015) but no significant interaction between those two variables during the period of commitment to a 1.2 floor on the EUR/CHF rate.

Positive causality from sight deposits to the exchange rate supports the view that forex purchases contributed to reduce appreciation of the Swiss Franc during the discretionary intervention periods. Interestingly, the impact of such intervention on the ER is substantially stronger in the second discretionary intervention period (after the end of the strong intervention period) than in the first discretionary intervention period (prior to the beginning of the strong intervention period). A possible explanation for this phenomenon is that the demonstration effect of the strong intervention period along with continued verbal interventions by the SNB suggesting its interest in countering "excessive appreciation" even after the discontinuation of the floor increased the awareness of forex market participants to the potential impacts of such intervention. In this sense the period of commitment to a floor might have affected the ER even after the floor was removed.

The positive and significant causality running from the ER to sight deposits is, most likely, due to the fact that depreciations of the CHF raises the value of sight deposits in terms of the Franc. The fact that there is no significant causality between sight deposits and the ER during the strong commitment period supports the view that, since this commitment was credible financial markets largely disregarded changes in sight deposits as indicators for the ER. For the same reason the reverse causality, form the ER to sight deposits vanished too. During this period deviations from the ER floor were minimal so that the first difference of the EUR/CHF rate was essentially zero. As a consequence there were no changes in the domestic currency value of sight deposits. This view is supported by Figure 7. The figure shows that except for several isolated months.

Figure 7: First difference of sight deposits at the SNB, 2006-2017 (domestic and foreign banks and institutions),

Source: Data Portal of the SNB.
The vertical red lines delimit the period of commitment to the floor.

during which sight deposits changed by large amounts, as the SNB backed its strong preannounced determination to defend the floor also by deeds, there were no substantial changes in sight deposits. The view that the 1.2 floor was credible during most of the strong intervention period is also backed by most recent studies that derive credibility measures from EUR/CHF option markets (Mirkov, Pozdeev and Soderlin (2016), Janssen and Studer (2017) and Jermann (2017). An exception is Zimmerman and Hertrich (2015) who report a substantial increase in the probability of breakup of the floor after August 2014.

Although the immediate impact of interventions is on nominal ERs their ultimate objective is to influence the effective nominal and real ERs – and through them exports and economic activity. It is therefore interesting to examine the impact of changes in relevant nominal rates on effective and real ERs in the two countries. Table 2 reports the elasticity of the effective nominal and real ERs with respect to (wrt) the EUR/CHF rate for Switzerland and wrt the USD/ILS rate for Israel. Several regularities emerge from the table. First the elasticity of the Swiss nominal effective ER wrt the EUR/CHL is substantially larger than the elasticity of its Israeli counterpart wrt the USD/ILS. This is largely a reflection of the fact that the weight of the Euro in the Swiss effective rate is more important than the weight of the USD in the Israeli effective rate. Second the elasticity of the Swiss real effective ER is much smaller than that of its nominal effective counterpart. Finally, in Israel the difference between the elasticities of the nominal and real effective rates wrt to the USD/ILS rate is negligible.

Table 2: Elasticities of nominal and real effective exchange rates with respect to the EUR/CHF rate in Switzerland and with respect to the USD/ILS rate in Israel: 2016-2016

	Elasticity of Nominal Effective	Adjusted R-squared	Elasticity of Real Effective	Adjusted R-squared
wrt EUR/CHF for Switzerland	0.93	0.98	0.46	0.89
wrt USD/ILS for Israel	0.69	0.35	0.68	0.51

All the estimates are highly significant.

Finally, recent work from the research department of the BOI reveals that, controlling for world demand for imports, a depreciation of one percent in the effective nominal and real ERs lagged two years induces an increase of between 0.3% - 0.6% in a quantity measure of exports. The corresponding sectoral elasticities range from a maximum of 1.4 for pharmaceuticals to a minimum of 0.31 for services. (Bank of Israel Report (2016), Hebrew, page 57).

5. Pros and cons of forex interventions in small open economies

Switzerland and Israel are small open economies. They are therefore particularly sensitive to deviations of the exchange rate from its equilibrium value as well as to short term fluctuations in this variable. Due to nominal price and wage stickiness in conjunction with the speed with which nominal exchange rates respond to new information fluctuations in the second variable quickly translate into movements in effective exchange rates. This effect was particularly in evidence during the global financial crisis due to the virtual disappearance of inflation.

Conventional wisdom is that, at least during normal times, central banks should not interfere with the free operation of forex markets. The main argument in support of this position is that, by facilitating the undisturbed flow of financial capital, free forex markets improve the cross-country allocation of capital in the world. This view presumes that forex markets correctly reflect the fundamental information in goods and financial markets, that the resulting equilibrium is undisturbed by the existence of big players and that it is therefore efficient in some sense.

However forex markets do not always correctly reflect fundamental information particularly so during financial panics as recently demonstrated by the global financial crisis. In addition they are not always immune from the influence of big players such as central banks of large economies. Through interest rate policy and QE operations these central banks have substantial influence on the nominal exchange rates of small open economies. When temporary expansionary monetary policies of major trading partners of a small open economy lead to appreciation of the domestic currency lack of reaction by the domestic CB exposes domestic producers to temporary foreign competition. This reduces economic activity and leads at the margin to the closure of relatively less efficient domestic firms and to a drop in employment. Due to the existence of set up costs and the loss of foreign markets some firms may not reopen even after the expansionary policies of large CB's subside. Obviously this leads to a permanent loss in production and employment. Consequently, an important input into the domestic CB's decision about whether to react to foreign expansionary policies by similar domestic policies is its evaluation of the persistence of foreign expansionary policies.

The needs of trade are best served by stable effective exchange rates. Periods of substantial uncertainty on financial markets lead to excessive fluctuations in nominal and therefore effective exchange rates. During such episodes forex intervention by the CB may be called upon to prevent excessive variability in the nominal and real effective exchange rates. Those considerations apply to both Switzerland and Israel but are probably more important in the first country due to the safe haven feature of the Swiss currency in combination with the larger degree of openness of the Swiss economy (the Swiss GDP share of import plus exports in 2016 was 119 percent and that of Israel "only" 58 percent).

One may argue that, as long as the policy rate is strictly in the positive range, it is preferable to offset the impact of foreign expansionary policies by means of interest rate policy rather than by forex interventions. In the absence of additional motives for intervention (such as building up a sufficient amount of forex reserves) this may be a valid argument. However this argument no longer holds when the ZLB is reached for the

obvious reason that the policy rate cannot be decreased further.[18] In this range the CB has to rely on unconventional monetary policies. In a relatively closed economy like the US such policies are implemented through the purchase of (mainly) domestic assets. By contrast, in small open economies like Switzerland and Israel they are achieved by the purchase of (mainly) foreign assets.[19]

6. How to improve the tradeoff between leaning against appreciations and "excessive" reserves accumulation?

Persistent intervention designed to slow down appreciation of the domestic currency leads, after a while, to the accumulation of large amounts of reserves. When, as was the case in Israel in 2008, such reserves were initially considered to be too low intervention was unambiguously desirable since it slowed down appreciation and also moved reserves in the desired direction. At that juncture Israeli intervention appeared to be a particularly good deal since it enabled the BOI to build up reserves at relatively cheap prices in terms of domestic currency. By contrast the buildup of forex reserves in Switzerland appeared from the start as an inevitable cost that the Swiss economy had to pay in order to slow down unwanted appreciation. As the Israeli pool of reserves grew policymakers at the BOI came to share a similar attitude.

From a national point of view forex reserves can be viewed as one form of investment abroad. Hence arguments against "excessive" levels of reserves must have their roots in a belief that the resources invested in the creation of those reserves could have been used more efficiently elsewhere. Since the immediate "payment" for intervention just takes the form of an expansion in the monetary base the immediate resource cost is similar to the direct cost of seignorage -- which is negligible.

However, if due to potential conflicts with other objectives it is necessary to sterilize the increase in the base, the interest cost of sterilization becomes relevant as well. When this is the case and the return on reserves is lower than the cost of sterilization an argument against "excessive" forex reserve is that the CB loses money on those reserves. This argument is based on CB accounting in terms of domestic currency in conjunction with the fact that traditionally CB reserves are invested conservatively in high grade government obligations with relatively short maturities. Since the yield on such assets is low the return on reserves is often smaller than the interest cost of sterilization when such sterilization is implemented. In addition the accounting losses on the books of the CB are magnified by appreciations due to domestic currency accounting.

An important function of forex reserves is to shield the importing capacity of the country from various economic and geopolitical events that may have undesirable effects

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[18] The ZLB need not be strictly at zero as demonstrated by the recent negative policy rates of the ECB and of Switzerland. But, there is little doubt that that there is a floor to how much policy rates can deep into the negative range without abolishing cash or introducing other substantial institutional changes. The floor is probably not far from the current -0.75 Swiss policy rate. Buiter (2009) and Rogoff (2016) propose institutional changes designed to abolish the ZLB constraint.

[19] Besides Switzerland and Israel other small open economies such as South Korea, Sweden, the Czech Republic and Columbia engaged in direct foreign interventions in order to reduce the impact of negative rates cum QE operations in the US, the Euro area and Japan on their economies.

on its capacity to import and to access international capital markets. This capacity depends on the forex value of reserves rather than on the domestic currency counterpart of reserves. Internal procedures at the BOI allow for this difference by measuring the rate of return on reserves in terms of a numeraire of foreign currencies that reflect the main currencies Israel uses in its foreign trade. Nonetheless, for the purposes of domestic accounting and potential transfers of profits to the Treasury, rates of return are calculated in terms of domestic currency.[20] By contrast the SNB utilizes domestic currency accounting for both purposes.

Calculation of sterilization costs in terms of domestic currency appears to be misguided for more than one reason. First, because the CB aims to achieve a number of macroeconomic objectives such as price stability and a high level of economic activity and employment rather than to maximize profits. Second, as explained above, when the CB intervenes in the forex market the economy obtains a forex denominated claim on the rest of the world in exchange for the issue of additional amounts of the domestic monetary base. The direct real cost of this operation is negligible. Admittedly the intervention may entail a cost of sterilization but this cost should be calculated in terms of the relevant forex numeraire index rather than in terms of domestic currency.

Last but not least, once desired policy moves to the ZLB or below it the cost of sterilization disappears and may even become a source of revenue. Thus, when appreciation pressures persist at the ZLB or below it forex intervention "buys" claims against the rest of the world by expanding the domestic monetary base in addition to

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[20] But in practice, due to a large balance of accumulated domestic currency losses, the BOI has not transferred any profits to the Treasury for quite a while. .

Table 3: Returns on forex reserves in terms of forex numeraires and in domestic currency (percentages): Israel and Switzerland

Year	1 Israel: Return in term of a forex numeraire	2 Israel: Return in domestic currency	3 Switzerland: Return in term of a forex numeraire	4 Switzerland: Return in domestic currency	
2002	5.2	17.8	10.5	0.5	
2003	2.2	-1.3	3.4	3.0	
2004	1.7	1.8	5.7	2.3	
2005	2.6	6.5	5.5	10.8	
2006	3.8	-2.3	3.0	1.9	
2007	6.9	-0.5	4.4	3.0	
2008	6.0	1.6	0.3	-8.7	
2009	1.9	3.6	4.4	4.8	
2010	1.7	-7.1	3.8	-10.1	
2011	1.3	7.9	4.0	3.1	
2012	1.6	0.1	4.7	2.2	
2013	0.9	-4.7	3.2	0.7	
2014	1.3	8.7	5.1	7.8	
2015	0.6	-2.5	1.3	-4.4	
2016	1.6	-1.4	3.7	3.3	

Sources:

Israel – BOI, Markets Division.

Switzerland – SNB Annual Report, 2016, p. 86. Columns 3 and 4 in the table correspond respectively to the fourth and sixth columns on page 86 of the repo

slowing down the rate of appreciation. This is essentially a form of seignorage in which the domestic CB acquires forex denominated claims on the rest of the world by issuing high powered money. As long as there are appreciation pressures in the market the risk of inflation is negligible. When ultimately those pressures subside and inflation risks reappear the CB can react by raising the policy rate.

Table 3 shows rates of return on forex reserves for Israel and Switzerland in terms of respective forex numeraires as well as in terms of domestic currencies. The table reveals that rates of return in terms of forex numeraires are invariably positive. However domestic currencies returns are substantially more variable than their forex numeraire counterparts and are occasionally negative particularly since the start of the GFC. The latter is a reflection of the fact that, since the start of the crisis, both currencies are subject to appreciation pressures.

Interestingly when the ILS depreciated in 2002 due to a yet incomplete anchoring of inflation in conjunction with a current account deficit the domestic currency rate of return on reserves shot up to 17.8 percent.[21] As the current account permanently moved into a surplus and inflation became fully anchored after 2003 such a "brilliant" performance was (luckily for the economy) never repeated. Relatively large domestic currency negative rates of return occurred in both countries in 2010 when both currencies appreciated as the Greek sovereign debt crisis was gathering steam and again in Switzerland in 2015 after the SNB stopped defending the floor on the EUR/CHF rate.

In view of the relatively high and consistently positive forex returns recalculation of the costs of interventions in terms of the relevant numeraires of forex is likely to show that positive costs of sterilization arise less frequently than when they are (mistakenly) calculated in terms of domestic currencies. This statement is particularly relevant for Switzerland in which the forex numeraire returns are higher than their Israeli counterpart during most of the years in Table 3.[22] This still leaves an open question about how to improve the tradeoff between leaning against appreciation and the cost of maintaining excessive reserves when the forex numeraire cost of intervention is positive. It is likely that, since the outbreak of the GFC this question is relatively more relevant for Israel.

A radical way to improve this tradeoff is to create an institutional framework that makes it possible to invest excessive forex reserves in long term, well diversified, higher yielding, but also more risky assets like equities and long term bonds. The longer investment horizon should make it possible to iron out the higher short term variability of such assets while taking advantage of the well documented positive equity premium.[23]

There are at least two ways to do that at the institutional level. One is to continue to manage forex reserves as one pool at the CB but to increase the fraction of investment in stocks and long term bonds. The other is to separate the management of precautionary CB reserves from the financial management of excess reserves by creating a sovereign wealth fund (SWF). The SNB chose the first option. It raised the fraction of reserves invested in stocks above the traditional low fraction held by CBs rather early and

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[21] Further details appear in sections 5 and 10 of Cukierman and Melnick (2015).

[22] The SNB started to invest in equities relatively early. In 2010 the fraction of reserves invested in stocks was already 11 percent (SNB 104th Annual Report (2011), p.67). This fraction was subsequently raised to around 20 percent. .

[23] A recent comprehensive survey of evidence on the equity premium appears in discussion note 1/2016 of Norges Bank Investment Management.

continued to manage forex reserves at the CB. As the level of forex reserves increased during the GFC this forced the Bank to substantially raise (with some reluctance) the fraction of its internal resources devoted to long term financial management. However this appears like a modest cost in comparison to the benefits of longer term high yield investment of forex reserves.

       A SWF is usually created when, due to some real windfall or persistent forex intervention, there is a large accumulation of forex reserves. Creation of the Chinese SWFs is due in large part to past years of forex intervention while those of Saudi Arabia and Norway to the oil windfall. Although the source of accumulation in the second case stems from the discovery of a real resource there is a sense in which accumulation due to intervention is also a windfall since it enables the CB of a country whose currency in high demand to acquire real obligations on the rest of the world by just issuing domestic high powered money.

Table 4: Yearly returns of the Norwegian sovereign wealth fund in percentages (Returns are measured in terms of a relevant numeraire of foreign exchange currencies)

Year	Total Return	Equity Return	Fixed Income Return	Real Estate Return
1Q2017	3.78	5.53	0.77	0.62
2016	6.92	8.72	4.32	0.78
2015	2.74	3.83	0.33	9.99
2014	7.58	7.9	6.88	10.42
2013	15.95	26.28	0.1	11.79
2012	13.42	18.06	6.68	5.77
2011	-2.54	-8.84	7.03	-4.371
2010	9.62	13.34	4.11	
2009	25.62	34.27	12.49	
2008	-23.31	-40.71	-0.54	
2007	4.26	6.82	2.96	
2006	7.92	17.04	1.93	
2005	11.09	22.49	3.82	
2004	8.94	13	6.1	
2003	12.59	22.84	5.26	
2002	-4.74	-24.39	9.9	
2001	-2.47	-14.6	5.04	
2000	2.49	-5.82	8.41	
1999	12.44	34.81	-0.99	

Real Estate return for 2011 is for 9 months
Source: https://www.nbim.no/en/the-fund/return-on-the-fund/

An important advantage of a well-managed SWF is that the higher yields it achieves is likely to offset most if not all of the (positive) costs of sterilization. A successful example is the Norwegian SWF. Historically the fund has been investing about sixty percent of its portfolio in stocks and decided recently to raise this fraction to 70 percent. Table 4 shows historical rates of return of the fund. The mean yearly total return and variability are both quite high. Between 2002 and 2016 the mean return is 6.24 percent and the standard deviation is 10.65. Two negative returns occur in 2008 and 2011 both of which were years of exceptional systemic crises. In 2008 the simmering subprime crisis became a worldwide financial panic following the downfall of Lehman Brothers and 2011 witnessed one of the peaks of the Euro Area sovereign debt crisis. Except for those two years and another negative return in 2002 all the yearly returns were positive between 2002 and 2016.

The mean and standard deviations of yearly returns on forex reserves in Israel and Switzerland over the 2002-2016 period are compared in Table 5 with those of the Norwegian SWF over the same period. The mean and standard deviations of returns is lowest in Israel and highest in the Norwegian SWF with Switzerland in between. This is a natural reflection of the fact that the fraction of equities and of long term bonds is lowest in Israel, higher in Switzerland and highest in Norway. Basically, as we move across those three pools of funds both the mean return and its variability increase over time. This comparison highlights the potential of a SWF for the Israeli economy.

Table 5: Comparison of the mean and standard deviations of returns on reserves, 2002-2016: Israel and Switzerland versus the Norwegian Sovereign Wealth Fund (SWF)

Country	Mean Return	Standard Deviation
Forex Reserves - Israel	2.62	1.94
Forex Reserves - Switzerland	4.20	2.27
Norway's SWF	6.24	10.65

 Source: Calculated from data in Tables 3 and 4.

Creation of a SWF raises an important question about two interconnected issues: How should the fund's resources be used and the identity of the fund's manager. There is widespread agreement that windfalls should be used mainly to fund long term national activities rather than current expenditures. The main options for management of the fund are the CB, an independent body or the Treasury. At first blush the management of a country's wealth would appear as an additional natural function of the Treasury. However historical experience suggests that, when managed by the Treasury, the fund may be used for the financing of current budgetary expenditures rather than for the funding of long term national needs. It is therefore imperative to separate the management of a SWF from the current budgetary activities of Government.

Those questions are currently particularly relevant for the BOI that has cumulated, by its own historical standards, a sizable reserve pool due to intervention designed to slow down appreciations as well as to offset the impact of gas discovery on the exchange

rate.[24] Another important question concerns the specification of the purposes for which the net profits of a SWF can be used. Whatever the ultimate institutional location of a SWF appropriate legislation should assure that its funds are used mainly for financing long term needs of the economy and its citizenry. One natural candidate for such long term financing is the subsidization of compulsory pensions in Israel. A back of the envelope illustration of the orders of magnitudes involved follows: In 2015 the total subsidy for this purpose was a bit less than one billion ILS. Current forex reserves are about 100 billion $ which, at a USD/ILS rate of 3.6 amount to 360 Billion ILS. Thus a net rate of return of 0.27 of a percent (1/360) on reserves suffices to cover the current compulsory pensions subsidy,

Due to aging of population this amount will grow over time but, judging by the past return performance of the SNB and of the Norwegian SWF, is unlikely to exhaust the potential long term returns from a well-managed SWF. Moving this and other longer term items off the regular yearly budget to a SWF will free resources for other current uses. But an important word of caution is in order at this juncture. Since the temptations to use returns from a SWF for regular budgetary expenditures are strong it is imperative that the list of items to be financed from this source be determined in advance by a public committee of experts and policymaker and cemented by law. Furthermore, the institution in charge of managing the SWF should be given enough independence to resist political pressure designed to divert funds to current government expenditures.

7. Concluding remarks

A striking difference between the strong intervention periods of Switzerland and Israel is that in the first case the commitment was to maintain an exchange rate floor with respect to another currency (the Euro) while in the second it was a commitment to acquire preannounced quantities of forex reserves. Assuming that in both cases the main motive for intervention was to slow down appreciation in order to prevent shrinkage of exports it is likely that in both cases the intermediate target of both CBs was the effective ER.

This begs a question about the reasons for those different forms of commitment. There are several reasons for the difference. First, the main trading partner of the Swiss economy is the Euro zone (EZ) while Israeli trade is split between the Euro and the Dollar blocks. As a consequence (and as documented in table 2 of the paper) maintenance of a floor wrt the Euro is more tightly linked to the Swiss nominal effective ER than is its Israeli counterpart to either the Euro or the dollar. Second Switzerland is more open than Israel by conventional trade measures and more integrated in world capital markets. Last but not least, during distress times in the EZ excess demand for the Swiss Franc due to the safe haven motive is substantially larger than is the demand for the Israeli currency. As a consequence the SNB has to engage in stronger counter measures including faster convergence to the ZLB, negative policy rates and no sterilization of intervention

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[24] The level of intervention earmarked for the second purpose is small in comparison to other discretionary intervention. Details appear in Figure 1 of Ribon (2017).

operations. Higher Israeli inflation and real growth during most of the GFC also contributed to differences in monetary policy and intervention policies.

The previous discussion suggests that the Swiss commitment to a floor was stronger and also more risky in terms of forex reserves buildup than the Israeli commitment to buy preannounced quantities of forex. Was it also more effective? A perusal of Figure 1b in the paper suggests that the floor managed to prevent an appreciation of at least 7% over three years in the Swiss effective ER. Similar, but not fully comparable results by Sorezcky (2015) for the Israeli strong intervention period reveals that the USD/ILS rate gradually responded to intervention reaching a maximum of 11% difference after nine months from the start of intervention, decaying to 6% after twelve months and ultimately converging to zero five months later toward the end of the strong intervention period. Although the Swiss evidence refers to the effective rate and the Israeli evidence to the nominal USD/ILS rate this comparison supports the view that the strong Swiss intervention was more effective . This view is also backed by the fact (shown in Figure 1a and Table 1) that during the floor period fluctuations in the EUR/CHF rate converged to almost zero.

During the bulk of the GFC the SNB did not sterilize interventions. This led to a massive expansion of the monetary base. Prior to reaching the ZLB this policy deliberately reinforced the expansionary impact of monetary policy. Once the ZLB was reached and the policy rate became negative sterilization was not even feasible since it would have required paying a positive rate on sight deposits at the SNB – a course of action that is not possible under negative policy rates. In a broad sense the unsterilized forex interventions of the SNB are equivalent to the US quantitative easing (QE) operations. In both cases these policies induced substantial increases in the monetary base. [25] But in the Swiss case the bulk of large scale asset purchases were directed at foreign rather than at domestic financial assets for two related reasons. First, due to its extreme openness, the stimulatory impact of QE operations that lean against appreciations is stronger in Switzerland than in the US. Second, due to its small size, the Swiss economy does not have enough domestic assets to support large scale domestic asset purchases.

Conventional wisdom maintains that CBs should not interfere directly with the free operation of forex markets. Instead it should affect the exchange rate only through interest rate policy. The GFC demonstrated that this view is limited for several reasons. First, when the natural rate of interest becomes negative, the ZLB may prevent the actual policy rate from moving toward its natural counterpart.[26] Further monetary expansion can then be achieved by policy instruments such as QE and forex interventions. Second, when major trading partners engage in sustained but ultimately reversible low or negative rates cum QE, forex interventions can temporarily shield the domestic economy from the

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[25] Although the US base expansion was substantially larger in absolute terms than its Swiss counterpart it constituted only 23 percent of US GDP.at its peak in 2014. In contrast the Swiss base was over 80 percent of GDP at the end of 2016.

[26] Estimates by Laubach and Williams (2015) and Curdia (2015) imply that the natural rate has been negative during most of the GFC and that it is likely to be in the negative range more often than before the crisis in the future. Although, as argued in Cukierman (2016), there are reasons to believe that some of those estimates are biased downward the prediction that negative natural rates will be more likely to occur in the future appears reasonable.

adverse effects of such foreign policies on domestic exports. This factor is particularly important in small open economies such as Switzerland and Israel.

Evaluation of forex reserves in terms of domestic currency may be quite misleading. Since such reserves represent an obligation of the rest of the world toward the domestic economy they should be valued in terms of the relevant (for the domestic economy) basket of foreign currencies rather than in terms of domestic currency. Given fixed world prices, when the domestic currency appreciates or depreciates the real value of this obligation does not change. A similar argument applies to the measurement of the rate of return on reserves. Table 3 in the paper shows that, in both Switzerland and Israel, rates of return in terms of domestic currency have been lower and more variable than their counterparts measured in terms of relevant forex numeraires.

Nonetheless calculation of CB profits and losses from reserves are often done in domestic currency particularly when the resulting final figure is used in order to distribute some of the CB profits to its shareholders when such profits are positive.[27] Although it uses an appropriate forex numeraire to evaluate the return on reserves the BOI also calculates gross returns from forex investments in terms of domestic currency in the Bank's yearly profit and loss statement. A net contribution of reserves to the Bank's profit and loss statement is then obtained by subtracting the interest paid by the Bank to sterilize forex intervention. In public discussions the resulting figure is often identified as the "cost of sterilized intervention" in the forex market.

One may take issue with this procedure for at least two reasons. First, this procedure abstracts from the implicit seignorage income that the Bank obtains due to secular increases in the monetary base. Second, even if we limit ourselves to a comparison of the return on reserves with the interest cost of sterilization, it makes more sense to perform this calculation in terms of the relevant forex numeraire rather than in terms of domestic currency. The reason, again. is that net (like gross) returns from holding reserves should be measured in terms of changes in the value of the real obligations of the rest of the world toward the domestic economy rather than in terms of domestic currency whose fluctuations are largely unrelated to changes in the real value of those obligations.

Beyond the measurement issue lurks an important question about the optimal disposition and potential use of returns from forex reserves. This question received less attention in both Israel and Switzerland prior to the GFC when forex reserves were substantially smaller. Following their rapid expansion it became clear to policymakers in both countries that, from some level of reserves and up, the traditionally conservative investment strategy of central bankers is no longer appropriate. Both central banks gradually moved to some equity investments with the SNB taking an early lead.

The paper argues that the existence of large forex reserves is similar to national wealth originating from a natural resource and should be handled accordingly. This requires the creation of an institutional framework that would allow long term investment of reserves levels beyond the necessary precautionary amounts along with the creation of a legal framework that would assure the use of returns from reserves for national long

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[27] In Switzerland, for example, the CB occasionally distributes profits to the Cantons provided they are positive in terms of domestic currency. Profits in terms of domestic currency have been substantially reduced over the last ten years due to appreciation of the Swiss Franc. This ocurred in spite of the fact that returns in terms of forex were significantly larger on average. .

term objectives. One possible model discussed in the paper is the Norwegian sovereign wealth fund.

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