

**EXECUTIVE  
BOARD  
MEETING**

SM/22/113

May 26, 2022

To: Members of the Executive Board  
From: The Secretary  
Subject: **Switzerland—Selected Issues**

Board Action:	Provides background to SM/22/112—Staff Report for the 2022 Article IV Consultation
Tentative Board Date:	<b>Friday, June 10, 2022</b>
Publication:	Yes*
Questions:	Mr. Horton, EUR (ext. 39850) Mr. Zeng, EUR (ext. 35723) Ms. Valderrama, EUR (ext. 37816) Ms. Maslova, EUR (ext. 38306)
Document Transmittal in the Absence of an Objection and in accordance with Board policy:	After Board Consideration—Food and Agriculture Organization, Organisation for Economic Cooperation and Development, World Trade Organization

**\*Unless an objection from the authorities is received prior to the conclusion of the Board's consideration, the document will be published.**





# SWITZERLAND

## SELECTED ISSUES

May 25, 2022

Approved By  
European Department

Prepared By Li Zeng, Laura Valderrama and Svitlana Maslova

## CONTENTS

### BIG ACQUISITION, SMALL ACCUMULATION: WHY?—A LOOK AT SWITZERLAND'S

<b>BOP-IIP DYNAMICS</b>	4
A. The Puzzle of Big Acquisition and Small Accumulation	4
B. Analysis of Switzerland's Integrated IIP Statement	5
C. A Cross-Country Comparison	9
D. Summary	12

### FIGURES

1. An Illustration of the BOP-IIP Dynamics	4
2. Switzerland: The Puzzle of Big Acquisition and Small Accumulation	4
3. Switzerland: Franc NEER Index	6
4. Cumulative Financial Account Balances versus Changes in NIIP, 2008–20	10
5. Cumulative Financial Account Balances versus NEER Changes, 2008–20	10
6. Cumulative Financial Account Balances versus Changes in REER, 2008–20	12
7. Norwegian Krone REER and Oil Prices	12

### TABLES

1. Switzerland: Net International Investment Position	6
2. Switzerland: International Investment Position by Component	7
3. Switzerland: Investment Returns of Foreign Assets and Liabilities	8
4. Switzerland: Shares of Equity Investment	9
5. Switzerland versus Israel: Cumulative International Investment Position Changes, 2008–2020	10
6. Switzerland versus Israel: International Investment Returns (%), 2008–2020	10
7. Decomposition of 2008–2020 Cumulative Financial Account Balances	12
References	14

## **A FORWARD-LOOKING APPROACH TO CALIBRATE MACROPRUDENTIAL TOOLS IN SWITZERLAND**

<b>SWITZERLAND</b>	<b>15</b>
A. The Build-Up of Systemic Risk	15
B. The Policy Response	17
C. Transmission Channels of Macroprudential Tools	19
D. A Modeling Approach to Quantify Banking System Resilience	21
E. Stress Test Results under Current Macroprudential Tools	27
F. Calibration of Borrower-Based Macroprudential Tools	28
G. Policy Implications	31

### **FIGURES**

1. Switzerland: Macrofinancial Relevance of the Mortgage Market in Switzerland	16
2. Policy Response, Mortgage Credit, House Prices, and Interest Rates	18
3. Leverage in Residential Real Estate Loans	18
4. Impact of Interest Rate Shocks on Affordability Risk	20
5. Stress Test Scenario: Key Variables	26
6. Stress Test Results	28
7. Timeline of Macroprudential Policy Interventions	29
8. Impact of Borrower-Based Tools Under Adverse Scenario by Vintage	30
References	33

### **ANNEX**

I. Technical Aspects of the Model	34
-----------------------------------	----

## **NATURAL GAS IN SWITZERLAND: CONSUMPTION, IMPORTS, AND RISKS**

A. Motivation	36
B. Natural Gas Reliance in Switzerland and the European Union	37
C. Analyzing an Impact of a Stop in Russian Gas Imports	40
D. Policy Implications	41

### **FIGURES**

1. Energy prices	36
2. Switzerland: Gross Energy Consumption in Switzerland	37
3. Switzerland: Energy Usage for Heating and Electricity	38
4. Heat Production in Switzerland and the EU	38
5. Natural Gas Usage	39
6. Monthly Natural Gas Imports	39
7. Imports of Natural Gas	40
8. Switzerland: Baseline	40

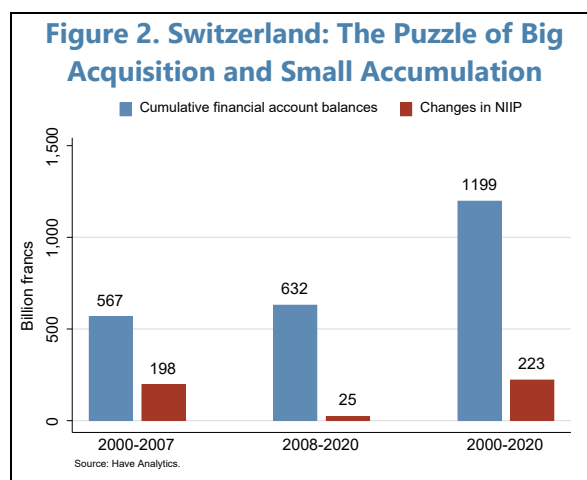
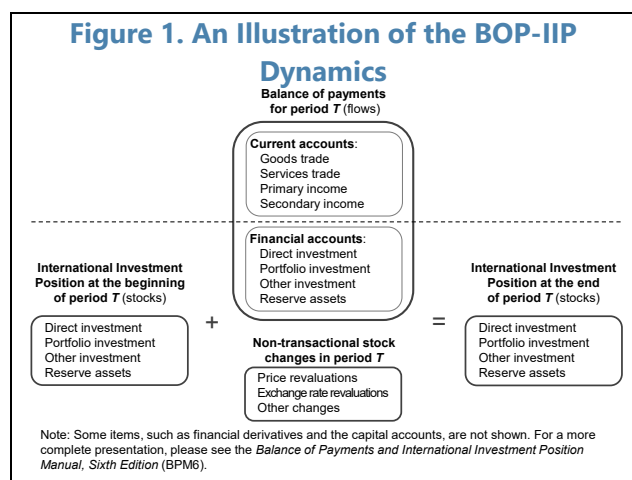
9. Scenario of No Russian Gas Imports	41
References	43

# BIG ACQUISITION, SMALL ACCUMULATION: WHY?<sup>1</sup>—A LOOK AT SWITZERLAND'S BOP-IIP DYNAMICS

*This paper identifies exchange rate revaluation losses and relatively low returns on foreign assets as key factors for the large gaps between Switzerland's net foreign assets acquisitions and accumulations. It suggests a few directions that may help Switzerland reduce the gaps, including robust global diversification by Swiss investors that would also relieve appreciation pressures on the franc, improving the currency composition of foreign assets to reduce exchange rate risks, and raising foreign investment returns, e.g., through improved pension fund performance.*

## A. The Puzzle of Big Acquisition and Small Accumulation

**1. The balance of payments (BOP) and the international investment position (IIP) are two important macroeconomic accounts to assess an economy's external activities.** The BOP is a flow table that records external transactions during a certain period. It has two components, the current account (CA)—showing the sources of savings (a positive balance) or dissavings (a negative balance), and the financial accounts (FA)—showing how the savings in the CA are allocated for asset accumulation or how the dissavings in the CA are financed (Figure 1). The IIP, on the other hand, is a stock table reflecting the economy's external assets and liabilities at a certain point of time. The changes in IIP stocks during a period can be accounted for by the FA of the BOP, often with small discrepancies due to other, non-transactional changes (e.g., valuation changes related to exchange rate movements). Such discrepancies, however, were quite large for Switzerland.



**2. Switzerland has, on a net basis, acquired large amounts of foreign assets over time. The increase in its net IIP, however, has been much smaller.** The BOP data show that Switzerland's cumulative finance account balance (CFAB) amounted to CHF1.2 trillion during 2000–2020 (Figure 2).

<sup>1</sup> Prepared by Li Zeng (EUR). The author would also like to thank Mark Horton and seminar participants at the Swiss National Bank for their helpful comments.

The increase in its net IIP, however, was only around CHF220 billion during the same period. Such a gap between the net acquisition of foreign assets and the increase in the net IIP (the “acquisition-accumulation gap”) was more striking in 2008–20, the period after the global financial crisis (GFC): while Switzerland’s net acquisition of foreign assets was over CHF600 billion, its net IIP increased by only CHF25 billion.

**3. This paper aims to shed light on the acquisition-accumulation gaps from two different perspectives.** The first angle draws on the new [Swiss integrated IIP statement](#), which provides a detailed breakdown of changes in IIP stocks. The second angle takes a cross-country perspective, comparing Switzerland to a group of economies that also had large net foreign assets acquisitions, but with different IIP accumulation outcomes.

## B. Analysis of Switzerland’s Integrated IIP Statement

### Net Position of Total Investment

**4. From an aggregate perspective, negative exchange rate revaluations were the main driver of the acquisition-accumulation gaps.** The integrated IIP statement breaks changes in IIP stocks into transactions, exchange rate revaluations, price revaluations, and other changes (Table 1).<sup>2,3</sup> For the period 2000–2020, negative revaluations due to exchange rate movements (CHF 704 billion) accounted for nearly 60 percent of the acquisition-accumulation gap (CHF 977 billion). These revaluation losses were particularly large relative to transactions in the post-GFC era (CHF 558 billion versus CHF 632 billion). This is not surprising given the sharp nominal appreciation of the franc since 2008 (Figure 3). “Other changes” was another important category underlying the acquisition-accumulation gap, which, to certain extent, reflects the challenge of accurately measuring the BOP and IIP for a small, open economy like Switzerland (see footnote 2). Price revaluations was also a contributing factor, but only played a minor role compared to exchange rate revaluations and other changes.

---

<sup>2</sup> *Price revaluations* reflect unrealized nominal holding gains/losses due to price changes, while realized holding gains (if reinvested) or losses are recorded as part of transactions. *Other changes* are changes in IIP stocks which are caused neither by transactions nor revaluations. They arise from, for instance, expansions in the reporting population or reclassifications.

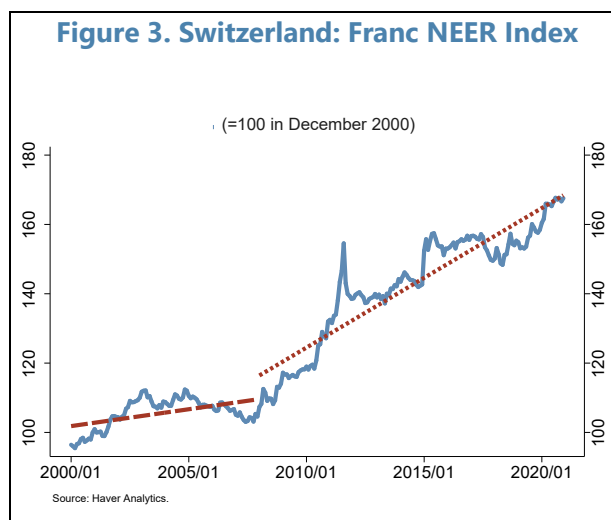
<sup>3</sup> In the IMF’s external sector assessment (ESA) exercise, the gaps between the current account balances and IIP stock changes were partially accounted for through adjustors for measurement issues under the sixth edition of the IMF *Balance of Payments and International Investment Position Manual*. For more discussions on these adjustors, see “[The Measurement of External Accounts](#),” IMF Working Paper 19/132. In the integrated IIP statement, which gives a more complete breakdown of those gaps, the impacts of the measurement issues are reflected in different components. For instance, the adjustor for nominal interest on fixed income securities is captured as a part of the exchange rate revaluations, and the adjustor for retained earnings of portfolio equity investment is a driving factor for the price revaluations.

### Analysis by IIP Component

**Table 1. Switzerland: Net International Investment Position**

Billion francs	Beginning IIP	ΔIIP	Transactions	Revaluations		Other volume changes	Ending IIP
				Exchange rate	Price		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
2000-07	540	199	567	-146	-105	-117	738
2008-20	738	23	632	-558	39	-89	762
2000-20	540	222	1199	-704	-66	-207	762

Source: Swiss National Bank Data Portal.  
Note: Excluding financial derivatives.



**5. An analysis of the gaps by IIP component has three focuses: exchange rate revaluations, investors’ willingness to invest, and investment returns.** Changes in Swiss investors’ willingness to invest abroad (and willingness of non-residents to invest in Switzerland)—an important factor that interacts with exchange rate movements—are assessed by comparing transaction volumes before and after the GFC.<sup>4</sup> The investment return rates of certain assets are estimated using the following equation:

$$\text{Investment return rate} = \frac{\text{Investment income (from BOP CA)} + \text{price revaluations}}{\text{Average stock position}}$$

**6. All major components of the IIP experienced significant exchange rate revaluation losses during 2008–2020, except other investment.**<sup>5</sup> *Direct investment* lost CHF 235 billion due to exchange rate revaluations during 2008–2020 (Table 2). While the exchange rate revaluation was also negative during 2000–2007, the magnitude was much smaller (CHF 37 billion). Developments for *portfolio investment* and *reserve assets* were similar.<sup>6</sup> *Other investment*, in contrast, enjoyed a small exchange rate revaluation gain (CHF 17 billion) during 2008–2020. Since *other investments* are mostly cross-border banking activities, this is probably an indication of sound exchange rate risk management by banks.

**7. The private sector in Switzerland appears to have become less willing to invest abroad after the GFC, while the SNB leaned against such a trend.** During 2000–2007, the net acquisition of foreign assets by the Swiss private sector averaged CHF 73 billion a year.<sup>7</sup> This turned into a net

<sup>4</sup> Changes in transaction volumes may also reflect other factors, such as regulation changes.

<sup>5</sup> *Other investment* mainly covers cross-border banking activities, such as foreign deposits and cross-border loans.

<sup>6</sup> For *portfolio investment*, foreign liabilities brought some exchange rate revaluation gains. But they were smaller compared to the losses on assets, because most of such foreign liabilities were denominated in Swiss franc.

<sup>7</sup> *Direct investment* +CHF27 billion, *portfolio investment* +CH51 billion, and *other investment* -CHF5 billion.

reduction of foreign assets during 2008–2020, averaging CHF 16 billion a year.<sup>8</sup> This shift was driven by *other investment* and *portfolio investment*, while the average annual net FDI abroad remained largely unchanged before and after the GFC.<sup>9</sup> By contrast, the SNB acquired, on average, CHF 65 billion reserve assets each year after the GFC, compared to a small net reduction of CHF 2 billion a year before.<sup>10</sup> As a result, while the net IIP of non-SNB sectors declined by CHF846 billion during 2008–2020, the SNB's net IIP increased by CHF869 billion. The additional acquisition of foreign assets by the SNB, however, only partially offset the decline in private investment abroad. This may be a reason why, despite the SNB's large FXI operations during 2008–2020, the Swiss franc still faced persistent appreciation pressures in this period.

**Table 2. Switzerland: International Investment Position by Component**

Billion francs	Beginning IIP	ΔIIP	Transactions	Revaluations		Other volume changes	Ending IIP	Billion francs	Beginning IIP	ΔIIP	Transactions	Revaluations		Other volume changes	Ending IIP
				Exchange rate	Price							Exchange rate	Price		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)		(1)	(2)	(3)	(4)	(5)	(6)	(7)
<b>Direct investment, net position 1/</b>								<b>Portfolio investment, net position</b>							
2000-07	166	141	213	-37	0	-35	307	2000-07	257	93	410	-76	-137	-105	351
2008-20	307	-96	372	-235	0	-233	212	2008-20	351	-280	179	-229	-101	-130	70
2000-20	166	45	585	-272	0	-268	212	2000-20	257	-187	590	-304	-238	-235	70
<b>Other investment, net position 1/</b>								<b>Portfolio investment, assets</b>							
2000-07	46	-50	-39	-27	0	16	-4	2000-07	808	463	455	-87	19	77	1271
2008-20	-4	-470	-762	17	0	275	-474	2008-20	1271	215	148	-274	286	55	1486
2000-20	46	-520	-802	-9	0	291	-474	2000-20	808	678	603	-361	305	132	1486
<b>Reserve assets 2/</b>								<b>Portfolio investment, liabilities</b>							
2000-07	70	15	-16	-7	31	7	85	2000-07	551	370	44	-11	156	182	921
2008-20	85	869	842	-111	141	-2	954	2008-20	921	496	-31	-45	387	185	1416
2000-20	70	884	826	-118	172	4	954	2000-20	551	866	13	-57	543	367	1416

Sources: Swiss National Bank Data Portal, IMF staff calculations.

1/ Due to two-way holdings by financial holding companies and active balance sheet management by banks, a further breakdown of *direct investment* and *other investment* by assets and liabilities is not particularly informative and therefore not shown in the table. For these two categories, net transactions (rather than transactions of foreign assets) were used to assess Swiss investors' willingness to invest abroad. For more discussions on this issue, please see "Swiss Franc - Safe Haven for Whom?" IMF Selected Issues Paper, Country Report 21/131.

2/ The price revaluations for 2000-2007 and 2000-2020 included gains of around CHF25 billion from an extraordinary revaluation of SNB's gold holdings in 2000.

<sup>8</sup> *Direct investment* +CHF29 billion, *portfolio investment* +CH14 billion, and *other investment* -CHF59 billion.

<sup>9</sup> For *direct investment* and *other investment*, net transactions (rather than transactions of foreign assets) were used to assess Swiss investors' willingness to invest abroad. This was due to the large amounts of offsetting transactions, e.g., caused by financial holding companies or banks' active management of both their assets and liabilities. For more discussion, please see "[Swiss Franc – Safe Haven for Whom?](#)" in IMF Country Report 21/131. The reduction of net *other investment* holdings was probably a contributing factor to banks' good exchange rate risk management in the post-GFC era. On *direct investment*, one caveat is that much of the outward FDIs occurred after the U.S. tax reforms in 2017—net FDI outflows averaged nearly CHF100 billion during 2018–2020. This was likely driven by financial holding companies' withdrawals.

<sup>10</sup> Foreign exchange purchases by the SNB through FXIs were mostly concentrated in a few episodes with particularly large safe-haven capital inflows, for example, in early 2010 after the outbreak of the Greece debt crisis, in 2012 with the spread of the European debt crisis, in late 2014 and early 2015 with the anticipation of QE operations by the ECB, and in early 2020 after the outbreak of the Covid-19 pandemic.

**8. The difference in returns on *portfolio investment* assets and liabilities was another important reason for the acquisition-accumulation gap.** During 2008–2020, the average return rates on Switzerland's *portfolio investment* assets and liabilities were 4.3 percent and 5.3 percent, respectively (Table 3). The average return rate on *reserve assets*, 3.9 percent, was lower.<sup>11</sup> Had *portfolio investment* assets and *reserve assets* achieved the same return rate as *portfolio investment* liabilities, the acquisition-accumulation gap during 2008–2020 (CHF609 billion, see Table 1) would have been narrowed by around CHF260 billion.

**Table 3. Switzerland: Investment Returns of Foreign Assets and Liabilities**

(%)	Average investment return rate excluding exchange rate revaluations				Average investment return rate including exchange rate revaluations			
	Direct investment	Portfolio investment	Other investment	Reserve assets 1/	Direct investment	Portfolio investment	Other investment	Reserve assets 1/
<b>Assets</b>								
2000-07	9.2	3.2	2.7	3.6	8.1	2.0	0.7	2.5
2008-20	5.3	4.3	1.5	3.9	3.7	2.6	-0.1	2.2
2000-20	6.0	3.9	2.0	3.9	4.5	2.4	0.2	2.2
<b>Liabilities</b>								
2000-07	8.6	5.0	2.9		8.2	4.7	1.2	
2008-20	5.5	5.3	1.4		5.0	5.0	-0.1	
2000-20	5.9	5.2	1.9		5.4	4.9	0.4	

Sources: Haver Analytics, Swiss National Bank Data Portal, IMF staff estimates.  
1/ For reserve assets, the year of 2000 was not included in the calculations, to exclude the gains from an extraordinary revaluation of SNB's gold holdings in 2000.

**9. Investment performance differences can be, at least partly, explained by risk profiles associated with *portfolio investment* assets and liabilities.** During 2008–2020, the average shares of debt securities and equities in Swiss *portfolio investment* assets abroad were 55 percent and 45 percent, respectively (Table 4). In contrast, over 90 percent of foreign portfolio investments in Switzerland were equities. The SNB maintained a different risk profile on its substantial and growing portfolio investment: during 2011–2020, the shares of equity investment among SNB foreign currency reserves averaged 17.5 percent.

**10. If exchange rate revaluations are also considered, the returns on foreign assets in the post-GFC era look even less attractive relative to those on foreign liabilities.** The 1-percentage-point return gap between *portfolio investment* assets and liabilities widens to 2.4 percentage points (Table 3). This seems to suggest that the decline of private Swiss investors' interest in overseas portfolio investment in the post-GFC era was rational, and its interaction with the exchange rate

<sup>11</sup> During 2008–2020, investment on foreign currency securities accounted for, on average, 80 percent of total reserve assets. This ratio was around 55 percent during 2000–2007.

(lower return *and* depreciation of non-CHF holdings) may have led to a self-reinforcing component in the persistent appreciation pressure on the franc during this period.<sup>12</sup>

## C. A Cross-Country Comparison

### 11. The cross-country analysis focuses on the post-GFC period and compares Switzerland with ten other economies that also acquired significant amounts of foreign assets.<sup>13</sup> We are

particularly interested in the post-GFC era, because Switzerland's acquisition-accumulation gap was especially large in this period (Figure 2). The 2008–2020 cumulative financial account balances (CFABs) of the economies in the group all exceed 30 percent of their respective 2020 GDPs.<sup>14</sup> Limiting the sample to these economies ensures a certain degree of comparability, thereby making the analysis of a complex, multifaceted problem more trackable.

	Portfolio investment, assets	Portfolio investment, liabilities	Reserve assets 1/
2000-2007	46.4	89.4	
2008-2020	45.0	90.5	17.5
2000-2020	45.5	90.1	

Sources: Haver Analytics, Swiss National Bank annual reports, Swiss National Bank Data Portal, IMF staff calculations.

1/ Average of 2011-2020 year-end shares.

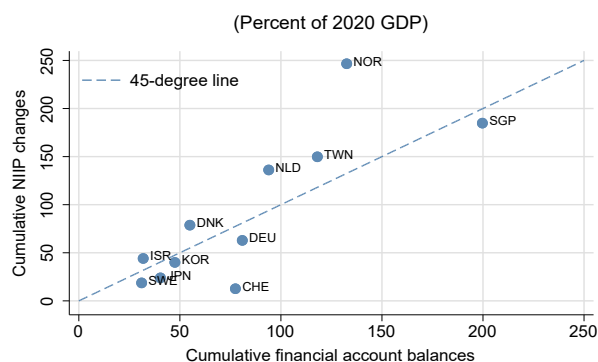
**12. More specifically, the paper aims to provide a better understanding of Switzerland's large acquisition-accumulation gap by exploring two specific, exchange rate-related questions.** The questions concern exchange rates because the large appreciation of the franc, as discussed in the previous section, was a key driver of Switzerland's acquisition-accumulation gap. The first question is why Israel managed to achieve a larger net IIP increase than its cumulative foreign assets acquisition, despite a 45-percent nominal appreciation of the shekel, second highest among the group and only next to the 55-percent appreciation of the Swiss franc (Figures 4 and 5). The second question is why some currencies (e.g., the Norwegian krone, the Singapore dollar, and the new Taiwan dollar) appreciated much less than the franc, even though the net acquisitions of foreign assets of these economies were much larger than Switzerland's.

<sup>12</sup> See also "[Swiss Franc – Safe Haven for Whom?](#)" IMF Selected Issues Paper, Country Report 21/131, IMF.

<sup>13</sup> These include Germany, Israel, Japan, Korea, Macao SAR, Netherlands, Norway, Singapore, Sweden, and Taiwan Province of China.

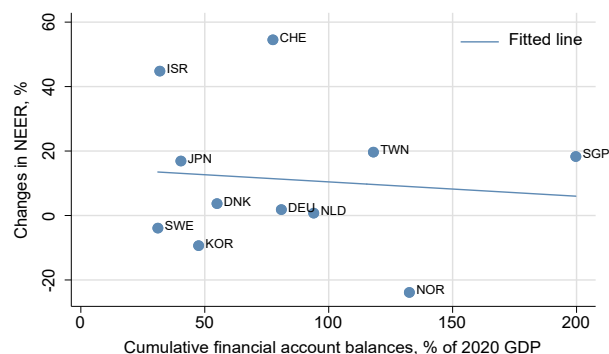
<sup>14</sup> A few economies were excluded due to their distinctive features, including Hong Kong SAR (with a currency board exchange rate system linked to the U.S. dollar) and Macao SAR (highly dependent on tourism, with a 54-percent contraction of real GDP in 2020), Belgium (with a particularly large financial sector balance sheet relative to the overall economy), and oil-exporters Saudi Arabia and Russia.

**Figure 4. Cumulative Financial Account Balances versus Changes in NIIP, 2008–20**



Sources: IMF World Economic Outlook database; IMF staff calculation.  
Note: Based on IMF WEO data denominated in USD.

**Figure 5. Cumulative Financial Account Balances versus NEER Changes, 2008–20**



Sources: BIS, IMF World Economic Outlook database; IMF staff calculation.  
Note: The financial account balances were calculated using IMF WEO data denominated in USD.

**Question 1. How to explain the difference between the acquisition-accumulation gaps for Switzerland and Israel, despite similarly large appreciations of their currencies?**

**13. Exchange rate revaluations explained a large part of the difference between the acquisition-accumulation gaps of Israel and Switzerland.** For Switzerland, negative exchange rate revaluations (CHF558 billion) offset nearly 90 percent of its net foreign assets acquisitions during 2008–2020 (Table 5, Column 2). In contrast, Israel experienced only a small exchange rate revaluation loss (ILS4 billion) compared to its net foreign assets acquisition (ILS130 billion).

**Table 5. Switzerland versus Israel: Cumulative International Investment Position Changes, 2008–2020**

	Israel Billion USD (1)	Switzerland Billion CHF (2)	Switzerland Billion USD 1/ (3)
<b>ΔIIP</b>	186	25	198
Transactions	130	632	644
<b>Exchange rate revaluations</b>	<b>-4</b>	<b>-558</b>	<b>-381</b>
Assets	0	-895	-32
Liabilities	5	-337	349
Price revaluations	56	39	30
Other changes	5	-89	-96
Memorandum items:			
Exchange rate revaluations			
Assets (% of avg. stock)	0.0	-21.7	-0.8
Liabilities (% of avg. stock)	1.9	-9.7	9.9

Sources: Haver Analytics, Swiss National Bank, IMF World Economic Outlook database, IMF staff estimates.

1/ Estimated based on the Swiss IIP in CHF. For period T, the beginning IIP was converted using the exchange rate of period T-1, and the ending IIP, transactions, price revaluations and other changes were converted using the exchange rate of period T. The exchange rate revaluations in USD were calculated as (ending IIP\_USD - beginning IIP\_USD - transactions\_USD - price revaluations\_USD - other changes\_USD).

**Table 6. Switzerland versus Israel: International Investment Returns (%), 2008–2020 1/**

Denomination currency	Israel USD	Switzerland CHF	Switzerland USD
<b>Total</b>			
Assets	<b>5.0</b>	<b>4.0</b>	4.0
Liabilities	<b>4.6</b>	<b>4.1</b>	4.1
Direct investment			
Assets	6.3	5.3	5.3
Liabilities	6.3	5.5	5.5
Portfolio investment			
Assets	<b>8.2</b>	<b>4.3</b>	4.4
Liabilities	<b>5.0</b>	<b>5.3</b>	5.5
Other investment			
Assets	2.8	1.5	1.5
Liabilities	1.2	1.4	1.3
Reserve assets			
Assets	1.8	3.9	3.9

Sources: Haver Analytics, Swiss National Bank, IMF World Economic Outlook database, IMF staff estimates.

1/ Investment return rate = (Price revaluation + investment income) / average stock.

**14. In addition to the slight difference in strength of the franc and shekel, other factors also contributed to the difference in exchange rate revaluations.** These include the currency used for IIP denomination, the currency compositions of foreign assets and liabilities, and the size of net IIP. Denominated in USD, the negative exchange rate revaluations for Switzerland would become

smaller relative to total transactions (Table 5, Column 3). On the other hand, the still-sizable exchange rate revaluation losses (USD381 billion) suggest that a currency mismatch between Switzerland's foreign assets and liabilities played an important role as well.<sup>15</sup> During 2008–2020, Israel's net IIP averaged around 30 percent of GDP, while the ratio was almost 100 percent for Switzerland, exposing it to more exchange rate revaluation risks.

**15. Investment returns appear to be an important factor underlying the differences for Israel and Switzerland as well.** While the overall return on Israel's foreign assets (5.0 percent) was higher than that on its foreign liabilities (4.6 percent), it was the opposite for Switzerland (Table 6). If the returns on Switzerland's foreign assets and liabilities were the same as Israel's, it would have had around CHF300 billion additional price revaluation gains during 2008–2020. This investment performance difference is most notable for *portfolio investment*: while the average return on Israel's foreign assets was 3.2 percentage points higher than that on its foreign liabilities, the differential was -1.0 percentage point for Switzerland.<sup>16</sup> This seemed mostly driven by their different asset returns (Israel 8.2 percent versus Switzerland 4.3 percent) rather than liabilities. Higher risk appetite might help explain Israel's better investment returns, although more work is needed to understand what other factors, and to what extent they have, played a role.<sup>17</sup>

**Question 2. Why did some currencies (e.g., NOK, SGD and TWD) appreciate much less than the franc, even though these economies had larger CFABs than Switzerland?**

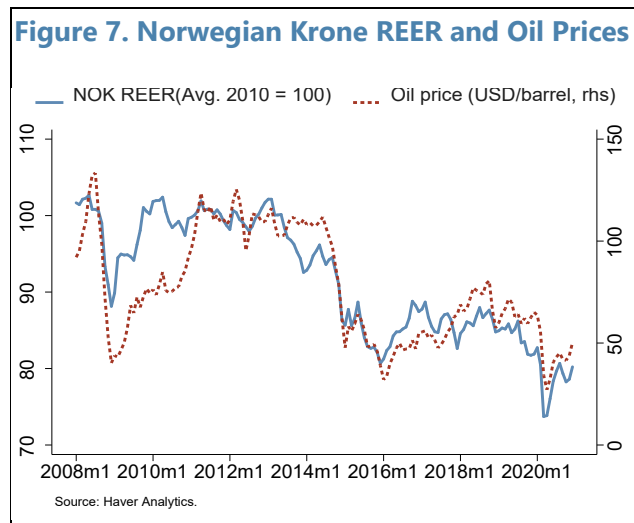
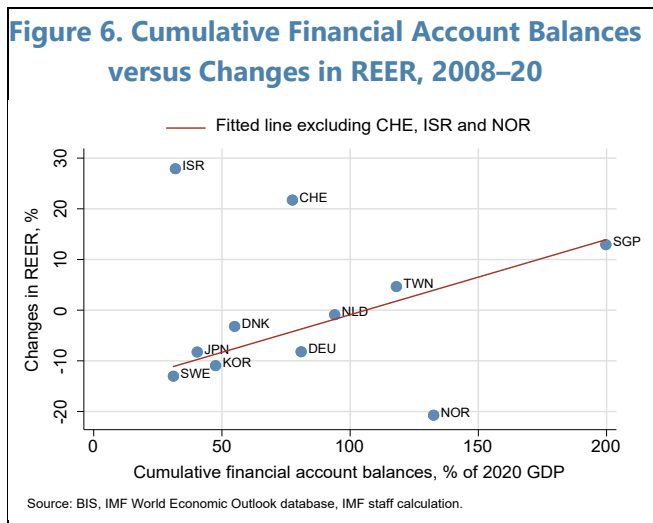
**16. Inflation differentials seem able to bridge the disconnect between nominal exchange rate changes and CFABs for most economies in the sample.** Without considering Switzerland, Israel or Norway (the lone major commodity exporter among the group), a simple regression of changes in real effective exchange rates (REER) against CFABs produced a very good fit, with an  $R^2$  of almost 0.9 (Figure 6). This shows that, for these economies, higher CFABs (the flip side of current account balances) were indeed associated with larger exchange rate appreciations or smaller depreciations—after adjustments for inflations. Given the importance oil products in Norway's overall exports, the REER of krone was closely linked to oil prices (Figure 7). The excess depreciation of the krone was likely, at least to some extent, driven by the collapse of oil prices during 2014 and 2015—the krone REER depreciated by 16 percent in this period, accounting for  $\frac{3}{4}$  of the total depreciation during 2008–2020.

---

<sup>15</sup> The sizable exchange rate revaluation losses when the IIP is denominated in USD suggest that Switzerland must have more foreign assets than liabilities that were denominated in currencies that were weaker than the USD (e.g., euro), and/or more foreign liabilities than assets that were denominated in currencies that were stronger than the USD (e.g., the franc). A detailed breakdown of the Swiss IIP by currency can be found at the [SNB Data Portal](#).

<sup>16</sup> Since the calculations of the investment return rates did not include exchange rate revaluations, whether the Swiss IIP was denominated in CHF or USD did not make a big difference.

<sup>17</sup> The average share of equities in Israel's *portfolio investment* assets during 2008–2020 was about 55 percent, compared to Switzerland's 45 percent. This may have reflected, for example, the two countries' different demographics, which may have led to different risk appetites of their pension funds.



**17. The fact that the SNB and the Bank of Israel had to lean against safe haven flows and the resident and non-resident private sectors through FXIs seems to help explain the particularly large appreciations of their currencies.** Among the economies in the sample, only in Switzerland and Israel, did the non-central-bank sectors record net capital *inflows* between 2008 and 2020 (Table 7). In some other economies, such as Singapore and Taiwan Province of China, central banks also had to step in to mitigate appreciation pressures, although it was the non-central-bank sectors that did the most heavy-lifting (by investing abroad). While the fit of regressing REER changes against CFABs for the full sample was poor ( $R^2$  of 0.01),<sup>18</sup> adding the non-central-bank sectors' shares in total capital outflows (the last column of Table 7) as an additional regressor increased the  $R^2$  to 0.74. This suggests that the low willingness of non-central-bank sectors to invest abroad may indeed have played an important role for the larger appreciations of the franc and the shekel compared to others.

**Table 7. Decomposition of 2008–2020 Cumulative Financial Account Balances**

Country	Reserve assets accumulation (% of 2020 GDP)	Country	Non-central-bank capital flows 1/	
			% of 2020 GDP	% of 2008–2020 CFAB
CHE	115.3	CHE	-37.9	-48.9
SGP	70.7	ISR	-0.6	-2.0
TWN	42.2	SWE	25.6	82.4
ISR	32.5	JPN	33.0	81.7
DNK	12.6	KOR	37.7	79.3
KOR	9.8	DNK	42.3	77.1
JPN	7.4	TWN	75.8	64.2
SWE	5.5	DEU	80.4	99.4
NLD	0.8	NLD	93.2	99.2
NOR	0.7	SGP	129.0	64.6
DEU	0.5	NOR	131.8	99.5

Sources: Haver Analytics, IMF WEO Database, IMF staff calculations.

1/ A negative value indicates net capital inflows.

## D. Summary

**18. The paper identifies exchange rate revaluation losses and relatively low returns on foreign assets as two important factors for Switzerland's large acquisition-accumulation gaps.** The strength of the franc was a main reason for the exchange rate revaluation losses, but the

<sup>18</sup> The same regression as the one underlying the fitted line in Figure 6, but without excluding Switzerland, Israel and Norway.

currency composition mismatch between foreign assets and liabilities and the large size of the net IIP (and therefore exposure) also played roles. In the post-GFC era, the Swiss private sector became more reluctant to invest abroad. The cross-country comparison suggests that this might help explain why the franc appreciated more than other currencies, even though all of the economies in the sample had sizable CA balances. The difference in investment returns can be attributed in part to portfolio risk profiles, as measured by the allocation between debt securities and equities.

**19. Since there were complex trade-offs associated with these outcomes, the paper’s findings should be interpreted more from a positive rather than a normative perspective.** For instance, while Switzerland’s large official FX reserves may be less-than-optimal from a perspective of aggregate investment returns—because the SNB has a different risk profile than private sector investors, FXI operations by the SNB have helped to reduce volatility on the FX market and mitigate appreciation pressures on the franc and therefore downward pressure on domestic inflation in Switzerland and, to some extent, the self-reinforcing loop between Swiss investors’ home bias and the appreciation trend of the franc. Another example of such a trade-off is that while appreciation of the franc has led to significant IIP revaluation losses, it has also brought a substantial increase of foreign purchasing power to the overall wealth of Swiss residents.

**20. That said, this study points to some directions that may help Switzerland reduce its acquisition-accumulation gap.** One is to relieve appreciation pressures on the franc in a fundamental and sustainable way, including through more robust global diversification by Swiss investors.<sup>19</sup> Swiss investors should also be more active in assessing and improving the currency composition of their foreign assets to limit exchange rate revaluation losses. Finally, there appears to be room for private Swiss investors to improve the returns on their foreign investments. For instance, pension funds are an important part of the asset management industry. The large number and relatively small size of pension funds in the current system indicate room for efficiency gains through consolidations.<sup>20</sup>

---

<sup>19</sup> See also [“Swiss Franc – Safe Haven for Whom?”](#) IMF Selected Issues Paper, Country Report 21/131, IMF.

<sup>20</sup> See [“Switzerland: 2021 Article IV Consultation Staff Report,”](#) Country Report No. 21/130, IMF.

## References

- Adler, G., Garcia-Macia, D. and Krogstrup, S., 2019, "[The Measurement of External Accounts](#)," IMF Working Paper 19/132, International Monetary Fund.
- International Monetary Fund, 2009, "[Balance of Payments and International Investment Position Manual, Sixth Edition](#)," 2009, International Monetary Fund.
- International Monetary Fund, 2021, "[Switzerland: 2021 Article IV Consultation Staff Report](#)," Country Report No. 21/130, International Monetary Fund.
- Swiss National Bank, 2019. "[Switzerland's international investment position – breakdown of changes in stocks](#)," focus article of September 2019, Swiss National Bank.
- Zeng, L., 2021, "[Swiss Franc – Safe Haven for Whom?](#)" IMF Selected Issues Paper, Country Report No. 21/131, International Monetary Fund.

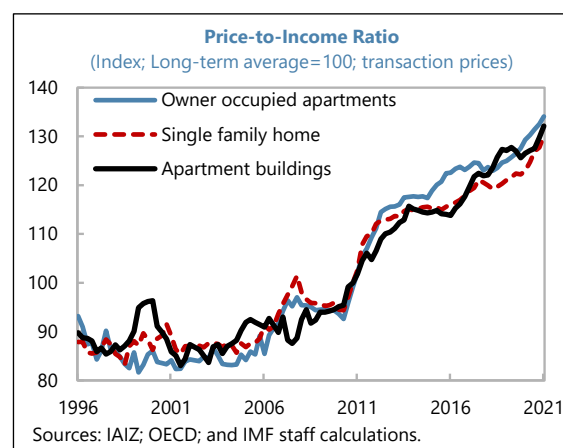
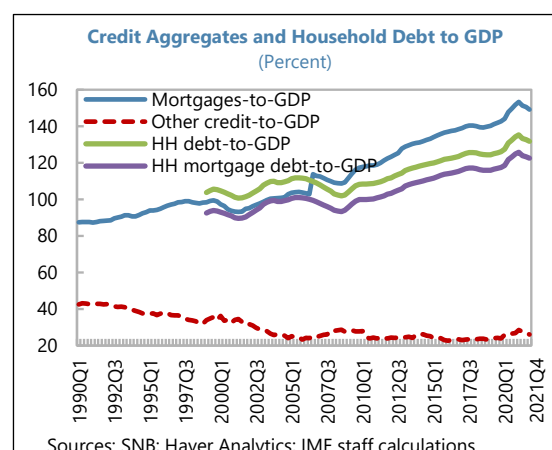
# A FORWARD-LOOKING APPROACH TO CALIBRATE MACROPRUDENTIAL TOOLS IN SWITZERLAND<sup>1</sup>

*Housing matters for economic activity and financial stability in Switzerland. The mortgage market is large relative to the size of the economy and banks are heavily exposed. House prices have significantly outpaced income growth, and this trend has accentuated during the pandemic. The Swiss authorities have taken decisive action to address unsustainable developments, but vulnerabilities have increased. This paper shows that a fuller set of macroprudential tools can be more effective to reduce systemic risk. Adequate calibration and a forward-looking approach are key given lags between policy announcements and policy effects. The paper quantifies a suite of LTV/DSTI caps, amortization requirements, and ‘speed limits’ calibrated at the vintage level to guard against the build-up of vulnerabilities and strengthen resilience.*

## A. The Build-Up of Systemic Risk

**1. Strong growth of credit in Switzerland over the past several years has resulted in a “too-big-to-fail” mortgage market.** Mortgage volumes relative to GDP have experienced significant growth since 2008, while the ratio of other types of credit to GDP has decreased. The mortgage market reached 150 percent of GDP in 2021, a 40 percentage-point increase since the global financial crisis. Robust mortgage-credit growth has been echoed by rising household indebtedness, which topped 130 percent of GDP at end-2021. The two ratios—mortgages-to-GDP and household-debt-to-GDP—are high by European and international standards).

**2. The Swiss financial system is heavily exposed to mortgages.** The Swiss banking sector is the largest in Europe relative to the size of the economy, reaching 5 times GDP. Mortgages are 85 percent of total bank loans and half of bank assets. Most household (95 percent) and corporate (65 percent) loans are mortgages. Credit markets are thus vulnerable to real-estate price corrections. Household mortgage credit, at 110 percent of GDP,

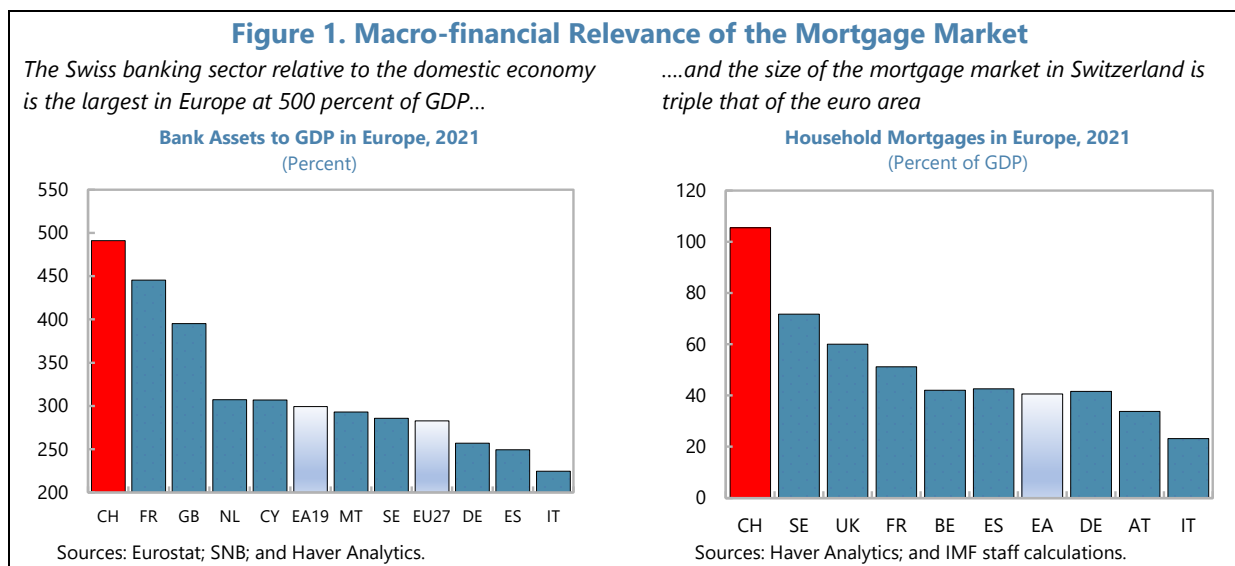
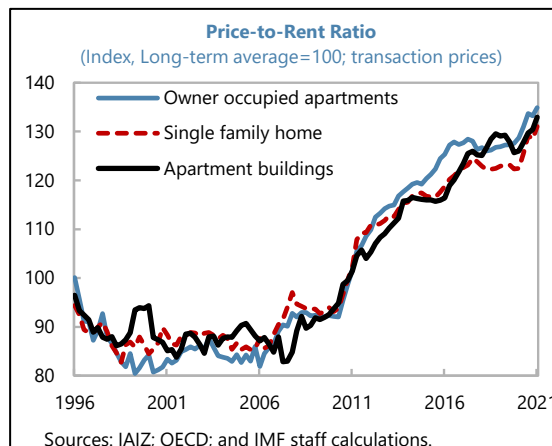


<sup>1</sup> Prepared by Laura Valderrama (EUR). The author thanks Mark Horton for helpful comments, Stéphane Riederer and Roland Goetschmann for their suggestions and productive discussions, and colleagues at the Swiss National Bank and FINMA for providing detailed feedback.

is 3 times euro-area levels (Figure 1). The wider financial system is also heavily exposed to the real estate market: pension fund and insurers asset allocation is increasingly tilted to investment property and mortgages—23 and 12 percent of assets, respectively.<sup>2</sup>

**3. The residential real estate market shows clear signs of overheating.** With negative policy

interest rates of the Swiss National Bank (SNB) since December 2014, price growth has resulted in imbalances in residential real estate and mortgage markets.<sup>3</sup> Investors have increasingly turned to residential real estate in search-for-yield.<sup>4</sup> Prices accelerated further during the pandemic with households building up savings and increasingly working from home, and mortgage rates hovering at around historically low levels of 1.1 percent. Gains have been particularly strong in the Lake Geneva and Zurich regions. In the self-owner-occupied segment (SORE), strong demand and surging preference for ownership has outpaced supply, as construction remains below pre-Covid levels. Vacancy rates of dwellings are tight and declined in 2021 to 1.54 percent from 1.72 percent in 2020. Residential price-to-income and price-to-rent ratios have increased for privately-owned apartments, single-family homes, and apartment buildings and are 30 percent above long-term averages.



<sup>2</sup> Investment property accounts for 20 and 7 percent of assets for pension funds and insurers, while mortgages represent 3 and 5 percent of assets. These lenders represent 2 and 4 percent of the overall mortgage market, respectively.

<sup>3</sup> The pass-through of the policy rate to benchmark mortgage rates is shown in Figure 2.

<sup>4</sup> The gap between real house price and real household income growth rates rose from 60 bps pre-Covid to 130 bps.

## B. The Policy Response

**4. The build-up of imbalances has triggered a series of policy responses by the Swiss authorities.** The persistent increase in real estate prices and the build-up of vulnerabilities have prompted a series of responses by the Federal Council, SNB, FINMA, and the banking sector. Switzerland became the first country to activate a residential real estate countercyclical capital buffer (CCyB) in February 2013 at 1 percent. At that time, the financial and the business cycles were out of sync. The policy rate was zero as the inflation rate was subdued at -0.3 percent. With easy monetary conditions, house prices had risen sharply, at an average annual rate of 7.5 percent over the previous two years, supported by strong mortgage growth exceeding 5 percent. The sectoral CCyB was increased to 2 percent in January 2014, as real estate imbalances persisted (Figure 2).

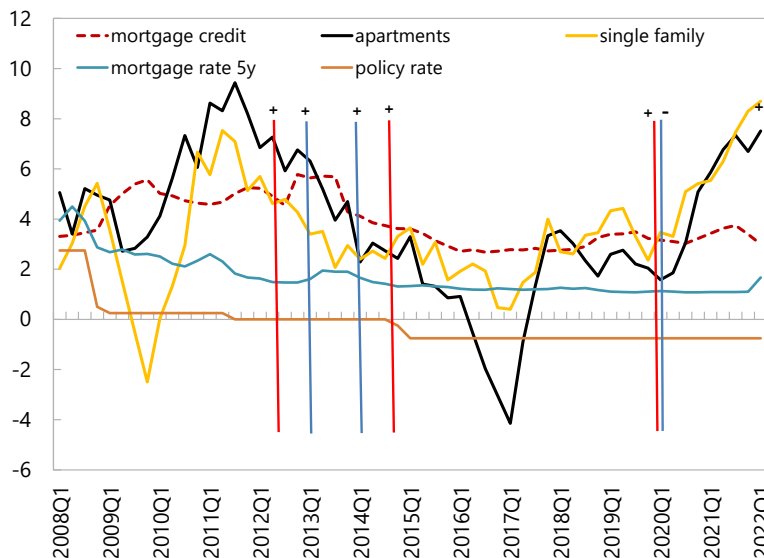
**5. The authorities have directly involved banks in the design of macroprudential instruments under “self-regulation” guidelines.**<sup>5</sup> A new self-regulatory regime entered into force from July 2012. For the first time, it laid out minimum requirements concerning down-payments by borrowers (at least 10 percent of the property value) and introduced compulsory amortization to two thirds of the value of the collateral within a maximum of 20 years. A revision to self-regulation rules was made in September 2014 involving a shorter period of 15 years for mandatory amortization. In January 2020, requirements of mortgage loans for investment properties were tightened: the maximum period for mandatory amortization was revised down from 15 to 10 years; and borrowers now need to provide a minimum down-payment of 75 percent of the property value. While the revised guidelines do not explicitly include the buy-to-let segment, most banks seem to apply the adjusted rules to this segment following FINMA’s recommendation.

**6. FINMA has helped build bank resilience by tightening underwriting standards.** As the Swiss supervisory authority, FINMA has deployed a range of supervisory tools to enhance resilience in residential real estate. It has introduced Pillar 2 multipliers on Internal Ratings-based (IRB) models, and applied the adjustments to the capital adequacy ordinance adopted by the Federal Council such that mortgages exceeding 80 percent of the property value have a risk-weight of 100 percent for the part of the loan over the threshold. Full Basel III implementation, expected in 2024, will introduce an output floor (a limit on the capital requirements that banks calculate using their internal models) and higher risk-weights for riskier loans.

---

<sup>5</sup> These guidelines are professional rules of the Swiss Banking Association (SBA) for lending, credit monitoring, and reporting. These guidelines have been recognized by FINMA as a minimum regulatory standard in accordance with Circular 2008/10 “Self-regulation as a minimum standard”. The Federal Council changed the Capital Adequacy Ordinance (CAO) for banks to apply a risk weight of 100 percent for the entire loan amount which does not comply with the minimum standard.

**Figure 2. Policy Response, Mortgage Credit, House Prices, and Interest Rates**  
(+ Tighten; - Relaxed; Year-on-Year; Percent)



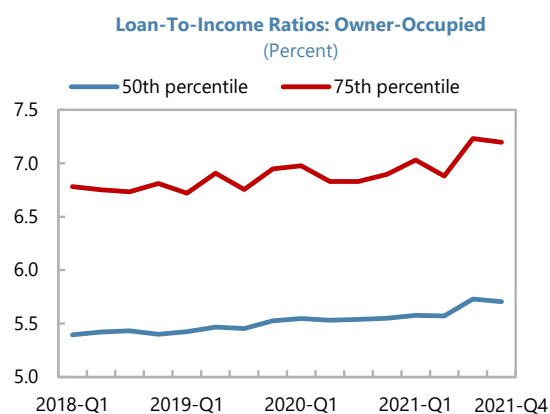
Sources: SNB; FINMA; Wuest Partner; IMF staff calculations.

Note: The vertical lines represent policy response to address imbalances in the mortgage and residential real estate sectors. The red lines are macroprudential policy interventions (introduction; adjustments to CCyB buffer); the blue lines represent self-regulation rules (introduction; amendments). House prices by segment (apartments; single family) are transaction prices.

**7. Yet, despite these actions, affordability risks remain elevated** (Figure 3). Despite recent tightening of self-regulation, affordability risks as measured by LTI ratios have increased. In the owner-occupied segment, the 75th value of the LTI distribution widened by 40 bps from 2018 to reach 7.2 at end-2021. Income-producing residential real estate (IPRRE) loan-to-rent ratios for both household and corporate investors have risen to reach 22 and 19 at the 75th percentile, respectively, high by international standards. As of Q4:2021, the LTV of rented-out property at the 90th percentile

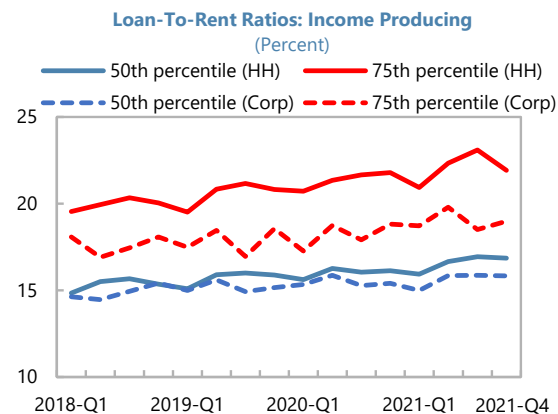
**Figure 3. Leverage in Residential Real Estate Loans**

*Leverage remains elevated for owner-occupiers...*



Sources: SNB; and IMF staff calculations.

*...as well as investment property investors*



Sources: SNB; and IMF staff calculations.

decreased to 75 percent for both households and companies from the 80 and 82 percent ratios reached in 2020 but remains elevated.<sup>6</sup>

**8. High leverage exposes borrowers to rising interest rates** (Figure 4). We estimate that a quarter (half) of new mortgage production could become unaffordable if rates were to increase to 3 percent (5 percent) across all sub-segments.<sup>7</sup> The 5-year fixed mortgage rate was 1.7 percent as of March 2022 (a 60-bps increase since December 2021), and long-term rates are 3.7 percent, so prospects of an increase to 3 percent are non-negligible. An important mitigating factor is that Swiss households with mortgage loans tend to have significant buffers in the form of financial wealth that they could use to fill potential liquidity shortfalls.

### C. Transmission Channels of Macprudential Tools

**9. Macprudential authorities can enhance banking system resilience by using capital-based tools.** Tools include capital buffers on real state exposures to absorb unexpected losses in times of stress.<sup>8</sup> For instance, in the European Union, a 202 capital requirements directive (CRD V) increased the flexibility of the systemic risk buffer to target specific systemic risks at the sectoral level, i.e., real estate.<sup>9</sup> Capital buffers can also reduce the build-up of vulnerability through the credit channel. Banks can pass through capital charges to mortgage rates, therefore dampening credit demand (price effect), while capital-constrained banks may be forced to reduce credit supply (quantity effect). Lower credit is likely to feed into more sustainable house prices, hence stabilizing the financial cycle.

---

<sup>6</sup> Some EU countries have set limits on the investment-led segment, including Ireland and Latvia with 70 percent LTV caps, the Czech Republic with a pre-Covid limit of 60 percent (relaxed to 90 percent during the pandemic), and Belgium with an 80 percent threshold (first-time buyers benefit from a 10 percent exemption).

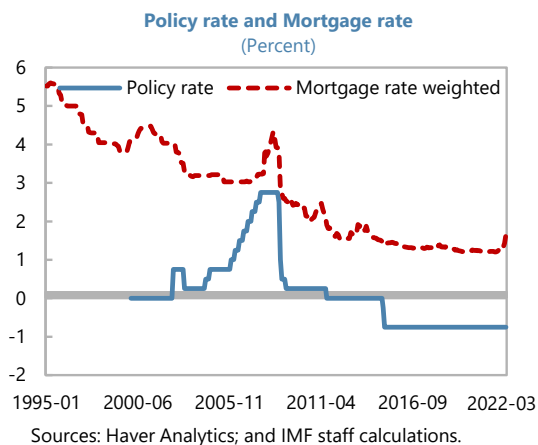
<sup>7</sup> Affordability risk is considered high when imputed costs from mortgage servicing (including amortization, interest, and maintenance) exceed one-third of income (owner-occupied segment) or rents (investment-led segment). To compute affordability risk, we assume that average LTV is 80 percent and maintenance costs represent 1 percent of loan value.

<sup>8</sup> Other instruments including regulatory provisions that increase buffers for expected losses and minimum risk weights that impose a capital floor on unexpected losses.

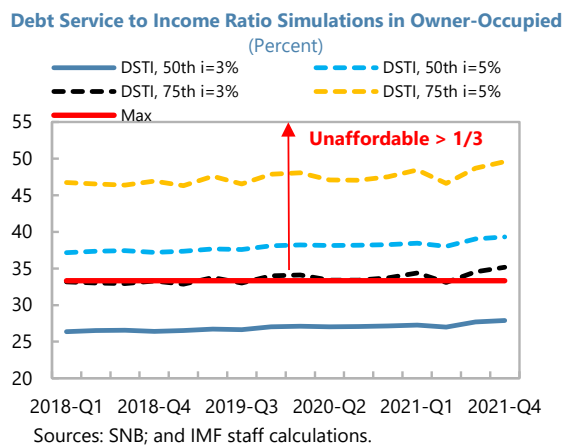
<sup>9</sup> To date, only Germany has announced a sectoral SyRB on residential exposures—2 percent from February 2023, in addition to a 0.75 percent CCyB. Others with positive current CCyB (broad-based) rates: Bulgaria, Czech Republic (0.5 percent, to be increased to 1.5 percent and 2 percent, respectively in January 2023); Luxembourg (0.5 percent); Slovakia (1 percent); and Norway (1 percent to be increased to 2 percent in December 2022). Others with announced CCyB increases include Estonia (1 percent in December 2022); Iceland (2 percent in September 2022); Sweden (1 percent in September 2022 and UK (1 percent in December 2022 and 2 percent in June 2023).

**Figure 4. Impact of Interest Rate Shocks on Affordability Risk**

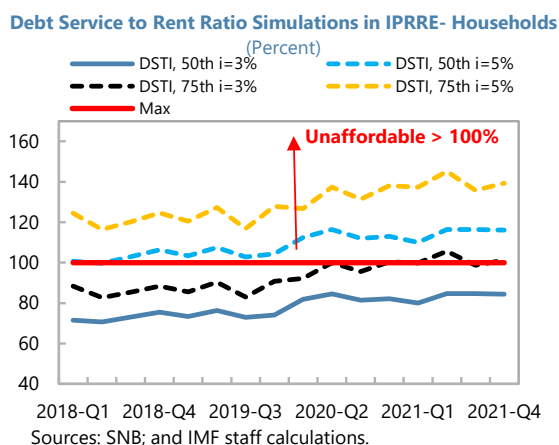
The long-term average mortgage rate reached 3.7 percent prior to the policy rate being set at 0.



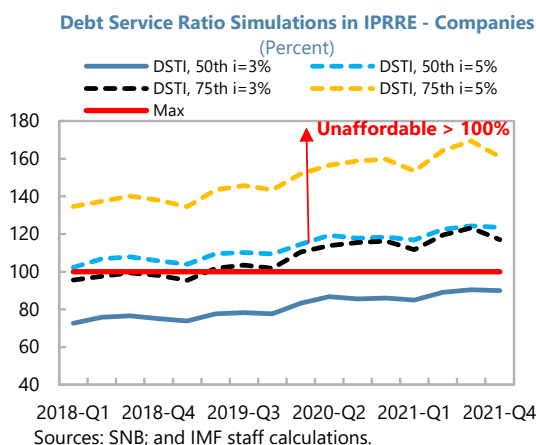
... A quarter (half) of recent mortgage flows could become unaffordable if rates increase to 3 (5) percent in SORE ...



...as well as in rented-out properties of households<sup>1/</sup>...



...and investment properties of companies



1/ This simulation assumes that income generated by the property is the only source of income for assessing affordability risk. As households typically have other sources of income, and can draw on their financial wealth, these figures tend to overestimate the level of affordability risk. Note: The top left chart shows the policy rate (mid of the LIBOR 3m target range until 2019; policy rate after 2019), and the weighted mortgage rate for new business weighted by the relative share of variable mortgages, fixed-rate mortgages, and LIBOR mortgages. SORE stands for self-occupied real estate. IPRRE stands for income producing residential real estate. Affordability risk is considered high when imputed costs from mortgage servicing (including amortization, interest, and maintenance) exceed one-third of income (owner-occupied segment) or rents (investment-led segment). To compute affordability risk, we assume that average LTV is 80 percent and maintenance costs represent 1 percent of loan value. The chart 'Debt Service Ratio Simulations in IPRRE – Companies' takes into account the tightening of the amortization requirement established by self-regulation in August 2019, effective in January 2020.

**10. To contain the build-up of vulnerabilities, macroprudential authorities (and lenders) can rely on borrower-based tools that strengthen borrower balance sheets.**<sup>10</sup> To address financial stability risks arising from rapid house price inflation and increasing household debt, authorities can use borrower-based tools including LTV, DTI and DSTI regulatory limits on mortgage lending. These instruments also build bank resilience indirectly by reducing the loss rate of the

<sup>10</sup> While a tightening of lender's underwriting standards will help contain mortgage growth, self-regulation guidelines are not designed to reduce systemic risk and thus help to prevent crisis, by contrast with macroprudential authorities' goals.

mortgage portfolio. While LTV restrictions reduce bank losses given default, debt serviceability requirements (DTI, DSTI) lessen borrower probabilities of default.

## D. A Modeling Approach to Quantify Banking System Resilience

**11. The calibration of a wide range of macroprudential tools warrants a modeling approach that assesses the performance of vintage pools.** A vintage approach is needed as borrower-based tools are applied to the production of new mortgages whereas sectoral capital buffers are applied to the outstanding portfolio. A vintage analysis also allows for a deep understanding of the effects of loan maturation and external factors such as changes in real estate prices, interest rates, and disposable income. Mortgage vintage analysis tend to show the dispersion of delinquency between more recent vintages originated during the run-up of housing prices and older, more established vintages that were originated before the expansionary phase of the cycle.

**12. A granular risk model allows macroprudential authorities to understand the credit risk of different real estate market sub-segments.** A critical segmentation is by type of property. The model needs to quantify credit risk in the owner-occupier segment and income producing real estate segment separately, given differences in risk drivers and sensitivity to shifts in interest rates and other macroeconomic factors. The model also needs to produce credit risk projections according to the regulatory buckets used by macroprudential authorities to monitor vulnerabilities and activate regulatory limits.

**13. Structural changes in the Swiss real estate market call for a structural approach.** The limited data from past real estate crises in Switzerland, the presence of structural changes in housing finance (e.g., the structure of the market changed markedly in 1995, when Swiss residents were allowed to draw on their second and third pillar pension assets to fund part of the mortgage down payment), and adjustments to the regulatory framework (Section B) mean that structural models are more reliable than statistical approaches based on past loan performance. Statistical approaches are also hindered by the recent benign cycle of default risk in Switzerland, with average loss rates in the mortgage portfolio at just 5 basis points over the last 20 years.

### The Model

**14. We use a granular structural model by vintage to project mortgage risk.**<sup>11</sup> A loss event is defined by the ‘double trigger’ of default. A borrower defaults if they can no longer afford to service the loan and if the value of the house is lower than the value of the loan.<sup>12</sup> This assumption implies that a borrower in financial distress could avoid default, as long as they have positive home

<sup>11</sup> The modeling approach follows Gornicka and Valderrama (2020), which builds on Harrison and Mathew (2008). A general application of this model is found in IMF (2021).

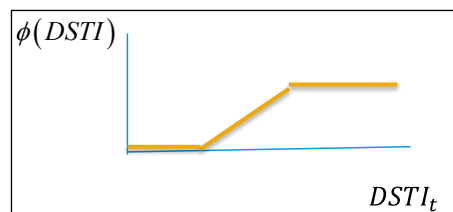
<sup>12</sup> This definition is well established in the legal literature whereby a borrower becomes insolvent when he/she fails the ‘cash-flow test’ (cannot repay the debt as it comes due) and ‘the balance sheet test’ (the value of its assets fall below the value of its liabilities).

equity that can be extracted to refinance the loan or repay the debt.<sup>13</sup> The model is calibrated by segment, i.e., owner-occupied mortgages and investment loans and risk buckets.

**15. The probability that a borrower *i* gets into financial distress is driven by:**

$$\Pr(FD_{i,t}) = \Phi(DSTI_{i,t}) \cdot D_i + \beta_1 \cdot \Delta DSTI_{i,t}^\gamma + \Phi(DSTI_{i,t}) \cdot (\beta_2 \cdot U_t + \beta_3 \cdot \Delta U_t^\alpha) \quad (1)$$

which is a function of: (1) affordability risk, measured by the debt service-to-income ratio (DSTI); (2) the change in the debt servicing capacity since the last period ( $\Delta DSTI$ ); (3) the likelihood of being unemployed ( $U$ ) and the change in the unemployment rate ( $\Delta U$ ); and (4) a demographic factor ( $D$ ).



The impact of idiosyncratic events (demographic shocks, migration to unemployment) is non-linear across affordability buckets.<sup>14</sup> The exponential effect of affordability shocks on financial distress captures an ‘expenditure-based’ approach whereby stretched borrowers struggle to maintain consumption, increasing default risk. We assume that idiosyncratic shocks have no impact on financial distress below a DSTI threshold level, then it raises gradually until an upper threshold where the effect has full impact.

**16. Economic default is triggered if a financially distressed borrower cannot repay the loan by selling the house or drawing down on his wealth:**

$$\Pr(ED_{i,t}) = \begin{cases} 1 & \text{if } \tilde{P}_{i,t} - C + FinWealth_{i,t} < NPV(L_{i,t}, r_t^{type,M}, r_t^f, T_{t,s}) | FD_{i,t} \\ 0 & \text{Otherwise} \end{cases} \quad (2)$$

where  $\tilde{P}_{i,t}$  is the market property value,  $C$  is the transaction cost of selling the property, and  $FinWealth_{i,t}$  is the borrower’s liquid financial assets. The net present value of the loan (NPV) consists of two elements: (1) the outstanding loan amount  $L_{i,t}$  and (2) the penalty for early prepayment, i.e., the discounted value of foregone interest payments, which increase with the mortgage rate locked-in at the time of default  $r_t^{type,M}$  (which depends on the type of mortgage and the resetting price schedule of the loan), and its remaining maturity  $(T_{t,s} - (t - s))$  for a loan issued at time  $s$ .<sup>15</sup> The 5-year fixed mortgage rate  $r_t^f$  is used to discount the amount of future interest payments.

<sup>13</sup> By contrast, the model does not consider “strategic defaults,” i.e., a situation where the borrower decides to stop repayments once the value of the underlying collateral falls below the value of the loan. Incentives to do so might exist in the case of non-recourse loans, which is not the case in Switzerland.

<sup>14</sup> This is to capture the empirical observation that higher DSTI buckets are more sensitive to increases in servicing costs (UK crisis).

<sup>15</sup> The penalty for early prepayment decreases with the current value of interest rates. The model uses the conservative assumption that the bank charges a positive penalty for early pre-payment even if market rates rise calculated as the net present value of foregone interest rate payments for a specified number of months.

**17. To generate the probability of default (PD), we use a Monte Carlo algorithm over more than 250 vintage-LTV buckets:**

$$PD_{i,t} = \Pr(FD_{i,t}) \cdot \Pr(ED_{i,t}) \quad (3)$$

We divide the portfolio into risk buckets and simulations are carried out for each bucket and vintage, separately. For a given ‘vintage-LTV bucket’ of mortgages, a number  $N$  of borrowers already in financial distress is considered. For each of the  $N$  borrowers a house price draw is generated from a distribution with a mean equal to the average house price level in the tail risk scenario. For each of the house price draws, the model determines whether condition (2) is satisfied (i.e., if the borrower defaults). In the next step, the bucket-specific PD is calculated as the total number of defaults divided by the number of draws, 10,000, and multiplied by the bucket-specific probability of financial distress from equation (1). To reduce simulation noise, this simulation process is then repeated 2,000 times for each bucket. In the final step, the ultimate outputs, i.e., portfolio-wide PD, LGD, and the loss rate are calculated by combining separately estimated outputs for 252 vintage-LTV buckets (12 LTV buckets; 21 vintages) and weighting them by their outstanding share in bank portfolio at end 2021.

**18. Upon default, a bank’s loss given default (LGD) is driven by the discounted sale price of the repossessed collateral net of the foreclosure discount:**

$$LGD_{i,t} = NPV(L_{i,t}, r_t^{type,M}, r_t^f, T_{t,s}) - (1 - \delta) \cdot \frac{\bar{P}_{i,t+n}}{(1+r_t^f+spread)^n} \quad (4)$$

where the first term denotes the outstanding debt and the second term the recovery value.  $\delta$  denotes the foreclosure discount at which the bank sells the property at time  $t+n$ , where  $n$  reflects the time needed to sell off the collateral, and  $spread$  is the risk-adjusted spread used to discount the value of the risky asset.

**19. The highly non-linear interaction between PD and LGD will have implications for the design of macroprudential tools.** A large correction of house prices increases the chance of borrowers going into negative equity and therefore default (PD). It also increases the LGD for banks if borrowers fail to maintain their mortgage payments. Similarly, an upward shift of interest rates increases affordability risk (PD) and lowers the recovery rate of a defaulted loan (LGD). This suggests that LTV restrictions or interest-rate affordability tests can help prepare both households and banks for the potential fallout from a sharp reversal in the housing market or rising interest rates.

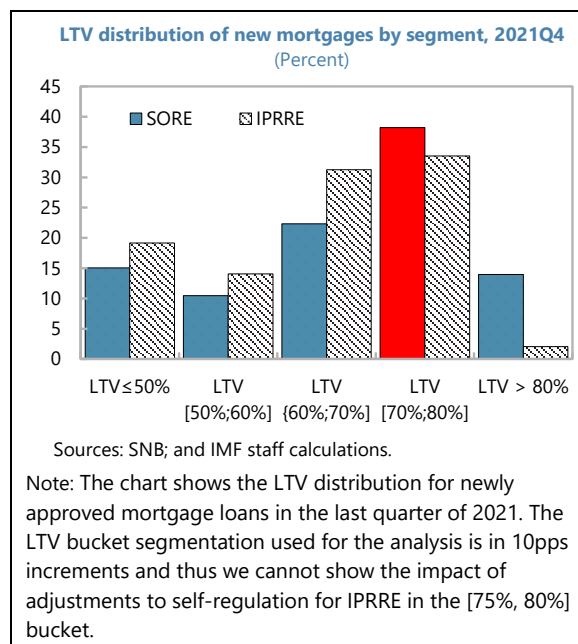
## The Dataset

**20. We use SNB survey data on new mortgages, which provide a rich characterization of loans approved since 2017.** The quarterly dataset covers all loans granted by Swiss banks with a domestic mortgage lending volume of at least CHF 6 billion. It includes new mortgages that finance the purchase of real estate, as well as commutations (refinancing of a loan with another lender) but excludes rollover loans with the same lender. The dataset used to calibrate the model draws on SNB

survey data but eliminates construction loans and removes outliers. The survey records a loan's general characteristics (e.g., borrower, type of loan, credit limit, income, value of collateral, rent, interest rate, down payment). This allows a very granular segmentation. The data are segmented by type of business transaction (i.e., SORE and IPRRE segments) and vintage (20 vintages). In the IPRRE segment, income is defined as yearly rental income on the property. Within each segment/vintage, loan risk characteristics are grouped into 12 LTV buckets, 8 DTI buckets and 11 DSTI buckets. To account for the correlation structure of risk factors, we construct matrices for 96 LTV/DSTI buckets, and 132 LTV/DTI buckets.

**21. The data point to some recent improvement in LTV ratios, but with unequal effects across segments.** High-LTV lending has declined in the IPRRE segment but remains elevated for self-occupiers (SORE). The recent tightening of self-regulation rules for investment properties is reflected in a decrease of high-risk LTV loans (>70 percent) from 41 in Q1:2017 to 36 percent in Q4:2021.<sup>16</sup> However, the share of high LTV loans in the SORE segment increased during the intervening period, with a bunching of loans below the 80 percent threshold.

**22. Borrower leverage, as captured by the DTI, has increased over time across segments.**<sup>17</sup> Affordability risk is particularly elevated for highly leveraged borrowers with low equity buffers. The share of loans in the [70%, 80%] bucket with DTI exceeding 5 reached around 30 percent in both the SORE and IPRRE segments. This value seems high by international standards, where the most common maximum DTI cap in peer countries is 4.5.<sup>18</sup> On the other hand, debt servicing ratios remain contained due to the presence of non-amortizing mortgages for loan amounts below two thirds of the value of collateral at issuance.



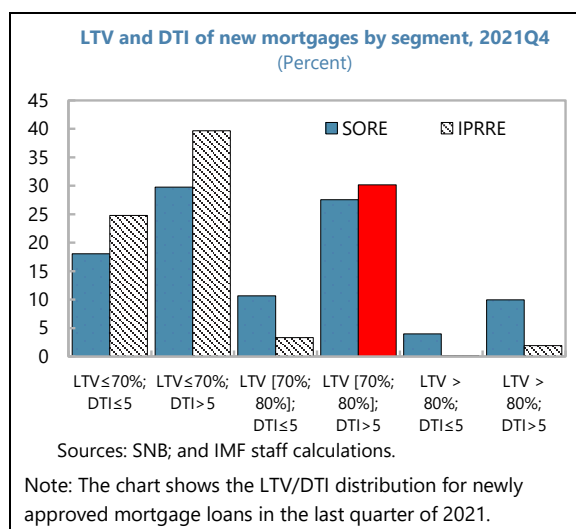
<sup>16</sup> The adjusted self-regulation rules now require borrowers to provide a minimum down payment of at least 25 percent of the LTV. As the LTV bucket segmentation used for the analysis is in 10pps increments we show the statistics at the 70 percent cap which lies near the 75 percent threshold.

<sup>17</sup> The share of loans with a DTI higher than 6 has increased from about 35 to 50 percent over 2017–2021 in both, the SORE and the IPRRE segments.

<sup>18</sup> E.g., Denmark (exception for wealthy borrowers); UK (15-percent exemption), Sweden (where higher LTIs trigger additional amortization). A cap of 3.5 is set in Ireland (20-percent first-time borrower exemption). Others have implemented a DTI limit with a broader debt concept (Norway—5; Latvia—6, 10-percent exemption; Slovakia—8 of net disposable income or 6.4 gross). A caveat to the comparison is that income is defined on a net basis in the SNB survey on new mortgages whereas some countries may use a gross definition of income.

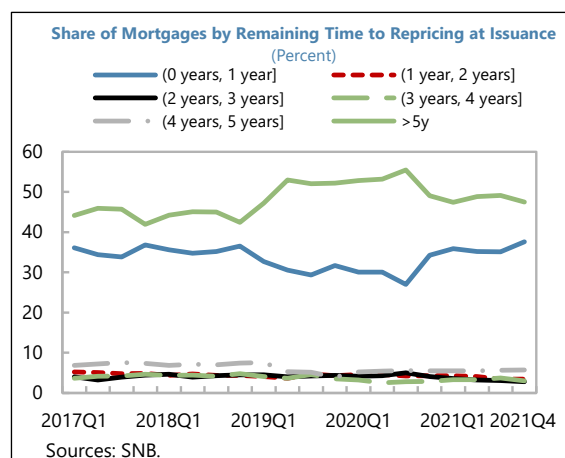
**23. To reconstruct vintages of mortgage flows we use mortgage stock data, aggregate issuances, self-regulation rules on amortization, and interest rate repricing data.**

Credit risk depends on Point-in-Time (PiT) risk parameters (LTV, DTI, DSTI) However, SNB survey data are at origination. Also, the dataset only starts from Q1:2017. To assess the risk of bank mortgage portfolios we need to estimate the volume of mortgages by the vintage outstanding as of end 2021. We also need to project PiT credit risk parameters by taking into account loan repayments, the housing cycle, and the macrofinancial cycle (e.g., interest rates, household income, rents). Mortgage stock and aggregate inflows data are available starting in 1990.<sup>19</sup> We use interest rate repricing data at issuance starting in 2017 and extend it back to 1990 assuming a pattern similar to the first vintage. For the average vintage), it is worth noting that around two-fifths of new loans reprice within a year.<sup>20</sup> Starting in 1990, we use 6 repricing buckets and assume a uniform distribution of quarterly repricing within each bucket over the life of the mortgage. For each vintage, we estimate the repriced interest rate prevailing at end 2021 and apply interest rate shocks with pass-through effects driven by repricing schedules.



**24. Accounting for financial wealth of Swiss households is critical to assess mortgage risk.**

Wealthy borrowers may draw on their financial wealth to fill liquidity gaps in debt service repayments. Higher wealth is associated with lower default risk (equation (2)). The financial wealth of households in Switzerland has more than doubled over the past 20 years. Per capita net worth in Switzerland is around CHF 480,000, the highest level among peer countries (Annaheim, Heim, 2021). In standard credit risk models, borrower wealth is not typically considered as an input. Yet, Swiss banks use wealth indicators of borrowers in their underwriting affordability criteria. To account for borrower wealth, we use data from Swiss Wealth Statistics by individual. We compute wealth by household, merge this with SNB statistics on the breakdown of wealth, and apply a haircut linked to



<sup>19</sup> A challenge of using aggregate mortgage stock data is that its coverage is broader than the granular dataset used to calibrate the model drawing on the SNB's HypoB survey data which excludes refinancing loans with the same lender. For the calibration of the model, we also excluded commercial real estate (CRE) from the HypoB survey.

<sup>20</sup> This is likely driven by mortgage loans for investment properties. But the repricing data is not broken down by sub-segment.

market liquidity by instrument (0 percent for cash, 10 percent for debt, and 20 percent for equity and collective investment schemes; insurance, pension schemes, and real estate are excluded). For the SORE segment, we consider household wealth at the 50th percentile, while for the IPRRE segment we take the 75th percentile to reflect the higher wealth of investors.

### Model Calibration

**25. The model is calibrated using the loan loss experience in Switzerland in the early 1990s and in real estate crises in peer countries.**<sup>21</sup> The 1990s Swiss recession, characterized by a sharp decline of real estate prices in combination with an economic slowdown, is used to estimate the default rate elasticity to macroeconomic risk factors, the allocation of stressed sales between those caused by unemployment shocks and interest rate shocks, and transaction costs. The UK real estate crisis of the 1990s is used to calibrate the relationship between default rates and financially distressed borrowers, the sensitivity of financial distress to initial unemployment, and the elasticity of financial distress to shifts in debt serviceability ratios by DSTI buckets. The Annex shows the main parameters of the model.

**26. We compute Point-in-Time risk parameters for each LTV-vintage bucket.** The procedure takes into account self-regulation amortization requirements, the housing cycle, macrofinancial fluctuations, and the repricing schedule from issuance to the current period (December 2021). We estimate the implied amortization rate, which is consistent with aggregate SNB statistics of mortgage stocks and flows. Then we apply self-regulation minimum amortization requirements, which depend on LTV at origination and the mortgage vintage (given adjustments to self-regulation in 2012, 2014, and 2020). See the Annex for more details on the procedure.

### Stress Test Scenario

**27. To assess the resilience of the banking sector to a sharp housing price correction, we**

**Figure 5. Stress Test Scenario: Key Variables**

Portfolio	SORE		IPRRE	
	Baseline	Adverse	Baseline	Adverse
HH disposable income/rent	g=7.5%	g=-3.6%	g=3.2%	g=-1.2%
Real estate price	N [0, sdev=15%]	N [-25%, sdev=15%]	N [0, sdev=20%]	N [-25%, sdev=20%]
Unemployment	-0.03 pp	+1.7pp	-0.03 pp	+1.7pp
Benchmark rate	1.33%	+300bps	1.33%	+300bps

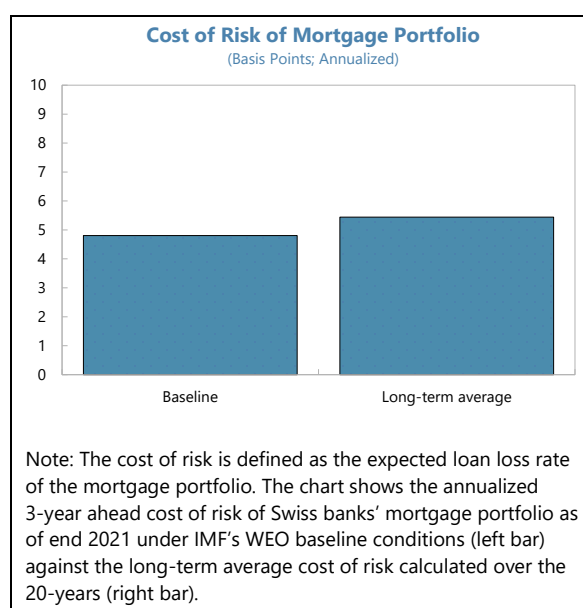
Note: The scenario generates quarterly projections of key macrofinancial variables. The table shows cumulative changes over 2022-24. Baseline projections are based on the IMF's WEO forecast. Adverse projections are based on an inflationary recession scenario using econometric techniques. The size of the shocks are in line with SNB's combined 'protracted recession in the euro area' scenario and 'global interest rate shock' scenario (FSR, 2021).

<sup>21</sup> Switzerland experienced a house price bubble in the 1980s that burst in the early 1990s (Schneider and Wagner, 2015). During 1989–91, the mortgage variable rate jumped from 5.0 to 7.8 percent (peaking at 8.0 in Feb 1991), real estate prices dropped by 16 percent peak-to-trough, unemployment increased by over 50 basis points, and the estimated loss rate of the portfolio increased by over 50 basis points to 1.03 percent.

**consider a 3-year inflationary scenario combined with a domestic recession** (Figure 5). The stress scenario tests the resilience of the Swiss banking sector to a deep recession, sharp falls in real estate prices, and higher global interest rates, which trigger large shifts in benchmark rates. In Switzerland, household disposable income in the scenario falls by 3.6 percent and house prices decline by an average of 25 percent peak-to-trough – at the upper-end of SNB’s estimated overvaluation (SNB, 2021). Price changes follow a stochastic process with fluctuations of up to 40 percent. The unemployment rate increases by 60 percent, and benchmark rates widen by 300 basis points. Tenant rent payments are less affected as under Swiss regulation, initial rents can be adjusted if interest rates increase.<sup>22</sup> Baseline projections follow IMF’s April 2022 WEO forecast over 2022–24.

## Model Performance

**28. The model matches long-term averages of default risk under baseline conditions.** A key component to the implementation of a model-based credit risk assessment is model validation. The aim is to ensure that the model structure and parameters are calibrated accurately, and the model performs consistently under baseline scenario assumptions. We conduct a validation exercise by assessing whether the model can replicate long-term default rates during the moderate but sustained expansion of the housing cycle that has taken place over the last 20 years. The results show that the weighted loss rate of the mortgage portfolio predicted by the model (weighted by the shares of the SORE and IPRRE segments) of 5 basis points, replicates the long-term average of loss rates in the Swiss banking system.

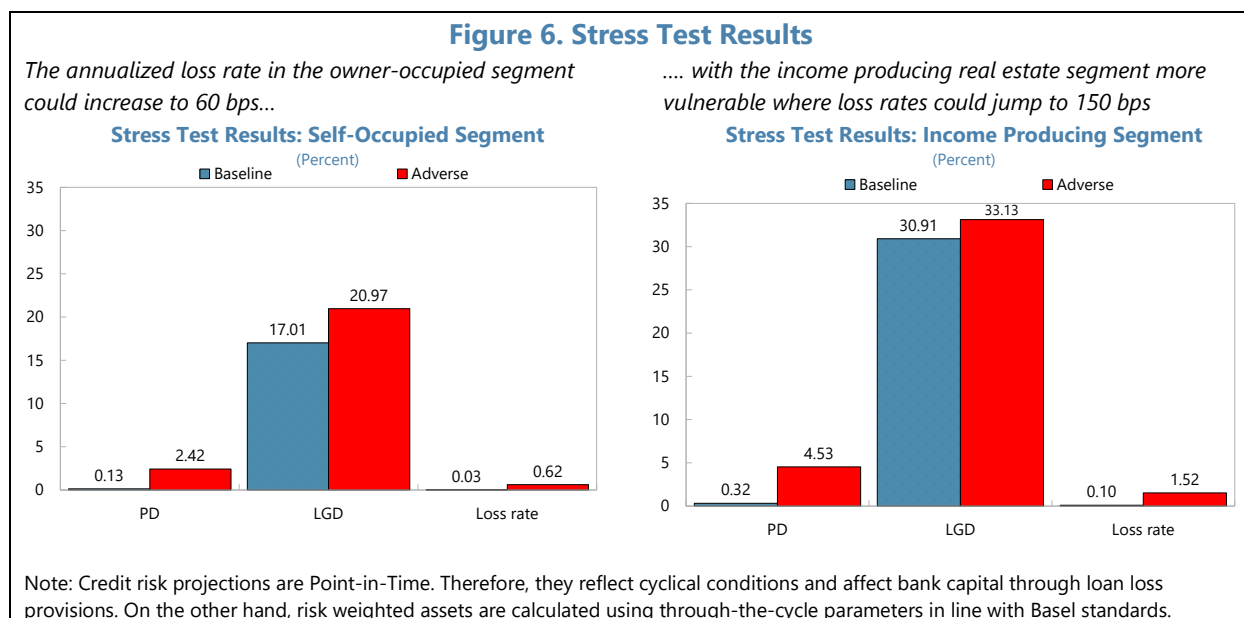


## E. Stress Test Results under Current Macroprudential Tools

**29. Banks are, on aggregate, resilient to stress, but a real estate crisis could have a significant impact on macrofinancial stability.** Stress tests results suggest that the annualized loss rate of the mortgage portfolio could rise from 5 basis points under the baseline to 90 basis points under stressed conditions. The impact of a sharp real estate correction is more severe in the IPRRE segment where default rates could jump to 4.5 percent (Figure 6). Over the 3-year stress test horizon, losses could reach CHF 27.6 billion (14 percent of CET1 capital), with the aggregate CET1 ratio declining by 230 basis points to 14 percent. The sectoral CCyB would absorb 25 percent

<sup>22</sup> We use an econometric model to forecast rental payments over the stress test horizon as a function of change in real estate prices, household income, and mortgage rates.

of losses. Although banks could withstand the shock on aggregate, as they could use their managerial buffers to absorb losses, some banks could breach their capital conservation buffers. Banks with weakened balance sheets could curtail credit to financially-distressed borrowers amplifying the initial shock. Consumption would be affected by rising living costs, which would reduce real household disposable income, higher debt-servicing costs, and lower household wealth, creating negative feedback loops and deepening the recession.



## F. Calibration of Borrower-Based Macroprudential Tools

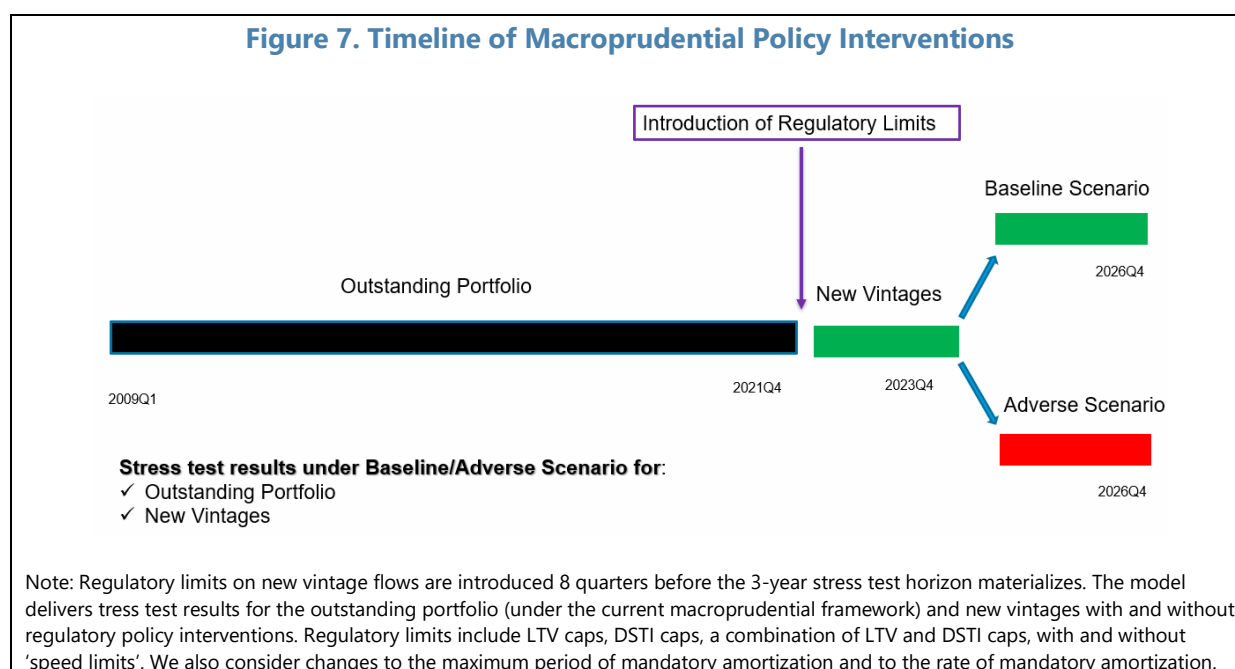
**30. The aggregate picture for banks and mortgages looks strong, but there are pockets of vulnerability in recent vintages.** Recent borrowers are more exposed to rising interest rates and declining house prices than earlier borrowers as they have repaid less principal, experienced smaller home equity gains, and benefited less from income growth. Also, their serviceability capacity has been tested at lower interest rates.<sup>23</sup> Our stress test results show that the loan-loss rate of recent vintages is between one third (IPRRE segment) and three quarters (SORE segment)—more than that of the portfolio on average.

**31. Further tightening of self-regulation rules could contain the build-up of vulnerabilities in the mortgage and real estate markets.** The Swiss authorities could encourage the banking sector to reduce the maximum period of amortization from 15 to 10 years in the owner-occupied or buy-to-let segment. Revised guidelines on mortgage lending could also increase the amortization rate by requiring that borrowers pay down the mortgage to less than two thirds of the lending value of the property.

<sup>23</sup> While the Swiss Banking Association guidance stipulates that mortgage borrowers should meet an imputed affordability criteria at an assumed 5 percent interest rate, in practice there are numerous exemptions to this rule as Figure 3 illustrates.

**32. The Swiss authorities could also introduce a range of borrower-based instruments to keep borrowing at sustainable levels.** The set of possible instruments include LTV, DTI, DSTI or a combination of instruments. Design considerations include whether regulatory caps are hard limits applied to all new issuances or whether a speed limit might be used by required banks to reduce the volume of high-risk lending to below a specific share of new commitments. Another consideration is whether restrictions would apply temporarily when financial risk is elevated or whether the policy setting would be set to address structural risk (more) permanently.<sup>24</sup>

**33. To account for lags between policy announcements and policy effects, we assume that new macroprudential tools are introduced before the adverse scenario materializes.**<sup>25</sup> First, we assume that in the absence of new macroprudential measures mortgage flows in the next 8 quarters share the average risk characteristic of issuance observed in the last four quarters of data (Figure 7). Meanwhile, some outstanding loans mature. Macroprudential limits reduce the relative mass of high-LTV or DSTI above the limits to zero if ‘hard’ limits are introduced, or to a specific percentage if ‘speed limits’ are applied. We assume that there is a bunching of new loans just below the regulatory limits as observed empirically. During the 8 quarters, house prices and macrofinancial factors follow April 2022 WEO assumptions. For each choice of macroprudential tools, we compare the losses on the aggregate portfolio generated in the adverse scenario with the losses observed on new vintages under ‘No limits’ and under each policy intervention.

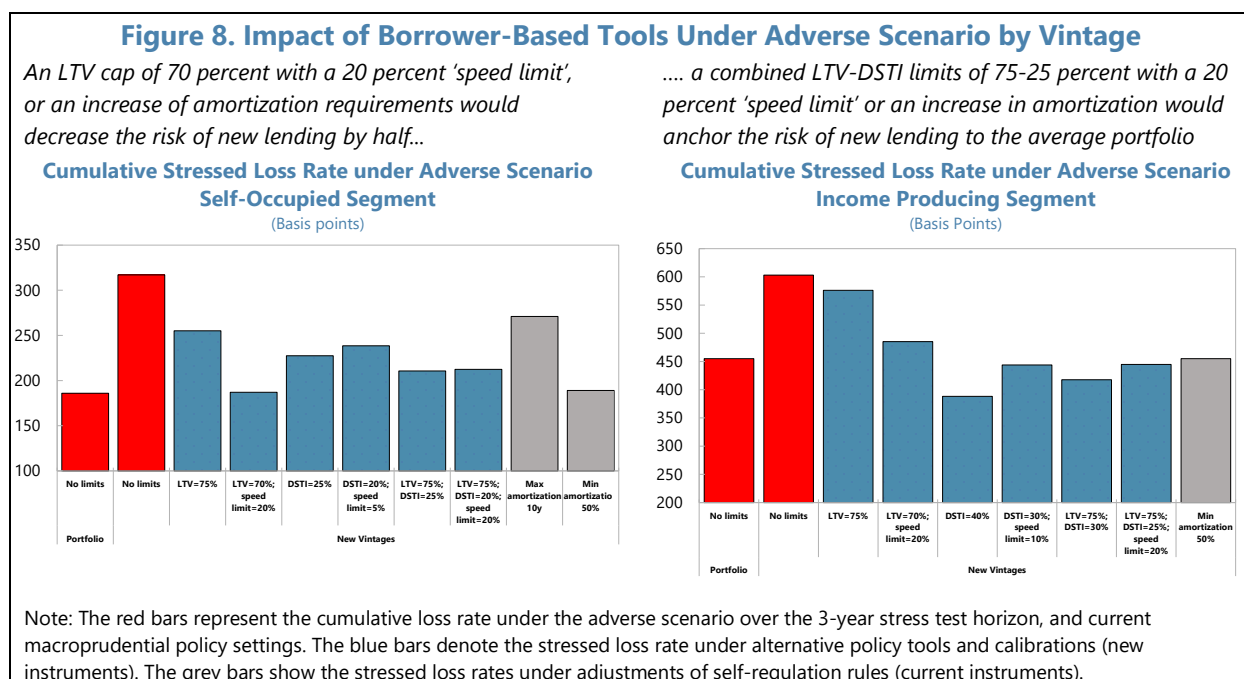


**34. Introduction of an LTV-DSTI cap with a ‘speed limit’ or an increase in amortization requirements could guard against the rise in credit risk for new vintages.** Figure 8 shows that

<sup>24</sup> The Reserve Bank of New Zealand (RBNZ) was relatively unique in using temporary LTV restrictions with speed limits in mid-2013 (BIS, 2016).

<sup>25</sup> See Zurbrügg (2022) for a discussion of macroprudential policy in Switzerland and implementation lags.

different combinations of macroprudential limits can have a similar impact on expected losses of new mortgages. A simple rule that can guide the selection of the preferred tool/limit is to target the risk of new vintages to the average risk of older vintages. For instance, an LTV cap of 70 percent with a 20 percent ‘speed limit’,<sup>26</sup> or an increase of amortization requirements to half of the value of the collateral (from two thirds under current self-regulation) would reduce by 40 percent the risk of new lending in the SORE segment. Likewise, a combination of LTV-DSTI limits of 75–25 percent with a 20 percent ‘speed limit’ or an increase in the amortization rate to 50 percent of the lending value of the property would cut the risk of new vintages by 25 percent in the IPRRE segment. In both cases, the risk of new issuance would be anchored to the risk of the outstanding portfolio (Figure 8).



**35. Anchoring the risk of new vintages to the average portfolio using borrower-based limits would save about CHF 1 billion of regulatory CET1 by year.** Lowering the risk of new vintages would also ease capital requirements for IRB banks. To estimate the average impact, we follow the next steps. First, using the Basel III IRB supervisory formula, we back out the effective maturity to match Swiss banks risk-weights on the mortgage portfolio to the reported PDs and LGDs. Second, we use the structural model to project PDs and LGDs of new vintages (no limits) and plug them into the IRB formula— adjusted to create Through-the-Cycle (TTC) projections - and calculate capital requirements. Third, using the same procedure we compute the capital required on new vintages (limits targeting the risk of the portfolio), assuming that 10 percent of the portfolio is being added yearly. The difference between the two amounts equals the savings in banks’ regulatory capital from applying the borrower-based tools calibrated in the paper.

<sup>26</sup> A ‘speed limit’ allows for a certain proportion of the volume of new loans to be exempt from a particular measure. These limits could be unconditional or targeted to specific types of loans (e.g., first-time home buyers, green mortgage loans, etc.).

## G. Policy Implications

**36. A real estate crisis could have a substantial impact on macrofinancial stability in Switzerland.** The Swiss financial sector has proved resilient despite negative interest rates and challenges related to the pandemic, and more recently, to the war in Ukraine. Default rates have remained at historically low levels. However, the Swiss mortgage market is very large relative to the size of the economy. Swiss banks are highly exposed to mortgages with geographical concentration at the canton level. While Switzerland has not experienced a sharp housing boom in recent years, residential real estate prices have increased persistently, and a wide range of indicators point at rising vulnerabilities in the mortgage and real estate market across sub-segments. The pick-up in housing demand from ultra-low interest rates, search-for-yield, and shifting preferences during the pandemic may prove transitory rendering house prices unsustainable. A sharp price correction would be a drag on economic activity and lower household wealth affecting investment and consumption.<sup>27</sup> Banks could be severely impacted and accentuate downturns through credit rationing, fueling adverse feedback loops to the real economy.

**37. The Swiss authorities have rightly re-activated the CCyB buffer to build resilience.** After the de-activation of the CCyB buffer in March 2020 to encourage banks to support the real economy during the Covid-19 pandemic, the Federal Council approved SNB's proposal to reactivate the buffer at its maximum 2.5 percent level in January 2022 (effective from September 2022). This move was intended to increase financial system resilience given clear signs of overvaluation (and of sustained recovery from the pandemic shock). The reactivation complements FINMA's close work with the banking sector to tighten self-regulation guidelines for investment property mortgages in January 2020.

**38. A fuller set of macroprudential instruments could help contain the build-up of vulnerabilities, strengthen resilience, and preserve regulatory capital.** While the banking sector is, on average, resilient to a real estate crisis, a deep house-price correction accompanied by a protracted recession could erode banks' capital buffers. Under the adverse scenario presented in this paper, the 2.5 percent CCyB buffer could absorb 25 percent of cumulative losses over a 3-year stress period. Risks are accumulated in recent vintages as earlier borrowers have repaid more principal, seen larger gains in equity, and were tested at higher lending rates. An introduction of an LTV/DSTI cap with a 'speed limit,' or an increase in amortization requirements could guard against the build-up of vulnerabilities in new lending flows by reducing the share of homebuyers that could become financially stretched. This could also help strengthen banking sector resilience by decreasing losses under severe stress and save regulatory capital under baseline conditions. Our calculations suggest that anchoring the risk of new vintages to the average risk of the portfolio would save about CHF 1 billion of regulatory CET1 capital by year. More sustainable mortgage lending would also dampen house price fluctuations, thus supporting financial stability.

<sup>27</sup> In Switzerland, real estate assets represent over half of total household net wealth.

**39. The Swiss authorities could start considering adding borrower-based tools to the macroprudential toolkit, making use of 'speed limits' to minimize impacts on mortgage-market access.** One concern is that borrower-based measures could have a disproportionate impact on first-time home buyers or lower-income households. The use of 'speed limits' allows flexibility in implementation and can be easier to enforce, minimizing distortions to allocative efficiency. The Swiss authorities could start public consultation with the banking sector and relevant stakeholders to complete the macroprudential framework in case affordability risks keep increasing and new tools need to be activated. Beyond macroprudential measures, adjustments to taxation (e.g., abolition of imputed-rent taxation or phase-out of mortgage interest relief) and actions to support the rental market (e.g., targeted subsidies, social housing) could help decrease affordability risk and support sustainable house prices.

## References

- Annaheim, M., and Heim, L. (2021), "Household wealth in Switzerland: concepts and trends in an international comparison," Swiss National Bank.
- Bank of International Settlements (2016), "Macroprudential Policy," BIS Papers No. 86, September.
- \_\_\_\_\_ (2005), "An Explanatory Note on the Basel II IRB Risk Weight Functions," July.
- Basten, C., and Koch, C. (2015), "Higher Bank Capital Requirements and Mortgage Pricing: Evidence from the Countercyclical Capital Buffer (CCyB)," BIS Working Paper No 511.
- Bloor, C., and Lu, B. (2019), "Have the LVR restrictions improved the resilience of the banking system?," Reserve Bank of New Zealand Analytical Note Series, May.
- EBA (2020), "Final guidelines on the appropriate subsets of sectoral exposures to which competent or designated authorities may apply a systemic risk buffer in accordance with Article 133 (5) (f) of Directive 2013/36/EU," September.
- \_\_\_\_\_ (2022), "Overview of national macroprudential measures," March. Available at [https://www.esrb.europa.eu/national\\_policy/html/index.en.html](https://www.esrb.europa.eu/national_policy/html/index.en.html).
- ESRB (2014), "Recommendation of the European Systemic Risk Board on guidance for setting countercyclical buffer rates."
- FINMA (2021), "FINMA Risk Monitor 2021," November.
- Gornicka, L., and Valderrama, L. (2020), "Stress Testing and Calibration of Macroprudential Policy Tools," IMF Working Paper 20/165, August.
- Harrison, I., and Mathew, C., (2008), "Project TUI: A Structural Approach to the Understanding and Measurement of Residential Mortgage Lending Risk," Reserve Bank of New Zealand.
- Reserve Bank of New Zealand (2022), "Financial Stability Report," May.
- Schneider, M. and Wagner, K. (2015), "Housing Markets in Austria, Germany and Switzerland," Oesterreichische Nationalbank, Monetary Policy & The Economy, Q1/15.
- Swiss National Bank (2021), "Financial Stability Report," June.
- Valderrama, L. (2021), "Macroprudential Policy Calibration in Slovakia," Selected Issues, Chapter 2, IMF Country Report No. 21/134.
- Zurbrugg, F., (2022), "Macroprudential policy beyond the pandemic: Taking stock and looking ahead," International Center of Monetary and Banking Studies, Swiss National Bank.

## Annex I. Technical Aspects of the Model

### Model Calibration

**Table A.1. Key Parameters of the Mortgage Model**

Parameter	Value
Calibrate sensitivity of FD to shifts in DSTI	$SORE \quad \beta_1 = 0.0003 \quad \gamma = 2.5$ $IPRRE \quad \beta_1 = 0.00004 \quad \gamma = 2.5$
Calibrate sensitivity of FD to initial DSTI by bucket	$\phi(DSTI) = \begin{cases} \left( \frac{DSTI - 10\%}{25\% - 10\%} \right) & 10\% < DSTI < 25\% \\ 1 & otherwise \end{cases}$
Calibrate sensitivity of FD to initial unemployment	$\beta_2 = 0.06$
Allocate financial distress to unemployment shock	$\begin{pmatrix} Unemp & 10\% \\ Interest & 90\% \end{pmatrix} \quad \alpha = 1 \quad \beta_3 = 0.150$
Estimate sensitivity to demographic factors	$D = 0.2$
Estimate transaction costs	$C = 4\%$
Estimate liquid financial assets (SORE)	$1.15\% \cdot \bar{P}$
Estimate liquid financial assets (IPRRE)	$10.0\% \cdot \bar{P}$

Note: The calibration and parameterization of the model uses the loan loss experience of the burst of the real estate bubble in Switzerland and in the UK in the early 1990s. While the Swiss crisis was related to commercial real estate, the UK crisis also affected the owner-occupied residential segment. The calibration procedure using the UK crisis is adjusted to reflect the mortgage characteristics and regulatory framework in Switzerland.

**Table A.2. Other Parameters of Mortgage Model**

Parameter	Value
Foreclosure discount	10%
Time to sell collateral after foreclosure	1 year
Discount rate	1.1%
Spread on discount rate on foreclosed collateral	1.0%

Note: Parameters provided by SNB based on expert judgment. The discount rate is the 5-year benchmark mortgage rate.

### Credit Risk Parameters: From Origination to Point-in-Time (PiT)

We calculate the Point-in-Time (PiT) risk parameters of loans issued from 1990Q1 through 2021Q4 using information on the risk characteristics of the loans, and data provided by SNB on household disposable income, interest rates at origination, and real estate prices. We denote the time of issuance as  $s$ , the current period as  $t$ , and the maturity of the loan as  $T$ .

First, we compute the PiT LTV ratio by backing out the outstanding principal of the loan net of repayments at time  $t$  taking into account self-regulation rules on amortization at the time of the issuance and repricing the collateral at market value at time  $t$ :

$$LTV_{t,s} = \frac{LTV_s \cdot P_s - \max\left(\left(\frac{(LTV_s - \min\_amort_s) \cdot P_s \cdot \left(1 - \frac{T_{t,s} - (t-s)}{\min\_amort_s}\right)}{maturity}\right), 0\right)}{P_t} \quad (A.1)$$

Then, we compute the income PiT using information extracting income at origination from DSTI and mortgage rates at origination, and quarterly income growth  $g$ :

$$Income_s = \frac{\max\left(\left(\frac{(LTV_s - \min\_amort_s) \cdot P_s}{maturity}\right), 0\right) + LTV_s \cdot P_s \cdot Interest_{t|s}}{DSTI_{s,s}} \quad (A.2)$$

$$Income_t = Income_s \cdot (1 + g)^{t-s} \quad (A.3)$$

This allows us to compute DSTI PiT ratio as:

$$DSTI_{t,s} = \frac{\max\left(\left(\frac{(LTV_s - \min\_amort_s) \cdot P_s}{maturity}\right), 0\right) + LTV_s \cdot P_s \cdot Interest_{t|s}}{Income_t} \quad (A.4)$$

Similarly for DTI

$$DTI_{t,s} = \frac{\max\left(\left(\frac{(LTV_s - \min\_amort_s) \cdot P_s}{maturity}\right), 0\right)}{Income_t} \quad (A.5)$$

where  $Interest_{t|s}$  is the lending rate  $t$  of a mortgage issued in  $s$ . During the stress test horizon at time  $t+j$ , we compute the shock to DSTI as:

$$\Delta DSTI_{t+j,s} = \frac{(LTV_s \cdot P_s) \cdot Interest_{t+j|s}^{s+\lambda}}{Income_t \cdot (1 + shock_j)} \quad (A.6)$$

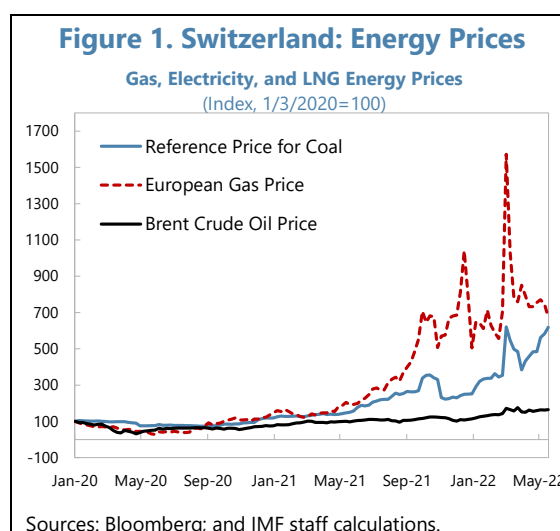
where  $Interest_{t+j|s}^{s+\lambda}$  is the lending rate as of  $t+j$  of a mortgage issued in  $s$  and with the last re-setting period of interest rate in  $s + \lambda$ .

# NATURAL GAS IN SWITZERLAND: CONSUMPTION, IMPORTS, AND RISKS<sup>1</sup>

The war in Ukraine has focused attention on energy security, including prices and supplies of oil and gas from Russia to Europe. This paper analyzes the natural gas sector in Switzerland, focusing on imports and consumption patterns. Comparisons with developments in EU countries find similarities; however, limited gas storage capacity in Switzerland appears to be associated with higher seasonality of imported volumes. Scenario analysis of the impact in interruption of gas supplies from Russia suggests prospects for demand-supply mismatches and risks to energy security, particularly over the winter season. A range of near- and medium-term policies could be considered to reduce these risks and boost energy security. The authorities have started to employ some of the policies; additional measures may be needed to ensure sufficient supplies for the 2022–23 heating season.

## A. Motivation

**1. The war in Ukraine has led to emergence of risks for energy imports from Russia.** Since the start of the war, energy prices in Europe have surged (Figure 1). Concerns are mostly focused on natural gas imports, as it would be more challenging to adjust to disruptions of gas supplies than oil or other products. While other hydrocarbons are imported at least partly by sea, rail, and road links, natural gas is predominantly transmitted via pipelines to and across Europe, many of which run from Russia. Other supply sources (liquefied natural gas, North Africa, Norway) face technical constraints (terminal and pipeline capacity). This limits the ability to replace Russian gas imports in the short term. A recent decision of by Russia’s Gazprom to stop gas supplies to Bulgaria and Poland has heightened concern.



**2. Switzerland shares risks of gas supplies with the rest of Europe as its gas transmission system is heavily linked to the continent’s gas networks.** As Switzerland is a land-locked country, it does not have a direct access to LNG flows and relies on the transmission of gas through pipelines. The main gas inflows to Switzerland come from a pipeline connecting Germany and Italy. Usually, natural gas flows from north to south, although the pipeline can operate in the opposite direction. Switzerland has other cross-border connection points with Germany, Italy, and France. Limited amounts of natural gas are held in storage by Swiss gas importers. This distinguishes natural

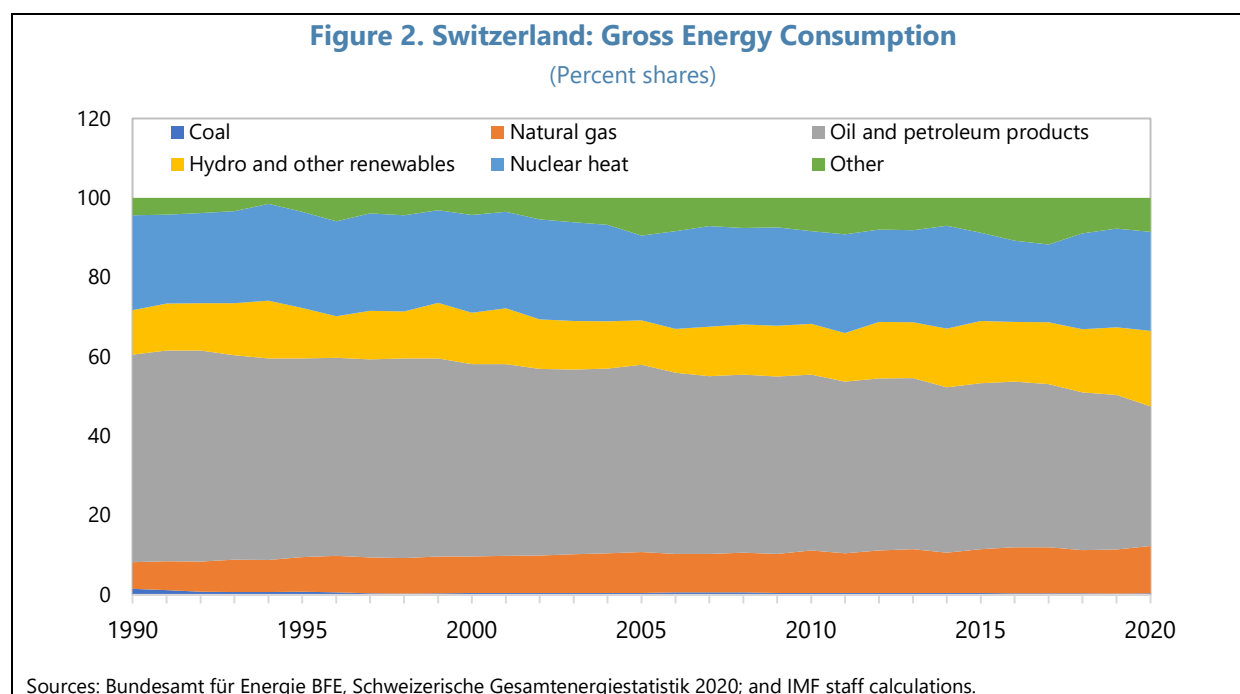
<sup>1</sup> Prepared by Svitlana Maslova (EUR). The author thanks Mark Horton and the Swiss authorities for helpful comments, including during a seminar presentation in Bern in April 2022.

gas from other energy products (e.g., petrol, diesel, and heating oil), for which stockpiles are required to meet average Swiss demand for several months.

**3. This paper analyzes the impact of a possible interruption of Russian gas imports on Switzerland’s energy balance and provides policy recommendations.** Section B considers developments in the natural gas sector in Switzerland, comparing these to developments in the EU. Section C presents a scenario analysis of the impact of a halt in Russian gas imports. Section D concludes and provides policy recommendation, with a discussion of measures being implemented by the Swiss authorities.

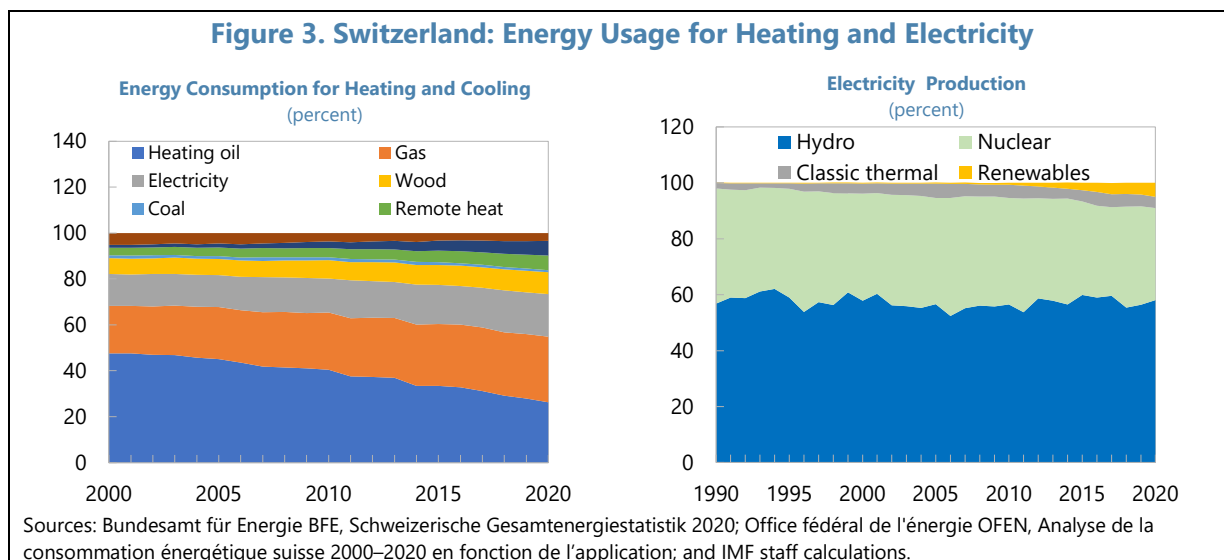
## B. Natural Gas Reliance in Switzerland and the European Union

**4. About a half of energy consumed in Switzerland comes from hydrocarbons.** Switzerland’s reliance on coal, natural gas, oil, and petroleum products declined from about 60 percent of gross energy consumption in 1990 to 48 percent in 2020 (Figure 2). Trends across different types of hydrocarbons varied during the period. Shares of coal and oil and petroleum products, respectively, in gross energy consumption declined from 1.5 and 52.3 percent in 1990 to 0.4 and 35.2 percent, while the share of natural gas increased from 6.7 to 11.9 percent in the period. The developments are quite similar to those in the European Union (EU), where the share of hydrocarbons also trended down. That said, the share of hydrocarbons in gross available energy in Switzerland is higher in the EU.

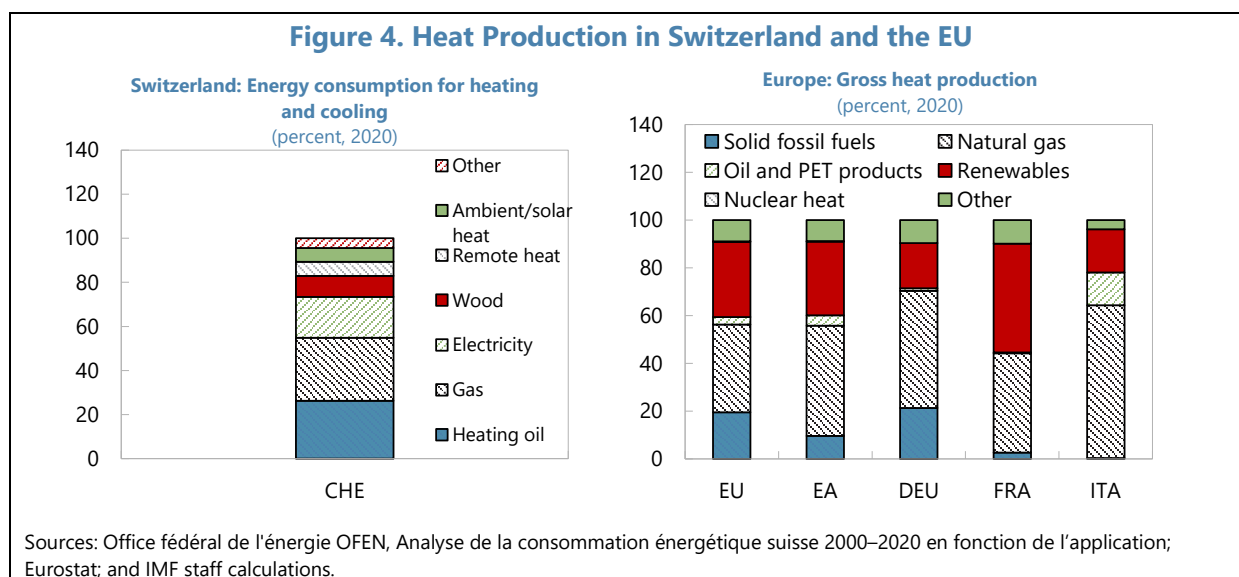


**5. Natural gas is mostly used for heating and cooling in Switzerland.** The share of natural gas in energy consumption for heating and cooling has increased over time, reaching almost 29 percent in 2020 (Figure 3). Gas became the key energy source for this purpose, exceeding the

share of heating oil. Unlike for heating and cooling, natural gas does not play an important role in electricity generation. Fossil-fuel thermal energy sources contributed just 4 percent to electricity production in Switzerland, which was largely generated by nuclear and hydro power plants.



**6. Reliance on natural gas for electricity and heating in Switzerland is relatively less than in the EU.** The shares of natural gas in electricity production and gross heat production were 20 and 37 percent, respectively, in the EU in 2020 (Figure 4). That said, reliance on natural gas varies significantly across countries in Europe and among Switzerland's neighbors.



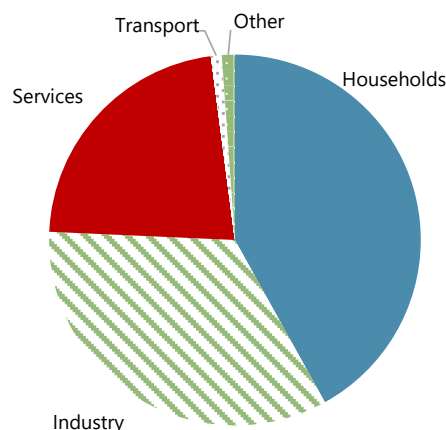
**7. About ¾ of natural gas was used by households and industry in 2019** (Figure 5). Households mostly used natural gas for heating. Among other sectors of the economy about a third of natural gas was used by manufacturing<sup>2</sup>, while public administration and real estate activities, professional, and scientific, technical and administrative activities consumed about 5 percent each.

**8. Consumption and imports of natural gas in Switzerland vary significantly across seasons.**

As much of natural gas is used for home heating, consumption is higher during the winter months (October–April) and low during summer (May–September) (Figure 6). Natural gas consumption in the EU countries also has seasonal patterns; however, imports of natural gas across the

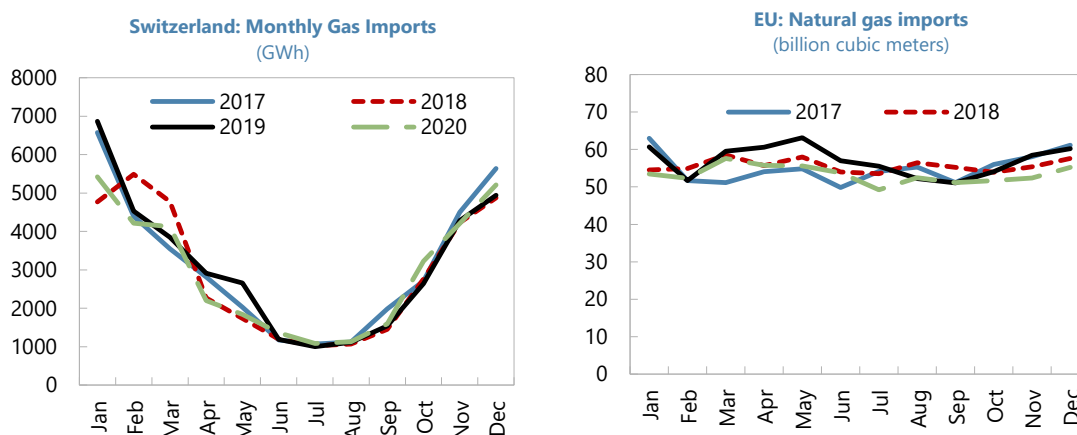
EU are less volatile due to use of gas storage facilities for smoothing. During warmer months, natural gas imports are accumulated in storage facilities to be withdrawn to supplement imports during months of high consumption. As an importer of gas from EU countries, Switzerland benefits from and contracts for space in storage facilities in neighboring countries, notably in France, but does not maintain sizable supplies domestically. Storage arrangements in EU countries may give priority to EU consumers during period of tight supply.

**Figure 5. Switzerland: Natural Gas Usage**  
(Percent, 2020)



Source: Bundesamt für Energie BFE, Schweizerische Gesamtenergiestatistik 2020; Office fédéral de l'énergie OFEN, Analyse de la consommation énergétique suisse 2000–2020 en fonction de l'application; Verband der Schweizerischen Gasindustrie Statistik 2021; and IMF staff calculations.

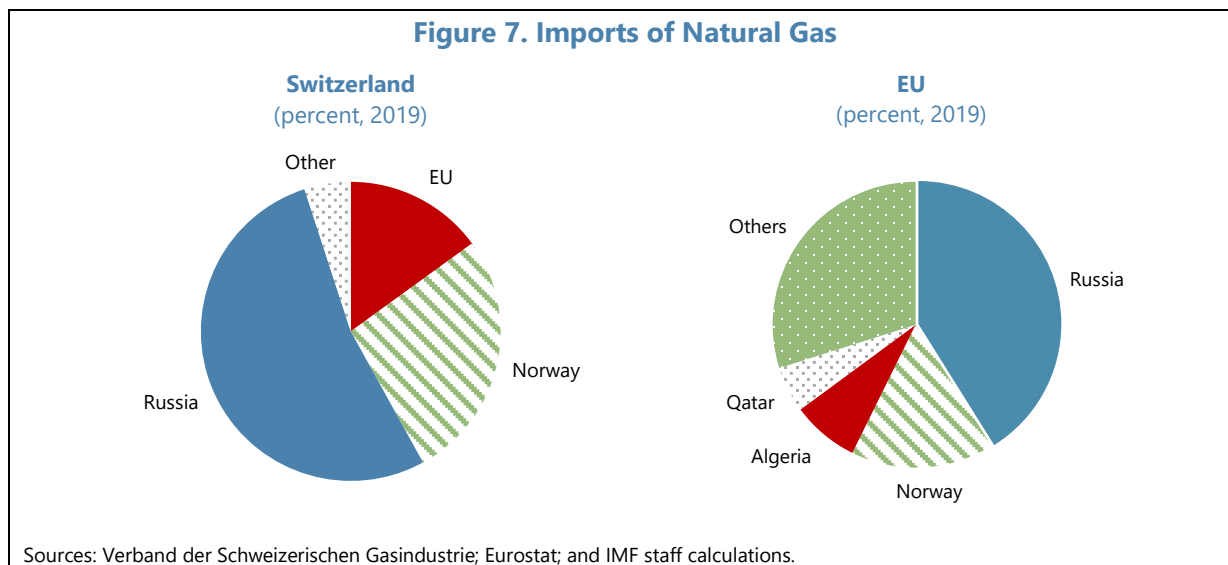
**Figure 6. Monthly Natural Gas Imports**



Sources: Verband der Schweizerischen Gasindustrie; Eurostat; and IMF staff calculations.

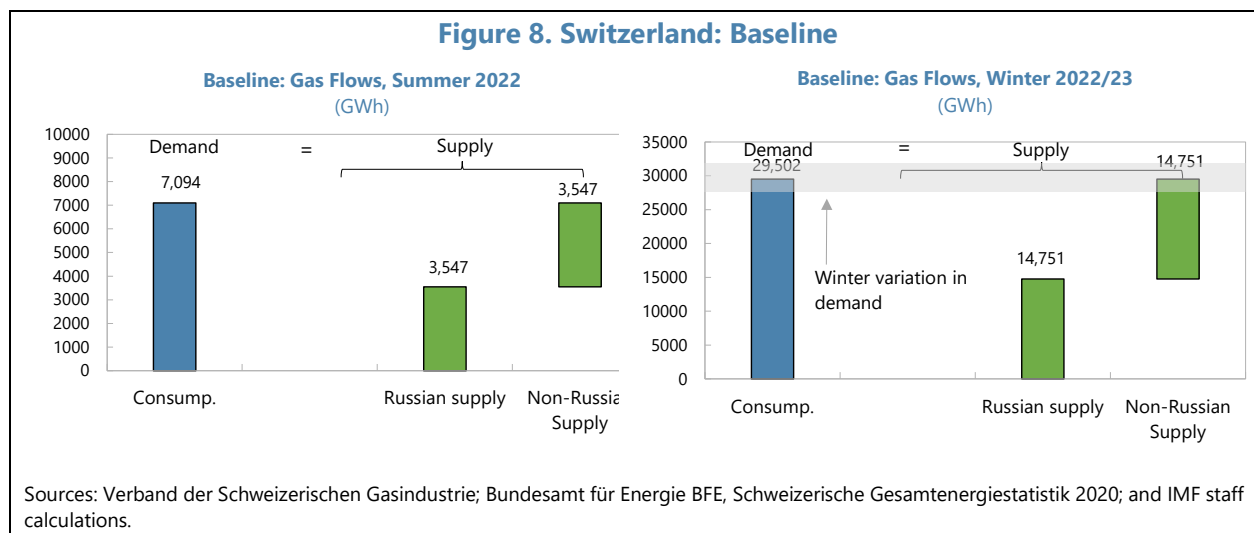
<sup>2</sup> Globally, the chemical, paper, and primary metal industries are among the largest natural gas consumers in manufacturing (see, for example, the 2018 Manufacturing Energy Consumption Survey, U.S. Energy Information Administration). The chemical and metal industries are important in Switzerland.

**9. Russia is the largest natural gas importer for both Switzerland and the EU.** However, dependence on Russian imports is somewhat larger in Switzerland: slightly more than a half of total gas imported to Switzerland originated in Russia in 2019; for the EU, this share was 41 percent. The share of gas originated in Russia in total imports to Switzerland declined in 2020 to 43 percent. Other important gas importers for Switzerland are Norway and the EU countries (transshipment). Most of imported gas is bought at a spot market.



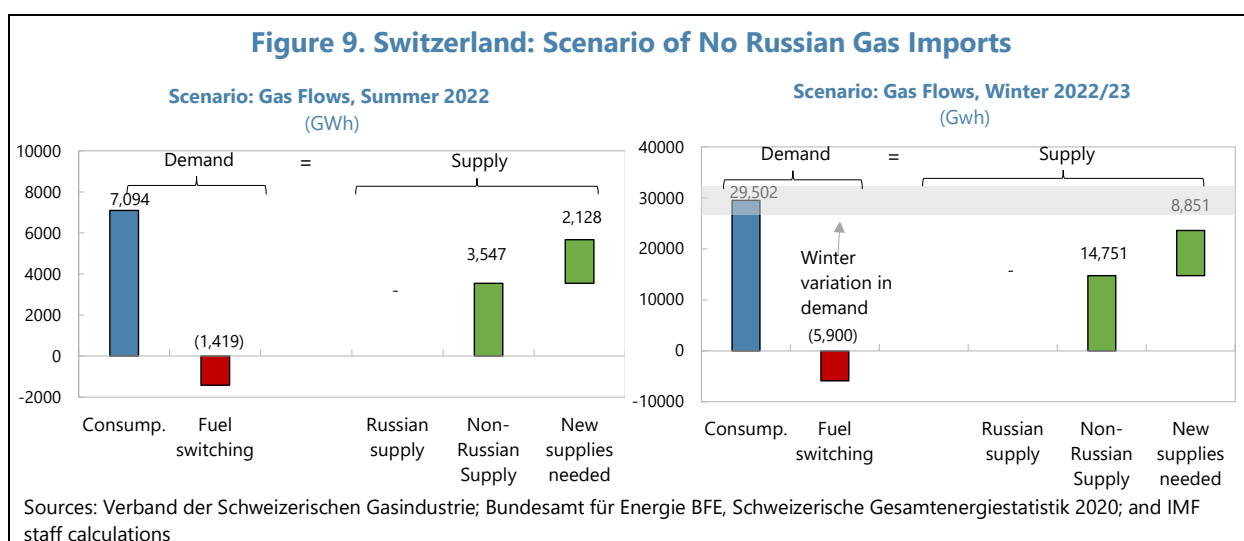
### C. Analyzing an Impact of a Stop in Russian Gas Imports

**10. Scenario analysis is used to model impacts of an interruption in natural gas imports from Russia.** A baseline scenario is developed from historical trends, assuming no changes to import flows from Russia. Switzerland’s annual gas imports averaged about 36.6 TWh during 2017–2020. About 80 percent of gas imports occurred in the winter season. As gas consumption



depends on weather conditions, some volatility in gas demand over the winter season is possible. It is assumed that half of the imported gas comes from Russia—broadly similar to the import composition in 2019–2020. The baseline assumptions imply imports of 3.5 and 14.8 TWh of natural gas from Russia in summer and winter seasons, respectively (Figure 8).

**11. The scenario for interruption of natural gas imports assumes no flows from Russia.** This means that Switzerland would face a supply gap of 18.3 TWh of natural gas; for the scenario, imports from other countries are kept unchanged. To compensate for the shortfall of natural gas supplies, companies could switch fuel from natural gas to other fuels like diesel oil (e.g., in dual-fuel plants). It is assumed that fuel switching would be able to compensate for about 20 percent of the gas consumption (Figure 9). This leaves a gap of 2.1 and 8.9 TWh in the summer and winter months, respectively. Reductions in demand would help reduce the gap, but the magnitude of the shock suggests that shortages/rationing may emerge if additional supplies of natural gas are not secured.



**12. The scenario suggests potential vulnerabilities to energy security in Switzerland if the risk of interruptions in imports materializes.** Large mismatches between demand and supply of gas may emerge, particularly during the winter season. Dual-fuel plants may help in industry, but less so for households. The timing of the interruption in imports would be important for the impact on the economy and population. In addition, the scenario analysis also has a strict assumption of no substitution from alternative suppliers. If Switzerland secures gas imports from other countries, this would help to reduce supply-demand mismatches; although it seems likely that if Swiss supplies from Russia are cut, so would natural gas supplies to neighboring EU countries, who would be similarly scrambling to identify new suppliers. Demand reduction would help, to an extent, but major manufacturers may be affected, and households may not be able to adjust to a full cut-off.

## D. Policy Implications

**13. The Swiss authorities are implementing policies to address risks of gas supply interruptions in the near term.** In order to ensure sufficient gas supplies for the 2022/23 winter

season, the authorities have created conditions for gas companies to jointly procure additional gas imports and LNG terminal and storage capacities. In late May 2022, the Federal Council required to book gas storage capacity for around 6 TWh (15 percent of the Switzerland's annual consumption), about a half of which has already been booked in France. In addition, 6TWh of natural gas that can be accessible at a short notice for a fixed fee will be purchased in France, Germany, Italy, and the Netherlands. Separately, Switzerland, together with Austria, Belgium, France, Germany, Luxembourg, and the Netherlands, has signed a political declaration to coordinate gas storage on a regional level (Pentalateral Energy Forum).

**14. Additional measures underway to boost energy security may help to reduce gas-supply-related risks.** The authorities have asked key companies to prepare risk-management plans in case of electricity-supply shortages. Incentives for house refurbishments are being implemented that could lead to a reduction in energy consumption, but will take time (and there may be shortages/bottlenecks for equipment like heat pumps or solar panels). Streamlining procedures for renewable energy projects would help tilt Switzerland's energy mix further towards green energy, although bringing these projects on line would take even longer. Measures adopted at the federal level are supplemented by initiatives at lower levels.<sup>3</sup>

**15. To strengthen energy security, the authorities could implement additional immediate and medium-term policies:**

- Immediate measures should target crisis preparedness and preparation for the next winter season. They could include developing and updating contingency plans for the sector and large consumers; high-frequency monitoring of natural gas supplies, distribution, and consumption; securing alternative gas supplies, and increasing use of other fuels where feasible. Near term, demand-management efforts could be considered, initially voluntary, but possibly price- or incentive-based or through use of smart meters. It could be also beneficial to consider solidarity agreements with neighboring countries—similar to the agreements between some EU countries, recognizing that EU neighbors are likely to be facing the same obstacles and demands. Separately, temporary and targeted measures to support parts of the economy most vulnerable to interruptions in gas supplies could be considered.
- Over the medium term, the focus should remain on progressing with green energy transition by increasing contribution from renewable energy sources and improving energy efficiency.

---

<sup>3</sup> E.g., the Zurich municipal utility company is gradually shutting down parts of natural gas transmission system in a bid to switch to distance heating.

## References

Federal Council (2022). Ordinance on Ensuring Deliveries in Case of a Severe Shortage of Natural Gas Supplies.

\_\_\_\_\_ (2017). Energy Strategy 2050.

IMF (2022). Regional Economic Outlook for Europe, April 2022.