

# Swiss Monetary Policy 2000–2009

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## 1. Introduction

Ten years ago the Swiss National Bank (SNB) announced a new monetary policy framework to take effect from January 2000. In the last issue of the 1999 Quarterly Bulletin the Bank explained the main elements underlying the new strategy: price stability, defined as an increase in the CPI of less than two percent per year, in the medium term as the principal objective; using the 3-month Swiss Franc Libor interest rate as the intermediate target; and basing interest rate decisions on forecasts of inflation.<sup>1</sup>

Judged by its own stated objectives the new policy strategy has been highly successful since inflation has mostly stayed within the range which the Bank defines as price stability. Of course, ten years is not a period long enough to pass a definite judgement on a monetary policy framework, in particular not since the external environment has until the past two years been benign. These two years have indeed been challenging for the conduct of monetary policy and only time will tell whether the SNB's response will be viewed favorably with the benefit of hindsight. In any event, the new strategy raises a number of issues both from

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1 The new framework was explained in some detail in a speech by Mr. Hans Meyer, the then Chairman of the Governing Board, at a lecture at the University of St. Gallen in January 2000 (MEYER 2000). In the speech Mr. Meyer emphasized that the new strategy adopted by the SNB should not be referred to as inflation targeting.

a conceptual and practical perspective. How different is the SNB framework from inflation targeting frameworks adopted by many other central banks? Do the differences matter in practice? Should other central banks consider adopting this framework? How has the strategy been implemented in practice? Can it be described by an interest rate reaction function similar to those which characterize the behavior of other central banks?

In this paper we seek to provide answers to these questions. We start, in Section 2, by describing the salient features of the new framework. That section also compares and contrasts the SNB's policy framework with conventional inflation targeting (IT) strategies. The main difference turns on the definition of price stability adopted by the SNB. While most inflation targeting central banks seek to achieve a single-point numerical target for the rate of inflation although in many cases use some band around it, the SNB considers any inflation rate within the range of zero to two percent as equally acceptable.<sup>2</sup> Its interpretation of the policy objective has important implications for the flexibility of the framework, for how the Bank communicates with the public, and potentially also for the performance of the policy framework and its transferability to other central banks.

Section 3 of the paper turns to a description of how the SNB implements the policy framework. In view of the important role inflation forecasts play in the strategy the section first examines the properties of the SNB's forecasts and compares them with forecasts made by market participants. It then turns to a narrative of the monetary policy decisions taken by the SNB since the introduction of the new strategy. As this narrative is based on the official statements published in the Bank's Quarterly Bulletin it gives an account of how the Governing Board justifies its policy decisions.

In Sections 4 and 5 we conduct to an econometric analysis of the determinants of changes in the policy interest rate. We estimate a reaction function akin to a Taylor rule (TAYLOR 1993), which shows that the SNB systematically reacts to the prevailing inflation rate, a measure of economic activity and the Swiss franc exchange rate. The results also indicate that there was a change in behaviour between the 1990s and the 2000s, that the quantity of money does not appear to play any independent role in interest rate decisions, and that the SNB does not simply set its policy rate in response to decisions of the ECB as some observers have claimed.

2 A similar objective is used by the Reserve Bank of Australia which seeks to achieve consumer price inflation of 2–3 per cent per annum “over the medium term.” See the page “About Monetary Policy” on the web site of the Reserve Bank of Australia.

The penultimate section of the paper contains an evaluation of the monetary policy decisions during the past year during which the policy rate was reduced by 250 basis points. This relaxation of monetary policy is broadly in line with what our estimated reaction function would have predicted, except it appears that the zero lower bound became binding around the first or second quarter of 2009. This may explain why the SNB then undertook a series of measures that might be called quantitative easing, including measures to prevent the Franc from appreciating further in the foreign exchange market.

Section 7 of the paper offers some brief concluding remarks.

## 2. The New Monetary Policy Framework: Inflation Targeting in Disguise?

### 2.1 *Inflation Targeting*

Almost ten years ago Frederic Mishkin, one of the authors of an early influential book on inflation targeting<sup>3</sup>, mentioned five criteria which in his view characterised inflation targeting:

- (i) the public announcement of medium-term targets for inflation;
- (ii) an institutional commitment to price stability as the primary goal of monetary policy, to which other goals are subordinated;
- (iii) an information-inclusive strategy ... for the setting of policy instruments;
- (iv) increased transparency ... through communication with the public ... about the plans, objectives, and decisions of the monetary authorities; and
- (v) increased accountability of the central bank ...<sup>4</sup>

Subsequent variations of this definition include the requirement that the central bank should specify explicitly the horizon within which it intends to bring actual inflation back to the target level in the event of a gap between them, and that the central bank should target its own forecast of inflation and should therefore provide detailed information about how it is constructed.

There are two reasons why a definition of inflation targeting may be useful. First, if one believes that a particular monetary policy framework can be described as “best practice”, then it would be desirable to have a relatively complete characterisation of this framework so that central banks can strive to conform to it.

3 See BERNANKE et al., (1999).

4 See MISHKIN (2000, p.105).

While this might appear uncontroversial, it should be recognised that what is considered “best practice” in one economic, historical, and institutional context may not be optimal in all circumstances.

A second, and related, reason to define inflation targeting is to be able to evaluate the macroeconomic consequences of adopting this policy framework. In practice most researchers have adopted a “de jure” approach by relying on the announcement of the central bank itself. This leads to a rather crude classification which could potentially group together relatively disparate frameworks. To be fair, a number of studies have gone further to investigate the consequences of more narrowly defined aspects of monetary policy frameworks such as the nature of central bank transparency and accountability, and a recent study MIAO (2009) introduces indices which are meant to capture how sophisticated IT central banks are in terms flexibility, transparency and strength of the institutional commitment to IT. It is interesting to note that in terms of these indices, a central bank which issues more inflation reports, which produces more explicit inflation forecasts, and which publishes its own projected interest rate path gets a higher (“better”) score, rightly or wrongly, than a central bank which is less elaborate in these respects.

Attempts to define IT and rank central banks according to relatively narrow criteria related to “best practice” may be a reason why some central banks do not refer to their monetary policy as IT even though some outside observers suggest that they are “de facto” following this strategy. The Swiss National Bank appears to be a case in point.

## *2.2 Gearing Monetary Policy to Inflation the Swiss Way*

Although the recent law governing the operations of the Swiss National Bank (SNB) came into force in May 2004, the origins of the current monetary policy framework dates back to the beginning of the decade.<sup>5</sup> The law states clearly that the goal of monetary policy is to ensure price stability, and it gives the SNB substantial independence to achieve this goal. Price stability has of course been the underlying objective of SNB’s policy since it abandoned the fixed exchange rate

5 See ROTH (2007, pp. 2–3) for a description of the legal background. Briefly, the Swiss Federal Constitution of 2000 specifies that as an independent institution the SNB shall conduct its monetary policy in the general interest of the country. The law of 2004 governing the SNB explains that “general interest of the country” shall be interpreted as achieving price stability and while doing so, the SNB should take into account the state of the business cycle. The SNB is free to define exactly what “price stability” means in practice.

policy in 1973. What is new in the current framework is the manner in which the price stability objective is defined and policy is conducted.

The framework of the SNB was explained in the No. 4/1999 issue of the SNB's Quarterly Bulletin (QB). Since then the framework of monetary policy and the SNB's interest rate decisions have regularly been described in speeches and publications by members of the direction and staff of the bank. Two particularly comprehensive examples are ROTH (2007) and BALTENSPERGER, HILDEBRAND and JORDAN (2007). Referring the reader to these documents for details of the framework, here we outline only its main features.

To make the notion of price stability operational, the SNB states that it seeks to keep inflation within the band of zero to two percent per year over the medium term. Importantly, it does not consider the mid-point or any specific value of the rate of inflation as more important than any other value within the region.

Nous sommes satisfaits avec n'importe quel taux de renchérissement non négatif inférieur à 2%, c'est-à-dire que nous n'entreprenons pas d'action correctrice lorsque l'inflation attendue se situe entre 0% et 2%. Nous ne visons donc pas un taux d'inflation précis comme objectif.<sup>6</sup> (ROTH 2007, p. 6)

Recognising the lags in the monetary policy transmission mechanism, explanations of policy decisions are explicitly based on forecasts of inflation, the latter being constructed on the basis of a variety of econometric models and indicators using a wide range of information. The point forecasts of inflation are published quarterly. Through speeches by members of the direction, publications aimed at the general public, as well as research reports intended for more specialised audiences, the SNB communicates its approach and policy decisions in a transparent and accessible fashion.

### *2.3 What's the Difference and Does It Matter?*

In the light of this description of the SNB's policy framework one might ask whether it isn't really plain vanilla IT. After all, price stability is the principal objective, the policy decisions are forward-looking and based on published inflation forecasts, and the bank generally strives to be transparent. There are, however, two notable if subtle differences between the SNB approach and what uncompromising IT proponents would insist on. First, as already noted the SNB's definition of price stability is relatively flexible in that it only articulates

6 "We are satisfied with any non-negative rate of inflation less than 2%, which means that we do not take any corrective action when the expected rate of inflation lies between 0% and 2%. Hence we do not target a specific rate of inflation." (Own translation.)

a band for the inflation rate and does not have any view on where the “optimal” position within the band is. Secondly, the SNB does not commit to any specific horizon within which it will bring inflation back to the target range in case this range has been breached. It merely states that it aims for price stability “in the medium term”.

So does this matter? For the SNB the distinction matters because it does not want to be boxed into a rigid view of how a monetary policy framework focusing on price stability should be designed. By not specifying a specific numerical value for the inflation target and by not declaring a horizon for achieving the target the SNB retains a greater degree of flexibility to react to unforeseen developments in the economy, including to exchange rate changes.

The flip-side to the flexibility might be that expectations of the private sector are less well anchored to a low-inflation equilibrium than they otherwise would be. This might be a serious concern for central banks that do not have a track record of maintaining price stability and which are adopting inflation targeting as a strategy to establish such a record. The situation is quite different for the SNB, which over an extended period of time has built up a strong reputation for sound monetary policy, which allows it to adopt a more flexible policy framework. Hence it prefers not to be labelled as an inflation targeting central bank.

### 3. Implementing the Policy Strategy

As already noted, SNB's new policy framework was announced in the No. 4 issue of the 1999 Quarterly Bulletin in German, French, Italian, and English. The title of the English version was “Monetary policy decisions of the Swiss National Bank for 2000.” This issue of the QB constituted the beginning of a new approach to communicating monetary policy decisions by the SNB, an approach that would evolve over several years. The most noteworthy changes were the inclusion of explicit forward-looking inflation forecasts, stating the policy implications in terms of a target band for the 3-month Libor rate and with explicit reference to the inflation forecasts, the reduced weight attached to monetary aggregates in the assessment of the risks to price stability, and the switch, starting with the No. 3/2002 issue, to publishing a full version of the QB in English on the SNB website. In this section we first discuss the presentation of the inflation forecasts and some aspects of their accuracy before going on to describe how decisions regarding the monetary policy interest rates are described and justified. In so doing we also note the gradual evolution of the structure of the sections in the QB which refer to inflation forecasts and monetary policy decisions.

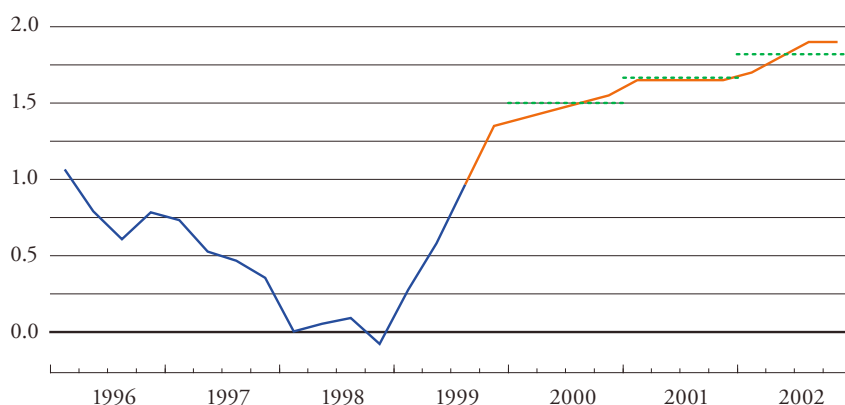
**Figure 1: The Inflation Forecast as Published in SNB Quarterly Bulletin No.4/1999**

Inflation Forecast December 1999 (Libor = 1.75%)

Percentage change in national consumer price index from previous year

— Inflation    — Forecast

- - - Average annual rate of price increases (2000: 1.5%, 2001: 1.7%, 2002: 1.8%)



### 3.1 The Nature of the Inflation Forecasts

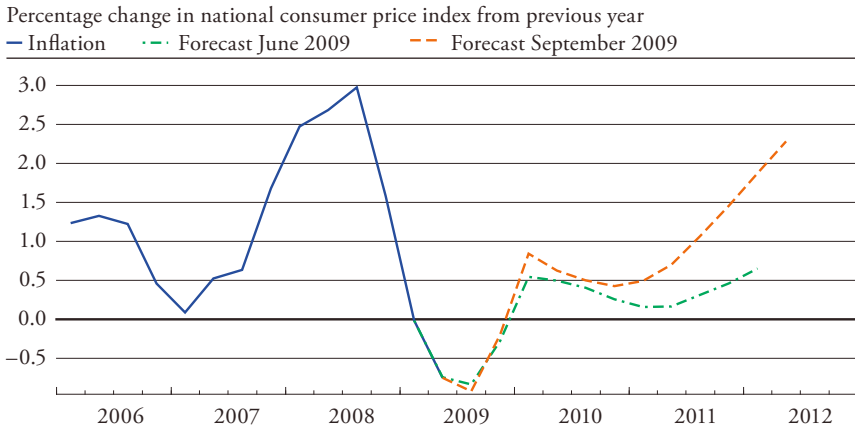
As implied by the new policy framework, monetary policy aims to achieve price stability defined as an inflation rate of less than 2%. Furthermore, given the lag with which a policy change influences, inflation which the SNB frequently referred to as about three years in length, policy decisions are taken in part on the basis of inflation forecasts. Consequently, the SNB started publishing its inflation forecasts in the QB.<sup>7</sup> The first forecast was given in the form of a chart, reproduced here as Figure 1.

This type of chart has continued to be published in the QB. At first it was published in two issues, No. 2 and No. 4, but from No. 1/2003 onwards it was included in every issue. The nature of the chart has remained broadly the same over the years as illustrated in Figure 2, which is taken from the No. 3/2009 issue. The two principal changes are the inclusion of two paths comparing the forecast

<sup>7</sup> It should be noted that the SNB does not publish any information about how precise its inflation forecast might be. Furthermore, it does not provide any forecasts for real economic activity although presumably the models used to forecast inflation also generate output forecasts.

**Figure 2: The Inflation Forecast as Published in SNB Quarterly Bulletin No.3/2009**

Inflation Forecast June 2009 (Libor = 0.25%) and September 2009 (Libor = 0.25%)



**Inflation Forecast of June and September 2009**

Average inflation in percent	2009	2010	2011
Forecast June 2009, Libor at 0.25%	-0.5	0.4	0.3
Forecast September 2009, Libor at 0.25%	-0.5	0.6	0.9

of the current quarter with that of the previous one, and explicitly noting the interest rate conditioning assumption underlying the forecasts.

The forecasts published by the SNB are conditional on the current setting of the policy interest rate.<sup>8</sup> While it recognises that conditioning forecasts on a constant policy rate can be criticised as being inconsistent with the policy that is likely to be pursued in the future, the practice has been defended in speeches by members of the Governing Board<sup>9</sup>, and is regularly used to signal future interest rate changes when the conditional forecast deviates from the price stability norm. We do not take a stand on whether it would be useful to publish inflation

8 Since the SNB sets a target range for the Libor rate which is typically 100 basis points wide, the conditioning interest rate is the rate within the range which the Bank aims to achieve, ordinarily the mid-point.

9 See, for example, ROTH (2007). Mr. Roth, the Chairman of the Governing Board of the Bank, notes that when the inflation target is defined in terms of a band rather than a specific value it is impossible to define a unique path for the policy interest rate.



forecasts based on other interest rate paths, but confine ourselves to characterising certain aspects of these forecasts as they appear in the QB.

As can be seen from Figures 1 and 2, the SNB provides numerical values of current-year as well as one and two-year ahead forecasts. These forecasts represent averages for the year in question. From the chart itself it is also possible to read off year-on-year forecasts for up to 12 quarters ahead.<sup>10</sup> As this horizon corresponds what the SNB considers to be the lag-length for the impact of monetary policy on the inflation rate, we will make use of these forecasts in our discussion of interest rate decisions in the next section.

Figures 3 and 4 contain current year and one-year-ahead inflation forecasts by the SNB and Consensus Forecasts together with the actual inflation rate corresponding to the forecast horizon.<sup>11</sup> While it is not possible to discern any significant differences between the two forecasts for the current year, the Consensus Forecasts appear to be slightly more accurate for the one-year ahead horizon. This impression is confirmed by a comparison of root-mean-square forecast errors.<sup>12</sup>

The reason for the slight difference in the precision of the forecasts could be that the panel members contributing to the Consensus Forecasts take into account possible future interest rate decisions by the SNB. To investigate this hypothesis we regress the difference in the squared forecast errors on the absolute value of the change in the policy interest rate during the year subsequent to the forecasts.<sup>13</sup> If changes in policy interest rates are at least partially anticipated by the Consensus Forecast panel, and to the extent that these changes impact the actual inflation rate, we should observe a negative slope coefficient in the regression. The results are consistent with this interpretation as shown in the Table 1 below. Note also that when the change in the Libor is not accounted for the constant term is negative and significantly different from zero corroborating our earlier claim that Consensus Forecasts are more accurate than the SNB's forecasts at the one-year horizon. These results should not be construed as a criticism of the practice by the SNB of conditioning their forecast on a constant interest rate

10 For research purposes it would be useful if the SNB would publish the numerical values of the entire forecast path. We are grateful to Michel Peytrignet for providing us with these data.

11 Consensus Forecasts are published by Consensus Economics.

12 For current year forecasts these are 0.039 for the SNB and 0.031 for the Consensus Forecasts. For the one-year horizon the corresponding numbers are 0.422 and 0.181, respectively. The calculations are based on forecasts from 2000Q1 to 2007Q2, the end period being chosen to eliminate potential effects of the financial crisis.

13 We use the absolute value of the change in the policy interest in order to capture the size and not the direction of the change. Similar results obtain if we use the squared value of the change in the interest rate.

Figure 3: Inflation Forecasts for the Current Year

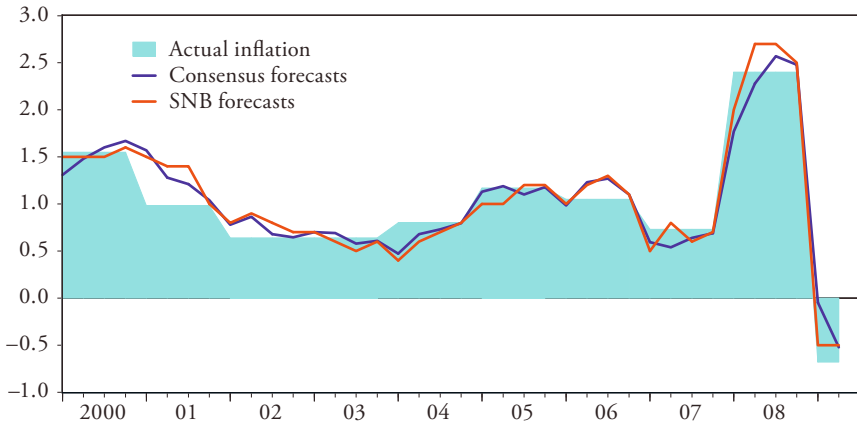
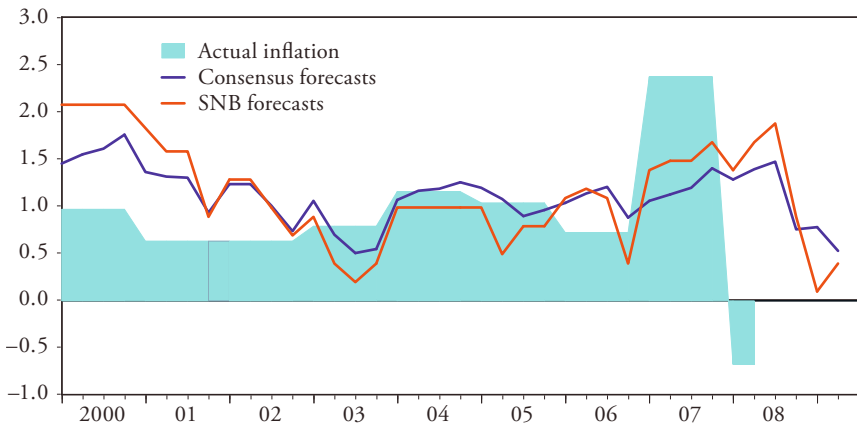


Figure 4: Inflation Forecasts One Year Ahead



as the Bank is fully aware of the fact that this may reduce the accuracy of the forecast. Rather, to the extent that our interpretation is correct, the results show that the private sector does not interpret the constant interest rate assumption as a statement of the intentions of the SNB.

**Table 1: Regression of the Difference in Squared One-Year Ahead Inflation Forecast Errors on the Absolute Value of Changes in the Policy Interest Rate**

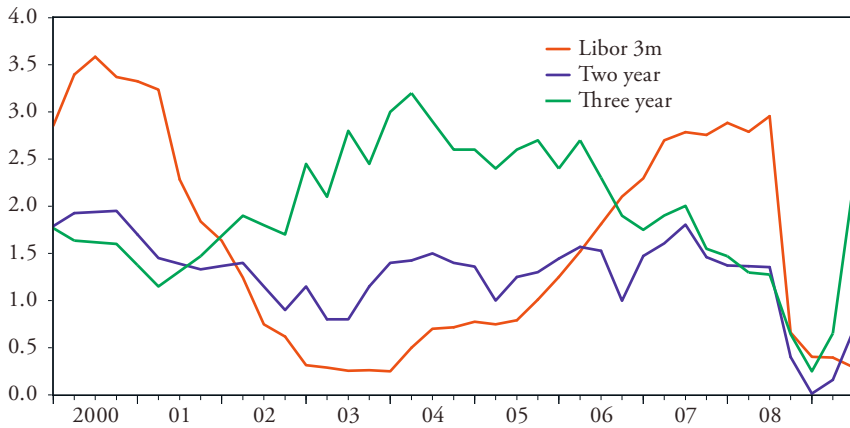
Sample period	Constant	Slope	R-squared (adj)
2001:1–2007:2	0.13 (1.44)	–0.50*** (5.03)	0.51
2001:1–2007:2	–0.24*** (3.61)		

*Notes:* Numbers in parentheses refer to absolute values of *t*-ratios; \*/\*\*/\*\* denote significance at the 10/5/1% level.

Our final remark on the inflation forecasts is that the current and one-year ahead forecasts rarely deviate from the 0–2% range regarded by the SNB as consistent with price stability. This is arguably a consequence of the success with which the SNB has carried out its mandate. But it is also because, since the introduction of the new monetary policy framework, the economy was not hit by major shocks having a rapid, large, and persistent influence on inflation process except in the last two years.

Looking at longer-term inflation forecasts, the picture is different. Figure 5 reveals that while two-year ahead forecasts are also in line with the price stability mandate, those for a three-year horizon have frequently exceeded the 2% upper limit. If the SNB takes monetary policy decisions in part with reference to forecasts of inflation at the three-year horizon, we would expect to see changes in policy interest rates in periods when this limit is broken. As a rough first impression this appears to be the case in some but not all situations as shown by the movements in the 3-month Libor rate also presented in the graph. We now turn to a brief but slightly more detailed narrative of the interest rate decisions and justifications by the SNB.

Figure 5: 3-Month Libor, Two-Year Inflation Forecast and Three-Year Inflation Forecast



### 3.2 Interest Rate Decisions

The SNB implements monetary policy by establishing a target range for the 3-month Swiss Franc Libor interest rate and by announcing a rate within the range that it aims for. This is usually the mid-point of the range. Operations in the shorter-term repo market are used to influence the Libor rate. The outcome of this process is already illustrated in Figure 5 using end of quarter data on the target rate and in Figure 6 using daily data.

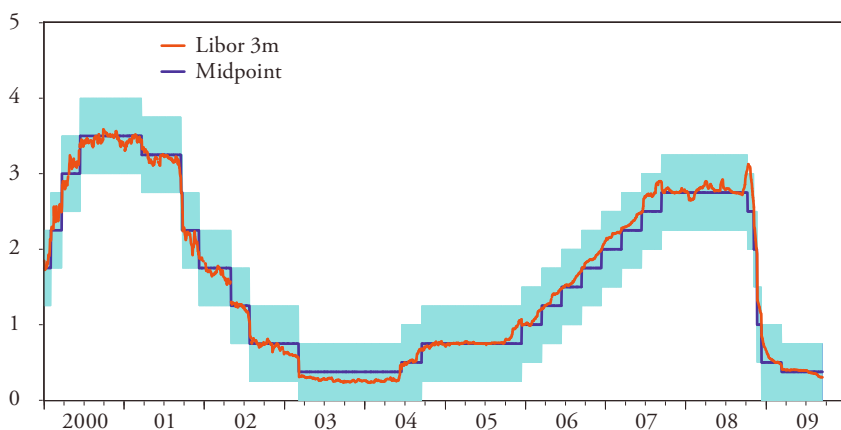
The interest rate decisions are explained in the QB in the form of a one to two page summary of the analysis of the monetary and economic developments of the Swiss economy.<sup>14</sup> This summary is followed by the chart showing the inflation forecast. The title of this summary has evolved over the years, but since the No. 1/ 2008 issue it is called “Monetary Policy Decision”.<sup>15</sup>

As shown in the charts, the range for the policy rate was increased in the early part of 2000 from 1.25/2.25 to 3.0/4.0 in three steps. This decision was justified by reference to increasing dangers of inflation (“dangers inflationnistes

14 A more detailed discussion of the determinants of inflation and the forecasts can be found in a separate section.

15 Starting with the No. 1/2004 issue of the QB, the section containing the economic and monetary analysis, the discussion of the inflation forecast, and the monetary policy decision has been called “Monetary Policy Report”.

Figure 6: Monetary Policy Interest Rates



croissants”) relative to those prevailing at the end of 1999.<sup>16</sup> Indeed, by the second quarter of 2000 the three-year-ahead inflation forecast was higher than the 2% upper limit defining price stability. Throughout 2000 the SNB referred to the relatively high forecasts for inflation as a reason for maintaining the interest rate corridor at 3.0/4.0, but noted in the fourth quarter that the medium-term forecast was consistent with price stability.

With reference to a reduced danger of inflation exceeding 2% in the medium term, the SNB lowered the policy rate by 25 basis points (bp) in the first quarter of 2001, and by a further 50 bp and 25 bp in the third and fourth quarters respectively. These decisions illustrate the flexibility built into the monetary policy framework. If inflation forecasts for the medium term remained consistent with price stability, the SNB could pursue other goals in the best interest of the economy, in this instance the real growth rate which showed some tendencies to weaken. Thus, the SNB stated in the No. 3/2001 issue that

Aucun indice ne montre que la stabilité des prix est menacée à moyen terme. Cette perspective permet à la Banque Nationale d’assouplir une nouvelle fois sa politique monétaire. (p. 9)<sup>17</sup>

16 The increasing inflationary pressures were explained by the business cycle upswing and the weakness of the Swiss Franc, the latter being referred to frequently in subsequent reports as an important variable for the interest rate decision.

17 “There are no indications that price stability is threatened in the medium term. This allows the National Bank to ease once more its monetary policy.” (Own translation).

Similar considerations, no threat to price stability and a weak economy but this time also including references to undesirable movements in the Swiss Franc exchange rate (“une évolution indésirable du cours du franc”), led the SNB to reduce its policy rate by 25 bp in the fourth quarter of 2001. The reduction of the policy rate by 50 bp in the second quarter of 2002 was justified unequivocally with reference to the strength of the Swiss Franc and the fact that inflation forecasts were still consistent with price stability even if the three-year-ahead forecasts were increasing (see Figure 5). The explicit reaction to the exchange rate induced the Chairman of the Governing Board to clarify the role of the exchange rate. In the No.2/2000 policy statement he said (p. 10):

Dans cette période, nous avons, par nos mesures, neutralisé le durcissement que la revalorisation du franc donnait aux conditions monétaires et réduit l’attrait des placements en francs.<sup>18</sup>

In other words, the appreciation of the currency was interpreted as a tightening of monetary conditions which was neutralized by the easing of the policy interest rate.<sup>19</sup>

In the first quarter of 2003 the target interest rate was reduced by a further 50bp to 0.25% (the range was lowered to 0/0.75).<sup>20</sup> In view of the fact that the three-year-ahead inflation forecast by now exceeded 2% one might have concluded that a policy easing was not opportune, especially given the SNB’s view of the length of the transmission mechanism of interest rate changes to inflation. Recognising this argument the monetary policy statement noted that “[t]he National Bank nonetheless believes that it still has sufficient time to make later adjustments to its monetary policy, and that it can keep inflation within the price stability range” (QB, No.1/2003, p. 10).

Throughout 2003 the two- and three-year-ahead forecasts of inflation continued to increase. By the fourth quarter of 2003 inflation forecasts 2.5 and 3 years ahead were both over 2%. As already noted, this configuration of inflation

18 “During this period we have, by the measures we have taken, neutralised the tighter monetary conditions brought about by the appreciation of the currency and reduced the attractiveness of Swiss Franc investments” (own translation).

19 It should be noted that in a highly open economy such as the Swiss, movements in the exchange rate have an immediate impact on the rate of inflation.

20 Part of the reason for lowering the interest rate was again the strength of the Swiss Franc. In this context it is of interest to note that the SNB felt that “[i]n spite of the fact that money market rates are already very low, the National Bank still has effective instruments at its disposal. In particular, these include intervention on the foreign exchange market” (QB, No. 1/2003, p. 10). The SNB, in other words, would not hesitate to intervene in the foreign exchange market should, in its judgement, the Swiss Franc appreciate excessively.

forecasts had led the SNB to raise the policy rate in early 2000. Yet the policy rate now remained at 0.25%. The SNB explicitly noted that there was still time to tighten monetary policy to prevent actual inflation from exceeding the 2% limit, suggesting either that it believed the transmission mechanism to be somewhat shorter than it had usually maintained, or that other considerations than price stability were sufficiently important to justify the risk of slightly over-shooting the price stability norm. The strength of the Swiss Franc convinced the Bank not to raise interest rates at this time. It did so only in the second quarter of 2004 when the policy rate was increased to 0.50%. By this time the three-year-ahead inflation forecast had reached over 3%, and the SNB felt it necessary to signal further monetary tightening. It stated:

... the projected annual inflation rate at the end of the forecasting period still exceeds 2%, suggesting that the SNB will have to raise the target range again during this period if it is to ensure price stability. (QB No. 2/2004, p. 9)

Such tightening did occur in the third quarter when the policy rate was increased by a further 25 bp.

In spite of repeatedly signalling further rate increases due to the medium-term pressure on prices, the SNB kept the target Libor rate at 0.75% until the end of 2005, referring as a justification to continued weakness of the economy. When this concern had dissipated the rate was increased by 25 bp in December 2005 and, in view of stubbornly high inflation forecasts at horizons beyond two and a half years, further increases continued to be signalled. As shown in Figures 5 and 6 such increases were in fact carried out throughout 2006 and into the second half of 2007. The decisions to tighten monetary policy were consistently based on the improved growth prospects and high degrees of capacity utilisation, and in spite of the fact that medium-term inflation forecasts by the end of 2006 had come down to levels which were consistent with price stability and which in late 2002 had been concurrent with a lowering of interest rates. As it had explained in announcing its new monetary policy framework the SNB clearly did not, contrary to the ECB, view an inflation rate lower than but close to 2% as a target. It seemed quite content in pursuing a policy which would bring the inflation rate down further inside the zone of price stability in order to pursue other objectives, notably the support of economic growth.

Towards the end of 2007 both the two- and three-year-ahead inflation forecasts had declined to 1.5%, and as a consequence of somewhat lower forecasts for economic growth, the SNB ended the series of interest-rate increases. Inflation forecasts continued to decline modestly during the first three quarters of 2008, but seeing no risk of actual price deflation (which would be inconsistent with the

SNB's definition of price stability) the SNB kept the policy rate at 2.75% in part because it felt that the high actual rate of inflation in 2008 (see Figure 1) might become incorporated into private-sector inflation expectations. There were also concerns that energy prices would continue to increase and that the Swiss Franc would weaken, both of which would bring about increased short-term inflationary pressures.

By the fourth quarter of 2008 and into 2009 the economic climate had deteriorated substantially prompting the SNB to ease monetary policy drastically in line with other central banks. The policy rate was brought down to 0.25% and amid threats of deflation, the zero bound on nominal interest rates, and an appreciating exchange rate the Bank intervened in the foreign exchange market to ease monetary conditions, thereby making use of the additional "effective instrument at its disposal". The impact of these measures on inflation is being determined as we write.

### *3.3 A Preliminary Assessment*

Judging by the evolution of inflation since the introduction of the new framework, the policy strategy of the SNB can be regarded as a success. The average inflation rate between January 2008 and July 2009 has been 1.0% and it has with few exceptions stayed within the 0–2% zone. The exceptions occurred in 2008 as result of particularly rapid increases in commodity prices and again in the beginning of 2009 in the context of the global economic crisis. But ten years is a short period for a definite verdict, and considering the inflation rate in a longer-term perspective reveals that it has been consistent with the current definition of price stability since 1994. One has to go back to the seventies and eighties in order to find significant departures from this norm. In addition of course, an evaluation of the performance of a policy strategy should take into account the external economic context within which the strategy is executed.

So instead of attempting to pass judgement on the policy framework based on the inflation outcome, we confine ourselves to assessing how the strategy has been implemented with the view of exploring empirically the determinants of interest rate changes in the next section.

Based on the narrative in the previous section it appears that the SNB only reacts to the inflation rate when it threatens to go outside the 0 – 2% band. This is indeed consistent with how the framework has been defined. Exactly how the SNB judges that there is a threat to price stability is harder to pinpoint. Three-year-ahead inflation forecasts have frequently been greater than the 2% limit without leading to changes in the policy rate. In spite of considering three years



to be the time for monetary policy to have an impact on inflation, statements by the SNB in the QB often imply that it does not consider it necessary to take action immediately when forecasts of inflation three years out are outside the zone defining price stability. So the effective danger signal seems to be forecasts of a somewhat shorter horizon. For instance, it could be that the SNB focuses on the two-year forecasts and uses the three-year forecast to signal to the public its views on the likely course of monetary policy over the longer run.

When price stability is not a threat, the SNB explains changes to the policy interest rate with reference principally to the state of the economy measured by either the output gap or the rate of change in the output gap or the rate of growth in the economy. In other words, the Bank makes liberal use of the flexibility built into the framework implied by having a range rather than a point target rate of inflation. In the same vein, when the SNB judges the exchange rate to be at an inappropriate level or moving in a direction that is threatening price stability, it may adjust the interest rate or, when the interest rate is close to the zero bound, intervene in the foreign exchange market. The reason for paying particular attention to the exchange rate appears not to be that it is a target in and of itself, but rather that it is an important determinant of inflation in the short- to medium term.<sup>21</sup>

The analysis above suggests that the SNB sets monetary policy in response to the inflation outlook, economic activity and the exchange rate. In the following section we study the SNB's policy choices more formally, using a series of conventional empirical reaction functions to organise the discussion. We also discuss whether the non-linear nature of the SNB's policy framework is apparent in the data.<sup>22</sup>

21 This was also the conclusion reached in CAMEN, GENBERG and SALEMI (1990).

22 The non-linearity stems from the fact that when the inflation rate is (projected to be) within the 0–2% range, interest rate decisions can be geared principally towards the stabilisation of output, whereas when there are signs of threat to price stability, the inflation objective becomes the main concern.

## 4. An Empirical Characterisation of Interest Rate Setting by the SNB

### 4.1 *The Choice of Interest Rates*

To estimate monetary policy reaction functions, we must first determine what interest rate to use to capture the stance of policy. This is not self-evident in the Swiss case. First, before the adoption of the new framework in 2000 monetary aggregates played a central role in the formulation of policy and there was no policy interest rate. Indeed, as we show below, the parameters in empirical Taylor rules estimated on data for the 1990s are typically insignificant, suggesting that this model does not provide a useful description of policy in that period.

Second, the one-week repo rate and 3-month Libor both play important roles in the new framework, in which the repo rate is changed so as to maintain Libor within the announced target band, which is determined by macroeconomic considerations. We therefore use Libor as a measure of the stance of policy. The obvious alternative would be use the midpoint of the target band as a measure of the stance of policy.<sup>23</sup> However, the SNB does not aim at maintaining interest rates at the midpoint and in fact allows the rate to vary in the target range in light of economic conditions, suggesting that Libor best captures the stance of policy

### 4.2 *The Econometric Model*

Let  $i_t$  denote the policy rate and  $i_t^T$  policy makers' preferred level for it. Let  $\pi_t$ ,  $y_t$ , and  $z_t$  denote, respectively, inflation, real economic activity, and any other variable(s) that impact on policy makers' interest rate target such as exchange rate changes, expected inflation, or measures of external economic conditions. Consider next the following expression for the preferred level for the interest rate:<sup>24</sup>

$$i_t^T = a_0 + a_y y_t + a_\pi \pi_t + a_z z_t \quad (1)$$

where  $a_0$  is a constant that controls for a non-zero target levels for the variables on the right-hand side of equation (1). The policy makers' preferred level is assumed

23 It is in principle possible to estimate an ordered probit model for changes in the preferred level of the Libor rate as in GERLACH (2007).

24 SVENSSON (1997) presents a simple model in which the target interest rate depends on the state of the economy, as measured by the output gap and the deviation of inflation from the central bank's target or objective, and show that the optimal reaction function takes the form of the Taylor rule. The linear instrument rule follows from the quadratic objective function, the

to increase if economic activity increases relative to its full-capacity level or if the inflation rate increases relative to its target level. Next, we allow for gradual adjustment of the actual interest rate as in JUDD and RUDEBUSCH (1998):

$$i_t - i_{t-1} = \beta_0(i_t^T - i_{t-1}) + \beta_1\Delta i_{t-1} + e_t \quad (2)$$

where  $e_t$  is a residual. Using equations (1) and (2), we obtain an expression for the change in the interest rate,  $\Delta i_t \equiv i_t - i_{t-1}$ :

$$\Delta i_t = \alpha_0 - \beta_0 i_{t-1} + \beta_1 \Delta i_{t-1} + \alpha_y y_t + \alpha_\pi \pi_t + \alpha_z z_t + e_t, \quad (3)$$

where  $\alpha_i \equiv a_i \beta_0$ . Having the change in the interest rate, rather than the level, as the dependent variable will influence the goodness of fit of the model. Since the fraction of the variance of changes in interest rates that is accounted for by the lagged level is very low, the present parameterization will yield a much lower R-squared than a level specification, for which the R-squared will be close to unity. This is helpful because it makes it clearer how much explanatory power the other regressors add.

#### 4.3 Inflation and Real Economic Activity

The original Taylor rule viewed the policy-controlled interest rate as being set in response to developments in inflation and the output. To capture inflation, we use the year-to-year change in the consumer price index.

It is less clear how real economic activity should be captured. We could in principle compute output gaps using real GDP. However, the national accounts data are only available with a considerable lag and are typically revised, sometimes repeatedly and by large amounts. This makes it difficult to believe that the output gap plays a central role in SNB's interest rate decisions.<sup>25</sup>

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assumption that the economy is linear, and that the target values for inflation and output are fixed. Our baseline empirical strategy can therefore be interpreted as asking whether the SNB can be described as if it is de facto following a traditional Taylor rule. As explained above, the SNB has not adopted a specific value of inflation as a target but rather a range. In this case the derivation of the optimal reaction function is more complicated as the trade-offs between different objectives are not linear. In Section 5.6 we discuss the nature of the non-linearity and search for evidence for its presence during the sample period we study.

25 Of course, output gaps are likely to capture the state of the business cycle to which central banks reacts. They are thus likely to be significant in an ex post analysis of central bank interest rate setting, even if they were unavailable at the time policy decisions were taken.

In studying the interest rate decisions of the ECB, GERLACH (2007) notes that policy decisions are frequently motivated with references to subjective measures of the state of the economy such as consumer or business “confidence” or “sentiment” which are available with a negligible lag. Since these subjective indicators tend to be strongly correlated with data on business conditions, central banks may use them to help assess the current state of economic activity. In the case of Switzerland, possible measures of the state of real economic activity is a quarterly index of consumer sentiment which is available from the SNB’s website or the monthly Swiss Purchasing Managers’ Index.<sup>26</sup>

As alternative to measures based on survey data, one could use the leading indicator for Switzerland constructed by the OECD, the KOF’s Economic Barometer, which are both available monthly, or the quarterly business cycles indicator of UBS. One advantage of these variables is that they are stationary, thus obviating the need to detrend them. This is attractive since statistical filters tend to give poor estimates of underlying trends at the end of the sample, that is, for the inherently most interesting observation.

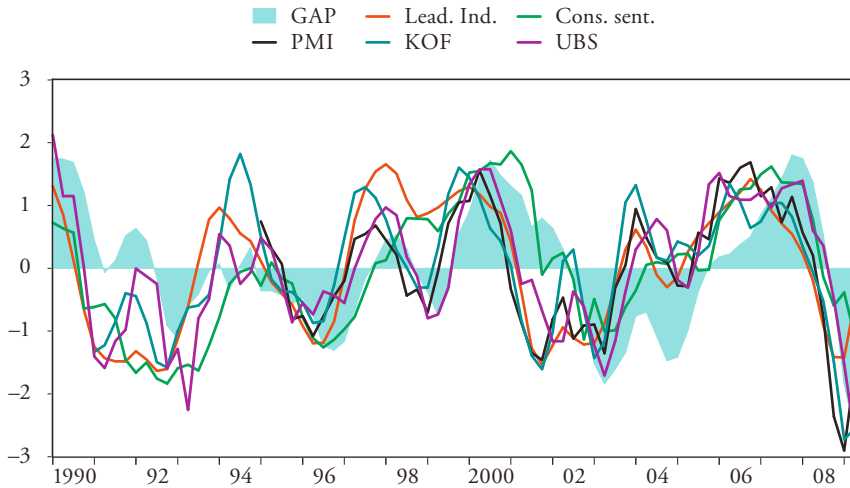
The time series are plotted in Figure 7 together with the Hodrick-Prescott filtered output gap. Two aspects of this figure are notable. First, all series are strongly correlated. This suggests that they all contain information about the current state of the business cycle. Second, the output gap seems at times to be moving with a slight lag to the other series.<sup>27</sup>

Of course, in setting interest rates the SNB forms a broad view of economic conditions, using a large amount of data and judgement, and does not rely solely on any single measure of real economic activity. We therefore think of the problem of selecting an indicator of real economic conditions as trying to find a proxy variable for the SNB’s assessment of the state of the business cycle. To do so, we explore the information content of all six different variables plotted in Figure 7 in the econometric work below. To preview the results, the Libor rate seems most closely correlated with the OECD leading indicator.

26 The PMI is available from Credit Suisse’s website, starting from January 1995.

27 This conclusion is supported by estimated cross-correlations which we in the interest of brevity do not report here.

Figure 7: Measures of Real Economic Activity



*Note:* The series has been normalized by subtracting the mean and dividing with the standard deviation.

#### 4.4 Sample Period

The sample period for the estimations starts in 2000 when the new monetary policy framework was introduced. Since the SNB sets interest rates four times a year (although additional interest rate changes are possible if the need arises), we use quarterly data. Given that many countries experienced large changes in monetary policy formulation in a number of countries following the collapse of Lehman Brothers in September 2008 and there is too little data to study this period in detail, we end estimation in 2008q2. For comparison purposes, we also provide some estimates for the period 1990q1–1999q4 and use our preferred model to construct out-of-sample for the period of financial markets turmoil that started after the collapse of Lehman Brothers in September 2008.

## 5. Estimation Results

Since the data are quarterly, we assume that the SNB's observes them instantaneously. The monthly time series are converted into quarterly data by using the last month of the quarter; the interest rate is that prevailing on the last day of the quarter.

### 5.1 *An Empirical Reaction Function*

We start by estimating the empirical reaction function in equation (3) with a measure of economic activity, the current inflation rate, and the effective exchange rate as the right-hand-side variables together with the lagged interest rate. Since preliminary estimates indicate that the lagged change in the Libor was always insignificant, we drop it from the model.

Column 1 in Table 2 shows the results when the leading indicator is used as a proxy for the SNB's assessment of the real economy. The lagged level of the Libor rate is highly significant, indicating that there is mean-reversion in the interest rate. The leading indicator is also highly significant as are inflation and level of the nominal effective exchange rate. Since the latter variable is defined such that an increase denotes an appreciation, the results suggest that the SNB tightens monetary policy in response to a more depreciated exchange rate, presumably because it raises inflation, both directly by increasing the domestic currency price of imports and indirectly by expanding aggregate demand, and because it influences the level of economic activity. The explanatory power of the regression is also surprisingly good: almost 80% of quarterly *changes* in the interest rate are explained.<sup>28</sup>

In the second column we use consumer sentiment to capture economic activity. It is highly significant but the explanatory power of the regression falls, as evidenced by the adjusted R-squared. Interestingly, the parameter on the lagged interest rate is now considerably larger, suggesting much faster dynamic reactions of interest rates to the regressors. Inflation and the nominal effective exchange rate remain highly significant and their parameters essentially unchanged.

In column 3 we present the results when the PMI is used instead of consumer sentiment. It is highly significant as is inflation and the level of the nominal effective exchange rate. Indeed, the adjusted R-squared is almost as high as when the leading indicator is used to capture the state of the real economy.

28 The standard error of the regression, which is 17 bp, provides an alternative measure of fit.

**Table 2: Estimated Reactions Functions**

Dependent Variable: Change in Libor

	1	2	3	4	5	6
Sample	2000q1– 2008q2	2000q1– 2008q2	2000q1– 2008q2	2000q1– 2008q2	2000q1– 2008q2	2000q1– 2008q2
Lagged interest rate	-0.20*** (4.78)	-0.46*** (7.90)	-0.21*** (5.01)	-0.18*** (3.59)	-0.27*** (5.75)	-0.53*** (5.69)
Leading indicator	0.09*** (7.20)					
Consumer sentiment		0.02*** (5.89)				
PMI			0.03*** (6.86)			
KOF				0.23*** (5.23)		
UBS					0.14*** (5.75)	
Output gap						0.30*** (3.79)
Inflation	0.18*** (3.39)	0.22*** (3.76)	0.18*** (3.18)	0.21*** (3.23)	0.16*** (2.49)	0.25*** (3.47)
Effective exchange rate	-0.03*** (3.43)	-0.05*** (4.13)	-0.04*** (4.36)	-0.04*** (3.58)	-0.05*** (4.43)	-0.06*** (4.24)
Adj. R <sup>2</sup>	0.75	0.68	0.73	0.64	0.67	0.53

*Notes:* Numbers in parentheses refer to absolute values of *t*-ratios; \*/\*\*/\*\* denote significance at the 10/5/1% level. The effective exchange rate is defined such that an increase denotes an appreciation.

In column 4 we report the result when the KOF economic barometer is used. While the results are similar to those obtained when consumer sentiment or the PMI is used, the fit of the regression is much lower. Replacing the KOF indicator with the UBS business cycle indicator (column 5) leads to very similar results.

Finally, in column 6, we use the output gap, computed using the HP filter, to measure real economic activity. While all parameters remain highly significant, the adjusted R-squared is much lower than before. Dropping the exchange rate and estimating a “standard” reaction function with only the output gap and

inflation as regressors leads to an even larger fall in the adjusted R-squared to 0.27, and inflation turns insignificant. This suggests that if the objective is to understand central bank interest setting, one can do much better than simply regressing the policy rate on the output gap and inflation by considering what measure of economic activity might be most closely correlated with the policy makers' perceptions of economic activity and by taking into account the structure of the economy (in this case the high degree of openness that suggests that the exchange rate matters).

We next explore whether the new policy framework actually led to a significant change in the behaviour of the 3-month Libor, whether measures of money growth should enter the reaction function, whether the exchange rate against the euro is more strongly correlated with the SNB policy choices than the effective exchange rate, whether euro area interest rates are significant in the reaction function for the SNB (and, if so, how that finding should be interpreted), and finally whether it is possible to detect any non-linear behavior in interest rate setting consistent with the definition of price stability as a zone rather than a point target. In the interest of brevity, in what follows we use solely the leading indicator to capture the SNB's assessment of real economic conditions since it is more strongly correlated with the Libor rate than the other measures of real economic activity.

### *5.2 Did the New Framework Lead to a Change in Interest Rate Behaviour?*

To explore whether the change in the framework led to a change in way 3-month interest rates move in response to economic conditions, in Column 1 in Table 3 we estimate the reaction function on the sample 1990q1–1999q4, and include a dummy variable for 1992q3 when exchange rate turmoil in the ERM led to strong appreciation pressure on the Swiss franc, to which the SNB responded by cutting interest rates. Interestingly, in this case only the exchange rate is significant, suggesting, as one would have expected, that the behaviour of three-month interest rates was quite different in the decade before the introduction of the new policy framework.

### *5.3 Money Growth*

Since the SNB historically has emphasised the importance of money in the transmission mechanism and the inflation process, in Column 2 we add the growth rate over four quarters of M2 and in Column 3 we instead add the growth rate of M3. Both money growth variables are insignificant and enter with a negative



**Table 3: Estimated Reactions Functions**

Dependent Variable: Change in Libor

	1	2	3	4	5
Sample	1990q1– 1999q4	2000q1– 2008q2	2000q1– 2008q2	2000q1– 2008q2	2000q1– 2008q2
Lagged interest rate	–0.06 (0.76)	–0.25*** (4.49)	–0.21*** (5.03)	–0.21*** (5.28)	–0.33*** (3.45)
Leading indicator	0.01 (0.42)	0.07*** (3.94)	0.08*** (5.65)	0.07*** (3.55)	0.06*** (4.22)
Inflation	–0.02 (0.19)	0.18*** (3.36)	0.16*** (2.92)	0.18*** (3.48)	0.14*** (3.04)
Effective exchange rate	–0.05** (2.55)	–0.04*** (3.77)	–0.03*** (3.05)	–0.04*** (3.97)	–0.03*** (3.75)
M2 growth		–0.01 (1.44)			
M3 growth			–0.02 (1.35)		
Exchange rate against euro				–0.02 (1.86)	
Change in euro area interest rate					0.41*** (3.39)
Lagged euro area interest rate					0.17* (1.76)
Dummy for 1992q3	–2.00*** (3.74)				
Adj. R <sup>2</sup>	0.38	0.76	0.76	0.77	0.82

Notes: Numbers in parentheses refer to absolute values of *t*-ratios; \*/\*\*/\*\* denote significance at the 10/5/1% level. The effective exchange rate is defined such that an increase denotes an appreciation.

coefficient. This suggests that higher interest rates depress money growth. In order to explore whether money does contain information for interest setting, it would be important to control for this reverse causality. Doing so is much beyond the scope of this paper.

#### *5.4 Euro Exchange Rate*

In Column 4 we explore whether the SNB responds to the nominal effective exchange or to the euro area exchange rate. Interestingly, we find that while the effective exchange rate is highly significant, the euro area exchange rate is only significant at the 7% level.

#### *5.5 Euro Area Interest Rates*

It is sometimes claimed that the SNB's interest rate decisions merely follow those of the ECB. Since we use three-month Libor rates to capture the stance of policy in Switzerland, in Column 5 we add the current change in, and the lagged level of, three-month interbank rates in the euro area to the model. While the estimates and significance of lagged interest rates, consumer sentiment, inflation and the exchange rate remain broadly unaffected, the change in euro area interest rate is highly significant while the lagged rate is only significant at the 7% level. The adjusted R-squared also rises.

How should this finding be interpreted? While some would argue that the SNB "follows" the ECB's interest rate decisions, a more plausible interpretation focuses on the fact that macroeconomic conditions in the two economies evolve in broadly the same way. Thus, innovation in short-term money market rates in the euro area contain information about economic developments that are common to the two economies but not picked up in the few variables we use to capture economic conditions in Switzerland. If so, one would expect the euro area interest to be insignificant if we used a broader information set to summarise Swiss macro economic developments.

#### *5.6 Is there Evidence of Non-Linear Reactions Related to the Definition of Price Stability as a Zone?*

ORPHANIDES and WIELAND (2000) discuss the implications for the form of the interest rate reaction function of a policy framework where the central bank targets a zone for inflation rather than a specific numerical value. In their framework the loss function of the central bank only depends on the deviations of output from the full-capacity level when the inflation rate is inside the zone of price stability, but it is quadratic in both inflation and output deviations outside the zone. This feature of the central bank's objective function implies that the optimal interest rate reaction function will be nonlinear even if the equations describing the evolution of inflation and output are linear.

While it is not possible to derive closed-form solutions for the optimal interest rate policy in the general case, the authors are able to characterize the nature of the solution. Two features are particularly noteworthy. First, as long as the inflation rate is well inside the zone of price stability, the optimal policy response to deviations of the inflation rate from the mid-point of the zone is approximately linear. In the realistic case where the economy is subject to stochastic shocks, the response will be greater than zero but smaller than in the standard linear-quadratic setup. Second, if the inflation rate is pushed farther from the mid-point of the zone, the optimal interest response increases steadily until it equals the linear-quadratic value when the inflation rate is well outside the zone.

To capture this non-linear response one could specify that the coefficient on inflation in equation (1) is some function of the deviation of the inflation rate from the mid-point,  $\bar{\pi}$ , of the price stability zone as in equation (4)

$$a_{\pi} = a_{\pi}^0 + a_{\pi}^1 g(|\pi_t - \bar{\pi}|) \quad (4)$$

Attempts to test this hypothesis were not successful in the sense that the non-linear effect was only present if the sample included the observations from 2008q4 to 2009q2, the last quarter for which we have data. However, this period saw many unusual developments – a collapse in economic activity and survey measures of economic conditions, a strengthening of the exchange rate and tensions in money markets that affected the wedge between Libor and the mid-point of the SNB's targeting range – which make it difficult to estimate the importance of the any “inflation zone” behaviour. We are thus left with a linear response function.

To interpret this finding, recall that the results obtained by ORPHANIDES and WIELAND (2000) suggest that the optimal response is approximately linear when the inflation rate is well within the zone of price stability. Arguably the sample period we are working with has this characteristic, so that the absence of non-linear response in the reaction function simply reflects the fact that shocks to inflation during the past ten years have been modest, except possibly during the past few quarters, a far too short a time period to yield reliable empirical estimates.

### 5.7 Does the Published Inflation Forecast Influence the Policy Decision?

Finally we ask whether the variables that enter the reaction function do so only because they determine the inflation forecast of the SNB.<sup>29</sup> To answer this question we would like to estimate the parameter  $\alpha_h$  in equation (5).

$$\Delta i_t = \alpha_h \pi_{t,b}^f(i_{t-1}, \xi_t) + x_t \beta + u_{t,b} \quad (5)$$

In this equation  $\pi_{t,b}^f(i_{t-1}, \xi_t)$  stands for the inflation forecast for horizon  $h$  conditional on the interest rate prevailing before the governing board takes its interest rate decision as well as on all other information,  $\xi_t$ , which enters into the inflation forecast. The expression  $x_t \beta$  represents the other variables which enter the policy reaction function. A significant positive value of  $\alpha_h$  and insignificant values of  $\beta$  would indicate that the SNB only reacts to its inflation forecast.

As it stands we can not estimate the parameters in (5) because the forecast published by the SNB is conditioned on the interest rate prevailing *after* the policy decision is taken, i.e. on  $\pi_{t,b}^f(i_t, \xi_t)$  in our notation.

To proceed we therefore make use of the fact that the two forecasts differ only by the effect of a change in the rate of interest on the inflation forecast, i.e.

$$\pi_{t,b}^f(i_t, \xi_t) - \pi_{t,b}^f(i_{t-1}, \xi_t) = -\gamma_h \Delta i_t \quad (6)$$

where  $\gamma_h$  measures the impact of a change in the policy interest rate at time  $t$  on the inflation forecast at horizon  $h$ . Using this relationship equation (5) can be transformed into

$$(1 - \gamma_h \alpha_h) \Delta i_t - (\alpha_h \pi_{t,b}^f(i_{t-1}, \xi_t) + x_t \beta) = u_{t,b} \quad (7)$$

Provided we knew the value of  $\gamma_h$  we could easily estimate the other parameters in this equation, notably  $\alpha_h$ . The values of  $\gamma_h$  were obtained by a preliminary regression of the inflation forecast on the three-month Libor rate as well as on the current values of consumer sentiment, inflation, and the exchange rate. The resulting values we use in the estimation of equation (7) are  $\gamma_8 = 0$ ,  $\gamma_{10} = -0.20$ , and  $\gamma_{12} = -0.57$ .<sup>30</sup>

29 This section was added in reaction to comments of our discussant, Marcel Savioz, at the conference.

30 The qualitative nature of the results discussed below are not sensitive to other reasonable choices for the value of  $\gamma_h$ .

To obtain estimates of the parameters in (7) we used generalized methods of moments with consumer sentiment, the inflation rate, and the exchange rate as elements of the  $x$  vector, and the same variables together with the lagged values of the inflation forecast and the interest rate as instruments. Results are presented in Table 4.

**Table 4: Estimated Reactions Functions**

Dependent Variable: Change in Libor

	1	2	3	4	5	6
Sample	2000q1– 2008q2	2000q1– 2008q2	2000q1– 2008q2	2000q1– 2008q2	2000q1– 2008q2	2000q1– 2008q2
Forecast horizon (quarters)	8	10	12	8	10	12
$\gamma_h$	0	–0.20	–0.57	0	–0.20	–0.57
Lagged interest rate	–0.41*** (4.64)	0.03 (0.81)	0.27*** (4.95)	–0.19*** (3.04)	–0.15* (1.75)	–0.35 (1.09)
Inflation forecast	1.73*** (4.87)	1.26*** (5.39)	0.57*** (5.60)	0.39 (1.10)	0.13 (0.51)	–0.31 (1.53)
Leading indicator				0.08*** (4.44)	0.09*** (3.33)	0.14* (1.79)
Inflation				0.13* (1.70)	0.15** (2.37)	0.20*** (3.02)
Effective exchange rate				–0.01 (0.48)	–0.02 (1.29)	–0.03* (1.92)
Sum of squared residuals	4.56	3.31	1.90	1.01	0.86	1.00
Pseudo Adjusted-R <sup>2</sup>	–0.30	0.05	0.46	0.68	0.73	0.68

*Notes:* Estimation is carried out by GMM with the lagged value of the interest rate, the inflation forecast and the effective exchange rate and the current values of the leading indicator and the inflation rate as instruments. Numbers in parentheses refer to absolute values of  $t$ -ratios; \*/\*\*/\*\* denote significance at the 10/5/1% level. The effective exchange rate is defined such that an increase denotes and appreciation. The “Pseudo Adjusted-R<sup>2</sup>” in the last row of the table is calculated as follows:  $1 - [(SER)^2 / (SED)^2]$  where SER = Standard Error of the Regression and SED = Standard Error of the change in 3-month Libor. This corresponds to the Adjusted-R<sup>2</sup> as calculated in Tables 2 and 3.

When only the SNB's inflation forecast is present in the equation (in addition to the lagged Libor rate) we note that it has a positive and significant effect on the change in the policy interest rate for all three forecast horizons (cols. 2–4). The results change significantly when the other conditioning variables are allowed to enter the equation. For the 8 and 10 quarter horizons (cols. 5 and 6) the coefficient on the SNB's inflation forecast is no longer significantly different from zero, and for the 12 quarter horizon the point estimate is actually negative albeit not significantly different from zero. The leading indicator variable does have significant explanatory power, however, and so does the current inflation rate. The point estimate of the exchange rate coefficient is significant only for the 12 quarter horizon.<sup>31</sup>

How should these results be interpreted? In our view, they do not imply that the SNB does not react to forecasts of future inflation, but rather that: (i) the published forecasts are not the best indicators of the threat to price stability in the view of the members of the governing board, (ii) the forecast horizon relevant for the interest rate decisions may vary over time, (iii) as for most inflation targeting central banks changes in policy interest rates reflect a trade-off between risks to price stability and concerns for employment and economic activity. According to the estimation results presented in this section, these concerns and trade-offs are better captured in an empirical reaction function of the SNB if the variables that reflect future inflation and economic activity are allowed to enter freely rather than through the inflation forecast alone.

### *5.8 Summarizing the Empirical Results*

Overall, our estimates of the reaction function indicate that the SNB reacts strongly to movements in economic activity and the exchange rate and, of course, to inflation. These findings warrant a number of comments.

First, estimates of the reaction function are reduced-form and depend on the central bank's loss function and on the structure of the economy (SVENSSON 1997). Finding that the SNB reacts to a variable, such as economic activity, may thus either be due to the fact that it is a target in its own right or to the fact that it impacts on a target variable, such as inflation.

Second, we interpret the fact that we find stronger (in the statistical sense) reactions to the leading indicator than to the other measures of economic activity as

31 It is noteworthy that the size of the coefficients on the lagged interest rate, the leading indicator, the inflation rate, and the exchange rate are similar to those reported in Table 2 when the inflation forecast was not included in the regression.

indicating that the former variables are more closely correlated with the SNB's view of economic conditions, which is built up by looking at a large range of economic indicators, than the output gap. One reason for that is that real GDP data are only available with a long time lag, and are then subject to potentially large revisions, so there is little reason for the SNB to focus on them when setting rates. Furthermore, our measure of the output gap relies on final estimates of real GDP and is constructed using a two-sided filter. Thus, it is likely to be a poor estimate of the SNB's real-time assessment of the output gap.

Third, reacting to the exchange rate is sensible in a highly open economy such as the Swiss since exchange rate movements impact on future inflation and economic activity.<sup>32</sup> Finally, the SNB may feel that the exchange rate occasionally exhibits excessive volatility unrelated to the underlying fundamental determinants and therefore acts to smooth out short term fluctuations. However, the SNB does not have a fixed objective for the level of the exchange rate since the appropriate level of the exchange rate depends on a number of factors, such as economic growth and inflation, and thus can be expected to vary over time.

Fourth, the finding that the SNB does not react primarily to its published inflation forecasts but to a broader set of variables suggests that the forecast is not a good summary statistic of the SNB's view of the likely future inflation rate. This is consistent with the fact that the published forecast is conditional on a constant policy interest rate and as such it does not necessarily represent what the SNB believes the future inflation rate will actually turn out to be.

Fifth and finally, the empirical results indicate that the relationship between Libor and the other macroeconomic variables did in fact change as a consequence of the introduction of the new policy framework. In contrast to in the 1990–99 period, Libor is now closely correlated with measures of economic activity, inflation and the exchange rate. This suggests that it is now easier for the public to understand how short-term interest rates respond to the current state of the economy. Policy may in this narrow sense have thus become more predictable and transparent.

32 Both of these reasons are consistent with the SNB's view that the exchange rate movements influence "monetary conditions" in the economy. See footnote 19.

## 6. Policy During the Current International Financial Crisis

From October 2008 until December 2009, the SNB lowered its policy rate by a cumulative 250 basis points as deteriorating internal and external economic conditions and a strengthening of the Swiss Franc brought about a sharp reduction in the outlook for inflation and real economic activity. The Bank also intervened in the foreign exchange market to stem the appreciation of the Swiss Franc and inject liquidity into the financial system. How do these policy responses compare with those that our empirical model would imply?

Figure 8 provides the elements for an answer. It shows the dynamic forecasts of the policy rate generated by our preferred model (using the leading indicator to capture real economic activity) estimated with data until 2008q2. The figure shows that Libor was unexpectedly high in 2008q3 after the collapse of Lehman Brothers, and that the SNB cut interest rates faster than one would have expected given its past behaviour. In 2009q2, the model suggests that the zero lower bound became binding and economic conditions subsequently called for even more monetary easing. To achieve such easing the SNB announced in March 2009 that it “will increase liquidity substantially by engaging in additional repo operations, buying Swiss franc bonds issued by private sector borrower and purchasing foreign currency on the foreign exchange market” (QB, 1/2009, p. 9).

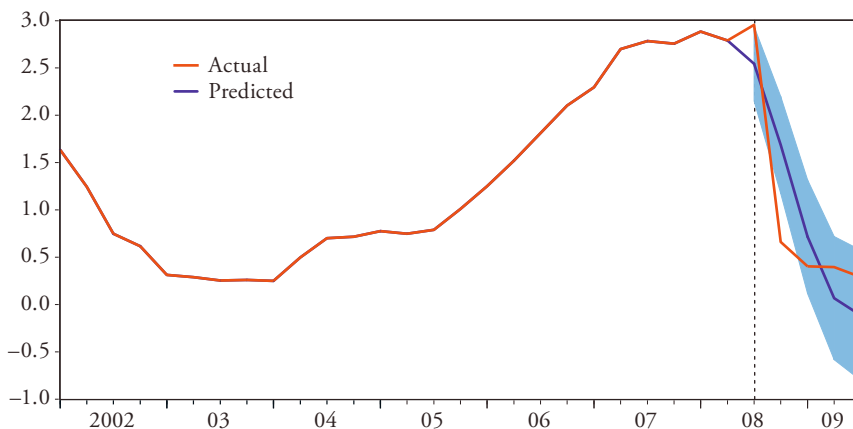
It is too early to tell the extent to which these operations have had an impact on bond yields, the exchange rate or, more generally, on economic activity and inflation. Besides, such an assessment would have to rely on models to determine what the counterfactual outcomes would have been. This is beyond the scope of the present paper but would be an important area for research, as it would clarify whether so-called unconventional monetary policy measures are effective, and if so, through which channels.

## 7. Conclusion

Ten years ago the Swiss National Bank announced a change in its monetary policy framework. The new approach makes an explicit reference to price stability as the principal objective of monetary policy and the SNB has interpreted this as being attained if the rate of inflation lies between 0 and 2 percent. The new approach has been highly successful in that inflation has remained firmly inside the range since the new framework was adopted, except for a period in 2008 when headline inflation surged due in large part to commodity price increases, and in 2009 when it turned negative in response to falling commodity prices.



Figure 8: Dynamic Out-Of-Sample Forecasts, Using the “Preferred” Model



The new framework entailed a switch from focusing on monetary aggregates as intermediate targets to implementing and communicating policy through a short-term interest rate. This, we believe, has made it easier for the general public to understand the conduct of policy. This is suggested by the fact that the correlations between short-term interest rates as a measure of the stance of policy, output and inflation are much stronger from 2000 onwards, suggesting that it is easier to understand how policy responds to economic conditions.

Is the SNB practicing inflation targeting? The Bank itself does not want to be labelled as such, principally because its objective is maintaining price stability (as defined above) rather than attaining a point target for the inflation rate, and because it does not commit to a specific time horizon for returning to price stability in the event that the inflation rate has become too high or too low. The Bank also believes that not being labelled an inflation targeter gives it more discretion to pursue other objectives inside the zone of price stability, and makes it easier to communicate its policy to the public. Whether the *de facto* behaviour of the SNB with respect to setting the policy interest rate is different from that of a self-proclaimed inflation targeter is not something we have been able to establish empirically, in large part because of the benign inflation environment during the period covered by the new framework. As researchers we would like to have greater shocks to the inflation process in order for our empirical tests to be more discriminating. As economic agents we are of course happy to do

without such shocks and to benefit from the success of the SNB in maintaining price stability.

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### SUMMARY

In January 2000 the Swiss National Bank adopted a new monetary policy framework incorporating a price stability objective defined as (any rate of) CPI inflation below 2 percent. We contrast this framework with inflation targeting strategies and review the SNB’s policy decisions since its introduction. Empirical results indicate that in setting policy the SNB reacts in much the same way as inflation targeting central banks. The recent sharp reduction in the policy rate is consistent with the estimated reaction function until the second quarter of 2009 when the zero bound became binding, while the deterioration of economic conditions still called for further monetary easing. This may explain the unconventional monetary policy measures adopted since then.