Forecasting Inflation at the Swiss National Bank

by

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The Swiss National Bank has been pursuing a new monetary policy concept since the beginning of 2000. Although the fundamental focus on maintaining price stability remains unchanged, the National Bank has, however, ceased to set intermediate monetary targets. These targets provided a policy framework for more than 25 years. The change in concept was necessitated by recent instability in demand for central bank money, which made it impossible to determine intermediate targets for the monetary base. Although the National Bank could also have set an intermediate target for a more stable aggregate such as M3, it chose a different approach, as communicating monetary policy decisions by means of intermediate monetary targets had become increasingly difficult.[1] While monetary policy continues to focus on maintaining price stability, this new concept is the most dramatic change in the National Bank's monetary policy framework since the introduction of floating exchange rates.

The new monetary policy concept has three elements. The first is an explicit definition of price stability. The National Bank regards prices as stable if the twelve-month rate of inflation, as measured by the headline consumer price index, is less than 2%. The second element involves the use of a broad-based inflation forecast as the key indicator in monetary policy decision-making. The third is a range for the three-month Libor rate, as an operative target in the implementation of monetary policy.

With its new concept, the National Bank has ceased to set intermediate monetary targets. Nonetheless, the development of the monetary aggregates – and the M3 measure of money supply in particular – remains a central monetary policy parameter. As such, the analysis of

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1 See Rich, G. 2000. "Monetary Policy without Central Bank Money: A Swiss Perspective." *International Finance* 3(3): pp. 439–469, and Baltensperger E., T.J. Jordan and M.R. Savioz. 2001. "The Demand for M_3 and Inflation Forecasts. An Empirical Analysis for Switzerland." *Weltwirtschaftliches Archiv (Review of World Economics)* 137(2): pp. 244–272.

money supply feeds into the inflation forecast. By experience the National Bank has found money supply trends to be a useful and reliable indicator of longer-term inflation.

Forecasting inflation plays a key role in the new concept. In addition to being the main element influencing monetary policy decisions, the inflation forecast is one of the most important ways in which the National Bank communicates with the public. This paper has two objectives. The first is to shed some light on the most important aspects of the inflation forecast. The second is to provide an overview of the models used by the National Bank to produce its forecasts.

Why forecast inflation?

A fundamental question is why the Swiss National Bank should base its monetary policy decisions on a forecast rather than on actual inflation figures. The reason is the existence of a long time lag before monetary policy starts to impact both on the real economy and on inflation. The transmission of monetary policy impulse to output, employment and prices is a complex process, which takes time. After a policy shift, wages and prices adjust only slowly to new conditions, which is why output and employment figures may deviate temporarily from their normal path. In Switzerland, it takes between four and eight quarters for changes in monetary policy to be felt by the real economy, and the greater part of the impact on prices may not become evident until six or even twelve quarters later.

The time lag forces the National Bank to pursue a forward-looking monetary policy. At any given time, Swiss monetary policy can only exercise a systematic influence on inflation in the following two or three years. If the National Bank wants to maintain price stability, it must attempt to keep inflation within acceptable bounds during this period. Monetary policy must thus be based on an inflation forecast which covers the period on which its effects are felt. Unless it remains forward-looking, monetary policy itself could easily destabilise the economy.

How is the inflation forecast produced?

The Swiss National Bank's inflation forecast takes the form of a broad-based consensus forecast, i.e., one which takes information and predictions from a range of sources into account. Sources include individual indicators, as well as a variety of econometric forecasting models. The data from the different models and indicators is then weighted and aggregated to produce the consensus forecast, which reflects the most probable course of inflation from the National Bank's perspective. The weightings given to the various predictions and information are not fixed, however. Instead, they depend in each case on a critical evaluation of the scenarios presented by the individual indicators and models, and are allocated as part of an in-depth analysis of the macroeconomic situation.

How does the inflation forecast influence monetary policy decisions?

The inflation forecast is the main indicator to guide monetary policy decisions. The Swiss National Bank forecasts inflation while assuming that the three-month Libor rate will remain unchanged over the forecast horizon. Forecasts which show a persistent rise in inflation to above the 2% mark indicate that monetary policy action is required. By modifying its policy – in this case by increasing the three-month Libor rate – the National Bank can influence inflation and counter a sustained rise in prices. To judge just how much action is required, it uses a variety of internal forecasts linked to different interest rate scenarios.

Unlike a persistent rise in inflation, a temporary overshooting of the forecasts followed by a return to price stability does not require policy action. The time lag involved means that it is almost impossible for monetary policy to prevent short-term movements in inflation – at least not without a disproportionately high cost to the economy. These short-term price swings are often caused by exchange rate and oil price shocks and do not distort economic growth in the long term provided they do not create an inflationary climate.

The National Bank has no automatic response mechanism to inflation forecasts. Instead, it is forced to evaluate which monetary policy measures might be appropriate at the time, taking particular account of the exact reasons for price movements. This analysis incorporates factors that cannot be covered by models.

Furthermore, the National Bank sometimes has to adjust monetary policy when a new up-to-date inflation forecast is not available. It then has to fall back on indicators which are also available *between* forecasts. Evaluating what monetary policy action needs to be taken, be it on the basis of inflation forecasts or indicators, can sometimes be extremely difficult. It is the greatest challenge that the National Bank faces in its monetary policy decision-making process.

What type of forecast does the Swiss National Bank publish?

Each June and December, the National Bank publishes its inflation forecast for the following twelve quarters. The figures take the form of a point forecast chart without confidence intervals, alongside a commentary on the risks associated with the forecast's accuracy. The forecast already takes into account the effect of the monetary policy decision taken by the National Bank in its assessment of the current situation prior to publication. It assumes that the three-month Libor rate will remain unchanged for the entire forecast horizon.

As the published forecast assumes a constant three-month Libor rate, it is not directly comparable with the forecasts issued by commercial banks and forecasting institutions, which also include the impact of anticipated changes of monetary policy. Consequently, by publishing inflation forecasts, the National Bank does not aim to offer an alternative to those issued by these institutions. They are intended instead to explain monetary policy

decisions to the public and to set out the course that the National Bank expects inflation to take, given a constant three-month Libor rate. The published forecast is thus an important way of communicating the National Bank's monetary policy. In parallel with each forecast, the National Bank also publishes a comprehensive monetary policy assessment. This gives a detailed explanation of the reasons behind policy decisions.

How should the published forecasts be interpreted?

In interpreting the published forecasts, it is important to understand that, although the forecast horizon extends over the following three years, the individual forecast itself is valid only until the next forecast is published or the next monetary policy decision is taken. As such, forecasts are valid for a maximum of six months. The Swiss National Bank will constantly have to respond to new shocks and adjust its monetary policy. It is thus highly unlikely that the three-month Libor rate will ever remain unchanged for the full three years. The inflation trend that is forecasted using the constant three-month Libor assumption gives certain clues to possible shifts in monetary policy in the first six months after the figures are published.

If inflation at the end of the forecast horizon is neither close to 2 or 0 percent nor displays any type of trend, the published forecast can offer no hint of potential changes in the three-month Libor rate over the next six months. The National Bank has already made the interest rate adjustments required – under the prevailing circumstances – to maintain price stability as defined above.

A published forecast that indicates an upward inflation trend or even a rate of above 2% at the end of the forecast horizon means that further interest rate hikes can be expected in the future. Such a case may arise when the Swiss National Bank chooses a gradual approach to dampen the risk of an overreaction with potential negative effects on the economy.

Why does the Swiss National Bank use a variety of forecasting models and indicators?

In reality, actual economic processes are extremely complex and almost impossible to grasp completely. By simplifying the situation, economic models help us to understand this complex reality and see how the pieces fit together. Depending on the nature of the question to be answered, different models must be constructed.

Even the analysis of one given issue is best undertaken using several models. Knowledge of economic interrelations is limited and incomplete. The actual stance of economic theory and the extent to which it can be tested empirically make it impossible to regard a certain model as the only correct way to look at a given problem. Different theoretical assumptions and econometric methods enable the same issue to be analysed using a variety of models.

The National Bank consequently applies a range of different approaches and models to produce its inflation forecasts. This gives the consensus forecast a broad base and avoids too strong a bias towards a model that may ultimately prove unsuitable.

What sort of models and indicators are used to produce the forecasts?

The Swiss National Bank uses both individual indicators and econometric models to produce its consensus forecasts. It also looks at market data and forecasts from other institutions. The individual indicators that are used cover economic activity, exchange rate developments and trends in the monetary aggregates. The economic activity and exchange rate indicators help to forecast short-term inflation. The output gap, i.e., the difference between actual output and its potential, is an important measure of how the economy is performing. Empirically, a rise in output above its potential rate is linked to a rapid rise in inflation. The National Bank calculates the output gap using a variety of methods in order to obtain as reliable an estimate as possible. As Switzerland is a small open economy, changes in exchange rates are quickly transmitted – via import prices – to the prices paid by consumers. Measures of the money supply are extremely valuable in assessing medium and long-term inflation trends. Changes in the growth rate and in a measure of the monetary surplus on M3, which covers cash and sight and time deposits, are reliable indicators of inflationary risk.

The parameters that are regarded as individual indicators, such as the money supply and the output gap, often form part of larger models. However, using them as individual indicators enables certain influences – not adequately covered by such models – to be taken into account. The causes of particular shocks can often be identified using these individual indicators, and analysing them is also useful in weighting the various forecasts produced by the models. When individual indicators are available monthly, they help to track inflation between the forecast periods. However, the drawback of individual indicators is that they may not offer a cohesive picture of the forces that are actually causing prices to rise. Different indicators often contradict each other and the impact on inflation cannot be quantified. Furthermore, the implicit theoretical assumption about the correlation between the indicator and the resulting inflation is not always clear.

The National Bank currently uses traditional structural models, vector autoregressive models (VAR) and M3 models to forecast inflation.

Traditional structural models are based on explicit assumptions about the way the variables are linked together in the economy. Relationships between variables are modelled in detail using behavioural equations and constraints. Specifically, variables are classified as either endogenous or exogenous using what are known as exclusion restrictions. The advantage of structural models is that they allow simulations to be carried out on the basis of different sets of assumptions – and they offer a clear economic foundation for the results. With these models, it is possible within the chosen framework to calculate consistent forecasts for a large number of variables. Long-standing familiarity with this method is another factor in the models' favour. Nonetheless, there are problems in that the chosen constraints may be

implausible and unsupported (or supported to only a limited degree) by theories or data. Behavioural equations can also be problematical in that, in reality, they may not be valid for the simulation carried out and can therefore produce distorted results.

VAR models assume that any economy is a fully interdependent system, i.e. that everything is linked to everything else. Unlike traditional structural models, then, a VAR model treats all variables as endogenous. It stipulates little if any economic structure so that few if any identification constraints are necessary. Those that are used are generally undisputed. The underlying idea is that the actual structure of the economy is too complex to comprehend fully and that it is better in this case to treat the transmission mechanism simply as a black box. VAR models are therefore based primarily on historical correlations between the various variables. The advantage of the VAR approach is that no (potentially implausible) exclusion restrictions need be set and that the data itself is weighted more heavily than is the case with traditional structural models. However, the results are economically more difficult to interpret, because VAR models do not contain any explicit behavioural equations and the number of variables used is usually rather small.

A brief outline of the approaches used by the National Bank – two traditional structural models, simple and structural VAR models and an M3 model – is given below.

The medium-sized macro model

The medium-sized macro model is an econometric structural model that is founded on basic neo-Keynesian philosophy.[2] In this type of model, short-term economic fluctuation is caused primarily by demand and price shocks, while the economy's long-term growth potential is limited on the supply side by demographic factors and technological progress, and long-term inflation corresponds to the difference between the expansion in nominal aggregate demand and the economy's real growth potential.

The model explains trends in capacity output as the result of economically determined depreciation and investment decisions. As such, capacity output takes on a certain cyclical nature in the medium term, i.e. as the economy expands, greater investment activity makes it grow faster than in phases of economic weakness. Over the long term, however, economic growth tends to return to the underlying trend set by the growth of the economically active population and technological progress.

In total, the model contains 30 behavioural equations that can be classified into different blocks. The first block explains the individual components of aggregate demand (private spending, capital spending, investment in construction and inventories, exports and imports). In the supply block, the gross domestic product (GDP) derived from these demand components is set against the economy's capacity output and the labour market situation. When capacity utilisation is high and unemployment is low, inflationary pressures rise. In the model's monetary block, this sort of tension produces a rise in interest rates given by a

[2] The medium-sized macro model is presented in detail in Stalder, P. 2001. Ein ökonometrisches Makromodell für die Schweiz. Swiss National Bank Quarterly Bulletin 19(2): 62–89.

Taylor rule. Higher interest rates and the appreciation of the Swiss franc that this induces will then subdue the components of aggregate demand and thus also price increases. The model uses a range of foreign variables that are treated as exogenous factors. These include GDP trends in Europe, the USA and Japan, inflation in Europe and the OECD, the price of oil and the USD-EUR exchange rate.

The advantage of the medium-sized macro model is that it puts inflation forecasts into the context of a detailed scenario for the business cycle and thus offers numerous economic policy simulation options. The medium model enables the impact on many variables to be analysed, which is not the case with smaller models. Conversely, however, it means that forecasts are heavily dependent on the assumptions made about trends in the world economy – the plausibility and reliability of which are always difficult to assess.

The small-sized macro model

The small-sized macroeconomic model employs two empirically tested relationships, namely the relationship between inflation and the output gap (the Phillips curve) and that between aggregate demand and the real interest rate or real exchange rate (the IS curve). The basic version of the model consists of four equations. The inflation equation describes changes in consumer prices as a function of the output gap, the exchange rate and historical rates of inflation. In the equation which determines aggregate demand, the output gap is influenced by the real exchange rate and the real interest rate. Here, the real exchange rate is equivalent to the nominal exchange rate, adjusted for the inflation differential between Switzerland and other countries, while the real interest rate is approximated from the difference between the nominal interest rate and average inflation over the preceding four quarters. The exchange rate equation explains the nominal exchange rate in terms of the interest and price gap compared with other countries. The model is closed with a monetary policy rule which allows for changes in the nominal interest rate in response firstly to deviations in output from its long-term potential, and secondly in inflation from the inflation target (Taylor rule).

In this basic version, four model equations determine the price level (i.e. inflation), output, the exchange rate and the interest rate. Exogenous variables are potential output and variables relating to other countries (price level, output and interest rates). In practice, the model is adjusted and expanded to take account of the issue in question. When carrying out policy simulations, it often makes sense to impose theoretical constraints on individual equations (such as, for instance, a vertical Phillips curve). However, in forecasting exercises the model is usually expanded by other variables that have proven useful in the past. It has been demonstrated, for example, that the model's inflation forecasts are more accurate when information from the monetary aggregates is included.

The advantage of the small-sized macroeconomic model over the medium-sized version is that it is simple and transparent. This makes the mechanics of the economy easy to understand. However, as fewer variables are taken into account, the resulting forecasts are less detailed.

VAR models

The Swiss National Bank currently uses two types of VAR models in inflation forecasting. The first – non-structural – approach is based on a large number of small VAR models. It is intended to produce an unconstrained forecast, i.e. a forecast which does not make assumptions about how certain variables will develop. The VAR models that are used may involve between one and five variables and are estimated both in levels and in first differences. Inflation is an essential element in every VAR model, while the other variables may be selected from a large range (GDP, various measures of the money supply, lending, exchange rates and interest rates). For each forecasting horizon, the first stage is to determine which VAR models have recently produced the most accurate forecasts. The models thus selected are then used for the current forecast, which represents a benchmark for discussions about the other forecasts. However, the non-structural approach is limited in that it does not actually allow monetary policy options to be simulated.

The second – structural – approach focuses on drawing up constrained forecasts and carrying out policy simulations.[3] The model used for these tasks comprises variables for GDP, consumer prices, the M1 measure of money supply and the three-month Libor rate. It identifies monetary shocks and their impact by means of economically undisputed constraints. One specific assumption is that monetary shocks have no impact on real variables over the long term (the principle of the neutrality of money) and that they can influence prices and output only with a certain time lag. The impulse-response functions of monetary shocks that these constraints produce correspond to prevailing views.

The impulse-response functions thus identified now allow the calculation of forecasts applicable to the given course of a particular variable. For example, inflation forecasts can be produced for which it is assumed that the interest rate will remain constant, or respond to predicted inflation during the forecast horizon. Structural VAR models of this type enable forecasters to overcome the confines of conventional VAR models and use the econometric benefits of the VAR method to produce real simulations. This type of model is still in the developmental stage, however, and little experience of it has been gathered to date. Moreover, the models can produce constrained forecasts for only a small number of variables. Although the economic interpretation of shocks is clear at an intuitive level, the unconstrained forecasts on which simulations are based are sometimes difficult to interpret.

[3] See P. Kugler and T.J. Jordan. 2000. "Vector Autoregressions and the Analysis of Monetary Policy Interventions: The Swiss Case". Swiss National Bank mimeograph.

The M3 model

Growth in the money supply has traditionally been a key inflation indicator. Countless studies demonstrate that, over the long term, differences in inflation can be explained by differences in growth in the money supply. However, financial innovations in recent years mean that it is no longer always easy to interpret the information the money supply actually contains. It has become particularly clear that money supply growth is often insufficiently meaningful on its own, thus making communication with the public more difficult. In its transition to the new monetary policy concept, the Swiss National Bank has therefore abandoned intermediate targets for the rate of money supply growth, and has adopted a broader analysis of the money supply itself in the context of inflation forecasting.

Money supply analysis at the National Bank focuses to a considerable extent on the M_3 aggregate.[4] Evidence from a number of studies suggests that demand for M_3 is sufficiently stable for it to serve as a monetary policy indicator. The M_3 model assumes a stable long-term relationship between the money supply, price levels, real output and the long-term interest rate. This stable long-term relationship makes it possible to calculate an equilibrium level for M_3, i.e. the level that might be expected on the basis of estimated demand for money, given current price, interest rate and output levels. The difference between the actual money supply and this equilibrium level can be interpreted as a monetary surplus. If M_3 is to be used as an indicator, growth rates and the monetary surplus must be analysed and interpreted together. When the M_3 model is expanded to include the monetary surplus as an error correction mechanism, it can also be used directly to produce inflation forecasts. In that case, inflation is forecasted as a function of the growth rate of M_3 and the monetary surplus, taking other variables into account.

Concluding remarks

The Swiss National Bank's new monetary policy concept involves, as in the past, a forward-looking approach – based, in this case, on a forecast of inflation. The Bank endeavours to make the best possible use of the information at its disposal in order to keep prices stable in the medium term. However, it should not be forgotten that the production of forecasts for a three-year period is extremely difficult and that forecasting errors are unavoidable.

Forecasting errors have many possible causes. A major cause is the unexpected events and developments which take place after the forecast has been produced and render it obsolete. Another reason is that monetary policy changes over time. The forecasts are always based on a constant three-month Libor rate. Any change in interest rates on the part of the National Bank necessarily impacts on the course of inflation and results in errors, as measured against earlier forecasts. A third source of inaccuracy is the unreliability of the

[4] See Baltensperger E., T.J. Jordan and M.R. Savioz. 2001. "The Demand for M_3 and Inflation Forecasts. An Empirical Analysis for Switzerland." *Weltwirtschaftliches Archiv (Review of World Economics)* 137(2): pp. 244–272, and Jordan, T.J., M. Peytrignet and G. Rich. 2001. "The Role of M3 in the Policy Analysis of the Swiss National Bank", in Monetary Analysis: Tools and Applications, H.J. Klöckers and Caroline Willeke (eds.), pp. 47–62. European Central Bank.

models used, as each model is an incomplete reflection of reality. Fourthly, the quality of available data will have an effect on the precision of the ultimate forecast. Many variables, such as the output gap, must be estimated and are thus highly questionable. Other parameters, such as GDP, suffer from distortion and measurement errors. Additionally, data is often revised or delayed, so that provisional figures or estimates must be used when the forecast is drawn up.

It is important to be aware of the limits of forecasts when taking monetary policy decisions. Forecasts are aids for decision making, but they can neither automate nor replace the policy process. Sound, far-sighted judgement is essential – and this is the greatest challenge facing monetary policy decision-makers.

The markets and the public must also be aware of forecasting limitations. The published forecasts serve to explain the National Bank's monetary policy decisions and illustrate how it sees inflation progressing as at the time of publication and under certain conditions. For the reasons given above, actual inflation will almost always differ from the forecast. It is also important to understand that the published forecast is derived from a complex forecasting process with no straightforward arithmetical thread running through it.

The models used to forecast inflation are being further developed all the time. Each model must be reviewed and adjusted continuously. At the Swiss National Bank, the range of models and indicators in use is not fixed. Ongoing endeavours to improve the analytical and forecasting arsenal are an integral part of monetary policy.