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This article analyses the Riksbank's forecasts for central variables during the period 2000-2006. The Riksbank's forecast precision is compared with several alternative forecasts, partly from other forecasters and partly from simple time series models. One of the results is that the Riksbank's forecasts are just as good as, and often better, than the competing forecasts. However, differences in forecasting performance are not statistically significant. Another result is that the Riksbank's inflation forecasts, in particular for UND1X, have shown appropriate qualities, such as relatively high precision and long predictability memory. The Riksbank's real economy forecasts are less exact than the inflation forecasts, but fully on a par with those of other forecasters

Riksbank forecasts of import prices and inflation

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Summary

This article assesses the Riksbank's forecasts of imported inflation and discusses to what extent errors in this respect have affected the Bank's forecasts of overall inflation. The assessment mainly refers to the period from 2000 onwards. The results show that inflation about two years ahead was overestimated in the Riksbank's forecasts by an average of about 0.2 percentage points per quarter. The Riksbank also tended to count on the kronor being stronger than was actually the case, particularly about one year ahead. This tendency was offset, however, by an overestimation of changes in foreign prices and margins, which has accordingly lowered the error in forecasting imported inflation. The forecast error in imported inflation may have been of relatively considerable importance for the inflation forecasts in certain periods but – according to the simulations for this article – not in the whole of the period considered here.

Introduction

The forecasts of UND1X inflation[2] are used as a basis for monetary policy decisions. The overestimation of inflation in recent years has been mainly attributed to two factors: underestimation of productivity growth and overestimation of import prices. The following excerpts from the *Inflation Report* indicate the importance that has been attached to the underestimation of imported inflation as a cause of the overshooting in inflation forecasts:

> The underlying inflation using the UND1X measure, where interest expenditure and changes in indirect taxes and subsidies have been excluded from the consumer price index (CPI), was

[1] I am grateful for comments on earlier drafts from Michael Andersson, Jesper Hansson, Kerstin Mitlid, Stefan Palmqvist, Staffan Viotti and Anders Vredin. I also wish to thank Josef Svensson for assistance with data and Peter Welz for performing the simulations with Ramses.

[2] UND1X is the consumer price index (CPI) excluding households' mortgage interest expenditure and direct effects of changes in indirect taxes and subsidies; see also http://www.scb.se/statistik/PR/PR0101/PR0101_BS_2007.doc. Further details are to be found in a technical memorandum in Swedish (UND1X och UNDINHX: beräkningar efter en SCB-modell, 1998-09-15) that can be ordered from Statistics Sweden.

> 0.9 per cent in January. This was lower than the Riksbank's forecast in December. Imported inflation in particular was unexpectedly low [*Inflation Report* 2006:1]
>
> Inflation was unexpectedly low in 2005 despite low interest rates and good economic growth – it was overestimated in the Riksbank's forecasts until the beginning of 2005. The unexpectedly low inflation can be linked to supply factors that have restrained inflationary pressure in the economy to a surprisingly large extent, in particular through high productivity growth and low import prices. [Inflation Report 2006:1]
>
> Since the previous Inflation Report, inflation has been lower than expected. The unexpected fall stems mainly from imported inflation, while domestic inflation has developed well in line with the forecast. [Inflation Report 2005:1]
>
> However, the most recent data shows that inflation has been even lower than expected, with CPI inflation at –0.3 per cent and UND1X at 0.1 per cent. This is mainly due to unexpectedly low import prices, … [Inflation Report 2004:1]

These excerpts clearly show that the forecast error in imported inflation has often been seen as the most important explanation for the forecast error in overall inflation. The low imported inflation can, of course, have been part of the reason why Sweden had a period of low inflation. What concerns us here, however, is not the expected development but the role that the forecast error in import prices (unexpectedly low imported inflation) has had for the Riksbank's (on average) overestimation of inflation (unexpectedly low inflation) in the period with an inflation target: have the forecasts of imported inflation been particularly poor?

Background

The decomposition of Swedish inflation (UND1X) into domestic (UNDINHX) and imported (UNDIMPX) components involves an attempt to classify goods and services by their import content. Other countries do the same. It has been found, however, that for Sweden as well as other countries (see Burstein, Neves & Rebelo 2003) many of the goods and services assigned to imported inflation have a large domestic component in the form of domestic margins, distribution costs for transportation, shops, etc. It should therefore be borne in mind that in practice this decomposition does not succeed in completely separating domestic from imported inflation.[3]

[3] See Hansson and Johansson (2007) for a further discussion.

The *relevance* of the distinction for monetary policy decisions is also debatable. The academic literature on this suggests that, for the choice of a target variable in monetary policy, it is rather price rigidity that is important, whether this concerns domestic prices, wages or import prices. The relevance of a price as a component in a target variable increases with its rigidity (see Benigno 2004; Christiano, Eichenbaum & Evans 2005; Corsetti & Pesenti 2005; Faia 2006; Huang & Liu 2005; Mankiw & Reis 2003; Marzo 2006; Monacelli 2005; Schmitt-Grohe & Uribe 2004; Woodford 2003).[4]

Studying forecasts for components of inflation can be of interest in an *evaluation* of the forecasts of inflation. Caution should be exercised, however, about interpreting the former in terms of the latter. A price change for one of the components may represent a relative price shift and then does not necessarily have anything to do with inflation. Relative price shifts can still affect inflation (in the short run) but that is a consequence of rigidities in nominal price adjustments.[5] There are grounds for being sceptical in general about seeing inflation as "the sum of price changes for a number of goods and services". Inflation should mainly be seen, in the spirit of Friedman, as "an entirely monetary phenomenon".

Fundamental macro theory holds that in the long run, inflation is determined by domestic monetary policy. In keeping with this, it is monetary policy abroad that determines import prices, which ultimately do *not* affect domestic inflation. This is because the *law of one price* is assumed to apply in the longer run, that is, the prices for equivalent goods and services in one and the same currency will be the same in different countries. In the short run, however, many prices are sticky and cause departures from this *law*. So import prices, particularly those that are rigid, can affect inflation in the short run. On average, imported inflation can be 4 per cent and domestic inflation 2 per cent while the krona appreciates 2 per cent.

Aims and scope

In this article I disregard such problems as the fundamental importance and relevance of import prices and concentrate instead of an evaluation of the forecasts of UNDIMPX the Riksbank actually produced from 2000 onwards[6], a period for which data are available for this purpose. If

[4] The problem for monetary policy is to achieve an allocation of resources that corresponds to what markets would generate if all prices were flexible (see Woodford 2003).

[5] For a fuller discussion of the significance of relative prices for inflation, see Assarsson (2004).

[6] An updated forecast data base is available for UND1X with outcomes and forecasts in real time for the period from 2000 onwards. For UND1X excluding oil there are data from 2003 onwards and for the foreign producer price index from 2004 onwards. Here I concentrate above all on data for the longer period because it is most meaningful to study systematic patterns in data for longer periods with many observations.

UNDIMPX is particularly difficult to forecast, it could contribute to larger errors in forecasts of UND1X.

This article has two aims:

- to analyse forecast errors in imported inflation
  – describe statistical characteristics of the forecast errors
  – compare with forecast errors for other variables
- to analyse how forecast errors for imported inflation affect inflation forecasts

The forecast error – the unexpected element – is the difference between forecast and outcome. The purely statistical analysis aims to elucidate interesting characteristics of the forecast error and its quality, for example whether the forecasts vary more, or less, than outcomes, the size of the forecast errors, whether they are biased, etc. Forecast errors for imported inflation are also compared with those for domestic inflation. The forecasts of imported inflation are composed of forecasts of underlying components such as the TCW exchange rate index and the foreign producer price index. Forecast errors in the underlying components are also analysed.

Besides the purely statistical analysis, there is the question – perhaps more interesting but also much more complex – of the importance of import prices for forecast errors for inflation. This is analysed with the aid of two models: a VAR model and the Riksbank's large macro model Ramses.[7] The aim is to arrive at the development of inflation that would have occurred if the Riksbank had forecast imported inflation more accurately.

The article continues with a description of how the forecast error for inflation can be decomposed into domestic and imported inflation, respectively, and the latter in turn into the exchange rate, domestic distribution costs and foreign prices and margins.[8] This is followed by the descriptive statistical analysis of forecast errors for these components. Simulations with the economic models are then presented.

[7] See Adolfson et al. (2007a) for a description of RAMSES.
[8] See also Andersson et. al. (2007) for an evaluation of UND1X forecast.

Inflation's components

Inflation's components, which are the object of the following statistical analysis, are defined in this section. Upper case signifies levels, lower case percentage changes. The aggregated level of consumer prices, UND1X, denoted here by P^C, is a weighted sum of domestic and imported price levels:

$$P^C \approx W^d P^d + (1 - W^d) P^i \tag{1}$$

where $W^d \approx \frac{P^d Q^d}{P^d Q^d + P^i Q^i}$ is the weight for domestic goods and services, P^d is the domestic price level, P^i the import price level in SEK and *Q* the corresponding volumes.[9]

Imports of goods and services are at foreign prices, which are assumed to be determined by $P^f = M^f \cdot MC^f$, where M^f is the foreign firms' mark-up and MC^f their marginal costs. The Riksbank does not either identify or forecast margins and marginal costs, only the foreign producer price index P^p, which can deviate from P^f. Let $\theta = \frac{P^f}{P^p}$ be a correction factor that measures the relative difference between P^f and P^p. The import price level can then be written:

$$P^i = S \cdot P^p \cdot M \cdot \theta \tag{2}$$

where *S* is the exchange rate defined as SEK per unit foreign currency. In practice and in aggregated terms, index figures are used, with the exchange rate represented by the nominal TCW index. A falling TCW index represents an appreciation of the krona. *M* is domestic distributors' mark-up, which includes distributors' margins as well as other distribution costs, e.g. wage costs. Data on forecasts and outcomes for P^i and *S* are available for the entire period from 2000 onwards and for P^p for the period from 2004 onwards. Let $P^r = M \cdot \theta \cdot P^p$ and $M^r = M \cdot \theta$. I denote P^r the price residual and M^r the distribution margin. Import prices can then be decomposed into the exchange rate and the price residual for the entire period from 2000 onwards and into the exchange rate, the foreign producer price index and the distribution margin for the later period from 2004 onwards.

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[9] The definition of UND1X in the Swedish CPI is somewhat more complicated. For instance one can start from a particular point in time, e.g. 0 for the beginning of the year (the Laspeyres type) $W_0^d \approx \frac{P_0^d Q_0^d}{P_0^d Q_0^d + P_0^i Q_0^i}$ or from the year-end (the Paasche tytpe) $W_1^d \approx \frac{P_1^d Q_1^d}{P_1^d Q_1^d + P_1^i Q_1^i}$. The CPI is a superlative index (an approximation of a true index of the cost of living), which tends to be in the interval between Laspeyres and Paasche indices, see Carling (2000).

The Riksbank publishes forecasts as annual changes, that is, for quarterly data as $p_t^C = 100\frac{P_t^C - P_{t-4}^C}{P_{t-4}^C}$. In the following I disregard the time index. Forecasts are indexed with *e* and forecast errors or unexpected values with *u*, that is, $p^C = p_e^C + p_u^C$.[10] This means that p_u^C is positive when inflation is underestimated and negative when it is overestimated.

We can now study forecast errors for the decomposition of UND1X, that is, for p_u^C, p_u^d, p_u^i as well as for the decomposed imported inflation as

$$p_u^i = s_u + p_u^r \tag{3a}$$

$$p_u^i = s_u + p_u^p + m_u^r \tag{3b}$$

First I shall describe the measures that are used in the statistical evaluation and then the data that are used. In the latter context there is the problem of overlapping data in the published annual forecasts; in an evaluation it can be preferable to use data in quarterly changes instead. After that the statistical characteristics of the forecast errors are presented.

Statistical measures

The evaluation uses a number of statistical measures that are more or less standard in this context. *Bias* – the tendency for a forecast error to point in a particular direction – is measured simply as the mean error: $ME = \frac{\sum(x_t - \hat{x}_t)}{n}$, where $\hat{x}$ is the forecast. A negative ME means overestimation of the variable. The *size* of the forecast error is often measured by using the mean square error: $MSE = \frac{\sum(x_t - \hat{x}_t)^2}{n}$), the root mean square error (RMSE), or the mean absolute error: $MAE = \frac{\sum|(x_t - \hat{x}_t)|}{n}$. MSE can be split into three components: bias, variance and covariance, see Pindyck & Rubinfeld (1998):

$$MSE = \frac{\sum(x_t - \hat{x}_t)^2}{n} = \left(\bar{x} - \left(\frac{\sum \hat{x}_t}{n}\right)\right)^2 + (\sigma_x - \sigma_{\hat{x}})^2 + 2(1-\tau)\sigma_x\sigma_{\hat{x}} \tag{4}$$

where $\bar{x}$ is the mean of outcomes, σ_x the standard deviation and τ the correlation between actual and expected *x*. MSE can be decomposed into three shares, for

bias: $\frac{\left(\bar{x} - \left(\frac{\sum \hat{x}_t}{n}\right)\right)^2}{\frac{\sum(x_t - \hat{x}_t)^2}{n}}$ (4a)

[10] We can write $p_{et}^C = E_{t-j}p_t^C$ where E_{t-j} is the expectations operator, showing that in period t-j there is an expectation of p_t^C in period t. Thus one starts from information that is known in period t-j.

variance: $\frac{(\sigma_x - \sigma_{\hat{x}})^2}{\frac{\sum (x_t - \hat{x}_t)^2}{n}}$ (4b)

and covariance: $\frac{2(1-\tau)\sigma_x\sigma_{\hat{x}}}{\frac{\sum (x_t - \hat{x}_t)^2}{n}}$ (4c)

The share for bias indicates the part of the forecast error that consists of bias, i.e. by how much the mean of the forecasts deviates from the mean of the outcomes. The share for variance indicates the part of the forecast error that consists of differences in variance, i.e. by how much the variance in the forecasts deviates from the variance in the outcomes. These two components represent the systematic part of the forecast errors, while the third component, the share for covariance, represents the unsystematic deviations.[11]

Data

The Riksbank's data on forecasts and outcomes, reported and published as annual changes for all variables, are analysed as regards UND1X inflation, decomposed in accordance (3a), for the period 2000Q1 – 2006Q3 and in accordance with (3b) for the period 2004Q2 – 2006Q2. The observations accordingly overlap – forecasts in a given quarter overlap the forecasts that are made in the next four quarters. The forecast errors will then normally be autocorrelated without necessarily being irrational.[12] There is then a risk that tests of bias and other aspects will be misleading. The problem can be reduced by using quarterly changes instead, that is, $100\frac{x_t - x_{t-1}}{x_{t-1}}$. The problem of overlapping observations is usually disregarded in evaluations and the statistical evaluations are then liable to be misleading. A possible alternative would be to start from the forecast annual changes but only use every fourth observation. However, such an approach excludes so much information that it will not be efficient.

In each period (quarter) the Riksbank produces forecasts for a range of horizons up to 13 quarters ahead. The first period in this evaluation is 2000Q1 and the last is 2006Q3, which gives a total of 27 quarters with quarterly changes. However, as the forecasts for the longer horizons, 10–13 quarters ahead, are available only from 2005Q3 onwards, the evaluation is mainly based on forecasts with 9 quarters as the longest horizon. This gives about 27x9=243 forecasts to evaluate. The data have been organised as a panel data base (data with both a temporal

[11] This decomposition is serviceable but differs from the more usual $MSE = \left(\bar{x} - \frac{\sum \hat{x}_t}{n}\right)^2 + \sigma_x^2$.

[12] Forecast errors generated in a model with rational expectations do not normally display any patterns (provided the observations do not overlap).

and a cross-sectional dimension) with the horizons as cross-sections.[13] The evaluation therefore makes it easy to study the characteristics of the forecasts for different horizons, for example those that are particularly relevant for monetary policy, but also the averages for all horizons.

The calculations of UND1X were revised as of 2005Q1. Forecasts made up to and including 2004Q4 followed the earlier definition. A forecast made at the end of 2003 for inflation two years ahead, that is, $E_{2003:4}P^{C}_{2005:4}$, can then be said to refer to the earlier definition and it is then most reasonable to evaluate it in terms of that definition. Calculations with the earlier definition were not published after 2004Q4 but the Riksbank has calculated a "synthetic" index that can be used for evaluating forecasts. The CPI Committee adopted the new method in May 2004 and the first forecast of the index with this method was made in 2004Q2. The 2004Q2 forecasts accordingly used the earlier definition for 2004Q2 – 2004Q4 and the new definition for 2005Q1 – 2006Q2. So in the evaluation it is necessary to use two different series for different forecasting occasions and horizons.

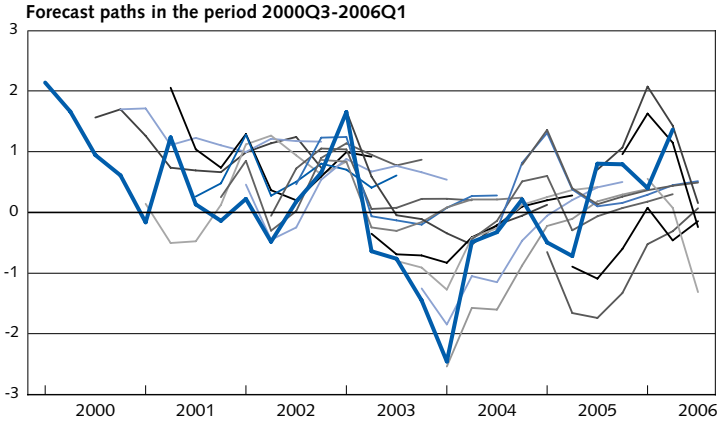
The forecasts are evaluated as far as possible from real-time data, i.e. the evaluations start from the information that was available at the time of the forecast, and in relation to what was actually being forecast. This applies, for instance, to the forecasts with the VAR model below (apart from foreign GDP) but not to the simulations with Ramses. Let us now begin the evaluation of the forecasts with a descriptive statistical analysis of the forecast errors.

A statistical analysis of the Riksbank's forecasts

Chart 1 illustrates how forecasts and outcomes for p^{i} developed in the period 2000Q3 – 2006Q1 in terms of annual changes based on quarterly data. Outcomes are represented by the thick curve. The other curves show how a forecast develops from the time it was made and up to the longest horizon 9 quarters ahead. For example, the curve that starts in 2001Q1 shows that the forecast for 1 quarter ahead was almost on the mark but the one-year forecast overestimated inflation by more than one percentage point. Forecasts and outcomes can be followed in this way for each forecasting occasion and horizon but the chart is primarily intended to present a general picture of the forecast errors.

[13] A balanced panel means in practice that the forecasts are evaluated for horizons that do not exceed 9 quarters.

Chart 1. Forecasts and outcomes for UNDIMPX
Forecast paths in the period 2000Q3-2006Q1



Note. The thick curve represents outcomes and the other curves represent forecasts made in different periods (one curve per period).

Sources: Statistics Sweden and the Riksbank.

The course of the curves shows that forecast errors usually grow with the forecast horizon. It will be seen that imported inflation was overestimated in 2001–03, while performance in 2004–06 was more mixed.

During 2001 the Riksbank foresaw that imported inflation would decline but not as much as it actually did. During 2002 the Riksbank expected an increase in imported inflation that was somewhat stronger than actually occurred. The unusually sharp drop in imported inflation during 2003 seems to have been largely unexpected; the forecasts were revised downwards as inflation slackened. When inflation rose again in 2004, the Riksbank's forecasts were on the low side to begin with but, as mentioned, the picture of 2004–05 is rather mixed. But the overall impression is that there tended to be some overestimation of imported inflation.

Corresponding charts for the other variables in decomposition (3a) are presented in Appendix 1. There it will be seen, for instance in Chart A1, that the Riksbank did not anticipate the increase in domestic inflation, p^h, to levels above 2 per cent 2001–02. The fall in 2002 seems to have been foreseen, on the other hand, but the temporary increase in 2003 was not expected. During 2004–06 domestic inflation was mostly overestimated, markedly at times. Thus, the overall impression is mixed: underestimation 2000–03 followed by overestimation 2004–06. The charts suggest that in the latter period it was domestic rather than imported inflation that was overestimated.

Chart A2 illustrates a tendency to "guide" the forecast towards 2 per cent. Inflation's upswing during 2001 was missed by the Riksbank, which predicted a slow increase towards 2 per cent. During 2002–03 inflation was close to the target and the Riksbank roughly foresaw both this and the marked drop at the end of 2003. Inflation in 2004–05, on the other hand, was markedly overestimated. To judge from the charts, it was domestic rather than imported inflation that lay behind the latter result.

The charts in Appendix 1 also show that the Riksbank underestimated the development of oil prices. The underestimation of imported inflation is much greater when the oil price is excluded. This is a questionable exercise, however, because in principle one could exclude some other price that was overestimated. To sum up, the picture of the period studied here is somewhat mixed and variable. A closer statistical analysis of characteristics of the forecast errors is presented in the next section.

Analysis of the forecast errors' characteristics

Chart 2 shows how the bias in the forecasts of annual rates varies over the range of horizons. The bias is small up to and including five quarters, after which it increases with the horizon and entails an overestimation of imported inflation. This agrees with the picture in Chart 1.

The size of the forecast error for different horizons is shown in Chart 3. It will be seen that the error is already relatively large for the second quarter. Forecasting power seems to be of short duration and the size of the forecast error appears to stabilise fairly soon at just under 1 percentage point.

Chart 2. Mean error in forecasts of UNDIMPX (measure of bias)

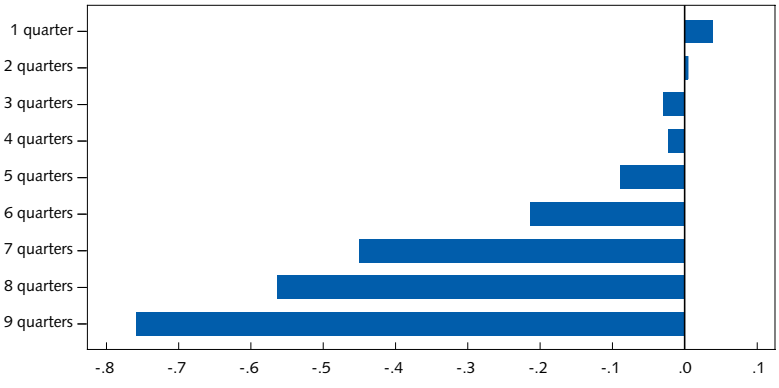


Chart 3. RMSE in forecasts of UNDIMPX (measure of size), quarter/quarters

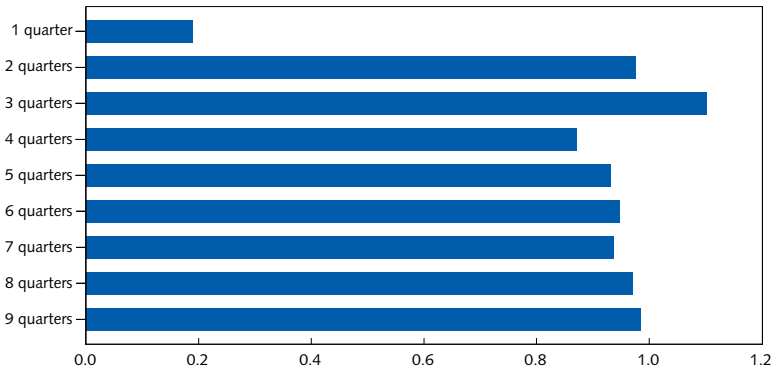


Table 1 summarises the mean errors (ME) of the forecasts as a measure of bias for UNDIMPX and the other variables in the decomposition (3). More detailed results are given in Appendix 2. The p value for the null hypothesis of no bias is shown in parentheses; a value of 0.1 is assumed to show that the hypothesis of no bias can be rejected with 90 per cent probability. With annual changes, the forecasts overlap, so a forecast error in one period persists for three more periods; the statistical inference should therefore be taken with a large pinch of salt. Another reason for doing so is that this is a total survey, not a sample. The classic statistical inference presupposes that the forecasts are assumed to be repeated many times. Here, however, it is reasonable to suppose that the future forecasts are generated differently because the Riksbank changes its staff, models, executives and so on. However, statistical inference is usually reported in these contexts and the p values are included here mostly as a service to readers.

Besides bias, Table 1 shows the size of the errors, measured as RMSE. The standard deviation in the forecast variable is shown in parentheses for comparison with the RMSE. If they are approximately equal, there is no forecasting power. The results are shown for three sets of horizons: 1, 2–5 and 6–9. The short horizon gives an indication of awareness of the current situation, while it is the longer horizon, 6–9, that is presumably most relevant for monetary policy.

Table 1. Forecast errors for different variables and horizons 2000Q1 – 2006Q3. Bias (ME) and size (RMSE). Data as annual changes. The p values for the no-bias hypothesis are in parentheses under Bias and the standard deviation for each variable in parentheses under Size. Data for PPI and distribution margin are for 2004Q2–2006Q3.

	Bias (ME)			Size (RMSE)		
Horizon	1	2-5	6-9	1	2-5	6-9
UNDIMPX	0.039 (0.298)	-0.033 (0.728)	-0.483 (0.000)	0.189 (1.237)	0.970 (1.055)	0.960 (0.992)
UNDINHX	0.029 (0.228)	0.337 (0.000)	0.085 (0.526)	0.122 (1.292)	0.733 (1.230)	1.233 (1.226)
UND1X	0.024 (0.209)	0.207 (0.000)	-0.104 (0.245)	0.097 (0.868)	0.564 (0.884)	0.799 (0.890)
TCW index	0.212 (0.436)	2.680 (0.000)	1.868 (0.000)	1.308 (4.858)	3.491 (4.961)	3.953 (4.339)
Residual price	-0.173 (0.525)	-2.749 (0.000)	-2.389 (0.000)	1.315 (4.675)	3.322 (4.613)	3.776 (4.024)
PPI	0.250 (0.095)	1.349 (0.000)	1.970 (0.000)	0.423 (1.998)	0.443 (1.905)	0.342 (1.886)
Distrib. margin	-0.122 (0.629)	-3.195 (0.000)	-5.378 (0.000)	0.727 (4.805)	2.234 (4.899)	2.275 (4.532)

For all variables the one-quarter errors are relatively small, with no significant bias. But soon after the one-year horizon the errors are already considerably larger and there is bias for several variables. Imported inflation was marginally overestimated and domestic inflation was underestimated by just over 0.3 percentage points. Overall inflation one year ahead was underestimated by 0.2 percentage points. Somewhat further ahead towards two years, imported inflation was markedly overestimated and this coincides with some overestimation of overall inflation.

From the decomposition of import prices it is evident that the krona was systematically overvalued (the TCW index is underestimated) both one and two years ahead. The residual price change was, however, markedly overestimated. The combined result is an absence of bias in imported inflation about one year ahead but an overestimation of about 0.5 percentage points at the two-year horizon.

The residual price change has been decomposed in turn into the change in the global producer price index and the distribution margin. The table shows that the change in the global producer price index was *underestimated* by an average of just over 1.5 percentage points and that consequently the distribution margin was greatly *overestimated*, by 3.2 percentage points one year ahead and 5.4 percentage points two years ahead.

The Riksbank publishes its forecasts mainly as annual changes, which means, for example that $E_t p_{t+9} = 100 \cdot \frac{P_{t+9} - P_{t+5}}{P_{t+5}}$ for annual changes and $E_t p_{t+9} = 100 \cdot \frac{P_{t+9} - P_{t+8}}{P_{t+8}}$ for first differences. While the former are perhaps most relevant, the latter are more suitable for statistical evaluations because the problem of overlapping observations is minimised here. It is therefore of interest to look at how using first differences alters the results. This is evident from Table 2.

Table 2. Forecast errors for different variables and horizons 2000Q1 – 2006Q3. Bias (ME) and size (RMSE). Data as annual changes. The p values for the no-bias hypothesis are in parentheses under Bias and the standard deviation for each variable in parentheses under Size. Data for PPI and distribution margin are for 2004Q2–2006Q3.

	Bias (ME)			Size (RMSE)		
Horizon	1	2-5	6-9	1	2-5	6-9
UNDIMPX	0,039 (0,292)	-0,054 (0,559)	-0,208 (0,053)	0,187 (1,761)	0,932 (1,776)	0,999 (1,744)
UNDINHX	0,028 (0,226)	0,114 (0,005)	-0,042 (0,335)	0,119 (0,561)	0,403 (0,627)	0,380 (0,508)
UND1X	0,024 (0,209)	0,059 (0,149)	-0,096 (0,022)	0,095 (0,564)	0,414 (0,572)	0,376 (0,533)
TCW index	0,185 (0,466)	0,891 (0,000)	0,033 (0,845)	1,221 (1,840)	1,847 (1,828)	1,559 (1,615)
Residual price	-0,146 (0,565)	-0,963 (0,000)	-0,287 (0,089)	1,228 (2,462)	1,756 (2,414)	1,517 (2,233)
PPI	0,224 (0,875)	0,106 (0,715)	0,586 (0,001)	4,358 (3,858)	1,036 (3,685)	0,566 (3,751)
Distrib. margin	-0,100 (0,952)	-0,839 (0,050)	-0,532 (0,145)	4,815 (5,447)	1,990 (5,273)	1,091 (5,180)

With first differences there is an overestimation of inflation about two years ahead but no underestimation one year ahead. Imported inflation is overestimated about two years ahead. There is a systematic underestimation of the exchange rate one year ahead but not two years ahead in this case, while the distribution margin is still systematically overestimated.

Another difference is that the changes in the global producer price index and the distribution margin now are smaller. The overestimation of the price residual may have to do with covariation between the forecast errors in the global producer price index and the distribution margin, respectively.

The size of the error in inflation forecasts still increases markedly with the horizon but not as distinctly as with forecasts as annual changes. There is, in fact, little increase in the case of the forecasts of the exchange rate, the global producer price index and the variables calculated as residuals.

Furthermore, the components of imported inflation vary much more than do the aggregates imported inflation and domestic inflation. It is the exchange rate's covariation with the other components that accounts for the forecast error for imported inflation not being larger. The Riksbank counted to some extent on an unduly strong krona but this was counterbalanced by the overestimation of prices abroad and margins.

Finally we have the decomposition of MSE into bias, variance and covariance in accordance with (4a)–(4c). Table 3 shows the results for data as annual changes. It will be seen that the main systematic deviations are bias at horizons 7–9 and variance at horizons 5–9.

Table 3. Decomposition (4a)–(4c) of errors in forecasts of UNDIMPX. Annual-rate forecasts.

	Horizon								
Variable	1	2	3	4	5	6	7	8	9
MSE	0.035	0.549	0.605	0.657	0.628	0.696	1.063	1.180	1.495
Bias' share	0.0	9.4	3.3	1.8	1.7	3.7	14.2	26.2	38.5
Variansandel	0.5	0.1	1.8	10.5	41.1	44.0	32.2	28.8	23.0
Covariance's share	99.5	90.5	94.9	87.7	57.2	52.3	53.6	45.0	38.5

Using data as quarterly changes instead (Table 4) gives much smaller shares for the systematic deviations, bias in particular. The deviations are larger for variance, with an appreciably higher variance in the outcomes compared with the forecasts. This may have to do with the familiar forecasting behaviour of not being sufficiently "bold".

Table 4. Decomposition (4a)–(4c) of errors in forecasts of UNDIMPX. First-difference forecasts.

	Horizon								
Variable	1	2	3	4	5	6	7	8	9
MSE	0.035	0.718	0.870	0.840	0.928	0.981	0.911	0.894	1.207
Bias' share	4.3	0.5	0.8	0.1	0.7	0.1	8.0	0.3	2.1
Variance's share	12.9	11.5	15.6	9.9	8.4	13.4	15.0	7.1	6.5
Covariance's share	82.8	88.0	83.6	90.0	90.9	86.5	77.0	92.5	91.4

All in all, the calculations, particularly the statistically more reliable set with first differences, show:

- an overestimation of imported and overall inflation two years ahead
- a systematic overvaluation of the krona's path in the coming year
- a systematic overestimation of the residual price both one and two years ahead
- a rapid loss of forecasting power as the horizon lengthens
- larger forecast errors for imported compared with domestic inflation
- large forecast errors for the global producer price index and distribution margins
- much greater variations in imported inflation's components than in aggregated imported and domestic inflation
- less variance in the Riksbank's imported inflation forecasts than in the outcomes
- the possibility of erroneous conclusions from evaluations using annual changes and overlapping observations

An analysis in economic models

This section presents simulations with alternative models in order to investigate whether the forecasts of import prices were an important factor behind the errors in recent years' inflation forecasts. This calls

for a model that has an economic structure with which to clarify causal relationships. There are a number of alternatives that can be said to be attractive for this purpose, though none of them is definitely better than the others. The Riksbank currently uses a dynamic stochastic general equilibrium model, Ramses, that is close to the cutting edge of research and accordingly meets high requirements from the research community.[14] It seems reasonable to use this model for the present purpose. Ramses has an economic structure based on optimising, forward-looking behaviour of economic agents. It is a highly aggregated model even though its theory is formulated for individual agents. The model performs calculations of shocks in variables, for example in prices of imported goods for investment and consumption.

A VAR (Vector AutoRegression) model is used as an alternative to Ramses. The specification of such a model does *not* start from economic theory. Instead, the variables that are considered relevant (they may be the same as in a structural model) are selected and allowed to influence each other. A simple version with two variables x_1 and x_2 could be written as follows:

$$x_{1t} = a_{10} + a_{11}x_{1t-1} + a_{12}x_{2t-1} + \varepsilon_{1t}$$
$$x_{2t} = a_{20} + a_{21}x_{1t-1} + a_{22}x_{2t-1} + \varepsilon_{2t}$$

that is, with only 2 variables and 1 time lag. Here, ε_{1t} cannot automatically be interpreted (identified) as a shock in x_1. This is because x_1 is not derived from economic theory, which is the case with a shock in, for instance, Ramses. If ε_{1t} correlates with ε_{2t}, a shock in x_1 in period *t* will not be solely a shock in x_1 but will also derive in part from a shock in x_2. So when effects of shocks are evaluated in VAR models it is customary to arrange for the shocks to be uncorrelated, which is done by a transformation of the matrix with shocks.[15] Instead of doing this, I have used the original matrix, which is practical and in this case reasonable because the highest correlation coefficient between the shocks in the system estimated below is 0.17 and not statistically significantly different from zero.

VAR model

A VAR (Vector AutoRegression) model is estimated here in the form of error correction, i.e. a model consisting of variables in levels as well as

[14] See Adolfson et al. (2007a) for a description of RAMSES.

[15] The most usual form of transformation is Choleski decomposition. However, it entails that the way in which the variables are incorporated in the system influences the effects of shocks, which makes the transformation more or less arbitrary.

changes.[16] It is then assumed to catch both long-term equilibrium relationships and short-term dynamics. The relationships are based solely on historical data. The VAR model is estimated for the period 1994–2006 so as to avoid the structural changes connected with the monetary policy realignment in the mid 1990s. The evaluation is made in relation to outcomes for the period 2004Q1 – 2006Q2 using real-time data, that is, the data that were actually forecast and the information that was available at the time of the forecast. The model is re-estimated for each forecasting occasion. Real-time data are used for all variables except international GDP.

THE VAR MODEL CONTAINS

- domestic variables:
  - GDP
  - UNDINHX
  - UNDIMPX
  - 3-month interest rate
  - real TCW exchange rate
- external variables:
  - international GDP (TCW-weighted)
  - international inflation (TCW-weighted)

A 2-quarter time lag is used. First of all, unconditional forecasts are made with the VAR model, after which the shocks are generated that are required in the model to generate the Riksbank's forecast of import prices. A new forecast is then made with these shocks and it yields forecasts of the variables in the model that are conditioned on the Riksbank's import price forecast.[17] Here, however, we are only interested in the forecast of inflation. As an additional alternative, I also condition the forecast of the *import price outcome* to check that that the model does not deliver a very odd forecast of inflation even when import prices are fully known.

The alternative forecasts of inflation can then be compared, see Chart 4, which shows forecasts and outcomes for UND1X inflation. The results show that the VAR model overestimates inflation in the period 2004Q1 – 2006Q2 by an average of 0.15 percentage points. The forecast conditioned on the Riksbank's forecast of import prices overestimates inflation little more than half as much; the difference is small but still statistically significant. So there does not seem to be any particular

[16] The model is estimated in the econometrics programme Eviews, which tests how many equilbrium relationships are contained in the data. These equilibrium relationships are then included as level terms in a VAR model of difference form. In the model estimated here there are 4 equilibrium relationships.

[17] Forecasts of p^d och p^i are generated in the VAR model and inflation is derived from (1).

inflation bias in the error in the Riksbank's forecast of import prices compared with the VAR model's forecast error. Moreover, the Riksbank's forecast error is somewhat smaller than the VAR model's, about 0.05 of a percentage point (statistically significant at the 5 per cent level using the test in Diebold & Mariano, 1995). Thus, these calculations indicate that it is not the error in the Riksbank's forecasts of import prices that lies behind the overestimation of inflation.

Chart 4. The VAR model's simulations of UND1X inflation 2004Q1-2006Q3

Anm. De olika kurvorna visar – utfall (fet heldragen kurva) – obetingad prognos (blå kurva) – VAR-prognos betingad på Riksbankens prognos på UNDIMPX (röd kurva) samt – VAR-prognos betingad på utfallet i UNDIMPX (grön kurva)

We can now take a closer look at the simulations, using the one that begins at 2005Q2 as an example (the second one in the forth row). We see a gross overestimation of inflation, with forecasts that are much the same regardless of whether they are unconditioned, conditioned on the Riksbank's forecast or on the outcome. This means that the forecast of import prices was of no major importance for the inflation forecast in this period, which was dominated by other changes.

Matters are different for the forecasts for 2006Q1, using information as of 2005Q4. The unconditioned forecasts with the VAR model are much the same as those conditioned on the Riksbank's forecast, while forecasts conditioned on the outcome gave a considerably lower path. So here it can be said that the overestimation of inflation was due to the error in forecasting imported inflation. However, this seems to have been the case only for inflation assessments in the past year, not for either earlier years or the period as a whole.

Ramses

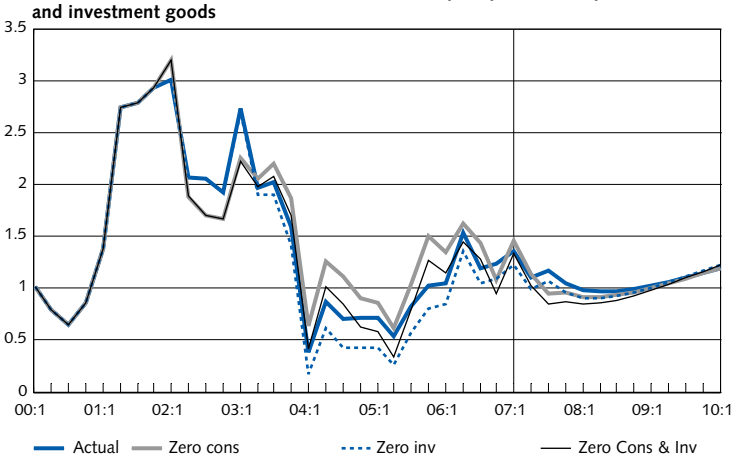
Ramses is a dynamic stochastic general equilibrium model (DSGE) of the Swedish economy.[18] The model incorporates explicit assumptions about the economic motives behind the behaviour of households and firms: it assumes that households and firms are forward-looking and aim to maximise utility and value, respectively. Decisions are based on predictions of the future. So when the Riksbank uses Ramses to forecast private sector behaviour, there is a presumption that the effects of monetary policy, for example, are influenced by the private sector's predictions of the Riksbank's actions.

The model has been tailored to describe the development of a number of macroeconomic variables with the help of Bayesian estimations. The model estimates 15 equations (12 domestic and 3 TCW-weighted external variables) for the period 1986–2006 and takes the change of monetary policy regime in the mid 1990s into account. The estimation method also makes it possible to estimate a number of unobservable variables, for example a number of shocks that drive the model's dynamics.

Two examples of such shocks are shocks in the price mark-up on imported consumer goods and on imported investment goods. The estimation calculates a whole sequence of shocks that affect the dynamic course of the model's variables. The course of inflation (UND1X) with and without these shocks in the external price mark-up is shown in Chart 5.

[18] See Adolfson et al. (2007b).

Chart 5. Effect on UND1X of shocks in the mark-up on prices for imported consumer and investment goods



The grey and the dotted curves represent inflation without the shock in the mark-up on consumer goods and on investment goods, respectively. It turns out that the shock in consumer goods pulls inflation up and the shock in investment goods pulls it down. The combined effect of these import price shocks on inflation is marginal, as can be seen by comparing the combined effect (the black curve) with actual outcome (the thick blue curve). In Ramses the source of the unexpectedly low inflation is instead the unexpectedly high productivity growth.

Conclusions

The evaluation is mainly of historical interest because the Riksbank no longer forecasts UND1X decomposed into domestic and imported inflation. As mentioned above, neither is it perhaps the most interesting in the context of monetary policy.

So what lessons can be drawn from the results presented here? The detection of systematic errors is interesting because it indicates the possibility of improvements. They might concern forecasts of inflation and imported inflation about two years ahead and of domestic inflation and the TCW index about one year ahead.

In the case of what I have called the price residual and the distribution margin, potential improvements may have less to do with models and more with obtaining better statistics on prices to importers.

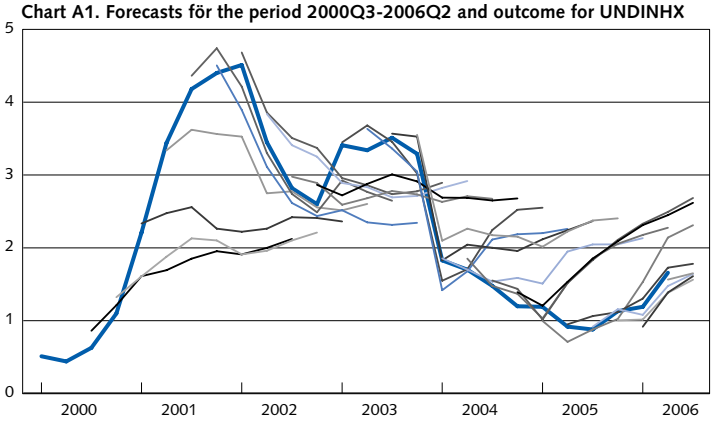
Another observation is that the systematic deviations in the forecast errors for imported inflation apply not only to the mean but also to the variance. They show that the variance in the Riksbank's forecasts is lower than in outcomes. So perhaps one should forecast somewhat more boldly than has been the case.

The conclusions from the evaluation can be summarised as follows:

- imported inflation and inflation two years ahead were significantly overestimated
- the exchange rate one year ahead was systematically overvalued
- the residual price was systematically overestimated both one and two years ahead
- forecasting power decreases rapidly as the horizon becomes longer
- forecast errors were larger for imported inflation than for domestic inflation
- there were large forecast errors for the global producer price index and the distribution margin
- evaluations using annual changes and overlapping observations can lead to erroneous conclusions
- the variance in the Riksbank's forecasts of imported inflation is smaller than in the outcomes
- the forecast errors in imported inflation were, according to simulations with a VAR model, an important factor behind the overestimation of inflation in 2006 but not for the period 2004–06 as a whole
- the forecast errors in imported inflation – prices for imported consumer and investment goods – were not important, according to simulations with the Ramses model, for the path of inflation from 2003 onwards

Appendix 1: Description of forecasts and outcomes

Chart A1. Forecasts för the period 2000Q3-2006Q2 and outcome for UNDINHX



Note. The thick blue curve is the outcome and each of the other curves represents a forecast made at a particular time.

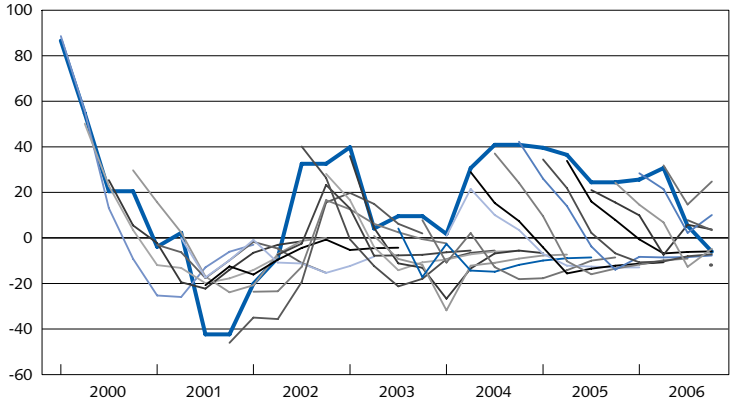
Sources: Statistics Sweden and the Riksbank.

Chart A2. Forecasts for the period 2000Q3-2006Q2 and outcome for UNDIX

Note. The thick blue curve is the outcome and each of the other curves represents a forecast made at a particular time.

Sources: Statistics Sweden and the Riksbank.

Chart A3. Forecasts for the period 2000Q1-2006Q4 and outcome for the price of oil in USD



Note. The thick blue curve is the outcome and each of the other curves represents a forecast made at a particular time.

Sources: Statistics Sweden and the Riksbank.

Appendix 2: Tables

Table A1. Forecast errors for particular variables and horizons 2000Q1 – 2006Q3. Mean error (ME) for particlar horizons and all horizons. Forecasts as annual rates

Horizon	All	1	2	3	4	5	6	7	8	9
UNDIMPX	-0.271	-0.001	-0.227	-0.141	-0.109	-0.103	-0.160	-0.388	-0.556	-0.758
UNDINHX	0.152	0.014	0.126	0.262	0.350	0.403	0.335	0.163	-0.022	-0.261
UND1X	0.012	0.007	0.010	0.129	0.198	0.236	0.173	-0.020	-0.198	-0.426
TCW index	2.071	0.212	1.154	2.383	3.404	3.962	3.329	2.247	1.223	0.450
Residual price	-2.309	-0.173	-1.229	-2.412	-3.428	-4.052	-3.542	-2.697	-1.787	-1.303
PPI	1.306	0.250	0.716	1.349	1.708	1.881	1.933	1.908	2.006	2.130
Distrib. margin	-3.250	-0.122	-1.184	-2.641	-4.212	-5.762	-6.271	-5.997	-4.765	-2.828

Table A2. RMSE for particular variables and horizons 2000Q1 – 2006Q3. Means for particular horizons and all horizons. Forecasts as annual rates

Horizon	All	1	2	3	4	5	6	7	8	9
UNDIMPX	0.879	0.189	0.975	1.103	0.872	0.931	0.948	0.938	0.970	0.985
UNDINHX	0.887	0.122	0.415	0.635	0.854	1.029	1.214	1.277	1.257	1.182
UND1X	0.617	0.097	0.460	0.555	0.584	0.655	0.812	0.814	0.827	0.744
TCW index	3.453	1.308	2.426	3.178	3.861	4.498	5.014	4.363	3.569	2.864
Residual price	3.301	1.315	2.277	2.934	3.736	4.341	4.763	4.272	3.492	2.578
PPI	0.396	0.423	0.827	0.460	0.253	0.232	0.306	0.384	0.293	0.385
Distrib. margin	2.085	0.727	1.577	2.153	2.546	2.660	2.993	3.379	2.300	0.429

Table A3. Forecast errors for particular variables and horizons 2000Q3 – 2006Q3. Mean error (ME) for particlar horizons and all horizons. Forecasts as first differences

Horizon	All	1	2	3	4	5	6	7	8	9
UNDIMPX	-0.104	0.039	-0.032	-0.035	-0.091	-0.059	-0.204	-0.236	-0.194	-0.197
UNDINHX	0.041	0.028	0.134	0.144	0.104	0.069	0.054	-0.013	-0.062	-0.167
UND1X	-0.007	0.024	0.080	0.083	0.043	0.027	-0.028	-0.089	-0.102	-0.180
TCW index	0.467	0.185	0.954	1.148	0.859	0.575	0.348	0.112	-0.089	-0.322
Residual price	-0.599	-0.146	-1.059	-1.182	-0.950	-0.634	-0.552	-0.348	-0.105	-0.075
PPI	0.252	0.224	-0.664	0.392	0.404	0.530	0.585	0.437	0.627	0.824
Distrib. margin	-0.635	-0.100	0.060	-1.115	-1.323	-1.256	-1.159	-0.550	0.286	0.221

Table A4. RMSE for particular variables and horizons 2000Q3 – 2006Q3. Means for particular horizons and all horizons. Forecasts as first differences

Horizon	All	1	2	3	4	5	6	7	8	9
UNDIMPX	0.879	0.187	0.863	0.951	0.931	0.982	0.991	0.947	0.948	1.110
UNDINHX	0.361	0.119	0.360	0.390	0.412	0.448	0.511	0.381	0.367	0.261
UND1X	0.362	0.095	0.414	0.390	0.411	0.439	0.472	0.344	0.339	0.349
TCW index	1.649	1.221	1.761	1.999	1.886	1.740	1.700	1.573	1.499	1.462
Residual price	1.591	1.228	1.560	1.879	1.935	1.651	1.676	1.596	1.397	1.400
PPI	1.196	4.358	2.738	0.488	0.421	0.496	0.480	0.531	0.438	0.812
Distrib. margin	2.006	4.815	3.437	1.704	1.371	1.448	1.445	1.237	0.590	-

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Is there an optimal way to structure supervision?

Stefan Ingves and Göran Lind
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This article is based on a speech held in Dubai at the Islamic Financial Services Board. The focus of the presentation is on countries where banking still is the dominant part of the financial sector but where other services such as insurance and securities trading are expanding. That said, also countries with more diversified and integrated financial sectors have strong reasons to ensure that the structure of their supervision is updated to follow sector developments, not least the new and more sophisticated approaches to regulation and supervision. There are also countries with a substantive but not necessarily advanced banking sector which, for commercial or political reasons intend to implement sophisticated supervisory and regulatory frameworks such as the Basel II capital requirements. To succeed in this endeavour, the demands on the supervisory system will be high.

The article is about finding the best way of structuring the financial regulatory authorities in a country, given the development of the country's financial system and other criteria. This issue has been hotly debated for a long time because of the important and political issues involved and the discussion is still going on. We will discuss the matter based on experiences from countries around the world, including situations in which we have been personally involved such as when a country reconsiders its institutional set-up after a crisis. First we will describe the alternatives for supervision that countries have chosen. Then we will discuss how certain key aspects for supervision, such as independence, accountability, transparency and efficiency can be accommodated under various supervisory structures. Third, we will debate the arguments for and against having supervision inside a Ministry or in a national central bank, which we will call NCB for short. We will also evaluate the arguments for and against combining various supervisory authorities.

There are two basic issues in the discussion on the organisation of supervision:

- Should supervision be inside or outside the NCB and the Ministries?

- Should supervision of different sectors be unified in the same authority?

These questions will be discussed later in our presentation. Let us first describe some of the present practices in organising supervision.

Present practices

Currently there is a great diversity of supervisory structures but the majority comes under one of the two main streams:

The first is the traditional one with bank supervision in the NCB and securities supervision in an independent standalone authority. Insurance supervision is in many countries also located in a separate authority, but in other cases it is a department of the Ministry of Commerce or some other ministry.

The second main stream is full unification of the supervision of banks, securities companies and insurance companies, all in one institution.

The trend since some 15 years is that bank supervision in a number of countries has been moved outside the NCB and has been consolidated with the supervision over securities and insurance companies. However, the most common structure is still the traditional one described above[1]

But there are many variations. One is the combination of banking and securities supervision, which is logical due to the close relations between banking and securities activities. Another is the combination of securities and insurance supervision with the aim to create a stronger authority with more resources and expertise. This combination is also logical since insurance companies are major actors in the securities' markets.

There are also some broader alternatives. The FSA in the UK, among others such as the Swedish Finansinspektionen, performs supervision over a wide range of financial institutions, including brokers, pension funds and many more. Its objectives also includes consumer education issues and the competitive position of the UK in international financial business. All kinds of supervision and other activities related to the financial sector are placed under one roof.

The Netherlands, Australia and others have followed an approach based on the purpose of the supervision. In these countries prudential supervision of banks and securities firms is conducted in separate bodies from the oversight of the conduct of the financial markets. The underlying rationale is that these activities are different. Ensuring the safety and stability of banks and securities firms requires different regulations and skills from monitoring market conduct and taking enforcement actions.

[1] Martin Čihák and Richard Podpiera: IMF Working Paper WP/06/57 from 2006.

The table below sets out in general terms the objectives of prudential supervision versus the oversight of market conduct, and financial stability versus consumer protection. Also in countries where there is no corresponding supervisory structure the existing supervisory authorities would need to keep these different objectives in mind when arranging their work.

	Protect the system	**Protect the consumer**
Prudential supervision	Financial and operational stability and adequate risk management in central financial institutions and functions	Well managed financial institutions and efficient and adequate regulatory frameworks which ensure that obligations to depositors, insured parties, holders of collective funds units, etcetera will be honoured
Market conduct oversight	Efficiency and confidence in the financial markets	Correct and relevant information to customers and investors, reasonable terms for and correct treatment of customers.

Source: Finansinspektionen, Sweden

Ireland, France, Finland and others have retained bank supervision in an organisation closely related to the central bank but not in the central bank itself. In this way they benefit from the resources of the NCB and can make some cost savings, but avoid some of the arguments against locating supervision in the NCB itself.

Other countries, among them Germany, have a stand-alone consolidated authority for financial regulation, BaFin, but the central bank maintains a role in the conduct of prudential supervision by performing most of the compilation of data from the banks. In this way the Bundesbank benefits from its vast network of regional branch offices and its knowledge of the local economy. The Bundesbank also administers audits of banks by hiring and overseeing the work of authorised audit firms, and evaluates banks' risk management models. Of course, such an approach of work-sharing presupposes close cooperation between the NCB and the supervisory agency and clear legal mandates for the duties of each authority.

Criteria for evaluating the organisation of supervision

The choice of structure for supervision is not an end in itself but a means to achieve certain objectives. We should therefore analyse the conditions that must be in place to ensure good supervision.

The first one is *operational independence*. There must be laws to prevent policy makers or financial market participants from trying to influence the operational decisions of the supervisor. Independence also

implies sufficient and stable resources to attract skilled staff, to build good IT-systems, and to inspect supervised entities. The head of supervision should be independently appointed and should not be dismissed for other reasons than those provided in the law. The head and the staff should be protected against frivolous law suits, as long as they conduct supervision in good faith.

Traditionally, independence has been best protected when supervision is conducted in an NCB since the NCB itself is independent due to its role in monetary policy. The NCB in most cases also has its own revenues and may set its own budget. Outside the NCB, independence must be ensured through explicit legislation and through clear rules for obtaining the necessary resources, e.g. by levying fees on the supervised entities. Contrary to supervision located in the central banks, or in other independent bodies, the supervisory sections which are entities within Ministries are by definition not operationally independent and their resources are dependent on budget appropriations. However, independence may be ensured in stand-alone authorities reporting to but operationally and financially independent from the ministries.

The second condition for good supervision is *accountability*. The authority must regularly provide information about its performance in various forms, such as Parliamentary hearings, speeches by the management, written reports and websites. On these occasions the authority describes and explains its actions and stands ready to receive criticism.

There is no specific structure of supervisory authorities that automatically leads to better accountability so clear rules must be set regardless of how the authority is structured. The rules and policies setting out NCBs' accountability for their monetary policies may act as examples for supervisory accountability, also when performed outside the NCB.

The third condition is *transparency*. The general public and in particular the supervised entities need to have full information about the regulatory framework and the general conduct of supervision. This does not include information about sensitive ongoing operational issues. In such cases the authority must carefully weigh the public's need for information against the risk that this might negatively affect the prevailing situation. The authority must consult with interested parties to ensure that efficient laws and regulations are drafted and after implementation they should cooperate with the market participants and others to ensure that the rules are well understood and implemented. Transparency is traditionally not a focus of supervisors and may sometimes conflict with other supervisory objectives, so it needs to be explicitly enacted, independently of how supervision is organised.

The fourth condition is the *efficiency and efficacy* of supervision. Does the authority perform its services at a reasonable cost? To a large extent this depends on the organisation of the work itself and not the overall supervisory structure. There is also an argument of economies of scale and scope, implying that some costs could be reduced if you combine the supervisory authorities. Generally, the same criteria should be applied on the organisation of supervision as in the process of creating new regulation, namely a cost-benefit analysis. Do the total costs of supervision, including costs borne by the supervised entities, provide commensurate benefits?

A more important aspect of efficacy is whether the authority lives up to its stated objectives, for instance to ensure a safe and sound financial system. This has not so much to do with the organisation of the authority but more with its legal powers and independence. An even broader issue concerns the appropriate range of objectives for a supervisory authority, for instance if consumer protection, competition policy or promotion of the financial sector should be included together with the basic objective of financial stability and smooth operations in the financial sector and its institutions. Our experience from many countries is that it is usually more efficient to separate these objectives between different authorities. For instance, handling consumer issues is resource intensive and may negatively affect confidence in the supervisory authority. That said, a supervisory authority does have knowledge about the financial institutions and instruments which makes it well placed to handle difficult consumer issues. It is important also from a supervisory perspective that customers of financial institutions are treated in a way that the public's overall confidence in the financial sector is maintained. Hence, responsibility for some consumer issues might be retained in the supervisory authority, including the oversight self-regulatory bodies. Having too many objectives might also lead to conflicting goals for the authority. As an example, it might in certain situations prove more difficult to propose needed regulatory measures while simultaneously having the objective of promoting the growth of the financial market.

To sum up: A country should be able to manage independence, accountability, transparency and efficiency satisfactorily in any kind of supervisory structure. For independence there might be some advantage with central bank supervision. But for cooperation leading to better efficiency there might be a slight advantage with a unified authority.

Arguments for and against various supervisory structures

After having discussed the conditions for good supervision let us now review some of the arguments for and against the various actual supervisory structures. We will first address the issues of having supervision inside or outside the ministries and the central banks. We will then turn to the arguments for and against unified authorities.

Supervision inside ministries may provide some benefits in the form of insight and staff expertise since the staff deals with similar issues in their other work, e.g., on regulation, maybe also access to resources. But there is a strong disadvantage in the lack of independence plus the risk to the public's confidence in the government if failures should occur in the supervised sector. There is also a serious governance issue in those countries where the government is the owner of financial institutions and also supervises them.

The above refers to the conduct of supervision within the ministries themselves. Many countries have formed supervisory authorities as separate bodies but, as with other public bodies, organisationally accountable to a ministry. Such a structure may work well, provided that operational independence and integrity for the authority in relation to the ministry is ensured. For instance, Sweden has a constitutional rule against ministerial involvement in operational issues in the authorities reporting to the ministries.

ARGUMENTS FOR RETAINING SUPERVISION IN THE NCB

What about supervision inside the NCB? First, banks have a special importance in the financial system. Their activities are often complex. Therefore, they need high quality, resource-intensive supervision. The NCB in most cases has a legally ensured basis for its independence and raising of revenues. NCBs can often recruit and retain good staff by offering attractive salaries and other advantages.

Second, Federal Reserve Board Chairman Bernanke[2] and others argue that information gathered in the conduct of supervision provides important input for the monetary policy. Having updated knowledge about the financial system is also important if the central bank is requested to provide liquidity support in a crisis situation. Although such information can be summoned from a supervisory authority outside the NCB, the NCB will be in a better position if it is already familiar with the situation through its in-house supervision. A similar argument is that the central

[2] Held at the Allied Social Science Association Annual Meeting, 9 January 2007. Link to the speech: http://www.federalreserve.gov/BoardDocs/speeches/2007/20070105/default.htm

bank is often operating or overseeing the country's main large value payments system. Thus the central bank will be able to spot potential liquidity problems at an early stage and can take timely remedial action if it has the supervisory powers to do so.

ARGUMENTS AGAINST RETAINING BANK SUPERVISION IN THE NCB

But there are also counterarguments to conducting supervision in the NCB. Some would reverse Bernanke's argument and say that just because the NCB is responsible for monetary policy, payments system oversight and, in many cases, liquidity support in a crisis, it should not be responsible for daily supervision. An NCB with such responsibilities might run into a conflict between the objectives of monetary policy and of supervision. Simply put, the NCB might be tempted to keep interest rates excessively low in order to prevent that some weak banks run into acute problems. In fact, some research results[3] based on OECD countries have indicated that the inflation rate is higher and more volatile in countries where the central bank has the sole responsibility for banking supervision. A failure in a supervised entity might affect the reputation of the NCB to the extent that its capability to perform effective monetary policy is hampered. In a crisis, there is a management problem in that the solution of a crisis in the supervised entities will preoccupy the minds of the NCB management so that it will not have the time to focus on other important issues. The "Finnish approach", mentioned above is an attempt to solve this dilemma by creating an independent body with a separate board for the supervisory decisions but still being a part of the central bank for its funding and sharing of administrative resources.

An overarching argument is that the Parliament should not delegate too much power to a non publicly elected body such as the central bank. But we do not see this as a major problem. The Parliament should set the parameters and limits for the powers of the NCB and the NCB will have to account for its conduct on a regular basis. If supervision is located in another authority, there will be similar issues of delegation and accountability.

We noted earlier that the current trend is to move supervision out of the NCBs. However, some countries have gone the opposite way by moving securities and insurance supervision under the umbrella of the NCB where only the supervision of banks earlier took place. They have benefited from the independence and resources of the NCB. However,

[3] Haubrich (1996) and Di Noia and Di Giorgi (2000). These and other issues related to the role, responsibilities and governance of central banks are discussed in the paper Governing the Governors: A clinical study of central banks, drafted by Lars Frisell, Kasper Roszbach and Giancarlo Spagnolo. A yet unpublished draft manuscript was issued in August 2006.

these sectors require partly different staff skills and methods and they include issues which are normally outside the mandate of a central bank such as investigations of market conduct and law enforcement actions against individual firms or persons. Failures in securities and insurance companies may affect overall confidence in the NCB, although these institutions are in most cases of limited interest to the NCB from the point of view of financial system stability. The risk of such failures occurring might even lead to what Professor Goodhart calls "a creep of the Central Bank safety net"[4] implying that exceptional liquidity assistance might be used for non-systematically important institutions. Our conclusion is therefore that you should only bring securities and insurance supervisors into the NCB if this is needed because they can not adequately fulfil their tasks outside the NCB for some reason such as lack of independence or resources. As a possible alternative you can bring them close to the NCB by using a "Finnish structure" with an independent supervisory body, only organisationally attached to the NCB.

After having discussed whether supervision should be inside or outside the Ministries and the NCB, we now turn to the issue of unified supervision. These are some often-heard arguments for the consolidation of supervisory authorities:

CONSOLIDATING PRUDENTIAL SUPERVISION IN ONE AUTHORITY

"Information sharing and coordination will be facilitated if the different sector supervisors are located in the same authority". In our experience this argument is mostly correct, both for practical and legal reasons. But this requires that the unified supervisor is really integrated and not just a combination of separate branches. We have seen bad examples of unified supervisors where the staff are not allowed to discuss mutual issues since there are still legal barriers between the departments within the authority! We have also seen bad examples of turf battles within a unified authority, which has certainly not facilitated information sharing.

"A unified authority will imply some cost savings because of economies of scale." However, this argument should not be exaggerated. Some administrative overhead costs may be reduced but other costs will remain. Most of the costs emanate from the supervisory operations and there is little scope for savings in this area. More substantial cost savings and more efficiency in supervision may be achieved through better streamlined cooperation between different sector supervisors but this can be achieved both when they are located separately and when they are within the same authority.

[4] Charles Goodhart: The Organisational Structure of Supervision; FSI Occasional Papers No 1, Nov. 2000.

The authority conducting banking supervision is in most countries more advanced and has more resources than the other supervisory authorities. By combining bank supervisors with other supervisors it is hoped that the former can share resources and knowledge with the weaker sectors. This argument if often heard, but in practice it does not always work as planned. The risk is rather that banking supervision is weakened when resources are transferred and when skilled banking supervisors leave the authority.

Another argument is that a unified supervisory authority could become stronger and thus more independent than the individual authorities. We would argue, though, that the issue of independence is not *per se* related to the unification of supervision. Independence could equally be given to a small standalone supervisory authority as to a unified large one.

IS THERE AN URGENT NEED TO CHANGE YOUR COUNTRY'S SUPERVISORY STRUCTURE?

Let us turn to another aspect which is relevant especially for countries with a dominating banking sector but where securities trading and insurance activities as well as other financial services are gaining market shares. Is there any urgency to change to unified supervision or could you wait? The main argument for changing is when the non-bank financial sector is expanding rapidly and is taking a significant market share. Consolidated supervision is then needed to ensure that all risks to the financial groups and markets are taken into account. We see some development in this direction in almost all countries. The financial sector is expanding and introducing new instruments and activities. The boundaries between banking, securities operations, and insurance business are becoming blurred. In many countries this is a slow process, but in others it moves faster. Financial conglomerates, bank-led or otherwise, encompass different financial services within the same organisation.

There are arguments against changing the supervisory structures in the near term. The first one is the flip-side of the argument above. Also the banks are getting larger and more complex. In many countries they still dominate the financial sector and the payments system. Hence, society has a clear interest in strong banking supervision to avoid costly bank failures. We should take into account that banking supervision in many countries functions quite well, while supervision of the other financial sectors is much weaker. Major structural changes involving bank supervision will therefore hamper the conduct of such supervision for a long time due to the focus on the transition rather than on the operations. There is also an obvious risk that qualified staff will leave bank super-

vision due to the less attractive work prospects outside the NCB. For instance, government salaries and other benefits are usually not as good and in most countries it is less prestigious to work outside the NCB. The result would be weaker bank supervision without compensating improvements in other sectors.

There are other ways of meeting the challenge. Many countries have instituted arrangements for closer cooperation between the supervisors. Memorandas of Understanding have been drafted so that information may be shared without legal or other impediments. Joint forums have been established where representatives from the different supervisory authorities meet regularly. Cross directorships imply that high level supervisors sit on each others' Boards and can inform themselves of developments.

Legislation might also be necessary in order to ensure that the NCB can always obtain the information it needs to fulfil its responsibilities on financial stability, extraordinary liquidity assistance in a crisis, and monetary policy. In Sweden, the central bank concluded a non-legally binding MoU with our bank supervisors but we also have the legal power to ask the banks directly for information.

It is difficult to sum up all the arguments for and against. If you are contemplating change in your country, We would say that a broad and objective assessment of the present strengths and weaknesses of your supervisory arrangements will provide good guidance as to which way to go. The optimal solution for the near term may not be the same as for the long term.

The aspects of cross-border supervision

Financial institutions increasingly operate across national borders. They establish branches and subsidiaries in other countries and they have different forms of business linkages with institutions in other countries. Is there any structure of the domestic regulatory authorities that is particularly suited to the efficient supervision of international financial operations? We do not think so. What matters is that there are arrangements between home and host supervisors which ensure information-sharing and close cooperation in particular in crisis situations. Such arrangements can be agreed on whether bank supervision is in a central bank or combined with securities and insurance supervision in a separate authority. That said, Roger Ferguson, a former Member of the Fed Board and Chairman of the FSF, argues that the well established global network among central banks, such as through the BIS, gives central banks a comparative advantage in informal information sharing and cooperation[5].

[5] Ferguson, R (2000) Alternative Approaches to Financial Supervision and Regulation, Journal of Financial Services Research, 17(1), 297-303

Which role remains for the central bank?

Ensuring jobs for the central bank staff is not a valid reason for retaining bank supervision in the NCB. Hence, the question is: Which would be the primary tasks of the NCB if supervision is moved out?

Of course, the task of conducting monetary policy would remain with the NCB. The NCB will also run the large-value payments system, or at least exercise oversight over it. In addition, the NCB should always have the responsibility for the oversight of overall stability in the financial system. Financial stability is a necessary condition for efficient monetary policy operations and is in itself an important component in a country's sustained macro economic growth. In those countries where the NCB will still be the lender-of-last-resort the knowledge gained from its financial stability analysis will be crucial in a crisis situation. But the NCB cannot perform an efficient financial stability analysis, nor act as lender-of-last-resort without close cooperation with the supervisory authorities. The other authorities will also benefit from the stability work by the NCB.

Challenges for effective supervision

Important developments in the financial sector and in financial activities pose challenges for effective supervision however it is presently organised. Some examples might be highlighted:

PRESSURE FOR INCREASED CO-OPERATION

The ongoing cross-border integration of ever larger financial groups puts new demands on supervisors. It adds to the pressures for increased co-operation between the authorities in different countries both in daily supervision and in crisis management. In order to achieve a higher degree of harmonisation, domestic legislation and regulation of the financial sector must increasingly be aligned with international standards, e.g. those set out by the international standard-setting bodies. Supervisory cooperation and harmonisation can to a large extent be achieved within existing laws and arrangements, including MoUs, but given the transnational character of many large financial groups the authors of this article believe that ultimately some supranational body will have to be established to ensure effective supervision and crisis management of these groups.

The blurring of the boundaries between the different subparts of the financial sector and the increasing role of other financial institutions than banks is not a new feature but the continuation of a long-term development. It fortifies the arguments for strengthened cooperation, starting at the national level, between the supervisory authorities. This is needed in

order to ensure that similar financial instruments and activities are regulated and supervised similarly, irrespective of where they have originated.

BROADER PERSPECTIVE IN ANALYSIS OF RISKS

Another development affecting financial prudential supervision and stability analysis is the altered dispersion of risks. A wide range of derivatives and other instruments are being used to shift risks between the financial institutions but also to and from non-financial companies and households. Asset securitisation is already a major financial activity in some countries and is spreading rapidly. Banks are increasingly adopting an approach of "originate to distibute", implying that they do not intend to hold most of their exposures until maturity. This altered risk profile among the financial and non-financial actors must be carefully monitored by central banks and supervisory agencies, irrespective of the institutional structure. At least the central banks must in addition assume a broader perspective in their analysis than merely the financial sector; the wider risk dispersion may result in outcomes which have a substantial macro economic impact, e.g. on consumption patterns and on future pensions.

STRENGTHENS DEMANDS ON SKILLS

The trend in financial activities has since long been one of gradually rising complexity. Both the instruments and the management of risks have become more sophisticated, inter alia based on ever more advanced applied financial theories. Albeit with some lag, the laws and regulations have followed suit. For instance, the regulatory framework for the Basel II capital requirements acknowledges that banks may use advanced mathematical models to measure various risks provided that certain conditions are fulfilled. Hence, supervisors have to acquire the skills needed to fully understand these models as well as the inherent risks and weaknesses in them. At the same time, financial regulation is generally moving in the direction of becoming more principles-based as opposed to rules-based. This strengthens the demands on supervisory skills since supervisors in addition to understanding different model approaches must be prepared to accept different approaches as long as they fall within the accepted principles.

There is a double-edged risk if the laws or regulations or the supervisory skills and resources are not adequate in relation to the challenges mentioned. In their approach to the supervised institutions the supervisors may then tend to err too far on the conservative side, unnecessarily stifling innovation in the financial sector. But in other cases the supervisors might be convinced by the institutions' own specialists and may ac-

cept models and instruments without fully understanding their potential implications.

As shown above, recent developments in financial instruments, activities and structures imply a shift in the focus of supervisory authorities. This increases the incentives for structural changes, such as integrated domestic supervisory agencies and arrangements for cooperation or even closer integration of supervisory activities across country borders. But, as has been noted earlier in this article, structural changes in themselves are meaningless unless they increase the effectiveness of the actual supervisory processes. Unless supervisors have the independence, integrity and adequate resources to fulfil their tasks they cannot function satisfactorily in any kind of structure.

Conclusions

To sum up: Our first conclusion is encompassed by the American expression "If it ain't broke don't fix it". If bank supervision works well in your country, let it be as is and strengthen the other sector supervisors instead. Operational independence must be implemented and at the same time rules for accountability and transparency. This is more important for good supervision than the structure of the supervisory authorities.

If you see good reasons in your country for changing the supervisory structure, you should follow a transparent process and be clear of the consequences. For obvious reasons, you must avoid making organisational changes when the financial sector is weak. Nor should you change during major developments in the financial sector, such as the introduction of the bank capital framework Basel II and the new accounting standard IAS 39. (However, introducing new and complex regulatory frameworks put higher demands on the supervisory system and may call for a strengthening also of its structure. If so, any major structural changes should be effected before the transition to the new framework).The changes must be accompanied by measures to strengthen the capacity of the new authority. Otherwise the change is merely cosmetic.

In many countries there is a political pressure to change the supervisory structure to show expediency, in particular when there has been a recent financial crisis and irrespective of the supervisory agencies' roles and behaviour before and during the crisis. As a result banking supervision may in such cases be moved out of the central bank or conversely, at other times, into it. Also the unification of the supervisory authorities is sometimes seen primarily as an issue of the delegation and distribution of powers within a country. In our experience, there is not much to gain from such a view. On the contrary, the politicians might be blamed for

future failures of supervision if this, at least partly, can be blamed on a less efficient organisational structure.

Finally, the time has come to answer the question in the title of this presentation "Is there an optimal way to structure supervision". Our answer is "No". The different supervisory structures reflect the specific situation of their countries, which changes over time, and there is no globally agreed best practice. As former Chinese Chairman Deng Xaioping once said: "The colour of the cat does not matter as long as it catches mice".

Alternative measures of inflation for monetary policy analysis

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When analysing and forecasting inflation it is of interest to study the extent to which overall inflation has been generated by underlying driving forces that are international as opposed to domestic. However, measuring the magnitude of these components at all exactly is a problem because the prices of different products are affected to different degrees, depending on the competition in different markets. Many domestic products, for instance, are directly affected by international forces because their prices are formed in an international market. Consequently it is not possible to arrive at a reliable measure of the share of inflation that is attributable to domestic as opposed to international forces. It is more relevant to study price developments for some well-defined aggregates, for example goods, services, food and energy.

The breakdown into domestic and imported inflation is misleading

The Riksbank's monetary policy objective is to keep the annual change in the Consumer Price Index (CPI) to 2 per cent. Monetary policy is also guided by various indicators of underlying inflation. One of these is UND1X, which is calculated as the CPI excluding household interest expenditure and effects of changes in indirect taxes and subsidies. Since the end of the 1990s, UND1X forecasts and outcomes are also published separately for goods that are predominantly produced in Sweden (UNDINHX) and those that are predominantly imported (UNDIMPX). The purpose of this has been to attempt to distinguish between domestic and international factors' influence on inflation.

While this distinction is interesting in theory, achieving it in practice is a problem. A case in point is the cucumber, which is classified as a predominantly domestic product. This is certainly correct in some seasons

[1] We are grateful to Stefan Palmqvist, Michael Andersson and Josef Svensson for valuable comments. Special thanks to Katarina Andersson at Statistics Sweden for providing detailed data on household consumption and assisting with the input-output analysis.

but in others it is probable that most of the cucumbers that are consumed in Sweden are imported. A poor harvest in Spain, for instance, can then lead to rising cucumber prices in Swedish shops and in the statistics that will be registered as rising UNDINHX inflation. The development of prices for goods that are mainly produced in Sweden is sometimes loosely referred to as "domestic inflation" and regarded as being solely determined by Swedish monetary policy and other domestic conditions. As the example of cucumbers indicates, this must be considered misleading.

But even if it were possible to arrive at an exact classification of the goods in UND1X that are imported and produced in Sweden, respectively, the result would still be misleading. Regardless of their import content, all goods in UND1X are sold in the Swedish market and are thereby affected by costs in Sweden for labour, transportation and so on. In the case of cucumbers, the price the importer pays is presumably just a minor part of the consumer price. At the same time, the price of many goods, even those that are produced in Sweden, is set in the world market and is therefore directly affected by external factors.

Similarly, the development of prices for predominantly imported goods and services, UNDIMPX, is often taken to be an indicator of external inflationary pressure and thus not directly affected by monetary policy in Sweden. Apart from the fact that policy rate adjustments clearly affect the nominal exchange rate and thereby prices to importers, this interpretation is also misleading.

In an analysis, the most relevant distinction is not based on whether items are produced in Sweden rather than abroad but on whether they are exposed to international competition and the extent to which in that case they are directly affected by exchange rates and prices abroad. Meat prices in Sweden, for example, are markedly affected today by prices in the EU even though the greater part of the meat that is consumed in Sweden is also produced here. Another example is electricity: consumption in Sweden is largely supplied by domestic producers but is priced on the Nordic exchange, Nordpool. Sweden is the largest user in the Nordic area, so Nordpool prices might perhaps be counted as predominantly domestic; in practice, however, Nordpool prices are increasingly influenced by the level of prices in the rest of Europe and even the world. The main reason why prices covary is not the physical possibility of transmitting electricity to non-Nordic countries but the fact that at the margin electricity is produced, even in the Nordic area, with the aid of oil, gas and coal, which are priced internationally. Moreover, trade in emission rights has entailed a direct price link between the Nordic area and the rest of Europe. In the event of lower demand for electricity in Germany, coal-fired power stations there require fewer emission rights; the price of

these rights then declines not only in Germany but also – since they are traded internationally – in the Nordic area. The marginal cost of generating electricity then falls in the Nordic area, too, regardless of whether or not physical transmission capacity exists between Germany and the Nordic area.

The fact that many product prices are directly affected by external prices, even if the products are produced domestically, means that the part played by external price impulses is greater than is indicated by, for example, calculations based on input content in input-output tables (see below). Since the theoretically most relevant measure of exactly how much consumer prices are affected by external inflationary impulses cannot be calculated in practice, the natural question is what other product divisions are available that are analytically relevant. Which well-defined grouping of products can be used to describe the extent to which consumer prices are affected by inflationary impulses from the rest of the world?

Price indices for goods, services, energy and food give a truer picture

A well-defined and widespread division of the products in household consumption is the one used by Eurostat for the EU harmonised index of consumer prices (HICP). This index is currently published with a breakdown into 5 main components (non-energy industrial goods, services, unprocessed food, processed food and energy). The classification is based on physical characteristics, which is a less ambiguous criterion than import content. Another advantage is that the classification matches the internationally accepted nomenclature for products and industries on which the statistics for national accounts, foreign trade and wages are based.

As the Riksbank's objective is formulated in terms of the CPI and analyses tend to be based on UND1X, a breakdown along the lines for HICP has been produced for this measure, too (see Table 1 and Chart 1): UND1X is divided into goods excluding food and energy services. This is done by starting from the CPI's approximately 70 sub-groups, which are classified and weighted together (see Table A1 in the appendix). The price index for each main component is then adjusted for direct effects of changes in indirect taxes and subsidies, after which the four indices are weighted together to constitute UND1X.

Table 1. UND1X main components, weights for 2007, average annual change, standard deviation and persistence 1995-2006

	Weight in UND1X for 2007	Average annual percentage change	Standard deviation	Persistence
Goods excl. food and energy	27.2	0.14	1.30	0.86
Energy	9.4	3.05	4.23	0.66
Food	17.7	1.13	1.33	0.75
Services	45.7	2.36	0.79	0.84
Total UND1X	100.0	1.52	0.77	0.78

Note. Persistence is measured with the coefficient for the first order autocorrection for each series' annual rate of change.
Sources: Statisics Sweden and the Riksbank.

Services prices normally rise faster than prices for goods, mainly because productivity growth tends to be lower in the production of services. Table 1 shows that the average rate of increase in services prices has been above the rates for goods and food since 1995. Energy prices vary most and services prices are the least volatile. The degree of persistence in price increases is higher for goods and services than for energy and food.

External factors' importance for inflation in Sweden depends on the competition

A natural approach to an analysis of inflation is to decompose inflationary impulses into factors that are mainly determined inside the country (unit labour costs and profit margins) and those that are mainly influenced by developments abroad (import prices that have to do with the nominal exchange rate). The empirical literature provides considerable support for the notion that exchange rate fluctuations and variations in prices abroad have a relatively large impact on import prices even when the short-run pass-through is only partial.[2] The impact on consumer prices, on the other hand, is remarkably small, which has to do with pricing behaviour in markets with imperfect competition, the occurrence of high costs for domestic distribution and macroeconomic adjustment processes. Moreover, all products, regardless of their import content, are marketed in Sweden and are accordingly affected by domestic conditions.

However, the fact that exchange rate movements do not have all that much effect on consumer prices does not mean that the nominal exchange rate is of little consequence for the economy's adjustment to different kinds of shock.[3] A relatively extensive literature on models for pricing behaviour indicates that for consumer prices for imported goods, a full adjustment is not the optimal response to a change in import

[2] See e.g. Campa & Goldberg (2002) and Bailliu & Fujii (2004).
[3] See the review of the interaction of price formation and exchange rates in the new open-economy macroeconomics, in Obstfeld (2002).

prices.[4] In principle, the optimal alternative is usually to try to keep market shares. Research in recent years has also highlighted the importance of domestic distribution costs when it comes to explaining the comparatively weak relationship between import prices and consumer prices.[5] Another notable factor is the stabilising role of the exchange rate in an open economy with a variable exchange rate. When a country experiences a loss of demand that is generated internally, for example by a contractive fiscal policy, the real price level declines relative to the rest of the world. In the short run this weakening of the real exchange rate occurs primarily as a weaker nominal exchange rate but in the longer run there also tends to be a fall-off in domestic production costs (unit labour costs). So although the weaker nominal exchange rate tends to result in higher consumer prices, the total effect on consumer prices is limited because in this situation unit labour costs and profit margins normally develop more slowly.

So in order to arrive at a proper picture of the extent to which consumer price inflation is affected by domestic as opposed to international factors, it is necessary to separate domestic production costs that are not exposed to foreign competition from other production costs.

The import content of household consumption is smaller than the UND1X weight for imported inflation

The calculated weight for mainly imported goods in UND1X (UNDIMPX) for 2007 is 33 per cent, which corresponds to the share these goods had of consumption in 2005. This probably overestimates the extent to which changes in import prices for imported goods directly affect the whole of UND1X and the CPI. At the same time, as discussed above, calculating the import content of household consumption at all exactly is difficult.

One approach to measuring the proportion of household consumption that is exposed to international competition involves making assumptions about which products are traded internationally. It is then commonly assumed that *goods* are traded internationally but not *services*. In most OECD countries the proportion of goods in household consumption that are traded internationally is in the interval from 40 to 70 per cent (see Table 2). However, the share of consumption that is directly influenced by international factors is considerably smaller than this, partly because a large part of the price of goods represents compensation for domestic costs, for example, Swedish wages, transportation, marketing, warehousing and shop space.

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4 See e.g. Bacchetta & van Wincoop (2003) and Devereux, Engel & Storgaard (2004).

5 See e.g. Burnstein, Neves & Rebelo (2003), Burnstein, Eichenbaum & Rebelo (2005) and Campa & Goldberg (2006).

A better way of measuring imported goods' share of household consumption is to study input-output tables from the national accounts. A disadvantage of these statistics is that they are published only at five-year intervals and with a considerable time lag. Moreover, they are uncertain, partly because the data on producers' consumption of inputs are based on earlier surveys and, in certain cases, on surveys in other countries. Using input-output tables for monthly calculations of how varying import prices affect consumer prices is therefore not appropriate. These data are, however, the best available for studying how much of the value of different consumer products is imported and produced domestically, respectively, and in which industries.

The direct import content is the share of final consumption that was produced abroad. This share is fairly small in a number of OECD countries (see Table 2). The total import content, on the other hand, also includes the imported inputs that Swedish producers use in their production of goods and services for household consumption. Fuel for taxis is one example, imported vegetables for catering is another. The total import content is therefore considerably larger (see Table 2). For Sweden, the direct import content is about 14 per cent and the total import content about 25 per cent.[6] Both these shares are smaller than the proportion of imported goods in UND1X (UNDIMPX).

Table 2. Share for traded goods and import content in household consumption in the mid 1990s.
Per cent

	Finland	Italy	Sweden	UK	USA
Traded goods' share in CPI	58.7	65.8	48.0	69.0	42.9
Import content in household consumption:					
Direct import content	13.1	6.6	13.6	12.0	4.7
Total import content	24.0	16.2	25.3	20.9	9.1

Note. Traded goods in CPI are defined approximately as goods excluding electricity. Import content is calculated from the OECD's input-output tables from 1995 or adjacent years.
Source: Table 3 in Burnstein, Eichenbaum & Rebelo (2005).

The import content and the degree of international price impulses are highest for goods and lowest for services

The non-imported share of consumption, about 75 per cent, is dominated by services, which are naturally produced locally. But even the consumption of imported products includes a considerable proportion of domestic value-added in the form of compensation to domestic labour and capital for distribution costs.

[6] This figure is in line with the Riksbank's estimates of how much the CPI is affected in the longer run by variations in import prices for consumer products. For an early example of such an estimation, see Dellmo (1996).

Input-output tables can also be used to estimate the import contents of different goods. Table 3 presents the direct and total import contents of approximately the groups of goods that are listed in Table 1. The breakdowns are not exactly the same because the published input-output tables are less detailed in this respect than the CPI and the UND1X (a fuller description of the breakdown and the calculations is given in the appendix). On account of other minor differences in definitions, the shares of household consumption in Sweden differ somewhat from the weights in UND1X. Still, the import content in goods, particularly energy and food, is clearly much higher than in services. It follows that international factors such as exchange rate movements probably affect price developments for goods more directly than price developments for services.

As traded products that are produced in Sweden are also exposed to international competition, it is of interest to attempt to estimate the share of household consumption that consists of traded goods. Different products' content of domestic value-added can be calculated with the aid of the input-output tables. Moreover, the value added can be divided between industries that produce goods and those that produce services. Treating the production of goods as exposed to international competition and the production of services as protected is a reasonable approximation, albeit clearly not strictly true. Imported services, for example, make up an appreciable share of total imports and are unquestionably traded internationally. Table 3 presents the percentage of traded products in each component as the sum of direct imports, consumption of imported inputs for domestic production and the value-added in goods-producing industries that can be derived from household demand for these goods, divided by household consumption. In 2000, traded products, defined in this way, made up about 34 per cent of households' total consumption in Sweden. This is about 10 percentage points more than the total import share. The difference comes from domestic value-added among producers of goods, for which the share is particularly large in the energy component. That is because in this calculation a large proportion of domestically produced electricity is treated as a traded product.

This measure of traded products' share of consumption can be seen as an upper limit to how much consumer prices are affected by international prices and exchange rates. Due to pricing behaviour, the pass-through from import prices is only partial even for traded products. The estimations in Campa & Goldberg (2006) indicate that in the OECD countries the average import price pass-through from the exchange rate is just over 60 per cent.

It should be noted that a sound calculation of the share for tradables calls for relatively complicated input-output analyses. The simplified

estimate presented in Table 2 gives a considerably higher proportion of tradables than Table 3 indicates; this is because the consumption of traded goods is represented there by the total consumption of goods, which is misleading because a large part of the consumer price of goods represents compensation for domestic distribution costs.[7] Prices for goods are therefore not affected solely by international factors.

Table 3. Import content and traded products' share in households' consumption in Sweden in 2000
Per cent

	Weight	Direct import	Total import	Traded products
Goods excl. food and energy	22.8	37.4	51.1	60.9
Energy	8.9	5.9	22.6	52.0
Food	16.7	18.5	33.2	53.7
Services	51.6	16.5	12.1	16.1
Households' consumption in Sweden	100.0	11.8	24.5	34.4

Sources: Statistics Sweden and the Riksbank.

New and old concepts closely linked

Unless it is extremely detailed, no product breakdown can be the most suitable solution for every purpose. The division proposed here, with four components – energy, food, other goods, and services – is currently considered to be useful for the analysis of inflation. It is easy to define, has an equivalent in the EU and the price formation bears at least some resemblance within each component.[8]

A sound reason for following price developments by UND1X subgroups is that it is then easier to separate different factors that affect inflation. Energy prices are set to a large extent in spot markets characterised by perfect competition. Food prices are liable to fluctuate widely on account of variations in the weather; they are also affected by EU regulations. For other goods, the high total import content means that import prices have a comparatively large impact on consumer prices; moreover, the production of goods is more exposed to international competition than is the production of services. Services prices are affected by import prices to only a limited extent; domestic factors are most important here, above all labour costs, productivity and competitive conditions. The development of these factors tends to be comparatively stable and services prices are the least volatile of the four components (see Table 1).

However, forecasting components and using the weighted results to forecast UND1X will not necessarily be more accurate than forecast-

[7] In addition to the above-mentioned distribution costs, there are other product taxes etc., which make up a substantial share of the consumer price (see the appendix). Neither are product taxes normally affected by international factors.

[8] In Sweden, analyses of inflation based on a similar breakdown have been published regularly since March 2006 by the National Institute of Economic Research in *Konjunkturläget*.

ing UND1X directly. At times, however, detailed information is available that, for certain subgroups, can help to improve short-run forecasts of inflation. Such information can concern energy prices in the world market, food prices and changes in various charges. Information of this type is usually not available for the longer run but can still be important for producing forecasts based on assumptions about the development of underlying factors. In recent years the Riksbank has, for example, assumed that fuel prices in the CPI follow forward prices for crude oil; this forecasting method may not be the optimum way of minimising deviations from outcomes but it is simple and transparent.

Studying prices in terms of components does not mean that the Riksbank considers some prices more important than others or that the inflation target shall be fulfilled for every kind of product. On the contrary, relative price shifts are normal. Services prices, for example, tend to rise faster than prices for goods.

The product breakdown described above may seem to be more weakly related to inflation's domestic and international driving forces than is the case with the earlier breakdown of UND1X into UNDINHX and UNDIMPX. In practice, however, the difference is not all that marked. For example, the Riksbank has frequently analysed UNDIMPX excluding petroleum products and the development of prices for this aggregate resembles that for goods excluding energy and food (see Chart 2); this is hardly surprising since it is largely a matter of the same products. In principle, the only difference is that the services item foreign travel and certain vegetables that are mainly imported are not included in industrial goods excluding energy and food.

The rate of price increases has risen in the past year for goods as well as services (see Chart 1). This is probably an effect of mounting pressure from costs in the Swedish economy. Food prices are also rising faster now than in 2004 and 2005, probably likewise as an effect of growing pressure from costs; higher commodity prices for certain food products have probably also contributed. The rate of change in energy prices tends to vary and is currently negative.

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Appendix

DEFINITION OF CONSUMER PRICES FOR FOOD, ENERGY, OTHER GOODS, AND SERVICES

Table A1. CPI sub-groups

Product code	Name	Weight in 2007, ‰
110	Bread and cereals	19.69
120	Meat	23.80
130	Fish	7.41
140	Milk, cheese and eggs	20.45
150	Oils and fats	3.15
161	Vegetables and fruits, Swedish	3.56
162	Vegetables and fruits, imported	6.88
163	Vegetables and fruits, mixed	15.99
170	Coffee, tea and cocoa	4.03
180	Other food	19.80
190	Soft drinks. mineral water and light beer	6.39
210	Beer, class 2	2.06
229	Spirits, wine and beer: Systembolaget	20.02
230	Tobacco	16.77
	Total, food	**170.00**
310	Women's cloths	20.16
320	Men's cloths	20.62
330	Children's and sports cloths	7.50
340	Textiles, yarns and sewing materials	0.60
370	Footwear, excl. services	8.44
467	Owner-occupied housing: repairs, goods	3.76
510	Furniture, carpets and lighting	23.21
520	Household textiles, other furnishing	9.01
530	Household appliances, excl. maintenance	4.65
540	Household utensils	9.52
550	Household items	6.45
610	Purchase of vehicles	44.46
622	Spare parts, cars	8.27
710	Radio, TV, video, etc.	13.04
720	Cameras, incl. colour film	0.96
730	Music instruments, records and cassettes	5.52
740	Flowers, etc.	6.75
750	Sport equipment and other recreational items	4.31
760	Toys, games and hobbies	4.97
770	Other recreational items, excl. maintenance	11.21
791	Books	5.81
792	Newspapers and magazines	8.75
911	Medicine	7.87
912	Health and medical goods	5.09
921	Personal care, goods	10.97
931	Other goods, excl. maintenance and gold	4.60
932	Gold goods	3.65
	Total, goods excl. food and energy	**260.15**
450	Gas and electricity, owner-occupied and rented housing	15.69
471	Owner-occupied housing, heating oil	3.30
472	Owner-occupied housing, electricity	25.96
623	Fuels	45.11
	Total, energy	**90.06**
410	Rentals for housing, cooperative flats, garages	139.81
462	Owner-occupied housing: write-offs	21.13
463	Owner-occupied housing: site leasehold, property tax	11.66
464	Owner-occupied housing: insurance fees	3.25
465	Owner-occupied housing: water, sewage, cleaning, chimney-sweeping	7.53
621	Repair and maintenance, car	15.74
624	Inspection, driver education, car insurance	12.74
631	Domestic transport services, excl. boat trips and removals	16.57
632	Foreign travel	22.61
641	Postal services	2.07
642	Telecommunication	32.93
781	Entertainment and recreation, excl. TV licence and gambling	25.06
782	TV licence	5.61
783	Lotteries, pools and tote-betting	11.73
913	Medical care	4.24

914	Dental services	11.80
922	Personal care, services	12.44
940	Wine, spirit and beer, restaurants	11.54
950	Catering services	37.58
960	Accommodation services	6.88
970	Funeral, insurance, financial services, education	21.87
981	Repair of domestic appliances	3.09
	Total, services	**437.88**
461	Owner-occupied housing, interest rates	41.91
	Total, CPI	**1000.00**

Note. The CPI broken down as above is published monthly by Statistics Sweden in connection with the publication of the CPI.

INPUT-OUTPUT CALCULATIONS

The most recent set of input-output tables refers to 2000 and was published on Statistics Sweden's website in May 2006. It presents supply (production and imports) and demand for 55 products/industries. The symmetrical input-output tables are product- by- product tables, calculated on the assumption of shared industry technology. The tables provide a picture of the structure of inputs in the economy. Given certain assumptions concerning production technology (e.g. constant returns to scale and no substitution effects), the tables can be used to calculate the extent to which an increase in demand for a particular product affects the production and import of various products. These calculations have been used here to calculate the import content and the share of production costs for a particular product that can be assigned to the production of goods and services, respectively.

Table A2 presents household consumption decomposed into 4 components: food (SNI 1, 5, 15–16), energy (SNI 10, 23, 40), other industrial goods (SNI 2, 13–14, 17–22, 24–36, 45) and services (SNI 50–95). With the input-output analysis it is possible to calculate how the price the consumer actually pays (the recipient's price) for each product breaks down into value-added tax, other product taxes and subsidies, and compensation for direct imports, consumption of imported inputs and value-added in different segments of the economy. (Value-added is broken down in turn into other production taxes and subsidies, compensation to labour and gross operating surplus.)

As value-added tax is levied as a percentage of the selling price, it is appropriate to relate the other costs to the product price excluding value-added tax. In 2000, total consumption in Sweden amounted to SEK 1,049 billion (see Table A2). The average rate of value-added tax was 10.8 per cent of the recipient's price (the low average rate is due to value-added tax not being levied on housing, which is a large item in the services component). Consumption excluding value-added tax accordingly totalled SEK 936 billion, of which 42 billion was compensation for other product taxes (mainly taxes on energy, alcohol and tobacco), 111

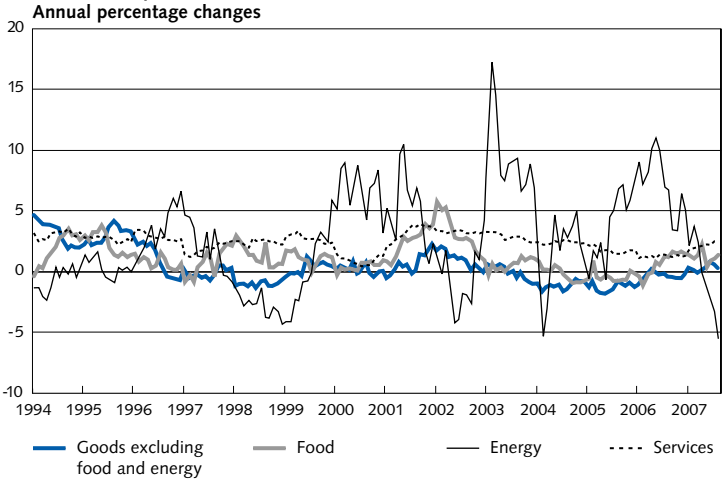
billion direct imports, 119 billion imported inputs for domestic production of consumer goods and services, and 665 billion domestic value-added. The direct import share (share of consumption excluding value-added tax) was 11.8 per cent and the total import share 24.5 per cent. Taking total imports, which are self-evidently traded in world markets, and adding domestic value-added in goods-producing industries (as an approximation of the segment of the economy that is exposed to international competition) indicates that tradables make up 34.4 per cent of total consumption. Corresponding figures for the four components are also presented in Table A2.

Table A2. Household consumption in Sweden in 2000
SEK million, current prices

		Food	Energy	Other goods	Services	Total
1=2+3+4+5+6	Purchasers price	175,363	93,243	239,279	541,269	1,049,154
2	Value-added tax	23,025	18,649	44,202	27,195	113,071
3	Other product taxes, tariffs, import fees and subsidies, net	16,763	27,885	1,358	-4,161	41,845
4	Direct imports	25,081	4,425	72,868	8,257	110,631
5=7+8	Domestic value-added	84,927	29,853	94,122	455,892	664,795
6	Consumption of imported inputs	25,567	12,431	26,729	54,086	118,812
7	Domestic value-added, goods	31,083	21,903	19,206	20,469	92,660
8	Domestic value-added, services	53,845	7,950	74,917	435,423	572,135
9=4/(1-2)	Direct import share	16.5%	5.9%	37.4%	1.6%	11.8%
10=(4+6)/(1-2)	Total import share	33.2%	22.6%	51.1%	12.1%	24.5%
11=(4+6+7)/(1-2)	Tradables share	53.7%	52.0%	60.9%	16.1%	34.4%
12=2/1	Value-added tax rate	13.1%	20.0%	18.5%	5.0%	10.8%

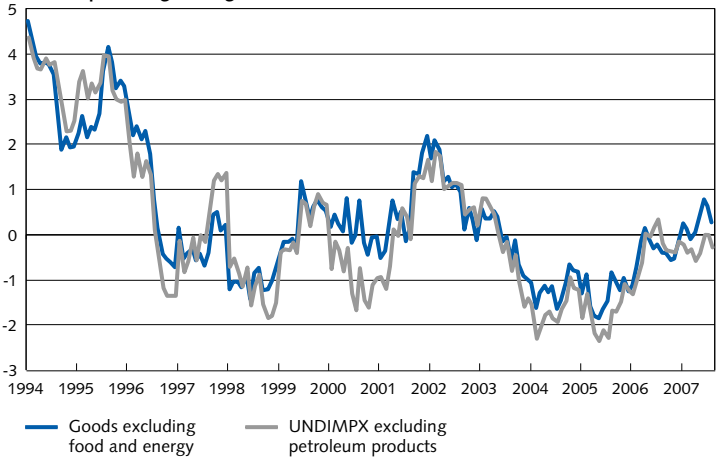
Source: Statistics Sweden, input-output tables published in May 2006; additional information on, for example, trading margins, taxes and subsidies for household consumption, from Statistics Sweden in March 2007.

Chart 1. Components of UND1X
Annual percentage changes



Sources: Statistics Sweden and the Riksbank.

Chart 2. Goods excluding food and energy in UND1X; UNDIMPX excluding petroleum products
Annual percentage changes



Sources: Statistics Sweden and the Riksbank.

An evaluation of the Riksbank's forecasting performance

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This article analyses the Riksbank's forecasts for central variables during the period 2000-2006. The Riksbank's forecast precision is compared with several alternative forecasts, partly from other forecasters and partly from simple time series models. One of the results is that the Riksbank's forecasts are just as good as, and often better, than the competing forecasts. However, differences in forecasting performance are not statistically significant. Another result is that the Riksbank's inflation forecasts, in particular for UND1X, have shown appropriate qualities, such as relatively high precision and long predictability memory. The Riksbank's real economy forecasts are less exact than the inflation forecasts, but fully on a par with those of other forecasters.

1. Introduction

The Riksbank's views on economic developments are currently presented three times a year in the Monetary Policy Report.[1] The Report also includes forecasts for the relevant variables for monetary policy up to three years ahead. Previously the Riksbank has presented and evaluated the models used in the forecasting work. Andersson and Löf (2007) describe the Riksbank's indicator models and show the forecasting performance they possess. Similarly, the forecast precision of the Riksbank's general equilibrium model and the Bayesian VAR model are presented by Adolfson et al. (2007). In the context of the evaluation work, this article presents an analysis of the forecasts the Riksbank has published in the Inflation Reports during the period 2000-2006.

Extensive studies of forecasting performance are quite rare. An evaluation of the Riksbank's recent monetary policy, including a relatively brief comparison of forecasts, is presented annually in the year's first Monetary Policy Report. Evaluations of various forecasters' assessments of the Swedish economy have been presented earlier by, among others, Blix et al. (2001 & 2002) and Bergvall (2005).

[1] Prior to 2007, the report was called the Inflation Report and in that guise was published four times a year prior to 2006.

Naturally, it is important to evaluate the Riksbank's forecasts not just for external purposes, but also for the Bank's internal development work. E.g., by evaluating forecasts, one can detect where there is room for improvement, gain a better understanding as to which variables are difficult to predict, and obtain information about which variables the Riksbank is good at forecasting.

The purpose of this article is to report the precision in the forecasts the Riksbank has presented in its reports and thus based its monetary policy on. The Riksbank's forecasting performance will be related to alternative forecasts from time series models and other analysts of the Swedish economy. Moreover, the forecasts are evaluated with regard to several statistical tests.[2]

The study shows that the precision of the Riksbank's forecasts is good in comparison to that of other forecasters. Another result is that the Riksbank's inflation forecasts have appropriate properties while the real economy forecasts appear somewhat less precise. The results also show that the forecast memory generally extends one year ahead in the case of the variables studied here.

The article unfolds as follows; the data and methods that are used for analysis are described in section 2. An evaluation of the Riksbank's forecasts is presented in section 3 and these are compared with those of other forecasters in general and the Swedish National Institute of Economic Research in particular. The article is summarised in section 4.

2. Data and methods of analysis

2.1 DATA

The data used in the study is taken from assessments on quarterly observations by the Riksbank and the Swedish National Institute of Economic Research (henceforth Konjunkturinstitutet or NIER), and from the Consensus Forecasts' compilation of annual forecasts from other forecasters.

The variables studied quarterly are GDP, UND1X[3], CPI and employment, which are central factors of monetary policy analysis. Moreover, the GDP to employment ratio[4] is analysed, as well as the hypothesis that inaccurate assessments of productivity have had a bearing on the forecast errors for the above variables. Another interesting aspect that has been discussed, with regard to inflation forecast errors, is the unexpectedly low import prices. This issue is investigated by Assarsson (2007) and is, therefore, beyond the scope of this article.

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[2] A more in-depth analysis of the Riksbank's forecasts is provided by Andersson et al. (2007).

[3] UND1X is a measure of core inflation.

[4] GDP/employment is used as a proxy for productivity since the most common measure of productivity, GDP/hours worked, has only been forecast quarterly for a limited part of the study period.

GDP, UND1X and CPI are investigated for the period 2000-2006 while the other variables are studied from 2002 and onwards. The period is determined, inter alia, by the sample of published (or documented) quarterly forecasts. E.g., annual forecast may be analysed for some variables over a longer period, while quarterly forecast have been produced for a more limited time span. Also see Andersson et al. (2007) for a more detailed description and a discussion on the data and the evaluation period.

The study includes a comparison of quarterly forecasts by the Riksbank and NIER. Quarterly forecasts have been provided by NIER for GDP, UND1X, CPI and employment, which has enabled a detailed analysis to be made for these variables.[5] The data includes NIER's forecasts for GDP from 2003 and onwards, while forecasts for the other variables begin in 2001.

In the case of GDP and CPI, a comparison is made of the performance of the Riksbank's forecasts for the year as a whole with several other forecasters, more precisely those who are in Consensus Forecasts' panel. This is done on the basis of the forecasts from October 2000 through October 2006, thus much the same period as for the analysis of quarterly forecasts. The intention is to compare various agents' forecasting accuracies at times when they all have access to the same amount of information. Achieving this in practice is, however, difficult on account of the considerable differences in the timing and regularity of the forecasts. In the present analysis we have striven to minimise this problem[6].

Chart 1 shows the forecasts published by the Riksbank for UND1X, GDP and employment in the whole economy. The forecasts are expressed as annual percentage change in order to be clear to study. The chart shows that during certain episodes the forecasts (fine lines in the chart) have missed the outcome (lines with squares), but also that periodically the forecasts have met the outcome relatively well. For example, the sharp upswing in inflation in spring 2001 was not foreseen in the assessments from the previous year, while the decline in the inflation rate during 2003 was predicted to a greater extent. Another example is the recent underestimation of employment. It can be difficult to extract a complete picture of the Riksbank's forecast precision from the charts, therefore the forecasts are analysed using certain statistical methods. These methods of analysis are described in the next section.

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[5] The authors are grateful to the Swedish National Institute of Economic Research for providing their forecasts.

[6] The comparison is always made with the survey from Consensus which were published closest to the Riksbank's cut-off date and in addition, a sensitivity analysis has been made for the subsequent Consensus survey. However, it can be a disadvantage to other forecasters that the forecast which has been reported to Consensus may be slightly out-of-date. See Andersson et al. (2007) for a more detailed discussion on this.

2.2 METHODS OF ANALYSIS

The Riksbank's published forecasts constitute a set of data for which the average accuracy can be estimated. This is done using the root mean square error (RMSE), which summarises how the dispersion of forecast error and bias.[7] The mean error (ME or bias) is used to study whether there are tendencies to a systematic over- or underestimation in the forecasts. The forecast errors are consistently related to the standard deviation for the respective series during the evaluation period to provide an idea of how far into the future the forecast information content extends.[8] Galbraith and Tkacz (2006) have studied the forecast memory of some Canadian and American macro variables and found that the memory for several time series models is generally limited to the first forecast year, that is, four quarters ahead.

The forecasts are generally evaluated in the form of quarterly growth rates,[9] the main reason being that such observations do not overlap. Annual growth rates are made up of changes in the latest four quarters, which means that two consecutive quarterly-observed annual growth rates have three quarters (75 per cent) in common. This makes drawing statistical inferences much more complicated than in the case of quarterly growth rates. ME is analysed for both quarterly growth (for variables which are studied in differences) and for annual growth (which is a function of the four immediately preceding quarters), since bias in quarterly growth may be aggregated to a larger bias in annual growth.

The forecasts are evaluated against the first, preliminary outcomes for the variables which are revised, for instance, GDP. GDP figures are regularly revised and this is significant for the measured forecast errors.[10] A comparison with the first outcome is usually termed a real time evaluation.

In addition to NIER and Consensus Forecasts, the Riksbank's forecast errors are compared with those of a simple autoregressive time series model (henceforth autoregression or AR model) in order to give a furher perspective of the size of the forecast deviation.[11] Further details about the AR models are available in appendix A.1.

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7 See description in Appendix A.1.

8 Here the forecasting memory is defined as the longest horizon where the forecast error variation (measured as the root mean square error) is lower than the series' variation (standard deviation). In the case of longer horizons, the conclusion is drawn that the (statistically) best forecast is the series' steady state (or average). Thus, a reasonable forecast for the longer horizons is to let the predicted variables move towards their respective averages in a coherent manner. Andersson och Löf (2007) describe forecast memory in more detail.

9 The evaluation is done for variables that are stationary (stable in mean and variation). Non-stationary variables are evaluated in growth rates.

10 By setting up the analysis with a focus on evaluation against the first outcomes, the effects of data revision can be distinguished. The data revisions properties from first to later outcomes may be studied separately as complement to this. See Andersson et al (2007) for further discussion on real time and final outcome evaluations and a description of revisions for GDP outcomes in the evaluation period.

11 An autoregression involves specifying a model so that a variable's value today is solely dependent on the variable's earlier outcomes. The autoregression is described in Andersson & Löf (2007).

Another question of interest is whether the forecast revisions made by the Riksbank over time have been reasonable. The Government (2002) and the Swedish National Audit Office (2006) suggest that an experiment with larger revisions than those that have actually been made for the Government's forecasts indicates that the forecast precision declines on average. This is, of course, a very complex issue. For example, revisions may have been warranted given the information available on the occasions the forecasts were made, while with hindsight it may look different. However, it may still be of interest to study afterwards how the revision pattern can be characterised. To make such a description of the revisions, correlations between observed forecast errors and forecast revisions are analysed here, (see Appendix A.2 for further information about this).

3. Forecasting performance

This section analyses the Riksbank's average forecasting performance in the period 2000 – 2006. The forecast performance is compared with NIER, Consensus Forecasts' panel and the autoregression.[12] Unlike the other forecasts, in the greater part of the evaluation period the Riksbank's predictions were based on the assumption of an unchanged policy rate in the forecast period. However, the assumption of a constant policy rate did produce relatively accurate policy rate forecasts in this period (although this was not the main purpose of the assumption). The accuracy of the policy rate forecasts is presented in Table 1, which shows that the constant-rate forecast was more accurate than the autoregressive for all horizons and that the predictability memory extends six quarter into the future.

3.1 INFLATION

Chart 2 shows that the Riksbank's forecasts for the average annual rate of increase in CPI in almost 75 per cent of the forecast occasions are more exact than half of the forecasters in the Consensus data.[13] A comparison of quarterly UND1X forecasts indicates that all in all the Riksbank has made slightly more accurate forecasts than NIER, see Table 1 which shows calculated RMSE. The differences vary somewhat for different forecast horizons (for example, the Riksbank's forecasts for annual growth in UND1X are nine per cent better than NIER's for the first forecast quarter, see figure 1.09 in Table 1) but on the whole they are small

[12] A more detailed analysis of the Riksbank's forecast accuracy is provided by Andersson et al. (2007).
[13] A more in-depth comparison between the Riksbank's, NIER's and Consensus's forecasts is given in Andersson et al. (2007).

and never statistically significant.[14] With regard to properties for quarterly forecasts, UND1X is mainly commented on here, but the tendencies for CPI are largely similar to those for UND1X (see Tables 1 and 2).

Compared with the AR model's forecasts, the Riksbank's RMSE forecasts for UND1X are consistently lower. For every horizon studied, the Riksbank's RMSE is smaller than the series' standard deviation for the evaluation period, which may possibly indicate a relatively strong forecasting capacity.[15] It is worth noting that the AR model is at something of a disadvantage in the comparison because it is ignorant of known monthly outcomes in the first quarter.[16]

Table 2 shows estimated mean error (ME or bias) for the Riksbank's forecasts. Bias in annual rate of increase for the horizons four and eight is also shown in Table 2. For every variable and forecast horizon, the hypothesis of no systematic forecast errors is tested, i.e., that the bias is zero.[17] For UND1X the estimates show a relatively small, and insignificant, bias for forecasts up to one year ahead. The bias is still insignificant in the case of longer forecasts, but the forecasts have, on average, been somewhat higher than the outcomes. Aggregated to annual percentage change, inflation has been overestimated by two tenths of a percentage point two years ahead. The bias for CPI two years ahead amounts to -0.6, the outcome has, on average, been lower than the forecasts, which is not negligible. However, these estimates for UND1X and CPI do not differ statistically from zero.

A review of the revisions made for UND1X show that forecast errors elicit distinct reactions; see Table 3 which shows the correlation between observed forecast errors and revisions. It is possible, however, that the Riksbank should have reacted less to the forecast error (for the four quarters ahead) and the revision actually made is correlated to 44 per cent with a hypothetical revision that would have eliminated forecast error. For the longer (eight quarter) horizon, the correlation between the Riksbank's revisions and the hypothetical revisions is just over 40 per cent. According to the correlations, it is possible that the Riksbank's revisions have, in general, been reasonable, given the limitations of the analysis (see section 2.2 above).

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[14] RMSE measures the average forecast precision for survey period. In addition to RMSE, the variation in the square error can also be calculated. If the variation is large, this suggests that the estimation of RMSE is uncertain and that small deviations between the Riksbank's and NIER's forecast predictability, for example, are not statistically significant. This can be interpreted as the forecasters' precision is expected to be similar in a repeat study (for example in several years).

[15] However, the seasonal deterministic component in UND1X makes the interpretation of the forecast memory difficult. This is discussed further in Andersson et al. (2007).

[16] One or two montly outcomes are often known for the first forecast quarter. The number of known price outcomes in the current quarter varies somewhat but in an average forecast occasion approximately 45 per cent of the outcomes for the first forecast quarter been available during the evaluation period (see discussion in Andersson et al. (2007)).

[17] The period studied is here regarded as a realisation from the Riksbank's forecast process.

3.2 GDP

The Riksbank's GDP forecasts have often been among the better ones compared to the other participants in the Consensus panel, see Chart 2. For example, on about half of the occasions, the Riksbank has made more precise forecasts than 80 per cent of the other forecasters, which is more often than NIER and the average for the other analysts.[18]

Compared with NIER's quarterly GDP forecasts, the Riksbank's have been marginally more accurate, see RMSE comparison in Table 1. As with UND1X, there are, however, no statistically significant differences in the forecast precision. In a comparison with the AR model, the Riksbank's forecast error for GDP is somewhat higher for the horizon one step ahead, somewhat lower two to four quarters ahead and then the forecast error is relatively similar. The forecast error gradually approaches the serie's standard deviation in the evaluation period and in the horizon five quarters ahead RMSE exceeds the standard deviation. This can be taken to mean that the Riksbank's GDP forecasts have a memory of four steps. The reason the forecast error decreases somewhat for longer horizons can be that the estimations are based on fewer observations, rather than precision actually increasing (see appendix A.1 for further discussion about this).

ME estimations for GDP also display a similar picture to UND1X, that is, the bias increases the longer the forecast horizon. According to the test, no estimations differ significantly from zero, even if the estimated mean error for annual percentage change two years ahead shows that GDP has been overestimated by some four tenths, on average, which is not negligible.

The Government (2002) and the Swedish National Audit Office (2006) indicate that the revisions of GDP made in the government forecasts have been acceptable, on average. For the Riksbank's forecasts four quarters ahead there is a strong correlation between observed forecast errors, initially, and the revision that was made, see Table 3. The Riksbank's revision pattern seems reasonable at this horizon in that the correlation between observed forecast errors and the hypothetical revision that would have given a zero forecast error is 68 per cent. For the eight quarter horizon the correlation between observed forecast errors and revisions to the forecasts is considerably weaker, which is understandable since the revision that would have been required for a zero forecast error is virtually independent of observed forecast errors. The Riksbank's revision pattern is studied in more detail by Andersson et al. (2007).

[18] As with the CPI, Andersson et al. (2007) presents more evaluation results from the Consensus Forecasts´data.

3.3 EMPLOYMENT

Predictions for the number of employed are not included in the data from Consensus Forecasts, thus, the Riksbank is only compared with the NIER and an autoregression in this case. The employment forecasts are evaluated in real time since there is some revision of outcome data. Table 1 shows that NIER's assessments have been more accurate than the Riksbank's for horizons up to one year ahead, while the reverse is true for forecasts two years ahead.

In the Riksbank's employment forecasts, there is no statistically significant bias, either in quarterly or annual growth. However, the point estimates of ME are somewhat larger for the first forecast year than for the second and the Riksbank's forecasts for employment generally have a somewhat lower forecast error than the AR model. RMSE for the employment forecasts is less than the standard deviation for all horizons studied, which implies that the memory extends eight quarters ahead. However, this should be interpreted with some caution since RMSE is very close to the standard deviation in the second forecast year (that is, 5-8 quarters ahead).

The revision properties of the employment forecasts are generally poorer than those of the GDP and UND1X forecasts, particularly for the longest horizon (Table 3). A positive forecast error leads to an upward revision of the forecasts four quarters ahead, while the forecast eight quarters ahead is, on average, left unchanged. The correlation between the revisions made by the Riksbank and the adjustments that would have eliminated forecast error is considerably weaker than in the case of GDP and UND1X.

3.4 GDP/EMPLOYMENT

Productivity is one of the central variables in the Riksbank's monetary policy analysis and it is, therefore, of particular interest to evaluate the forecasting performance. Furthermore, it is conceivable that the Riksbank's forecast errors for productivity have had implications for forecast deviations on other central variables, which may be worth studying closer.

In practical work, productivity is mostly measured as so-called labour productivity, calculated as GDP divided by hours worked. Since quarterly forecasts for hours worked have not been made sufficiently far back in time, this precludes a meaningful study of labour productivity as defined above. Therefore, a related but less conceptually suitable measure, namely the ratio of GDP to employment, is used instead. It is possible to find support so that a forecast evaluation of the ratio GDP to employ-

ment should be able to be used as an approximation of the properties in the productivity predictions (see Andersson et al. (2007) for a discussion about this). Analyses based on GDP/employment can only be done from 2002 onwards because quarterly employment forecasts were not produced earlier. As in the case of the separate analyses of GDP and employment, the evaluation of the ratio between them is done in real time.

The forecasts contain some positive bias at most horizons (see Table 2), i.e., the Riksbank has underestimated the productivity growth. Measured as the percentage annual change, this bias is relatively large, 0.68, for forecasts two years ahead.[19] However, the bias is not statistically significant. The AR model is generally somewhat more accurate than the Riksbank's forecasts in this period.

If the Riksbank's forecast errors for labour productivity affected other forecast deviations, this should be reflected in the correlations between the forecast errors for the different variables. One expected result is a negative correlation between GDP/employment and UND1X. This is in fact one of the detected correlations, see Table 4. Thus there are indications that the underestimation of GDP/employment entailed an overestimation of UND1X. There is, moreover, a negative correlation between the forecast errors for GDP and UND1X, which are under- and overestimated respectively. This is also congruent with effects of an unexpected development of productivity (i.e., productivity shocks).

4. Summary

All in all, the study shows that the Riksbank's forecasts perform satisfactorily compared with both those of other forecasters and with simple AR models. In particular, the Riksbank's same-year GDP forecasts are often among the most accurate. The same applies to CPI inflation, though in this case the difference compared with NIER and the Consensus panel is smaller.

Compared with NIER's, the Riksbank's quarterly forecasts also perform well. Their average forecast errors are somewhat smaller than NIER's for a majority of the variables but the differences are generally very slight and not statistically significant.

The Riksbank's inflation forecasts (CPI and UND1X) also have a forecast potential up to and (possibly) including the second year. Forecast memory for GDP extends about four quarters ahead. The forecasts show no significant signs of systematic errors, although CPI inflation has been overestimated by an average of six tenths in a two-year horizon. The

[19] GDP/employment evaluation covers the period 2002-2006. For that particular sample GDP and employment also exhibit positive bias.

overestimation of UND1X inflation two years ahead is considerably lower (around two tenths). The employment forecasts have forecast memory that is probably limited to the first year. In other respects their properties broadly resemble those of the GDP forecasts, that is, no clear signs of systematic misjudgement.

Although the revisions to the Riksbank's forecasts for GDP, UND1X and employment seem to have been too little, too late in some periods, the study finds no clear indications that a different, more aggressive revision pattern would have resulted in forecasts that, on average, were more accurate.

The development of labour productivity in the evaluation period was more favourable than had been predicted. The analysis of the approximate indicator of this, GDP/employment, shows a relatively weak forecasting performance that is partly connected with a systematic underestimation of the rate of increase. There are also signs that the Riksbank's misjudgements of productivity have played a part in the co-variation of the forecast errors for GDP and inflation.

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Appendix

A.1 AVERAGE FORECASTING PERFORMANCE

For the collection of Riksbank forecasts, the average accuracy can be estimated. The engaged measure of accuracy is the root mean squared error (RMSE), which summarises the dispersion of forecast errors and any average deviation.[20] The lower estimated RMSE is, the better the forecasting performance. For a forecasting method that is invariably accurate, RMSE is zero. The mean error (ME) is also studied. RMSE is used to measure the average size of forecast errors, while ME is used to study when the forecasts contain bias, that is, a systematic over- or underestimation.[21] To assess forecast memory, the forecast errors are related to the respective series' standard deviation in the evaluation period.[22]

The starting point as regards the AR models used in the evaluation has been two different variants; a so-called AR(1), with just the value for the preceding period (first lag) as the explanatory variable, and a second variant with the number of lags based on a model choice procedure.[23] The most accurate of the AR variants is chosen as a benchmark. The models are estimated on data from 1993 up to the latest observation that was available for the forecast in question. As the results suggest that in most cases the AR(1) specification performs somewhat better, it is mostly this which has been used as a benchmark[24].

It may be worth noting that the number of observations for an evaluation generally decreases with the length of the forecast horizon. The present database with the Riksbank's quarterly forecasts, for example, contain 27 one-quarter forecasts for GDP but only 18 ten-quarter forecasts. If the average forecast error seems to be remarkable for longer horizons, it is therefore important to be aware that this may be at least partly due to the sample's diminishing size. There are, for instance, some cases where forecast accuracy seems to improve appreciably at the longest horizons which should thus be interpreted with caution. To make this less of a problem, the present study focuses on forecasts that stop at eight quarters ahead. One problem (in a limited sample) that remains is that (possible) outcomes which are hard to predict at the start of an evaluation sample do not affect RMSE estimates in the longer horizons.

---

20 $RMSE(h) = \sqrt{\sum_{t=\tau_1}^{\tau_2} \left(y_{t+h} - y_{t+h}^{pred} \right)^2 / (\tau_2 - \tau_1 + 1)}$, where y_{t+h} is the outcome at time t+h and y_{t+h}^{pred} is the forecast at time t+h and h is the forecast horizon.

21 $MSE(h) = Bias^2(h) + pf \text{ var}(h)$, where pf var is the forecast error variance.

22 See Andersson & Löf (2007) for a detailed review of the forecast memory concept.

23 The procedure for the choice of lags (the information criterion) that is used here is BIC, (see Schwartz, 1978). BIC selects a specification on the basis of available data and a statistical criterion. In retrospect the selected model may, of course, turn out not to be the best in terms of average forecast accuracy.

24 The exceptions are UND1X and CPI where an AR(1) with seasonal dummies is used, since this functions better than both a common AR (1) and that which is generated by lag choice procedure.

For example, the unexpectedly high UND1X outcomes in 2001 do not affect the estimated precision in the longest horizons, and the estimated RMSE can, therefore, be lower for longer horizons.

A.2 REVISION PATTERNS

Economic forecasts are constructed from interpretations of data that are currently available, together with the forecaster's appraisal of the economic situation. The results in this article are an illustration of macroeconomic forecasts' considerable uncertainty. The forecasts are revised because forecast errors are observed when new outcomes become available. Revisions can, of course, be made for other reasons, too, such as new indicator statistics or a macroeconomic reassessment. These other reasons have been presented in the Inflation Reports but are normally very difficult to quantify and, accordingly, to analyse too. Of course, this sets certain limits on how informative a forecast revision analysis can be.

The Riksbank's average revision pattern is here characterised in terms of the correlation between the most recent observed forecast error for a variable and the revision that was actually made to the four- and eight-step forecasts. This correlation shows how old forecast errors coincided with the Riksbank's revisions but does not say anything about how well registered forecast errors were utilised. The correlation between the Riksbank's actual revisions and the hypothetical revisions that would have eliminated forecast error is also calculated.[25]

[25] The revision that eliminates forecast error is, of course, not feasible in practice. It is used here simply as a reference point to put the actual revisions into perspective.

Tables and Charts

Table 1: RMSE for quarterly forecasts 2000-2006, variables expressed as quarterly or annual per cent growth

			Forecast horizon (quarter)							
Variable	FC		1	2	3	4	5	6	7	8
Policy rate	RB		0.06	0.27	0.45	0.60	0.66	0.80	0.98	1.10
	NIER		2.17	0.80	0.70	0.78	1.06	1.12	1.17	1.31
	AR		4.24	1.68	1.38	1.25	1.23	1.13	1.08	1.04
	StD		0.95							
UND1X	RB		0.14	0.40	0.38	0.40	0.42	0.44	0.33	0.33
(quarterly rate)	AR		2.95	1.05	1.11	1.07	1.07	1.06	1.28	1.32
	StD		0.58							
	StD	SA	0.38							
UND1X	RB		0.10	0.49	0.54	0.50	0.47	0.53	0.62	0.76
(annual rate)	NIER		1.09	0.84	1.05	1.26	1.43	1.11	1.00	0.90
	StD		0.80							
CPI	RB		0.10	0.38	0.37	0.41	0.45	0.51	0.41	0.41
(quarterly rate)	AR		4.37	1.17	1.13	1.05	1.04	0.93	0.97	1.04
	StD		0.53							
CPI	RB		0.11	0.46	0.51	0.53	0.67	0.87	1.05	1.19
(annual rate)	NIER		0.73	0.91	1.09	1.18	1.11	1.03	1.01	1.04
	StD		0.90							
GDP	RB		0.30	0.31	0.28	0.28	0.36	0.37	0.34	0.31
	NIER		0.99	1.06	0.98	1.09	1.01	1.06	1.33	1.22
	AR		0.75	1.05	1.29	1.32	0.98	0.92	1.02	1.07
	StD		0.35							
Employm.	RB		0.35	0.32	0.36	0.36	0.38	0.40	0.38	0.37
	NIER		0.94	1.03	0.87	0.97	1.00	1.04	1.09	1.09
	AR		0.95	1.14	1.07	1.13	1.09	1.05	1.13	1.15
	StD		0.41							
GDP/employm.	RB		0.41	0.49	0.40	0.49	0.43	0.45	0.37	0.42
	AR		0.88	0.71	0.86	0.88	0.96	0.91	1.06	0.97
	StD		0.50							

Note. The table shows the forecast precision 1 to 8 steps into the future for the following forecasters (FC): the Riksbank (RB), the Swedish National Institute of Economic Research (NIER) and an autoregression (AR). For RB, RMSE is reported and for NIER and AR the ratio RMSE/RMSE(RB) is reported. A ratio greater than one indicates that RB's forecasts have been more precise (had lower estimated RMSE) and a ratio less than one shows that the Riksbank's forecasts have lower precision. StD is respective variables' standard deviation in the evaluation period. In the case of UND1X, seasonally adjusted standard deviation is shown for quarterly growth. Annual percentage change is used in a comparison with NIER's UND1X and CPI forecasts. GDP/employment is a transformation of other variables and is not reported for NIER.

Table 2: Estimated bias (ME) for quarterly forecasts 2000-2006, variables expressed as quarterly and annual per cent growth

		Forecast horizon (quarter)							
Variable		1	2	3	4	5	6	7	8
UND1X	Qu	-0.02	005	0.05	0.01	0.00	-0.04	-0.11	-0.12
	An				0.26				-0.19
CPI	Qu	0.04	0.04	0.00	-0.04	-0.05	-0.12	-0.19	-0.20
	An				0.06				-0.60
GDP	Qu	0.03	0.07	-0.09	-0.06	-0.13	-0.14	-0.09	-0.06
	An				-0.05				-0.37
Employm.	Qu	0.06	0.07	0.01	-0.05	-0.03	0.04	0.00	0.03
	An				0.27				0.20
GDP/employm.	Qu	0.05	-0.14	0.05	0.05	0.06	0.00	0.06	0.24
	An				0.12				0.68

Note. The table shows estimated bias (ME) for the Riksbank's forecasts. Qu indicates quarterly growth and An annual growth of the variable studied. Test of zero bias is adjusted for overlapping information. Employment and GDP/employment computations are based on data for the period 2002-2006.

Table 3. Revision correlations

Correlations between		Correlation (horizon) 4	8
GDP			
Obs FE	Revision	0.80	0.11
Rev (FE=0)	Revision	0.68	0.34
UND1X			
Obs FE	Revision	0.60	0.11
Rev. (FE.=0)	Revision	0.44	0.42
Employment			
Obs FE	Revision	0.39	-0.02
Rev. (FE.=0)	Revision	0.55	0.15

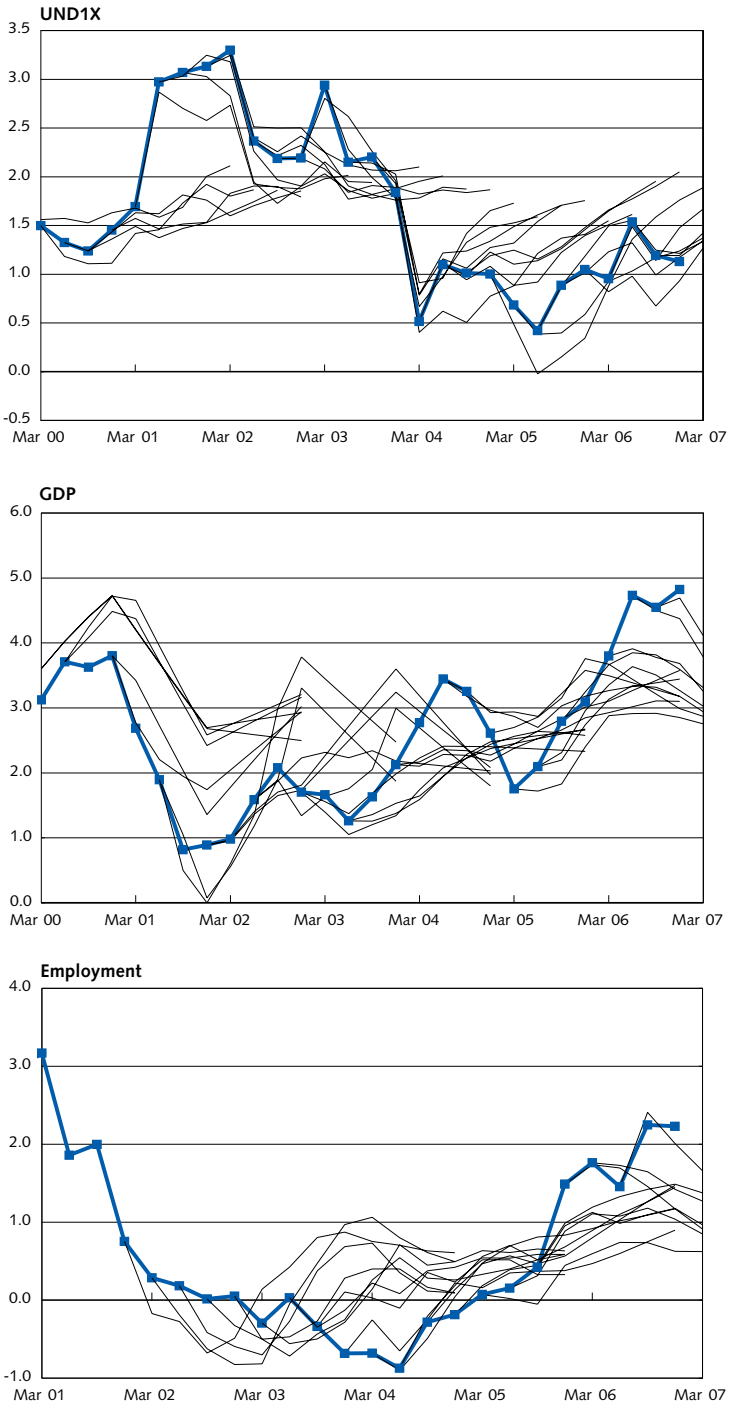
Note. The table shows estimated correlations between observed forecast errors (Obs FE.) and the Riksbank's revisions to forecasts (Revision), and the correlation between the Riksbank's (Revision) and the hypothetical revisions that would have eliminated forecast error (Rev (FE. =0)).

Table 4. Forecast error correlations

Forecast errors for		Horizon	Sign	Signif. level (%)
GDP	UND1X	2	-	5
GDP	Employment	1	-	5
		4	-	10
Employment	UND1X	1	+	10
		5	-	10
UND1X	GDP/Employm.	8	-	10
GDP	GDP/Employm.	2-5	+	1 to 5
Employment	GDP/Employm.	3	-	5

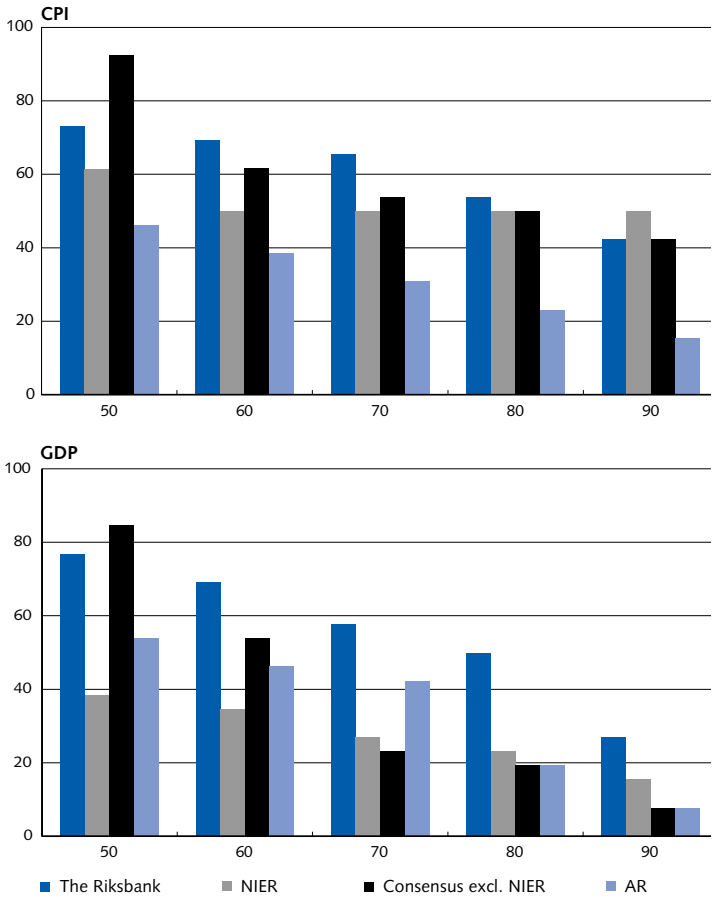
Note. The table shows the direction of correlations (Sign) between forecast errors for different variables. Signif. level denotes the (lowest) level of significance at which the zero correlation hypothesis is rejected.

Chart 1. GDP, UND1X and Employment: outcome and forecasts since 2000
Annual percentage change



Note. Lines with squares are outcomes. The other lines show the Riksbank's forecasts from the respective reporting occasions. Outcomes for GDP and UND1X are composed from the first version of data for each quarter (real time outcomes).

Chart 2. Ranking CPI and GDP, current year
Per cent



Note. The Y-axis shows how large a percentage of times analysts have been better than the percentage of analysts as illustrated in the X-axis. In order to see how large a proportion of times the Riksbank has been better than 50 per cent of other analysts, see 50 is on the X-axis, then study the blue column on the Y-axis. Here specifically, in barely

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