

## An assessment of the Riksbank's international forecasts

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### The Riksbank's forecasts for the foreign economy play a central role for its domestic forecasts

Sweden is a small, open economy and is thus highly affected by international developments. Consequently, when the Riksbank prepares an economic forecast, it starts by making an assessment of the economic activity and inflation abroad, with a particular focus on developments in Europe and the United States. The correlations between Swedish and foreign (KIX-weighted) GDP growth, inflation and policy rate since the 1980s are all above 0.8. This indicates that a very large part of the variation in economic activity in Sweden comes from abroad (see Figure 1).

The Riksbank's international forecasts are thus of central importance for the assessment of future economic developments in Sweden. A large error in the forecasts of the foreign variables can easily be mirrored by forecast errors for the domestic variables. It is therefore essential for the international analyses to be as reliable and accurate as possible.

In this commentary, we evaluate the Riksbank's forecasts for the foreign economy over the period 2007-2015. The variables analysed are GDP growth, inflation and policy rates.<sup>2</sup> The assessment suggest that, while foreign GDP growth and policy rates has, on average, been overestimated, there has been a tendency to underestimate foreign inflation. However, this underestimation has been fairly small. Overall, the forecasts are relatively accurate in the short term (a few quarters ahead) but deteriorate over the longer horizons. Furthermore, the accuracy of the Riksbank's foreign forecasts has improved since the global financial crisis. A comparison with other analysts shows that the Riksbank's projection performance of the foreign variables compares reasonably well with that of other institutions. Finally we analyse how important errors in the foreign forecasts are for the forecasting accuracy of the domestic variables. The analysis indicates that the accuracy of the forecasts for Swedish GDP growth, inflation and the policy rate could, on average, have been improved by around 50 per cent if there had been no errors in the forecasts of the foreign economy.

Towards the end of 2012, the Riksbank changed the method it uses for weighing developments abroad to take account of the importance various countries have for the Swedish economy. Previously, what are known as TCW weights, which were based on trade flows over the years 1989-1991, were mainly used to allocate weights to different countries. At the end of 2012, the Riksbank went over from TCW weights to KIX weights. KIX includes more countries than TCW and the weights are updated annually. One of the advantages of the KIX index is that it better captures the increasing importance of emerging market economies for the Swedish economy.<sup>3</sup> The

1. We would like to thank Mikael Apel, Hanna Armelius, Charlotta Edler, Mattias Erlandsson, Gabriela Guibourg, Stefan Ingves, Jens Iversen, Christian Nilsson, Christina Nyman, Marianne Sterner, Ingvar Strid, Ulf Söderström and Anders Vredin for their comments.

2. Outcomes extend up to the end of the first quarter of 2015 for GDP and up to the end of the second quarter for inflation and policy rates.

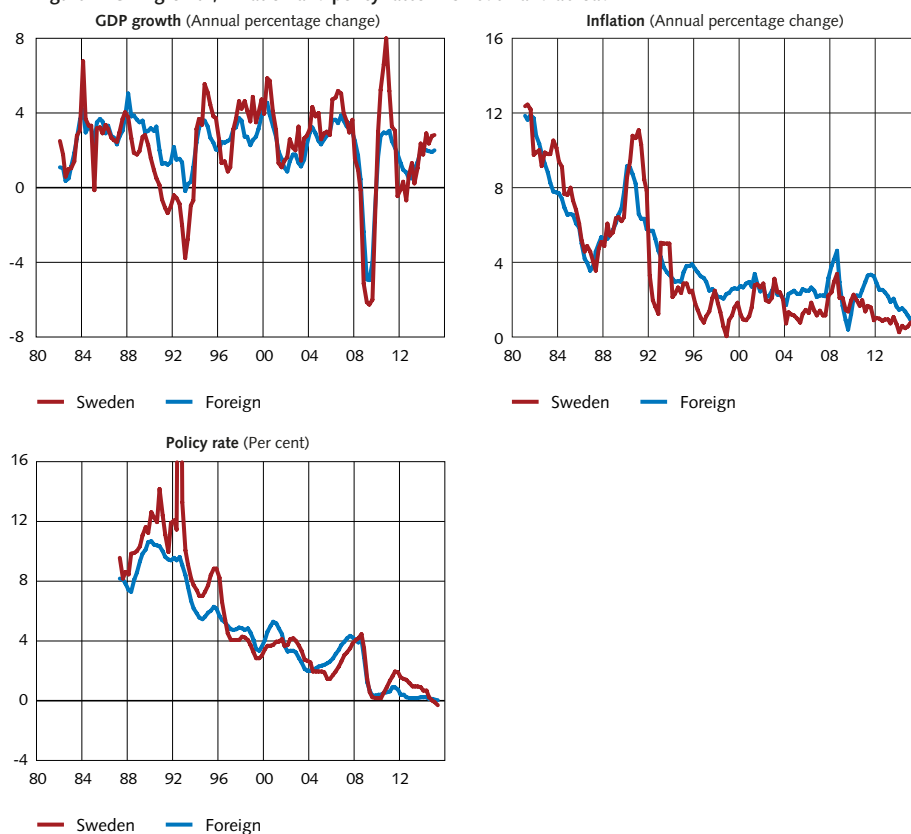
3. See the article "KIX index better reflects Sweden's international dependence" in Monetary Policy Report, October 2012, Sveriges Riksbank.

In this commentary, we evaluate the Riksbank's forecasts for foreign GDP growth, inflation and policy rates over the period 2007-2015. On average, the Riksbank has tended to overestimate foreign GDP growth and policy rates and to underestimate foreign inflation. However, this underestimation has been fairly small. The forecasts are relatively accurate in the short term (a few quarters ahead) but deteriorate over the longer horizons. A comparison with other analysts shows that the Riksbank's ability to forecast the foreign economy is close to average.

A preliminary analysis indicates that the accuracy of the forecasts for Swedish GDP growth, inflation and the policy rate could, on average, have been improved by around 50 per cent if there had been no errors in the forecasts of the foreign economy. The actual magnitude of the improvement, however, depends on how much the Riksbank has taken the rest of the world into account when conducting its domestic forecasts.

transition means that forecasts made before 2013 refer to TCW-weighted countries and those since 2013 refer to KIX-weighted countries. The analysis below therefore evaluates the forecasts against TCW- and KIX-weighted outcomes respectively.

Figure 1. GDP growth, inflation and policy rates in Sweden and abroad



Note. Foreign refers to KIX-weighted development. The KIX is an aggregate of the countries that are important to Sweden's international transactions. However, foreign policy rates means relative KIX weighting of the United States, the euro area, Norway and the United Kingdom alone. When calculating KIX-weighted inflation, the HICP is used for the euro area and the CPI for other countries. For inflation in Sweden, the CPIF is used. The figure showing policy rates has been cut off to make it easier to get an overview. The policy rate in Sweden was, on average, just over 41 per cent in the third quarter of 1992.  
Sources: National sources, Statistics Sweden and the Riksbank

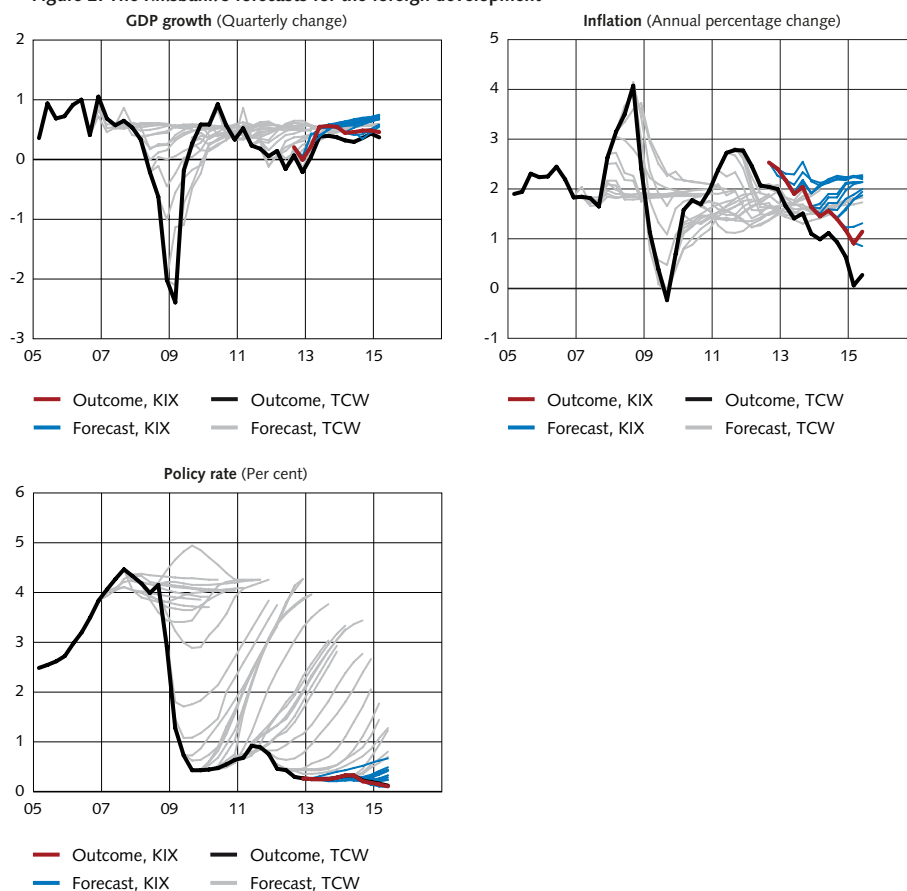
## The Riksbank has tended to overestimate foreign GDP growth and policy rates and to underestimate foreign inflation

In conjunction with the outbreak of the financial crisis in 2008, GDP and inflation fell heavily, at the same time central banks around the world rapidly cut their policy rates to record low levels. In many countries, the recovery after the crisis has been characterised by continued low GDP growth and large fluctuations in inflation. After the financial crisis, central banks have tried to hold inflation, GDP growth and employment up by holding policy rates at record low levels and have, in certain cases, cut policy rates even further. Several central banks have also supplemented their interest rate policies with various unconventional measures. The period since 2007 is thus exceptional, which has led to forecast errors being unusually large during this period.

On average, since 2007, the Riksbank has overestimated foreign GDP growth, particularly in periods of recession or slow growth. Foreign policy rates have also been overestimated over large parts of the period. At the same time, foreign inflation has, on average, been underestimated. Figure 2 shows the forecasts the Riksbank has published for foreign GDP growth, inflation and policy rates 1-12 quarters ahead, together with respective outcomes. The forecasts have occasionally been accurate and close to outcome, but have also, on other occasions, been somewhat inaccurate. It is often particularly difficult to make forecasts in an economic turnaround. One recurring pattern for forecasts is to overestimate outcomes during downturns and

to underestimate outcomes during upturns. For example, the Riksbank, like other forecasters, found it difficult to predict the depth and duration of the recession following the global financial crisis, as well as the strength of the recovery.

Figure 2. The Riksbank's forecasts for the foreign development



Note. Foreign GDP growth, inflation and policy rates are TCW-weighted for forecasts up until 2012 and KIX-weighted from 2013 onwards. Outcomes extend up to the end of the first quarter of 2015 for GDP and up to the end of the second quarter for inflation and policy rates. Sources: National sources and the Riksbank

In order to provide a more complete view of the Riksbank's forecast errors, we analyse the forecasts using statistical measures. Mean error (bias) and the root mean square error (RMSE) are two useful measures for evaluating forecasts. The mean error shows whether there are tendencies towards systematic over- or underestimation (bias) in the forecasts. A small mean error indicates that the systematic over- or underestimation is small (smaller bias), which is to say that the forecasts are more in line with expected values. However, large over- and underestimates can offset each other and generate a small mean error. Consequently, the mean error cannot be used to assess forecasting accuracy. Measures such as the RMSE (alternative mean absolute error), which indicates how great average accuracy is, are instead used for this purpose.

To assess whether the average accuracy is good or poor, RMSE can be related to the forecast variable's own standard deviation over the evaluation period. The size of the standard deviation gives an indication of how volatile a variable is. Reasonably, a variable with high volatility is more difficult to forecast, so it can thus be expected to have less accuracy (higher RMSE) than a variable with low volatility. The standard deviation thereby functions as a benchmark for the RMSE: if the RMSE exceeds the standard deviation, this means that the variable's own mean value is a better forecast.<sup>4</sup> In this analysis, 'forecast memory' is defined as the longest forecast horizon in which the RMSE is lower than the series' own standard deviation.

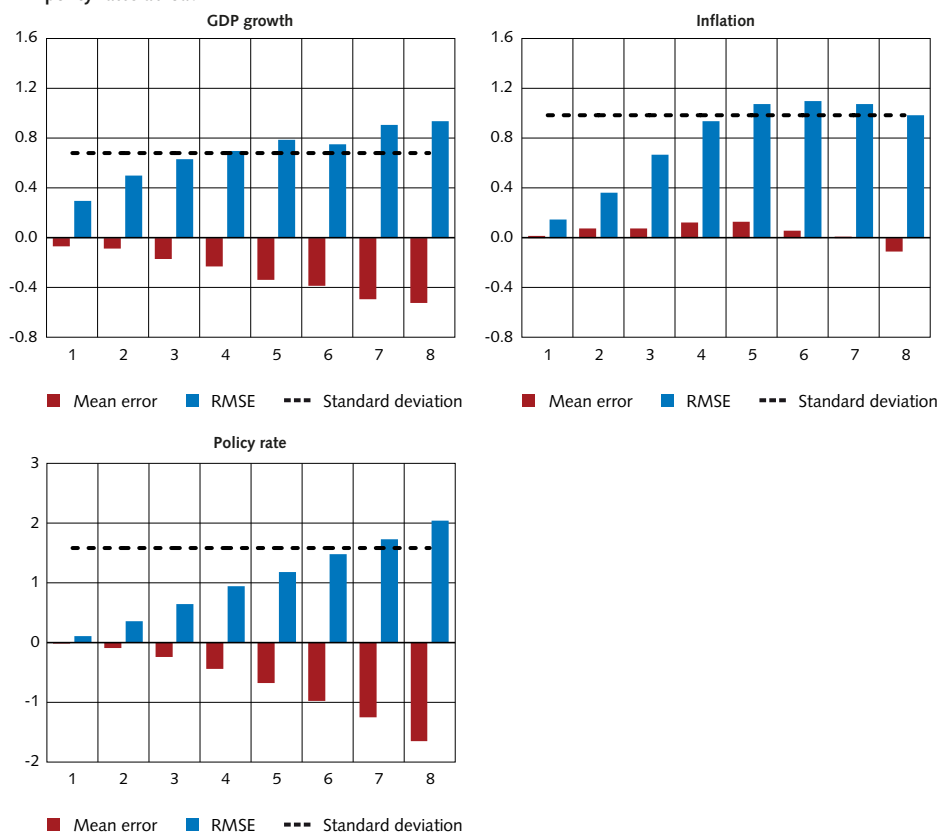
4. This formally applies to an ex-post analysis as the variable's mean value first becomes known ex-post.

## The Riksbank's accuracy is relatively good over the shortest horizons

Figure 3 presents the forecasts' mean errors and RMSE 1-8 quarters ahead, as well as the variable's own standard deviation over the evaluation period. As has already been observed in Figure 2, the Riksbank has, on average, overestimated foreign GDP growth (negative bias).<sup>5</sup> The mean error 8 quarters ahead reaches almost  $-0.6$  percentage points. At the same time, the Riksbank has, on average, underestimated foreign inflation. However, the mean errors for inflation are small over all horizons and reach 0.1 percentage points at most. Over the longest horizon (quarter 8), the bias has shifted sign and become negative, which indicates that the Riksbank's forecasts 8 quarters ahead have tended to overestimate outcomes. However, this result is driven by the large variation in outcomes over the evaluation period. The period around the outbreak of the financial crisis has a particularly great impact, when inflation abroad fell by more than 4.3 percentage points; from a peak of 4.1 per cent in the third quarter of 2008 to a trough of  $-0.2$  per cent during the corresponding quarter of 2009 (see Figure 2).

On average, the Riksbank has overestimated policy rates abroad over the evaluation period. The large policy rate cuts introduced in conjunction with the financial crisis at the end of 2008 resulted in large forecast errors and negative bias. But also the period after the immediate crisis was characterised by large forecast errors, when the Riksbank failed to predict that the international level of interest rates would remain very low for several years.

Figure 3. Mean error and RMSE (1-8 quarters ahead) in the Riksbank's forecasts of GDP growth, inflation and policy rates abroad



Note. Forecast errors are calculated as outcome minus forecast in percentage points. A negative forecast error thus indicates overestimation of the outcome. The standard deviation refers to TCW-weighted countries over the evaluation period. The difference between the standard deviations in TCW and KIX is marginal and does not alter the picture.  
Source: The Riksbank

Forecasting precision, measured in terms of the RMSE, shows that the Riksbank's accuracy is good over the shortest horizons but that it then deteriorates. However,

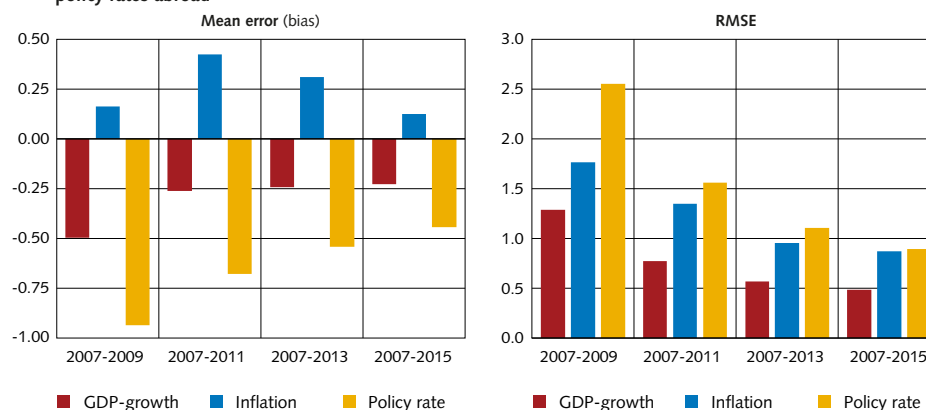
5. Forecast errors are calculated as outcome minus forecast in percentage points. A negative forecast error thus indicates overestimation of the outcome.

the so-called forecast memory, which is to say the number of quarters in which the forecasts provide a better prediction than the variable's own mean value, is limited. It stretches 2 quarters ahead for GDP growth, 3 quarters ahead for inflation and 5 quarters ahead for the policy rate. In particular, the Riksbank's forecasts for inflation and policy rates abroad demonstrate good precision in the short term in relation to the volatility in the series.

### Forecasting precision has improved since the global financial crisis

Forecast errors increased heavily following the global financial crisis as the Riksbank, like many others, failed to foresee that the financial crisis would bring about such a dramatic economic downturn and that inflation and policy rates would fall so rapidly. However, since then, both the bias and the accuracy of the Riksbank's forecasts for the foreign economy have tended to improve (see Figure 4). Figure 4 shows the development of the mean errors and RMSEs in the 4 quarters ahead projections for foreign GDP growth, inflation and policy rate since 2007. It clearly shows that accuracy, measured in terms of both the mean error and the RMSE, has improved for all variables. The development of the mean error for the inflation forecasts looks, however, somewhat different. The bias increased substantially between 2009 and 2011 before receding. The small size of the mean error for foreign inflation until the end of 2009 is due to previous years' average underestimates being counteracted by large overestimates in 2009.

Figure 4. Mean error and RMSE (4 quarters ahead) in the Riksbank's forecasts of GDP growth, inflation and policy rates abroad



Note. Forecast errors are calculated as outcome minus forecast in percentage points. A negative forecast error thus indicates overestimation of the outcome. The root mean square error (RMSE) is a common statistical measure used to describe and compare the precision of forecasts. The lower this value is, the more accurate the forecasts are.  
Source: The Riksbank

### Comparison with other forecasters

As the economy is constantly affected by different events that are difficult to foresee, the accuracy of the forecasts will vary. Above, forecast precision was related to the variable's own standard deviation with the aim of evaluating the accuracy of the Riksbank's forecasts for the foreign economy. However, a large forecast error may be due to a shock that could not have been foreseen. It is therefore necessary to complement the forecast evaluation above with, for example, a comparison of other analysts' forecasts. Such a comparison indicates whether the Riksbank's forecasts have an acceptable level of accuracy and whether it would have been possible to systematically make better assessments than those made by the Riksbank.

The problem with these comparisons is that the forecasters publish their forecasts at different points in time and thus do not usually base their forecasts on the same amount of information. A forecaster publishing its forecasts after all the others can base its forecasts on a larger amount of information and can be expected to have better accuracy. It is therefore not entirely fair to directly compare forecast errors. Thus, account must be taken to the differences in the amount of available information at each forecasting occasion. The Riksbank has worked out a statistical method that adjusts the mean absolute errors for these differences and can be used to make a

fairer comparison of different forecasters.<sup>6</sup> This commentary uses such adjusted mean absolute errors in the comparison of forecasts.

Few other analysts forecast KIX-weighted developments abroad as the Riksbank does. However, a larger number of analysts publish forecasts for the development of the euro area and United States. Consequently, a KIX-2 index, consisting of just the euro area and United States, was created to evaluate a comparable measure of GDP growth and inflation abroad.<sup>7</sup> The KIX weights vary over the years, but the euro area's weight lies at about 49 per cent and the United States' weight at around 9 per cent.<sup>8</sup> The KIX-2 index thus captures almost 60 per cent of the broader KIX index that the Riksbank usually uses.<sup>9</sup> In addition, the forecasting ability for GDP growth and inflation in the euro area and United States are compared separately. The forecast comparison refers to full-year forecasts conducted up to two years ahead of the realised outcome, measured as an annual average of the annual percentage change, for the period 2007-2014. The comparison covers twelve forecasting institutions for GDP growth and eight forecasting institutions for inflation. The full-year forecasts are evaluated against the first available outcomes.

### **The Riksbank's ability to make forecasts for the foreign economy lies close to average**

The comparison of the forecasting ability shows that there are certain differences in accuracy between the different institutions (see Figure 5). However, these differences are relatively small and few differences are statistically significant.<sup>10</sup> Figure 5 shows the estimated forecasting ability, adjusted mean absolute errors, over the period 2007-2014 for GDP growth and inflation abroad expressed in KIX-2 terms. This ability is reported as a relative deviation centred around the overall mean absolute error of all institutions, where a lower value indicates better forecasting ability. The result shows that the Riksbank's accuracy, for both GDP growth and inflation, is close to the average ability for all analysts. It is also worth noting that the IMF and OECD, who can be considered to be the largest forecasting institutions with the most resources for international forecasting, are also placed close to the average, which is to say that they do not have better accuracy than the Riksbank. It is not particularly remarkable that the differences in forecasting ability observed in Figure 5 are small as forecasters often exhibit so-called herd behaviour. This is because they have access to the same type of information and, in addition, study each other's forecasts and revisions.

The overestimation (negative bias) in the Riksbank's forecasts for GDP growth seen in Figure 3 is reflected by the bars for the mean error in Figure 5. Figure 5 also shows that other institutions, like the Riksbank, on average, overestimated GDP growth in the period 2007-2014. For inflation, the bias is small for the Riksbank. There is no clear consensus between the different forecasters' systematic errors. While some forecasters have tended to, on average, overestimate inflation abroad others have underestimated it.

6. For a description of the method, see Andersson, Michael and Ted Aranki, "Forecasters' ability – what do we usually assess and what would we like to assess?" *Sveriges Riksbank Economic Review*, 2009:3, Sveriges Riksbank.

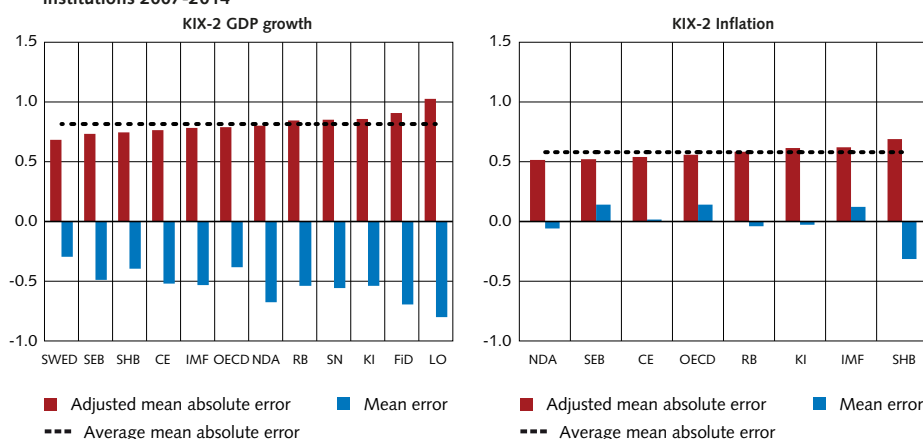
7. The Riksbank publishes no separate policy rate forecasts for the euro area and United States. There are, therefore, no available forecasts for international policy rates that the Riksbank's policy rate forecasts can be evaluated against.

8. See [www.konj.se/kix](http://www.konj.se/kix) for more details on the weights.

9. The correlation between KIX and KIX-2 for GDP growth and inflation respectively are both above 0.98.

10. Pairwise t-tests show that only those forecasters with the highest accuracy are significantly better than the forecasters with the lowest accuracy.

Figure 5. Accuracy and bias in forecasts for GDP growth and inflation abroad among different institutions 2007-2014



Note. KIX-2 refers to KIX weighting of the euro area and United States. CE=Consensus Economics, FiD=Ministry of Finance, KI=National Institute of Economic Research, LO=Swedish Trade Union Confederation, NDA=Nordea, RB=The Riksbank, SHB=Svenska Handelsbanken, SN=Confederation of Swedish Enterprise and SWED=Swedbank. Sources: National sources, respective forecasters and the Riksbank

Table 1 presents a breakdown of the Riksbank's ranking for the individual years, as well as a breakdown of forecasts for the euro area and United States. Note that this ranking does not take account of the fact that the differences in forecasting ability between the different forecasting institutions are relatively small. The table shows that there can be large differences in ranking from one year to the next, which suggests that the longer period should be studied to gain a better understanding of the forecasting ability of each institution. Based on this ranking, across the entire time period 2007-2014, the Riksbank's KIX-2 weighted GDP and inflation forecasts can be placed in the group of analysts with lower accuracy (place 8 of 12 for GDP and place 5 of 8 for inflation – see Table 1). For GDP growth, this refers to forecasts for both the euro area and United States. The result for KIX-2 inflation is, however, driven by the inflation forecasts for the euro area, in which the Riksbank was among the less accurate forecasters. On the other hand, the Riksbank's inflation forecasts for the United States were among the best.

Table 1. Annual ranking of the Riksbank's forecasting ability 2007-2014

	GDP GROWTH			INFLATION		
	KIX-2	EURO AREA	UNITED STATES	KIX-2	EURO AREA	UNITED STATES
2007	10	10	11	5	8	4
2008	6	7	6	5	4	4
2009	6	5	10	6	7	5
2010	7	7	7	3	4	4
2011	6	6	9	4	4	1
2012	8	8	5	5	5	2
2013	10	10	9	6	6	3
2014	12	11	12	5	5	5
2007-2014	8	8	11	5	6	2

Note. The figures in the table give the Riksbank's ranking, based on estimated forecast ability according to the adjusted mean absolute error. 12 forecasting institutions are included in the comparison for GDP (11 institutions for 2007) and 8 forecasting institutions are included in the comparison for inflation.

Sources: National sources, respective forecasters and the Riksbank

## Consequences of the errors in foreign variables for the domestic variables

Several forecasting institutions, including the Riksbank, the Ministry of Finance and the National Institute of Economic Research regularly evaluate their domestic forecasts. On the other hand, few, if any, have published an evaluation of their foreign forecasts and analysed how much the errors in their assessment of the foreign economy can explain the errors in their domestic forecasts. It is obvious that the assessment of developments abroad influences forecasts of the Swedish economy. As

the rest of the world is exogenous to the analysis of the Swedish economic outlook, a large forecast error in the assessment of developments abroad could contribute towards a forecast error in the domestic variables. An adjustment for forecast errors in foreign variables should therefore improve the forecast precision of the domestic variables and provide a view of how much of the error that can be attributed from errors in the forecasts for the foreign economy.

However, such an analysis is not uncomplicated and demands certain assumptions, for example regarding how developments abroad influence economic activity in Sweden and how the domestic forecasts would have been revised given the 'actual' development of the rest of the world. The forecasts would have to be produced by formal models in order to correctly derive the effects of alternative developments abroad. However, the Riksbank's forecasts are judgemental forecasts made using indicators and models. This makes it impossible in practice to determine the extent to which the errors in the Riksbank's domestic forecasts can be explained by errors in the forecasts for the foreign economy.

However, the analysis in this section is only intended to illustrate how important errors in the forecasts of foreign variables are for the forecasting accuracy of the domestic variables. In the example, the analysis is made using two models, of which one is a simple model that only captures historical correlations in data and the other is the Riksbank's macroeconomic model Ramses.<sup>11</sup>

### The effects of developments abroad on the Swedish economy

One way of illustrating the effects of errors in forecasts for the foreign economy on errors in domestic forecasts is to adopt the follow simple equation:

$$(1) \quad f_{p,h}^{i,dom} = \alpha_h^i + \beta_{1,h}^i f_{p,h}^{y,for} + \beta_{2,h}^i f_{p,h}^{\pi,for} + \beta_{3,h}^i f_{p,h}^{r,for} + \varepsilon_{p,h}^i$$

where the indexing  $p$  refers to the forecasting round and  $h$  is the forecast horizon which ranges from 1-8 quarters ahead. In this model, the domestic forecast error,  $f_i$  in the domestic variable  $i$  ( $i =$  Swedish GDP growth, inflation and policy rate, respectively) over the horizon  $h$  is explained by forecast errors in foreign GDP growth,  $f_{p,h}^{y,for}$ , foreign inflation,  $f_{p,h}^{\pi,for}$ , and foreign policy rates,  $f_{p,h}^{r,for}$ , over a corresponding horizon.  $\alpha_h^i$  is a constant that captures the possible bias in the domestic forecast errors. The error term  $\varepsilon_{p,h}^i$  captures everything else that is not observed in the model, and is assumed to be randomly distributed with the mean value of zero and constant variance.

This specification can be used to analyse the extent to which errors in the forecast of foreign variables have contributed to forecast errors in the domestic variables. The estimated coefficients,  $\beta_j^i$ , indicate the relationship between the Swedish forecast errors and the errors in foreign variables, which is to say how much Swedish forecast errors change on average when the errors in the respective foreign variables increase by one percentage point.

One shortcoming with this specification is that Swedish forecast errors are assumed to be solely a function of foreign forecast errors. As this is likely not the case, with the errors in Swedish variables in fact also being influenced by other, omitted factors (such as errors in other domestic forecasts, assumptions, ability), the estimated effects of errors in foreign variables risk being exaggerated.<sup>12</sup>

Another method for illustrating how the foreign economy influence the domestic economy and contribute to accuracy in domestic variables is to use the Riksbank's

11. RAMSES stands for the Riksbank's Aggregated Macro model for Studies of the Economy in Sweden. A detailed description of the model is presented in a paper by Adolfson, Malin, Stefan Laséen, Lawrence Christiano, Mattias Trabandt and Karl Walentin, "Ramses II: Model description", Occasional Paper no. 12, 2013, Sveriges Riksbank.

12. Estimation of a model with omitted variables can result in a failure to obtain unbiased estimations ("omitted variable bias"). The estimate of the variable of interest is likely to be biased, either positively or negatively, depending on how the omitted variables are correlated with the other variables (both dependent and independent variables) in the model.



general equilibrium model, Ramses. The model can be used to analyse the overall effects of a proposed alternative scenario, for example different foreign economic activity. As Ramses describes a small open economy, the domestic economy does not influence foreign GDP, inflation or interest rates. Domestic households and companies therefore take the foreign variables for granted when making their decisions. A known shortcoming with general equilibrium models for small open economies is that the effects on the domestic economy from foreign disturbances are generally small.<sup>13</sup> For this reason, such a model may underestimate the effects of the errors in foreign variables.

These two models give different estimates of the foreign variables' average effect on the Swedish variables (see Table 2). The effects from equation (1) are clearly stronger for all variables than the average effects in Ramses. For Swedish GDP growth, for example, equation (1) indicates that a one percentage point increase of the forecast error in foreign GDP growth, on average, increases the Swedish forecast error by 1.17 per cent, compared with 0.18 per cent in Ramses. As regards Swedish inflation and policy rate, equation (1) also indicates that the effect is strongest from the corresponding variable abroad (the diagonal in the upper panel of Table 2). This pattern is not as clear in Ramses. In Ramses, inflation abroad has a very small effect on Swedish inflation, and also on other Swedish variables. This could be because Ramses includes many complex relationships in which much of the effects of foreign inflation are absorbed by for example the exchange rate when the forecast path for foreign policy rates is held unchanged. As equation (1) probably exaggerates the effects and Ramses probably underestimates them, it is reasonable to believe that the 'actual' effects are somewhere in the middle.

**Table 2. Estimated effects of foreign variables on Swedish variables**

DATA-DRIVEN METHOD, EQUATION (1)			
	Swedish GDP growth	Swedish inflation	Swedish policy rate
Foreign GDP growth	1.17	0.29	0.28
Foreign inflation	0.09	0.80	0.41
Foreign policy rates	0.07	0.31	0.61
GENERAL EQUILIBRIUM MODEL, RAMSES			
	Swedish GDP growth	Swedish inflation	Swedish policy rate
Foreign GDP growth	0.18	0.19	0.24
Foreign inflation	0.08	0.00	0.04
Foreign policy rates	0.07	0.18	0.24

Note. Equation (1) is estimated by *mean group* estimation for each Swedish variable. Estimation is made for every horizon and an unweighted average gives horizon-neutral estimates of  $\beta_j$ .<sup>14</sup> The Ramses estimate refers to the average effect over horizons 1-8 of a one percentage point change across the forecast path of each foreign variable in which other foreign variables' forecast paths are held unchanged.

Source: The Riksbank

## An adjustment for errors in the forecasts for developments abroad improves accuracy of the Swedish forecasts

With the estimated effects in Table 2 as a basis, hypothetical forecast errors for the Swedish variables can be calculated.<sup>15</sup> These forecast errors indicate the expected size of the errors for each Swedish variable given the errors in the forecasts for developments abroad. The RMSE can then be calculated for all hypothetical forecast error series, and interpreted as the part of the forecast error which can be explained by forecast errors in foreign variables. An adjustment of the domestic forecast errors for errors in the forecasts for the foreign economy can be made by subtracting the RMSE calculated from the hypothetical forecast errors from the actual RMSE.

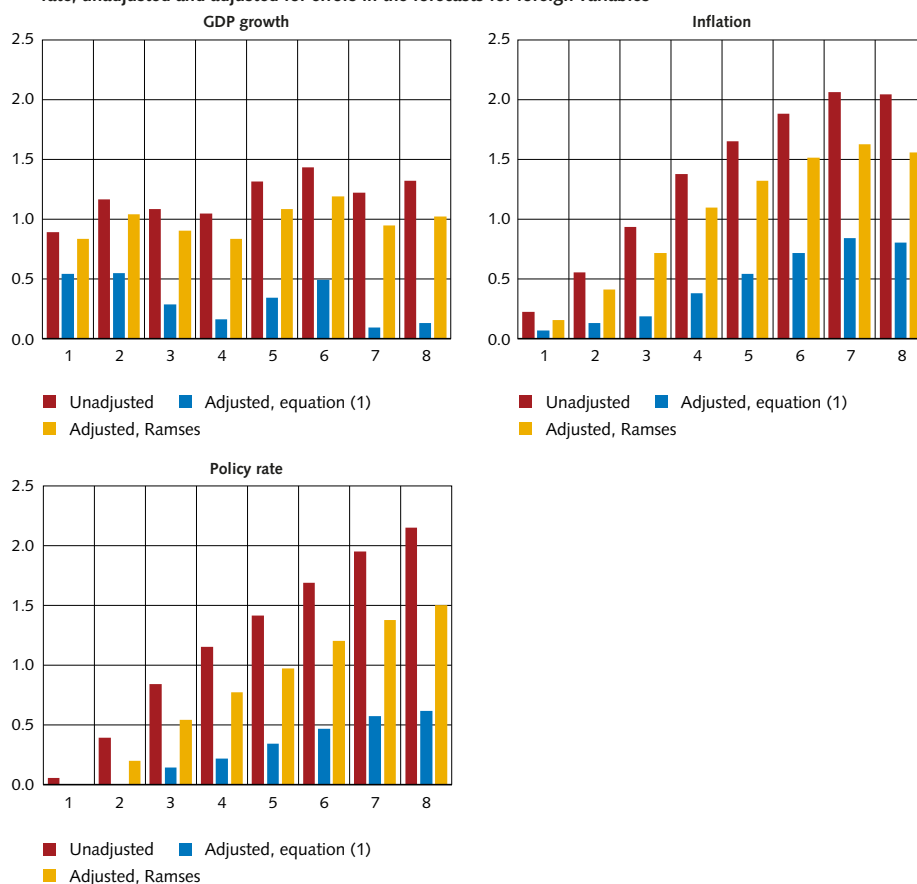
13. See for example: Justiniano, Alejandro and Bruce Preston, "Can structural small open-economy models account for the influence of foreign disturbances?", *Journal of International Economics* 81 (2010), 61-74.

14. For a description of the method, see Pesaran, M. Hashem and Ron Smith, "Estimating Long-Run Relationships from Heterogeneous Panels", *Journal of Econometrics*, vol. 68 (1), 1995, pp. 79-113.

15. By multiplying the estimated coefficients (from Table 2) by the corresponding foreign error at each point in time, a hypothetical forecast error series can be calculated for Swedish GDP growth, inflation and policy rate.

Figure 6 presents the RMSE together with the adjusted RMSE, given the estimates in Table 2, over 8 quarters.<sup>16</sup> An adjustment for the errors in the forecasts for the foreign economy improves the accuracy of the forecasts for Swedish GDP growth, inflation and policy rate, which is to say that the RMSE decreases. The adjustment made, given the data-driven method (equation (1)), is large and gives a significantly lower adjusted RMSE (on average, 70 per cent lower RMSE for all variables – see the blue bars in Figure 6). On the other hand, the adjustment based on Ramses is smaller, but still significant (on average, 30 per cent lower RMSE for all variables – see the yellow bars in Figure 6). Judging from the difference between the bars for unadjusted and adjusted RMSE, it seems that the forecast errors for developments abroad play an important role for the forecast errors for the Swedish economic outlook. The accuracy of the forecasts for Swedish GDP growth, inflation and the policy rate could be improved by an average of 30-70 per cent after an adjustment for errors in the forecasts for foreign development is made. This interval is relatively large, which reflects the difficulty in correctly identifying how developments abroad affect economic activity in Sweden. Given that equation (1) is likely to overestimate the effects of the foreign economy and Ramses probably underestimates them, it is reasonable to assume effects somewhere in the middle. Thus, this would indicate that the accuracy of the forecasts for the Swedish variables could, on average, have been improved by around 50 per cent if there had been no errors in the forecasts of the foreign variables.

Figure 6. RMSE (1-8 quarters ahead) in the Riksbank's forecasts of Swedish GDP growth, inflation and policy rate, unadjusted and adjusted for errors in the forecasts for foreign variables



Note. The adjusted RMSE from the various methods has been obtained by subtracting the RMSE calculated on the hypothetical forecast errors from the actual RMSE.  
Source: The Riksbank

16. The slightly unusual pattern observed in the forecast precision for Swedish GDP growth, in which accuracy does not deteriorate over the forecast horizon, is primarily due to the large forecast errors made (over different forecast horizons) in conjunction with the global financial crisis.

## Conclusions – important to monitor developments abroad

This commentary has assessed the Riksbank's forecasts for the foreign economy over the period 2007-2015. The variables that have been analysed are GDP growth, inflation and policy rates. On average, the result shows that the Riksbank has tended to overestimate foreign GDP growth and policy rates and to underestimate foreign inflation. However, the underestimation is fairly small. Forecast precision is relatively good in the short term (a few quarters ahead), but deteriorates over the longer horizons. The so-called forecast memory, which is to say the number of quarters for which the forecasts are a better forecast than the variable's own mean value, stretches 2 quarters ahead for GDP growth, 3 quarters ahead for inflation and 5 quarters ahead for the policy rate. The accuracy of the forecasts deteriorated sharply in conjunction with the global financial crisis but has since gradually improved again.

A comparison with other analysts shows that the Riksbank's ability to make forecasts for the foreign economy is close to average for both GDP growth and inflation abroad. All institutions have, like the Riksbank, overestimated GDP growth on average over the period 2007-2014. However, there is no clear consensus between the different forecasters' systematic errors in terms of inflation. Some have tended to, on average, overestimate inflation abroad, while others have underestimated it.

Given that Sweden is a small, open economy and therefore dependent upon what happens abroad, the assessment of developments abroad is central to the assessment of future economic activity and inflation developments in Sweden. The concluding analysis in the commentary illustrates how important errors in forecasts of foreign variables are for the forecasting accuracy of the domestic variables. The results indicate that the accuracy of the forecasts for Swedish GDP growth, inflation and the policy rate could, on average, have been improved by 30-70 per cent if there had been no errors in the forecasts for the foreign economy. This interval is relatively large, which reflects the difficulty in correctly identifying how developments abroad affect economic activity in Sweden. However, the actual magnitude of the improvement in accuracy depends on how much the Riksbank has taken the rest of the world into account when conducting its domestic forecasts.

It is, however, worth emphasising that the errors in the Riksbank's forecasts for the foreign economy do not differ considerably from those of other forecasters. It is thus difficult to believe that the Riksbank could improve these forecasts significantly. Nevertheless, the commentary shows that forecasts for the foreign economy play an important role for domestic forecasts and thus provides inspiration for continuing the work of improving the international forecasts and the analysis of how the rest of the world affects Sweden.