It's a myth that the Riksbank's forecasts have been governed by models

Jesper Lindé and André Reslow*
Jesper Lindé is on leave from his position of Head of Research at the Riksbank to serve as resident scholar at the International Monetary Fund (IMF), while André Reslow is on leave from the Riksbank for postgraduate studies at Uppsala University

In this study, we analyse how influential macroeconomic models have been on the Riksbank's published forecasts for GDP growth, inflation and the repo rate from 2006 to date. The analysis shows that the models are not so important in explaining the Riksbank's published forecasts. Rather, a great deal of judgments appear to provide the basis for the Riksbank's forecasts. Therefore, our findings show that the common view that the Riksbank blindly relies on and follows its models, recently fuelled anew by Goodfriend's and King's report, is merely a myth.

1 Introduction

A discussion has emerged lately about how the Riksbank uses models in its forecasting process. For example, the two external evaluators appointed by Swedish Parliament, Goodfriend and King (2016) raise the question in their evaluation of the Riksbank's monetary policy during the period 2010-2015. The evaluation criticises the Riksbank for being overly reliant on its models, and focusing too heavily on the models when constructing the forecasts. For instance, they write:

> "...there was heavy reliance, among both the majority of the Board and the dissenters alike, on forecasts produced by models developed by Riksbank staff. "

The evaluators also express this criticism as an important reason why the Riksbank have overestimated inflationary pressure in the economy during the evaluation period. Their conclusion is thus that the Riksbank ought to put less weight on the models in the future.

The conclusions of Goodfriend and King appear to have spread both in the mass media and in academia. For example, in the leading newspaper Svenska Dagbladet of 20 January 2016, financial journalist Louise Andrén Meiton wrote:[1]

> "The investigators also want the Riksbank to be less reliant on its models and focus more on reality. The inflation forecasts have pointed towards 2 per cent even though reality has been completely different."

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1 See Meiton (2016), translated from Swedish to English by the authors.

The economists Lars Jonung and Fredrik N. G. Andersson at Lund University write in their consultation response to Goodfriend's and King's inquiry:[2]

> "Lund University wishes to extend G&K's recommendation to include an overview of the weight that should be put on forecasts and statistical models in monetary policy decisions."
>
> "Lund University shares G&K's view that it is necessary for the Riksbank to review how it works with statistical models and forecasts. The University recommends a broader approach than that employed by the Executive Board in the past five years."

Furthermore, professor Annika Alexius at Stockholm University writes in her reaction to Goodfriend's and King's inquiry:[3]

> "One of the main reasons why the Riksbank always projects that inflation will return to 2 per cent is its very overconfidence in (erroneous) models which are discussed in the section above. Over the years, the Riksbank has been the object of much criticism on this very point, but nevertheless continues to produce inflation forecasts that always entail an imminent return to the inflation target."

But, have Goodfriend and King evoked a straw man, or is there any substance to the criticism? In order to find out the answer, two questions must be answered – one positive and one more normative.

The positive question is: Have the Riksbank's forecasts been dominated *de facto* by formal models, or have judgments beyond the models had a greater influence? In purely general terms, whether too little or too much consideration is given to models in the forecasting process tends to depend on how good the models are, and the confidence that officials and Executive Board members have in them. Everybody involved in the decision-making process is of course driven by the desire to perform a sound analysis and making the best possible monetary policy decision with the given information and tools at hand. If the models appear to give reasonable forecasts with good accuracy and otherwise have credible characteristics, it naturally follows that decision-makers and the staff give them greater consideration. In the same way, they normally pay less attention to them if they show poor forecasting capacity and have characteristics that diverge from the institution's view of the functioning of the economy.

The more normative question is: To what extent should the Riksbank take account of formal models in its forecasting process? Iversen et al. (2016) have compared the forecasting ability in the Riksbank's general equilibrium model "Ramses" and the Riksbank's primary statistical time series model (hereinafter "BVAR") with the official forecasts published by the Riksbank during the period 2007-2013.[4] *In the study, the authors show that the model-based forecasts have often been more accurate than the published forecasts.* In particular, it turns out that the BVAR model forecasts for inflation and the repo rate have been much better at predicting outcomes in relation to the forecasts published by the Riksbank for these variables during the period 2007-2013. The results can thus be used to argue in favour of the view

2 See Lund University (2016), translated from Swedish to English by the authors.

3 See Alexius (2016), translated from Swedish to English by the authors.

4 The first version of Ramses is described in Adolfson et al. (2008). Since the beginning of 2010, a second version of Ramses is used, which is described in Adolfson et al. (2013). Regarding BVAR, see Adolfson et al. (2007) for a description of the model used at the Riksbank, and Villani (2009) for a description of the methodology behind the estimation of this model.

that, insofar that the Riksbank really has put considerable weight on the forecasts of the models, it has had good reason for doing so.[5]

However, although it could be then argued that the Riksbank should give considerable attention to the models in the forecasting process, the question as to whether the models *have actually had a significant influence* on the Riksbank's published forecasts is still an open-ended question. This question should of course be answered *before* drawing the conclusion, like Goodfriend and King, that too great or too little consideration has been given to models when devising the main scenario in the forecast.

This paper therefore focuses on this question. To do so, we analyse the extent of influence that the models have had on the Riksbank's published forecasts in the medium term (2-12 quarters ahead) for GDP growth, inflation and the repo rate from 2006 to date.[6] The models that we consider are the Riksbank's main general equilibrium model Ramses and the time series model (BVAR) used for medium-term forecasts.

Our conclusion, which appears to be very robust, is that the Riksbank's published forecasts in the medium term are based on judgments rather than model forecasts. The direct contribution from the models has in fact been rather small in 2006-2016. This conclusion – which might appear unexpected following the argumentation in Goodfriend and King, 2016 – is, upon deeper contemplation, the only one that is reasonable. Although model forecasts are an important feature of the Riksbank's forecasting process, there is no rule as to how they should be incorporated into the published judgmental forecasts. Furthermore, the staff and Executive Board do not usually discuss the model forecasts in detail at the large forecasting meeting at which the forecast is largely determined.

It is important to make clear that forecasts for the short term (present plus one or sometimes even two quarters ahead) are based on various statistical indicator models (see for example Andersson and Löf, 2007, and Andersson and den Reijer, 2015). Our analysis is not about either these statistical models or forecast horizons; is aimed at the macro models that are the object of Goodfriend's and King's criticism: the Riksbank's macro models used for the medium term, which is the Riksbank's target horizon.

The remaining of the paper is structured as follows: We start by describing the data we use and describe how we measure the influence of models and judgments when the Riksbank devises a new forecast. After the data and methodology discussion, we describe our findings. Finally, we comment on the policy implications of the findings and make suggestions for further analysis.

2 Data and methodology

In this section, we first present the data we use in our analysis. We then study the informal interaction between the official forecasts and the model forecasts, before looking at the regression analysis we use to formally evaluate the extent of influence the macro models have had on the official forecasts.

2.1 Forecasts stored in real time

In order to conduct the analysis, we need data. The Riksbank's published forecasts are available on the Riksbank's website.[7] Model forecasts stored in real time are available in internal data systems at the Riksbank.[8] Model forecasts are saved at several different fixed points during the forecasting process, so there is therefore more than one model forecast

5 It should be remembered, however, that it is not uncommon for different models to be better or worse in different periods. Just because a model is good during a certain period does not necessarily mean that the same model will always be better.

6 2007 for the repo rate.

7 http://www.riksbank.se/en/Press-and-published/Published-from-the-Riksbank/Monetary-policy/Monetary-Policy-Report/

8 Since 2013, model forecasts have been stored in the Riksbank's data management system Doris. Forecasts prior to 2013 are stored in the Riksbank's former data system called Databiblioteket.

in each round of forecasting (see Hallsten and Tägström, 2009, for a description of the forecasting process). Because we consider the model forecasts to be a basis for the final forecast, we use the model forecasts established some time before the final forecast is published. The model forecasts are presented from time to time together with the staff's overall assessment to the Executive Board at the major forecasting meeting, referred to as the main forecast meeting (MFM) in the following. Although the model forecasts are not always presented at the MFM meeting, the Executive Board always receives the model forecasts in the written materials distributed ahead of this meeting. The MFM meeting usually falls two to three weeks before the formal monetary policy meeting when the Executive Board makes a decision on the final forecast, and monetary policy. In this study we therefore use the model forecasts done and saved at the point of MFM.[9]

It should also be remembered that models can be used in many different ways. For example, forecasts for the variables of interest to us can be generated conditionally or unconditionally on forecasts for other variables.[10] In this study, we use model forecasts that are conditional on a nowcast and a forecast for international developments.[11] In the Riksbank's forecasting process, various conditioning assumptions are used, but the most common is probably conditioning on the nowcast and international forecast. Another common analysis often performed is conditioning on various different interest rate paths to analyse the different inflation forecasts they give.

In our analysis we disregard the forecasts included in the nowcast on which the models are conditioned because we want to compare the models' endogenous forecasts with the Riksbank's published forecasts beyond the nowcast which is taken to be given exogenously in the models. Had we included the horizons covered by the nowcast conditioning in the analysis, this would have given a false illusion of the macro models having had a significant influence despite their forecasts actually being determined by various indicator models and staff assessments, see the studies of Andersson and Löf (2007) and Andersson and den Reijer (2015). The horizons that are included in the nowcast vary between different forecasting occasions. Usually, the nowcast covers the current and next quarter. For most forecasting rounds in our data, what the nowcast covers is quite clear, but there are some forecasting rounds in which this is not obvious, mainly before 2013. In cases where it is unclear, we therefore make two assumptions when we remove the nowcast from the data. The first assumption is that the current quarter in the published forecast is always a nowcast. The second assumption is that the next quarter is a nowcast in the forecasting rounds in which the stored Ramses forecast is the same as the BVAR forecast.[12]

2.2 Visual inspection of the forecasts

Figure 1 presents the forecasts that we use in the study (the thin red lines) together with the last known outcome for each variable (the thick blue line). The first row in the diagram shows three charts of the Riksbank's published forecasts for GDP growth, inflation (CPIF) and the repo rate. The second row shows the forecasts from BVAR and the third from Ramses. From the diagram, it can be seen that the Riksbank has tended to overestimate the underlying inflationary pressure during the period, and has hence also overestimated how quickly the repo rate can be normalised. In qualitative terms, Ramses has similar forecasts for inflation

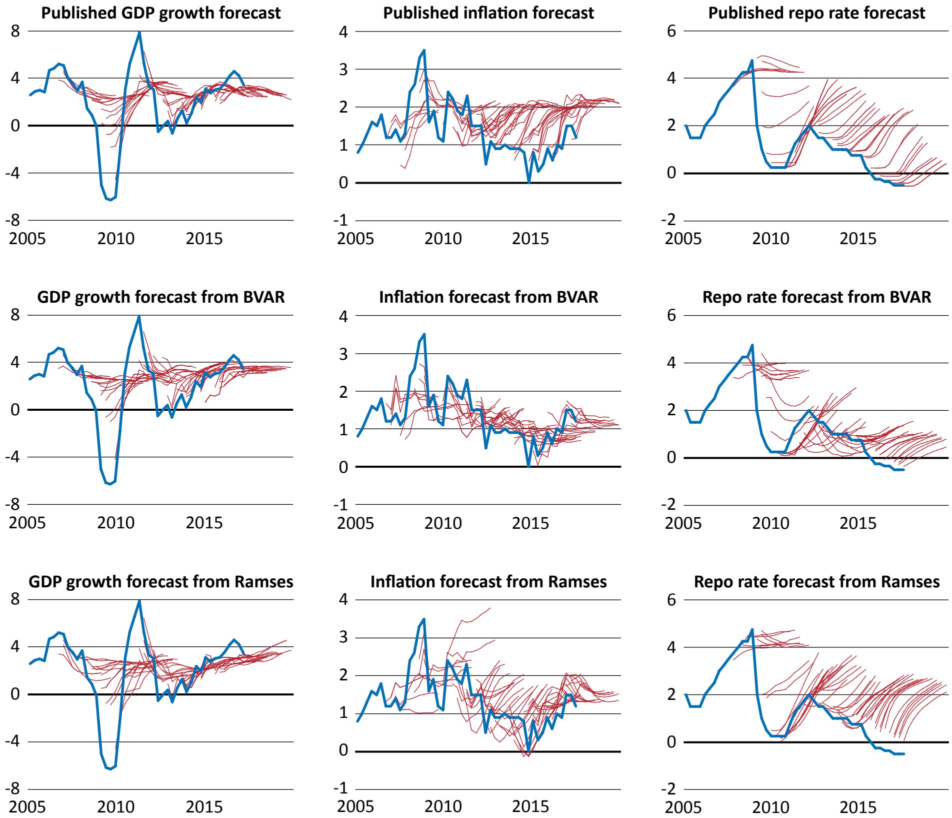
9 This applies to data from 2013. Prior to 2013, the Riksbank did not have a system with fixed points for *storing* model forecasts. Because of this, the point in time of model forecasts before 2013 can vary somewhat.

10 When a model is conditional on a forecast for another variable, the model considers the forecast for that variable to be given exogenously; its forecast is thus determined outside of the model. In an unconditional forecast, the forecasts are instead determined for all variables endogenously, i.e. entirely within the model. See Iversen et al. (2016) for a comparison of conditional and unconditional model forecasts.

11 The models therefore take the nowcast and forecast for international developments to be given exogenously when endogenous forecasts are established for other variables such as GDP growth, inflation and the repo rate on medium-term horizons.

12 It can be considered totally improbable that Ramses and BVAR would generate the same endogenous forecasts down to an exactitude of two decimals unless they are conditional on the staff's nowcast.

Figure 1. Published forecasts and model forecasts

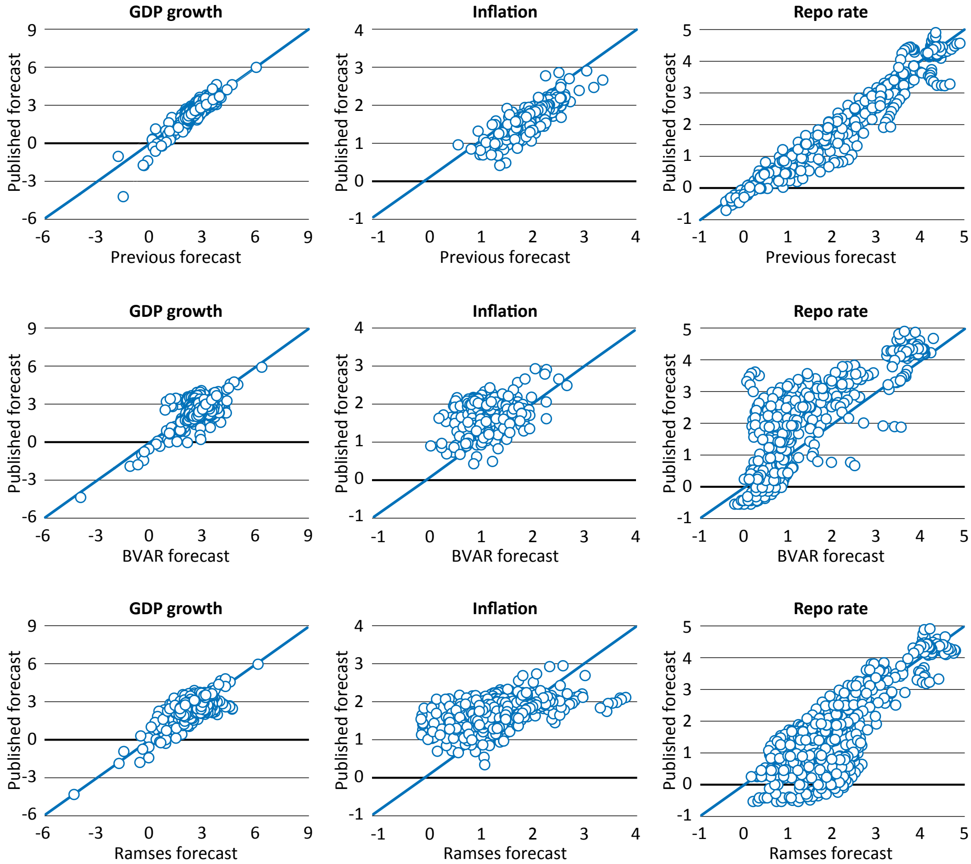


Note. The blue line depicts outcome and the red lines depict forecasts.
Sources: Statistics Sweden and the Riksbank

and the interest rate. It is interesting to see how the BVAR model deviates with systematically lower inflation and repo rate forecasts that are much closer to the actual outcome during the period. For GDP growth, it is difficult to see any substantial differences between the Riksbank's and the model's forecasts. From Figure 1, it can also be seen very clearly that the models' inflation forecasts have not at all always generated forecasts with an imminent return to the 2 per cent inflation target.

In order to get a deeper understanding of the relationship between the model forecasts and the Riksbank's published forecasts, we can in a chart plot the published forecast on the y axis and the equivalent model forecast on the x axis. These charts are shown in Figure 2. The first row also depicts the relationship between the current published forecast and the published forecast from the previous forecasting round. It illustrates the forecast revisions made by the Riksbank. In the charts we have also drawn a 45-degree line to facilitate interpretation. If the line cuts through the middle of the dots in the top row, we have no systematic upward or downward revision in the forecasts. In the charts in the second and third rows, it can be seen whether the published forecasts have been higher or lower on average than suggested by the models. If the dots are below the 45-degree line, the published forecasts have been lower on average. If they are above the 45-degree line, the forecasts have been higher on average. For example, it can be seen that the models' inflation forecasts have on average been lower than the Riksbank's published forecasts, and that Ramses has on average forecast a higher repo rate compared with the published forecasts. For the BVAR model, however, we see that almost all official forecasts for inflation and the repo rate have exceeded those generated by the model.

Figure 2. The relationship between the published forecast, previous forecast and model forecasts



Note. The line shows a 45-degree angle.
Source: The Riksbank

Another important insight from Figure 2 is that the spread between the model forecasts and the Riksbank's own forecasts is much wider than the spread between the Riksbank's new and previous forecast. The figure clearly shows that the Riksbank's new forecast and previous forecasts tend to be close to the 45-degree line. This indicates that often, the Riksbank has not made substantial forecast revisions in relation to the level of the forecasts. It also indicates that the previous forecast is often a very good prediction of the subsequent forecast. The same cannot be said about the models, however. Despite awareness of the current model forecasts, the figure shows that it is much more uncertain to use them to predict the new official forecast.

2.3 Our method for measuring models' influence on Riksbank's forecasts

We now go on to discuss how we measure the extent of influence the various models and judgments have had on the Riksbank's forecasts. An important distinction is to differentiate between the models' influence on the *level* and the *revision* of the forecast. We start by describing the extent of influence the models have had on the level, which we consider to be most important. We then go on to discuss a couple of different ways of measuring how they have contributed to the revision.

In order to measure the impact the models (Ramses and BVAR) have had on the *level* of the Riksbank's forecasts, we estimate the following simple regression model:

(1) $$F^{New}_{j,t+h} = \omega_R F^{R}_{j,t+h} + \omega_B F^{B}_{j,t+h} + (1 - \omega_R - \omega_B) F^{Old}_{j,t+h} + \varepsilon_{j,t+h}.$$

In the equation the published forecast F^{New} for variable *j's* outcome in time *t + h*, established in time *t,* is explained by the model forecasts from Ramses ($F^{R}_{j,t+h}$) and BVAR ($F^{B}_{j,t+h}$) established at the same time (i.e. forecasting round).[13] Equation (1) also allows the published forecast to be partially explained by the previous published forecast ($F^{Old}_{j,t+h}$), known as forecast smoothing. $F^{New}_{j,t+h}$ and $F^{Old}_{j,t+h}$ thus refer to two subsequent forecasts (forecasting rounds) for variable *j's* outcome in period *t + h*. An example is the repo rate forecasts established for the monetary policy reports (MPR) in April 2015 and February 2015, respectively, for the same outcome. The coefficients ω_R and ω_B, respectively, which we initially assume are the same for all horizons (*h*), thus measure the weights the Riksbank puts on Ramses and BVAR.[14] The idea behind Equation (1) is thus that the new forecast is based on an existing forecast, $F^{Old}_{j,t+h}$, which is either updated with the two models or with a new judgment, i.e. $\varepsilon_{j,t+h}$, in order to derive a new forecast $F^{New}_{j,t+h}$.

So, how do we measure the element of judgments in the published forecasts? When the regression in Equation (1) is executed using the least squares method, we obtain a coefficient of determination R^2. It is often referred to as the degree of explanatory power. The model's coefficient of determination, R^2, thus measures how much of the variation in the forecast in levels is explained by the models and by the previous forecast. This means that $1 - R^2$ is a natural measure of the extent to which new judgments explain the variation in the *forecast in levels*, because it measures the variance in the judgments (ε) in relation to the variance in the new forecasts.

We now go on to discuss the influence models have had on *the revision* in the forecast. On can do this in different ways, and we present two possible approaches below. Our first approach is a simple rewrite of Equation (1) as follows:

(2) $$F^{New}_{j,t+h} - F^{Old}_{j,t+h} = \omega_R(F^{R}_{j,t+h} - F^{Old}_{j,t+h}) + \omega_B(F^{B}_{j,t+h} - F^{Old}_{j,t+h}) + \varepsilon_{j,t+h}.$$

This equation can then be interpreted such that the forecast is revised if the model forecasts deviate from the previous published forecast, or if a new judgment is introduced through $\varepsilon_{j,t+h}$. It is important to understand that the parameters (ω_R and ω_B) and $\varepsilon_{j,t+h}$ are the same in both Equations (1) and (2). The difference is how the influence of the judgment is interpreted. The coefficient of determination will be lower in Equation (2) than in Equation (1) because forecast revisions in practice tend to occur gradually, and the previous forecast thus explains part of the variation in the new forecast. This means that *the influence of new judgments will be greater for the revision of the forecast than for the forecast in levels*.

Another important insight from Equation (2) is that equilibrium dynamics are embedded in this specification. If ω_R and/or ω_B are positive, and if one of the model forecasts starts to deviate systematically from the previous official forecast, the official forecast will be updated in the direction of the model unless the models' suggestion for a revision is "overridden" by judgments in several forecasting rounds. This means that $\varepsilon_{j,t+h}$ might very well be correlated between different forecasting rounds (*t*) and over the forecasting horizon (*h*) in a given forecasting round. A simple example is if ω_B is 0.5 ($\omega_R = 0$) and the BVAR model's inflation forecast is 1 per cent at the two- and three-year horizon while the Riksbank's previous official forecast is 2 per cent for both of these horizons. According to Equation (2) the Riksbank should then trim its forecast by 0.5 per cent on these horizons. If the Riksbank does not do so, a positive judgment ε of 0.5 per cent is thus used for these horizons. The positive judgment keeps the forecast unchanged at 2 per cent. If the same thing happens in the next forecasting round – i.e. that the model has a lower forecast than that ultimately published by the Riksbank – the judgment will be positive once more for those horizons. We study the characteristics of the judgments in more detail in section 4.

13 The same point in time refers to the same forecasting round.

14 However, it should be remembered that the Riksbank has more models than Ramses and BVAR, and that the other models can explain part of the forecast as well. Those models are most commonly used in the short term, primarily in the nowcast, but sometimes up to a one-year horizon for some variables.

Our second specification for measuring the models' influence when the Riksbank revises its forecasts is a simple difference model. This approach, which does not features any explicit equilibrium dynamics, quite simply says that the Riksbank's revisions are explained by model revisions and judgments. Equation (3) below describes such an idea. The difference from the previous specification is that the models' forecasts are not related to the current official levels of the forecasts, $F^{Old}_{j,t+h}$, but instead to the models' forecast in the previous forecasting round, i.e. only to their own revision tendencies.

(3) $$F^{New}_{j,t+h} - F^{Old}_{j,t+h} = \omega_R(F^{R}_{j,t+h} - F^{R,Old}_{j,t+h}) + \omega_B(F^{B}_{j,t+h} - F^{B,Old}_{j,t+h}) + \varepsilon_{j,t+h}.$$

In Equation (3), $F^{R,Old}_{j,t+h}$ and $F^{B,Old}_{j,t+h}$ denote the model forecasts presented at the previous forecasting round MFM. If the models' forecasts between the present and previous forecasting rounds have not changed much, Equation (3) implies that there is no reason for the Riksbank to revise its official forecast, unless it wishes to introduce new judgments. An important reason for why Equation (3) may be a better description of how the Riksbank uses the information from the models than Equations (1) and (2) is that there may be scepticism about a level forecast from a given model (for example Ramses' interest rate forecast), but nevertheless a belief that the revision tendencies, i.e. how the model interprets new information, deserves to be taken seriously.[15]

One difficulty with regression (3) is the choice of the previous model's forecast. Our benchmark choice is the model forecast generated at the previous MFM. This choice provides a relatively pure model revision from the perspective in that it uses the current and previous model forecasts that were available in real time for policymakers in calculating the revision. A possible issue with this approach, however, is that the previous model forecast is conditioned on a different nowcast than the previous final official forecast (i.e. the nowcast may have changed notably between the time of the MFM and when the official forecast were finally decided in the previous forecasting round). An alternative to measuring the old model forecasts with those presented at the previous MFM would hence be to recalculate the forecasts using the previous official forecast in the new nowcast quarters. This alternative method provides a clear revision tendency from the models based on the most recent nowcast and the previous official judgments.[16] However, this information is not stored over a longer period of time and we thus cannot use it for our entire estimation period. However, when we discuss the estimation results we will comment on how the findings change if Equation (3) is estimated for the forecasting rounds for which this information is available. [17]

Note also that by comparing the adjusted coefficient of determination for the forecast revision in the estimated Equations (2) and (3), we gain an indication of which method best describes the Riksbank's actions over the entire period. If the weights ω_R and ω_B are both close to 0 and the coefficient of determination is consequently close to 0, this means that the forecast revision is basically only explained by new judgments that do not correlate at all with the revision of the model forecasts.

We estimate Equations (1), (2) and (3) for three different variables: GDP growth, inflation (CPIF) and the repo rate separately. We also estimate the equations on a multivariate basis, i.e. for all three variables at the same time, to see if *one* set of weights can be found

15 There are at least two reasons for this. First, the potential growth capacity of the economy can change over time, which changes the level of the growth rate and the repo rate level in the longer term. Furthermore, the model's forecasts can be associated with a different monetary policy stance than that the Executive Board intends to pursue.

16 This means that if the assessment of the current situation (which may include a new outcome in the national accounts, along with a new appraisal for the next quarter) has changed only marginally (for example, if a stronger than expected GDP outcome in the national accounts is deemed to be transient in the appraisal for the subsequent quarter), the suggested revision from the models will tend to be small. An alternative approach that would likely tend to provide bigger revisions from the models is to limit the updated nowcast to quarters for with new outcomes are available, that is not condition on any further quarters after the new outcome. One would then calculate the revisions from the models contingent upon the same (but fewer) quarters.

17 This is from the MPR in July 2014. However, comprehensive data is absent for MPU September 2014, MPR October 2014 and MPR February 2015.

that explains how the forecast in levels and revision have been changed for all variables simultaneously. If a substantial weight is given to either of or both macro models, it is not entirely unreasonable to use the same weight for all variables to maintain model consistency for the different variables in the forecast. As we have mentioned previously, we use forecasts constructed during the period 2006-2016.[18] The estimations are based on data over all horizons $h = 2, 3, \ldots, H$ excluding certain nowcasts for $h = 2$ because these are occasionally determined outside of the models, as discussed previously. In each forecasting round, H is selected as to be as high as possible subject to be able to calculate a difference between the new and previous forecast for the same outcome (quarter). The maximum horizon, however, is 12 quarters.

3 Are Riksbank's forecasts and forecast revisions explained by models or judgments?

In Figure 2 we showed that the relationship between the published forecast and equivalent model forecasts appears to be weak, particularly for inflation and the interest rate. In this section we present the more formal results from our estimations. First, we present results for how influential the models have been for the level of the forecast, and then we move on to analyse the influence on the revisions.

3.1 The models' influence on the forecast in levels

Table 1 shows the estimation results from Equation (1) where we look at the influence on the *level of the forecast*. From the table, we see that the weights for Ramses (ω_R) and BVAR (ω_B) are low and that the previous forecast has a large weight in explaining the present forecast. This is a sign of a strong degree of *forecast smoothing* in the forecasting process, since the previous forecast obtains a significantly larger weight than the models' forecasts. In Table 1 we can also see that the coefficient of determination, R^2, which states how much of the variation in the forecast in levels can be explained by the models and the previous forecast, is high. This also leads to $1 - R^2$ being low. As we have described previously $1 - R^2$ measures to which extent judgments explain the variation in the forecast in levels. Since the coefficient of determination is relatively high, we can immediately draw the conclusion that the degree of new judgments in each forecasting round is relatively limited in relation to the level of the forecasts for all variables.

Table 1. Estimates and coefficient of determination for the forecast in levels: regressions according to Equation (1)

	GDP	Inflation	Interest rate	All
Previous forecast ($1 - \omega_R - \omega_B$)	0.78	0.91	0.86	0.87
Ramses (ω_R)	0.12	0.09	0.00	0.02
BVAR (ω_B)	0.09	0.00	0.14	0.11
Coefficient of determination (R^2)	0.89	0.77	0.94	0.92
Degree of judgment ($1 - R^2$)	0.11	0.23	0.06	0.08

Note. GDP is defined as annual GDP growth as a percentage (fourth difference). Inflation is measured as the annual change in CPIF as a percentage (fourth difference). The interest rate refers to the repo rate. All of the variables are measured as integers (one per cent has the figure 1.00 and not 0.01). "All" pertains to the weights obtained when selecting the weights to fit all variables simultaneously.

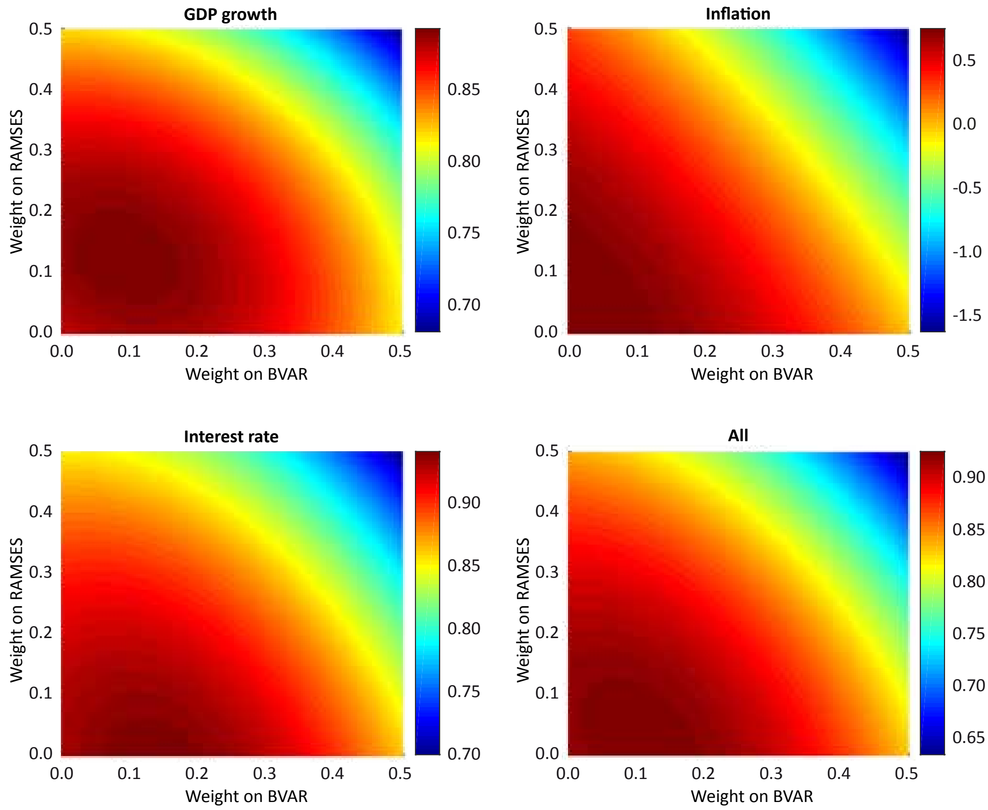
18 We include forecasts up to the April 2016 forecasting process. Comprehensive data for inflation forecasts from the models is absent from the MPR July 2008 to the MPR February 2009 reports, and is therefore excluded.

A potential problem with the estimations in Table 1 is that the model forecasts can be highly correlated with each other. In addition, they can be strongly correlated with the previously published forecast. Estimates of the weights can thus be unreliable due to multicollinearity problems, whereby different weights on both the models and the previous forecast can result in almost the same R^2 value. For this reason, we do not include any standard deviations for the weights in the table, but instead calculate the R^2 values for different values for ω_R and ω_B between 0 and 1 for the regression in Equation (1). We do so to see if we can obtain almost the same value for R^2 for distinctly different weights on the models and the previous forecast.

Figure 3 shows the results in the form of R^2 heatmaps, or R^2 contours for different combinations of ω_R and ω_B when we look at the forecasts at levels (the regression in Equation (1). The x axis shows the weight on the BVAR model (ω_B). The y axis shows the weight on Ramses (ω_R). The weight on the previous forecast is subsequently indirectly derived by calculating $1 - \omega_R - \omega_B$.[19] The colour scale to the right of each panels shows R^2 for the various parameter combinations. From the figure, we see that we obtain the highest R^2 value when the model weights are low and close to zero. We also see that the point where $\omega_R = \omega_R = 0.5$, i.e. the previous forecast has the weight 0, is associated with the lowest coefficient of determination for all the variables. In order to further clarify how the figures should be interpreted, we can look at the point estimates for GDP from Table 1. From the table, we see that Ramses is given the weight 0.12 and BVAR the weight 0.09. If, in Figure 3, we look at the point where we have 0.12 on the y axis and 0.09 on the x axis, we can see that this point is associated with a dark red colour. We also see that dark red is associated with the highest R^2 value. Table 1 shows that the coefficient of determination, R^2, for GDP is 0.89. We can also observe this value in Figure 3 from the bar to the right of the GDP chart, which shows that dark red indicates a R^2 value of over 0.88. Moreover, the figure clearly shows that if either or both of the models are assigned a higher weight than those reported in Table 1 – and hence a smaller weight is assigned to the previous forecasts – this results in a considerable drop in the coefficient of determination for all variables, both individually and combined. We can therefore firmly conclude that the models have been of secondary importance when the Riksbank has constructed the forecast. The previous forecast has, together with new judgments, had a much greater impact when the Riksbank has devised the new forecast in levels.

19 Note that Figure 3 only shows the results where ω_R and ω_B vary between 0 and 0.5, as we find it unintuitive to have negative weights on the previous forecast, which we would have had if we'd allowed the model weights to vary between 0 and 1. It is however important to realise that R^2 drops drastically for higher weights on either of the two models, irrespective of which variable we are looking at in Figure 3.

Figure 3. R^2-heatmaps for the level of the forecast; different combinations of ω_R and ω_B from Equation (1)



3.2 The models' influence on the forecast revisions

In order to analyse the effect of the models on *forecast revisions*, we use the two approaches in Equations (2) and (3). The results from the calculations according to Equation (2) can be seen in Table 2. As we have described previously, Equation (2) puts, by construction, the same weights on the models but with different coefficients of determination, R^2, because the regression must now explain the variation in the revisions instead of the variation in the level of the forecasts. Hence, the value of R^2 now measures how much of the revisions are explained by the models' deviation from the previously published forecast. As can be seen in Table 2, these values are very low and even negative for the repo rate.[20] The degree of judgments, $1 - R^2$, is thus very high and close to one for all variables according to the results from Equation (2). This approach thus suggests that the Riksbank's forecast revisions are largely explained by new judgments. The reason why the influence of judgments is lower in Equation (1) than in Equation (2) is quite simply that the variation in the level of the forecast is considerably greater than the variation in the revision of the forecast. Hence, a given size of a judgment, ε, which is introduced will be relatively small in relation to the level of the forecasts (the coefficient of determination increases), but greater in relation to the change in the forecast (the coefficient of determination decreases).

20 R^2 is calculated as: $1 - RSS/TSS = 1 - \Sigma_{i=1}^{n}(y_i - \hat{y}_i)^2/\Sigma_{i=1}^{n}(y_i - \bar{y}_i)^2$. Hence, a negative R^2 is obtained if the mean of the series $\bar{y}$ is a better explanation of y_i than the model's estimator $\hat{y}_i$.

Table 2. Estimates and coefficient of determination for forecast revisions: regressions according to Equation (2)

	GDP	Inflation	Interest rate	All
Ramses (ω_R)	0.12	0.09	0.00	0.02
BVAR (ω_B)	0.09	0.00	0.14	0.11
Coefficient of determination (R^2)	0.12	0.06	−0.07	0.04
Degree of judgment ($1 - R^2$)	0.88	0.94	1.07	0.96

Note. See the notes to Table 1.

Table 3 shows the results from our second approach, the estimations according to the specification in Equation (3). In this specification, the model projections are not related to the actual levels of the forecasts, but only to their own revision tendencies. The idea is hence that the Riksbank looks at which revisions the models make when revising its own forecast. In Equation (2) the models were related to the Riksbank's previous forecast, which can deviate from how the models viewed the situation at the same point in time.

Table 3 demonstrates that the estimations for the model weights (ω_R and ω_B, respectively) with the specification from Equation (3) are substantially higher than those from Equation (2) in Table 2. However, even if the sum of the weights for GDP growth and the repo rate now amounts to around 0.5, they are still well below 1. It can also be noted that the R^2 value is now somewhat higher and that the amount of judgments, $1 - R^2$, then declines somewhat. Nonetheless, R^2 amounts to 0.35 at the most (GDP growth). This means that the Riksbank's forecast revisions are still largely determined by judgments.

Table 3. Estimates and coefficient of determination for forecast revisions: regressions according to Equation (3)

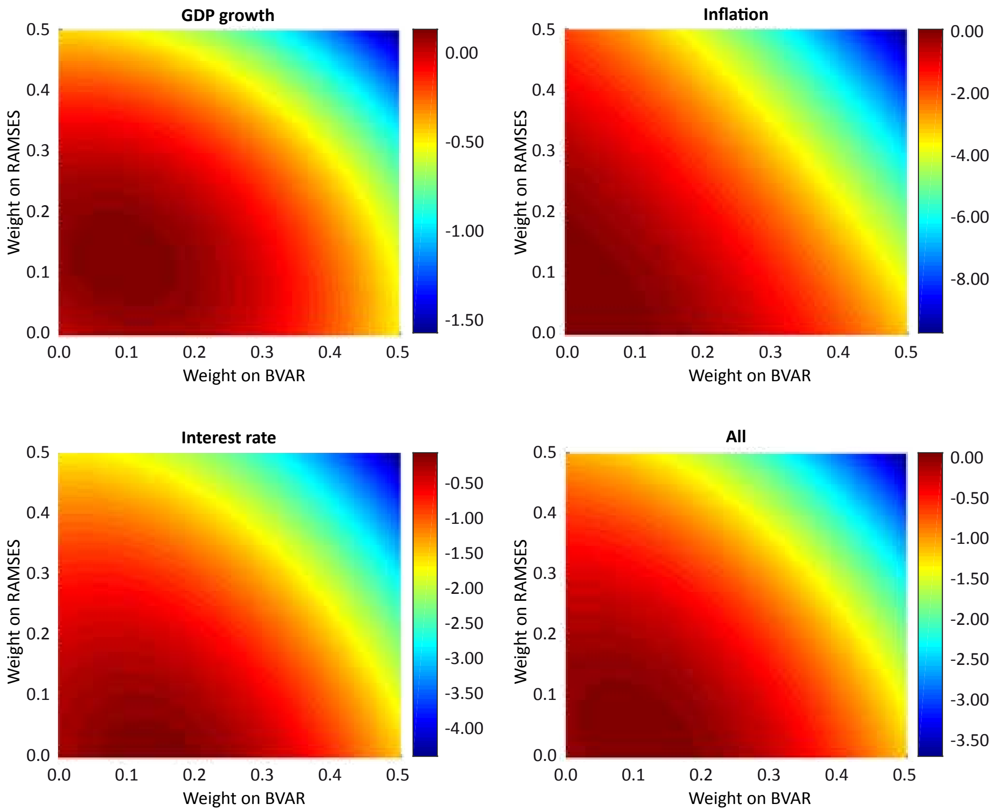
	GDP	Inflation	Interest rate	All
Ramses (ω_R)	0.28	0.15	0.42	0.29
BVAR (ω_B)	0.15	0.15	0.12	0.15
Coefficient of determination (R^2)	0.35	0.13	0.10	0.23
Degree of judgment ($1 - R^2$)	0.65	0.87	0.90	0.77

Note. See the notes to Table 1.

In order to ensure that the results in Tables 2 and 3 are robust when we vary the weights ω_R and ω_B, we present in Figures 4 and 5 R^2 heatmaps once again. We calculate them in the same way as we have described for Figure 3, except that we now calculate R^2 using the specifications in Equation (2) and (3) for different weights ω_R and ω_B. In relation to Figure 3, we see that the R^2 values are much lower, especially for high weights on the models for which the coefficients of determination now becomes negative. The only exception is the repo rate in our second approach (the regression in Equation (3)), for which the coefficient of determination remains close to 0. These figures thus strongly support our conclusion that judgments have a substantial impact on the revisions of the forecasts as well.

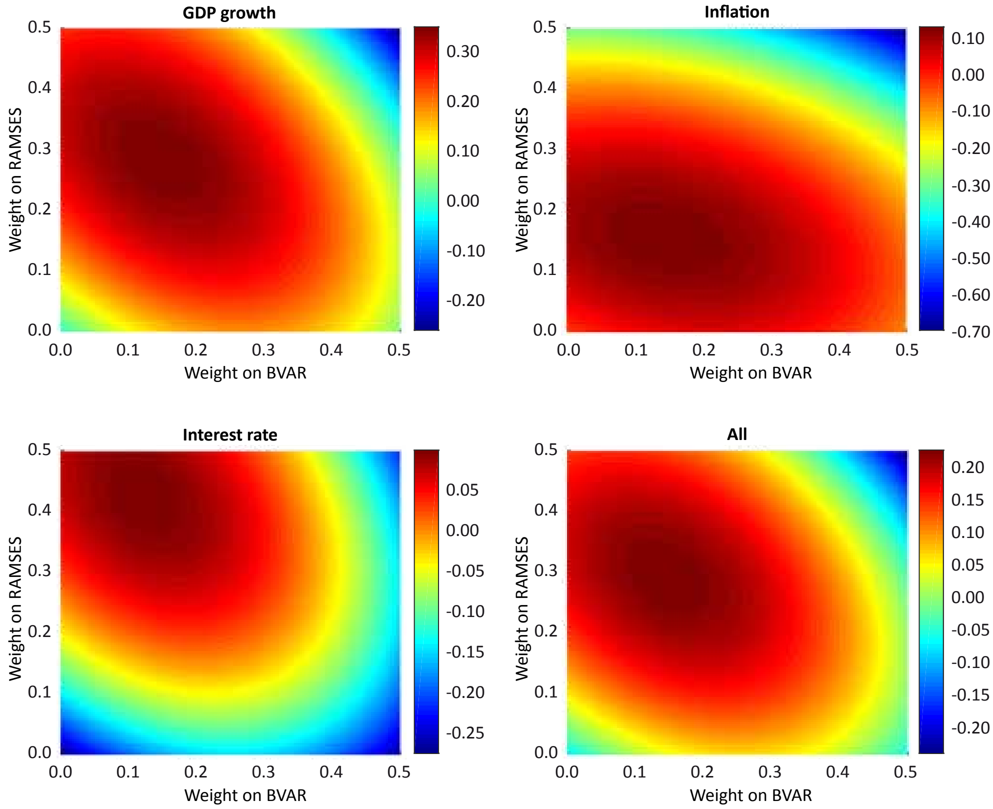
Because, as discussed earlier, it is not clear which model revisions one should compare, we also estimated Equation (3) when the revision of the model forecast is calculated as the new conditional forecast minus a forecast conditional on the previous official projection for the same quarters as the new forecast. Even this variant of the regression, which is likely to maximize the pre-conditions for a major impact of the models on the official forecast, implies that informal judgments explain a large part of the forecast revisions. More specifically, $1 - R^2$ is in this specification equals 0.54, 0.49 and 1.30 for the variables GDP growth, inflation and the policy rate.[21] Accordingly, it implies a somewhat lower degree of judgements for GDP growth and inflation but an even larger role of judgements for the repo rate in relation to our benchmark results in Table 3 (which calculated the models revisions as the difference in the conditional models forecasts made at the current and previous MFM). Nevertheless, even if the impact of the models is more notable with this specification (the sum of the weights ω_R and ω_B is above unity for all three variables in this specification whereas their average about 0.45 in Table 3), our conclusion that new judgments exert a large influence on the forecasts revisions holds up also for this method.

Figure 4. R^2-heatmaps heatmaps for forecast revisions: different combinations of ω_R and ω_B from Equation (2)



21 However, please note that we cannot directly compare these figures with those in Table 3 since they are calculated on far fewer forecast rounds (see footnote 15). When we re-estimate our version of regression (3) for the same time period, the estimated degree of judgement ($1 - R^2$ values) equal 0.60, 0.72 and 1.54. Because these estimates are relatively similar to those you get with the alternative way to measure model revisions, it is reasonable to believe that, the results in Table 3 would compare reasonably well to the alternative way to calculate the forecast revisions had the data for this method been available farther back in time.

Figure 5. ***R^2*-heatmaps heatmaps for forecast revisions: different combinations of ω_R and ω_B from Equation (3)**



3.3 The impact of the models over horizon and time

Until now we have studied how much of an impact the models have had over all horizons h = 2, 3,…, 12 simultaneously during the period of time 2006-2016. That analysis shows how the Riksbank has incorporated the models into its forecasts and forecast revisions on average. The conclusion thus far is that the models only have a moderate role in explaining the forecast in levels, and that a great deal of new judgments form the basis of the Riksbank's forecast revisions. Breaking down the data into different horizons and different periods of time might potentially provide deeper knowledge about how the Riksbank has used the models over time. If we divide up the data into different horizons (quarters), 2-4, 5-8 and 9-12, we can see how the relationship looks in the "short", "medium" and "longer" term in the forecast.[22] Such an analysis shows that the weight of the models is generally somewhat greater in the short term. The short term refers to the first year of the forecast horizon (quarters 2-4). The R^2 values too appear to be somewhat higher in the short term than in the medium and longer term.

Data can also be broken down into different periods of time to study how the impact of the models changes over time. We have chosen to study four different periods of time: 2006:1-2008:4, 2008:5-2010:6, 2011:1-2014:2 and 2014:3-2016:2.[23] We have chosen these specific periods to attempt to characterise different phases in monetary policy recently. The first period, 2006:1-2008:4, refers to the time before the financial crisis broke out. The second period, 2008:5-2010:6, refers to the time during the turbulence of the financial crisis, but before the post-crisis rate hikes. The third period, 2011:1-2014:2, refers to a time when the Riksbank hiked the interest rate, before subsequently starting to cut it again. The Riksbank has been criticised by some experts for having "leaned against the wind"

22 All results in this section are reported in Table A1 and A2 in the Appendix.

23 The serial number after the year refers to which report in the order during the year is concerned. For example, 2014:2 refers to MPU 2014:1 because that report was the second report in 2014.

during that period. The fourth and final period, 2014:3-2016:2, refers to a time of highly expansionary monetary policy with bond purchasing and a negative repo rate. The results from this breakdown show that the impact of the models has varied to quite some extent over time. This applies both to their total impact, and their relative weight. Nonetheless, the picture remains of the models having a low weight in explaining the forecasts over time, both at levels and in terms of revision. Rather, it is still informal judgments that are most important in understanding how the forecasts have changed between forecasting rounds.

4 What are judgments?

The results thus suggest that the Riksbank's forecasts are to a large extent explained by informal judgments. So, where do these judgments come from? A potential explanation is that they come from macro models other than those we use. However, Ramses and BVAR are the Riksbank's primary models, and it is therefore improbable that other models would have had a large impact. However, the two models we have considered contain far from all variables and mechanisms present in society, and they are based on different assumptions with the purpose of simplifying the economy they attempt to explain. The variables and mechanisms that are not included in the models can, at times, be observed by the Executive Board and the various experts that work in the Riksbank's forecasting process. All of this information that is not captured in the models affects the judgment that the Riksbank ultimately makes.

A trivial example of judgments is managing the effects associated with the Easter weekend. When consumption forecasts for the first and second quarter of a calendar year are made, consideration must be given to whether Easter falls in the first or second quarter. At Easter, households' consumption expenditure usually rises substantially, resulting in GDP growth for the entire quarter being higher than it would have been had Easter not occurred in that particular quarter. Because Easter does not always fall in the same quarter, it is not captured by common seasonal patterns, and an active judgment thus needs to be made to adjust the forecast for the quarter that contains Easter.

A perhaps more important example of when judgments are needed is the management of the impact of energy prices on inflation. Energy prices fluctuate sharply at times in connection with supply shocks, which the Riksbank's macro models cannot fully capture because they do not explicitly contain an energy sector. So, the Riksbank must use supplementary methods, such as partial models based on forward prices of oil and electricity, to adjust the inflation forecast.

Many of the judgments are thus based on capturing the factors that the models do not capture. It can often be the case that different models give different forecasts, because they contain different mechanisms and put emphasis on different variables. A large structural model can give one forecast, while at the same time various small indicator models can give another. Because all models are incomplete by necessity and can sometimes even provide partially contradictory results, an overall judgment is ultimately needed. In the Riksbank's annual account of monetary policy, many of the aspects that formed the basis of the monetary policy decisions in the past year are summarised. In the latest reports, for example, recurring discussion topics have been the exchange rate, high household indebtedness, rising house prices and substantial uncertainty about the economic development in the euro area.[24]

Before turning to the judgments that we calculate based on our forecast regressions, it is important to point out that we are not the first to do so for the Riksbank. Earlier studies of judgments in simple rules for the Riksbank notably includes Jansson and Vredin (2003) and Berg et al. (2004). These studies address a period of time before ours, in which divergences can be explained by factors such as creditability issues and substantial uncertainty about the

24 See Sveriges Riksbank (2014; 2015; 2016).

state of the economy. Nyman and Söderström (2016) also discusses informally the role of judgments in the Riksbank forecasting process.

4.1 Analysis of the Riksbank's judgments

So, how do the Riksbank's judgments look? Because judgments are important in explaining the forecast revisions, their characteristics are of key interest. From the estimated regressions in Equations (1) and (2), we obtain a measure of judgments $\varepsilon_{j,t+h}$. By analysing $\varepsilon_{j,t+h}$, we can get a better picture of how the Riksbank has used judgments in its forecasts. We prefer to base our analysis on the specification in these regressions because they have built-in equilibrium dynamics.[25]

An initial simple analysis that can be performed is to calculate a correlation matrix for the judgments for the different variables GDP growth, inflation and the repo rate. Table 4 shows such a matrix. The correlations shown there have been prepared by firstly calculating the average judgment

$$\bar{\varepsilon}_{j,t} = \left(\frac{1}{H-1}\right)\Sigma_{h=2}^{H}\varepsilon_{j,t+h} \tag{4}$$

over all horizons $h = 2,\ldots, H$ for variable j on each forecasting occasion, t. In each forecasting round, H is selected as far as it is possible to calculate a difference between the new and previous forecast for the same outcome (quarter). The maximum horizon, H, is however 12 quarters. The correlations are then based on the $\bar{\varepsilon}_{j,t}$ series between the different variables (GDP growth, inflation and the repo rate). In the table we see that the judgments for the repo rate in different forecasting rounds correlate positively with the judgments both for GDP growth and inflation. This means that the Riksbank, given positive judgments for GDP and inflation, has typically added a positive dose of judgment into the repo rate forecast. It is natural that both positive average judgments for GDP growth and the inflation rate correlate positively with the Riksbank's judgments for the repo rate, given that the Riksbank's target variable (CPI inflation) and resource utilisation (GDP growth) are normally considered important in predicting future inflationary pressure. It should also be noted that we measure the average judgment in a forecasting round. The judgment can thus differ in relation to the various models. An average positive judgment can be a negative judgment in relation to one of the models.

Table 4. Correlation matrix for average judgments in different forecasting rounds

	GDP	Inflation	Interest rate
GDP	1.00	−0.13	0.36
Inflation	−0.13	1.00	0.39
Interest rate	0.36	0.39	1.00

Note. The judgments have been calculated using the regression results in Tables 1 and 2 (which give the same residual), after which the average has been calculated according to the formula in Equation (4). See also the notes to Table 1 for the definition of the variables included in these regressions.

We can also estimate a simple regression according to the following equation:

$$\bar{\varepsilon}_{repo,t} = \beta_1\bar{\varepsilon}_{Inflation,t} + \beta_2\bar{\varepsilon}_{GDP,t} + u_t \tag{5}$$

25 We are aware that the results in Tables 2 and 3 indicate that the regression in Equation (3) better captures how the Riksbank works in practice (as the R^2 values are higher in Table 3 than in Table 2). Nonetheless, we argue that the regression in Equation (3) should be incorrectly specified, because there are no equilibrium dynamics incorporated into it. This implies that the level of the forecast in levels could basically be anything over time. This feature impinge on the statistical properties of the judgments measured with this regression. The judgments in Equations (1) and (2) are however immune to this criticism. We show in the appendix, however, that the results we present here are robust if we instead use the judgments from Equation (3). See Tables A3-A5.

In the equation above, the judgments in the repo rate are explained by the judgments for inflation and GDP growth. Note that we do not include an intercept because the mean for the assessments is by construction 0. The estimation can thus be seen as a test for whether the Riksbank follows the "Taylor rule" in its judgments. The Taylor rule, based on John Taylor's seminal paper from 1993 (see the study by Taylor, 1993), says that central banks can stabilise the economy by changing the interest rate by more than one-to-one in response to changes in inflation (see the study by Davig and Leeper, 2007, for an indepth discussion on this issue). In Equation (5) we should therefore expect β_1 to be greater than 1 if the Riksbank has followed the Taylor rule in its judgment. The results of that exercise is provided in Table 5. There, we see that the Riksbank has, in its judgment, changed the interest rate by a factor of 0.9 in response to altered judgments in inflation outlook, i.e. somewhat lower than one-to-one. However, there is considerable uncertainty about the point estimate, and taking this uncertainty into account, we cannot reject that the Taylor principle does not hold up since the null hypothesis that β_1 is greater than 1 cannot be rejected. Moreover, it is (almost) not possible to reject the original coefficients proposed by Taylor in his paper – 1.5 for inflation and 0.5 for the GDP gap (however, we have GDP growth instead of the GDP gap in our regression). It is also important to point out that when we estimate the equation for the judgments measured with the regression in Equation (3), we obtain the coefficients 1.31 and 0.14 (see appendix), which satisfy the Taylor rule. Another aspect is that the coefficient of determination in the regression is relatively low, 0.19, implying that a substantial part of the judgments for the repo rate are not mechanically associated with the judgments for inflation and GDP growth. Many more aspects have been incorporated into the judgments for the repo rate path. However, even though the judgments made can undoubtedly be criticised retroactively for various reasons, it is nevertheless important to note that they fulfil this (Taylor's) fundamental principle for practical monetary policy.

Table 5. Regression of judgments for the repo rate on judgments for inflation and GDP growth

	β	Std. Dev.	p-value
Inflation (β_1)	0.907	0.300	0.004
GDP (β_2)	0.315	0.192	0.109

Note. Results from the estimations according to Equation (5). Inflation is measured as the annual change (fourth difference) in CPIF. GDP refers to the annual change (fourth difference) in GDP. The estimation has a coefficient of determination, R^2, of 0.19.

The analysis in Tables 4 and 5 is based on average judgments for each variable in each forecasting round. We can also study the characteristics of the judgments in a given forecasting round. By estimating Equation (6) below we obtain a measure of the persistence over the horizons $h = 2,\ldots, H$ in each forecasting round. According to this equation, the judgment for a certain horizon is explained using the judgment in the previous horizon in the same forecasting round, t.

(6) $$\varepsilon_{j,t+h+1} = \beta_0 + \beta_1 \varepsilon_{j,t+h} + u_{j,t+h+1}$$

Table 6 reports the estimations for each variable. The results show that persistence is quite high for the judgments in each forecasting round, especially for the interest rate, for which it is as high as 0.97. A persistence coefficient close to 1 suggests that when the Riksbank establishes a new judgment in the near-term, it tends to add a similar dose on longer-term horizons as well. For GDP growth and inflation, the persistence is much smaller. Our estimations indicate that memory in a forecasting round for those variables is much shorter. This means that when a positive judgment is assigned to GDP growth or inflation in the near future, say for $h = 2$, relatively little of this judgment tends to spill over into the next year in the forecast. Some persistence in the judgments for GDP growth and inflation is reasonable because we measure the variables as fourth differences. Hence, the results imply that the judgments for inflation and GDP growth in the near-term typically have moderate indirect effects on the judgment in the following year within a given forecasting round.

Finally, it should be mentioned that we allow for a constant when we estimate the regression in Equation (6). In principle, the constant could indicate systematic positive or negative judgments. However, because of our method of measuring judgments, the constant will, by necessity, be small for all variables (especially bearing in mind that the judgments are measured as integers, i.e. one percentage point is 1.00 and not 0.01). This is so because we measure the judgments from the estimated equations using the method of the least squares, which means that they will be zero on average.

Table 6. Persistence in the judgments during a given forecasting round

	GDP	Inflation	Interest rate
β_0	−0.008 (0.007)	0.005 (0.004)	0.008*** (0.003)
β_1	0.712*** (0.021)	0.740*** (0.022)	0.970*** (0.008)

Note. Results from the estimations according to Equation (6). *** refers to significance at the 1 per cent level. Standard deviation in brackets.

5 Concluding remarks

In light of the recent discussion about how the Riksbank uses models in its forecasting process, we have in this study looked at how much the Riksbank *de facto* incorporates model forecasts into the final published forecasts. Goodfriend and King (2016), for example, directed sharp criticism at the Riksbank for being overly reliant on models and placing too much focus on models when devising forecasts. We have in this paper therefore studied to which extent the Riksbank's two main macro models, Ramses and BVAR, explain the published forecasts (and forecast revisions). The analysis shows that the models do *not* have a critical role for explaining the Riksbank's published forecasts, and that judgments account for a large share of the Riksbank's forecast revisions.

However, an important factor to bear in mind is that our method only measures the direct contribution from the macro models. Because the models often serve as conceptual frameworks for the functioning of the economy, they can nevertheless have a significant indirect influence on the official forecasts. Having said that, there is in principle no simple answer to the question as regards to the influence of the macro models on the forecasts, although our conclusion that the direct impact is relatively small indicates that the indirect influence ought also to be limited in practice.[26] There are, however, exceptions. An area in which the models are used frequently in normal circumstances is to perform alternative simulations for more expansionary or contractionary monetary policy. However, such simulations are most commonly about alternative scenarios for monetary policy, even though the monetary policy transmission mechanism embedded in the model may be used to adjust the main scenario when the Executive Board decides on an alternative rate path. According to our way of thinking, it is entirely misleading to go from these calculations to say that the forecast comes from the model. Instead, it's about preferred monetary policy stance**,** including a judgment of the effects on GDP growth and inflation.

26 For example, the macro models have the characteristics of inflation ultimately returning to the target (although, in the models, it usually takes much longer than two to three years before this occurs) and of monetary policy being neutral (i.e. it does not affect economic activity) in the longer term. These are examples of features of the model that informally affect how monetary policy is devised, but which are not necessarily captured in our analysis.

Despite this possible objection, our results show in all clarity that the view disseminated by Goodfriend and King – that the Riksbank blindly relies on and follows its models – is entirely misleading and is merely a myth. We have also shown that their perception of the Riksbank relying on models in which inflation always returns to the target "by itself" within the forecast horizon is a myth.

It is important to discuss and debate the Riksbank's forecasts and models, because this benefits the future development of new models and forecasting methods. However, it is also important to have a solid basis for what is expressed in the debate. With this study, we have attempted to contribute to the debate with a solid basis regarding how much the models actually affect the Riksbank's forecasts.

As discussed in greater detail in Nyman and Söderström (2016), it should also be remembered that there is not necessarily anything surprising about the Riksbank's published forecasts diverging from the models' forecasts. The Riksbank is a policy institution that conducts monetary policy to attain an inflation target. In other words, the Riksbank will decide on a repo rate that brings the inflation forecast close to, or to, the 2 per cent inflation target during the target horizon. The models can often have an inflation forecast that does not return to the target within the forecast horizon. Those forecasts are contingent on an endogenous repo rate in the models that is not necessarily consistent with the repo rate decided by the Executive Board. This ultimately implies that an overall judgment for inflation has to be made for the published forecast based on the stance on monetary policy decided by the Executive Board.

Backed by our analysis, we can thus eliminate the hypothesis that major forecast inaccuracies during the evaluation period are due to the Riksbank being overly reliant on its formal models. Instead, one should proceed by analysing the more normative question of whether the Riksbank's forecasting ability and interest rate decisions would benefit from relying more on macro models. The findings in Iversen et al. (2016) suggest that this might be the case, but the question should be investigated thoroughly.

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Appendix

Table A1. The models' impact over different horizons

Horizon (quarter):	**2-4**	**5-8**	**9-12**
GDP			
Ramses (ω_R)	0.58	0.04	0.04
BVAR (ω_B)	0.17	0.00	0.06
Coeff. of determination (R^2)	0.52	−0.09	0.10
Inflation			
Ramses (ω_R)	0.24	0.08	0.00
BVAR (ω_B)	0.24	0.01	0.01
Coeff. of determination (R^2)	0.31	0.00	−0.02
Interest rate			
Ramses (ω_R)	0.06	0.00	0.00
BVAR (ω_B)	0.10	0.15	0.13
Coeff. of determination (R^2)	−0.11	−0.08	−0.03
All			
Ramses (ω_R)	0.27	0.00	0.00
BVAR (ω_B)	0.18	0.10	0.09
Coeff. of determination (R^2)	0.23	−0.05	0.12

Note. Results according to estimations based on Equation (2).

Table A2. The models' impact over different periods of time

Period of time:	**2006:1-2008:4**	**2008:5-2010:6**	**2011:1-2014:2**	**2014:3-2016:2**
GDP				
Ramses (ω_R)	0.08	0.09	0.25	0.04
BVAR (ω_B)	0.48	0.15	0.06	0.12
Coeff. of determination (R^2)	0.27	0.09	0.29	0.16
Inflation				
Ramses (ω_R)	0.32	0.09	0.09	0.00
BVAR (ω_B)	0.00	0.25	0.00	0.03
Coeff. of determination (R^2)	0.16	0.29	0.13	0.01
Interest rate				
Ramses (ω_R)	0.43	0.27	0.17	0.00
BVAR (ω_B)	0.00	0.10	0.08	0.28
Coeff. of determination (R^2)	0.03	−0.19	0.21	−0.37
All				
Ramses (ω_R)	0.17	0.11	0.13	0.00
BVAR (ω_B)	0.07	0.15	0.05	0.11
Coeff. of determination (R^2)	0.06	0.03	0.18	−0.02

Note. Results according to estimations based on Equation (2).

Analysis of the Riksbank's judgments according to the error terms from the specification in Equation (3).

Table A3. Correlation matrix for average judgments in different forecasting rounds

	GDP	Inflation	Interest rate
GDP	1.00	−0.02	0.30
Inflation	−0.02	1.00	0.52
Interest rate	0.30	0.52	1.00

Note. The judgments have been calculated using the regression results in Table (3), after which the average has been calculated according to the formula in Equation (4). See also the notes to Table 1 for the definition of the variables included in these regressions.

Table A4. Regression of judgments for the repo rate on judgments for inflation and GDP growth

	β	Std.Dev.	p-value
Inflation (β_1)	1.310	0.283	0.000
GDP (β_2)	0.146	0.201	0.473

Note. Results from the estimations according to Equation (5). Inflation is measured as the annual change (fourth difference) in CPIF. GDP refers to the annual change (fourth difference) in GDP. The estimation has a coefficient of determination, , of 0.33.

Table A5. Persistence in the judgments during a given forecasting round

	GDP	Inflation	Interest rate
β_0	−0.011 (0.007)	−0.006 (0.004)	−0.010*** (0.003)
β_1	0.628*** (0.021)	0.728*** (0.022)	0.964*** (0.008)

Note. Results from the estimations according to Equation (6). *** refers to significance at the 1 per cent level. Standard deviation in brackets.