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In this economic commentary we investigate whether there are systematic patterns in Statistics Sweden's GDP growth revisions. The results show that there are some signs that the revisions systematically covary with the information that is available when the GDP growth rate is initially published. It is difficult, though, to use this information from a forecast perspective. Statistics Sweden's initial publication of GDP growth can therefore in general be viewed as an efficient forecast of expected GDP growth for a given quarter according to later publications.

Are there systematic patterns in Statistics Sweden's GDP growth revisions?

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It is a well known fact that national accounts are repeatedly revised and that these revisions create complications for a large number of agents. For decision-makers who strive to base their decisions on as complete an understanding of the state of the economy as possible, these revisions represent an extra source of uncertainty that must be taken into consideration. The revisions also make it more difficult for analysts and forecasters to make forecasts. Furthermore, it becomes more complicated to conduct ex post analysis of some economic decisions and relationships; for example, extensive academic literature shows that statistical analysis of macroeconomic relationships can produce significantly different results depending on whether revised or real-time data are used.[1]

One variable of particular interest to many agents is GDP. In light of the problems associated with revisions of economic data, we are investigating in this economic commentary if there are any systematic patterns in Statistics Sweden's GDP growth revisions. This topic is of interest since the presence of systematic patterns would mean, for example, that forecasters could take this into account and thereby make better forecasts of what an initial publication for a given quarter is expected to be according to later publications. The presence of systematic patterns in the revisions could also mean that Statistics Sweden is not using information efficiently in its calculations of the national accounts. This would then indicate that there is room for improvement to the methods used in the work with the national accounts.

Potential systematic patterns in the revisions need to be regularly analysed

To date, a limited number of studies have been conducted on systematic patterns in Swedish GDP growth revisions. For example, Öller and Hansson (2004) showed that even if the average value of the GDP growth revisions between 1980 and 1998 was positive, this did not constitute a statistically significant bias.[2] There was, however, an indication that the revisions were correlated with the business cycle and as such growth was revised upwards in upturns and downwards in downturns.

With regard to the unbiasdness of the published GDP growth data, Statistics Sweden (2009, p. 31) has pointed out that "an upward revision usually occurs". This comment was based on calculations for the period consisting of the first quarter of 2000 to the third quarter of 2009, where the revisions were calculated as the difference between the most recently published time series showing GDP growth and the initial publication.[3] Figure 1 shows the corresponding revisions for the period spanning the second quarter of 1999 to the fourth quarter of 2010 together with the growth data.[4] The average revision during this period is approximately 0.36, which is in line with Statistics Sweden's comment that GDP growth is generally revised upwards.

1. The term real-time data here refers here to a compilation of time series that shows how a specific economic variable's historical development is perceived at different points in time. See, for example, Croushore and Stark (2001), Orphanides (2001) and Orphanides and van Norden (2002) for discussions and applications.
2. Bias means that there is systematic over- or underestimation.
3. Later analysis from Statistics Sweden (2010) also indicates that the revisions tend on average to be larger than zero.
4. The growth rate is calculated as $x_t = 100(y_t / y_{t-4} - 1)$, where x_t is GDP at time t.

However, looking only at the simple average for a specific revision does not provide much information about the presence of any systematic patterns in the revisions. The purpose of this commentary is therefore to conduct a more thorough statistical analysis of the GDP growth revisions. Such an analysis is desirable since previous studies are somewhat dated and their results may therefore be invalid today. For example, changes in the methods for the production of statistics at Statistics Sweden may have changed the pattern of the revisions. This means that we must carefully consider which data should be used in the statistical analysis of this commentary. If the sample is "too long", there is a risk that we will pick up historical patterns that are no longer relevant. This, naturally, can generate inaccurate conclusions. If the first publication by Statistics Sweden is deemed to be biased, it can, for example, be reasonable for a forecaster to adjust the published GDP growth and thereby achieve a number that should be closer to the "true" value. However, if bias is present only in the earlier portion of the sample, and not the later portion, such a strategy would lead to larger deviations from the "true" value than if no adjustment had been made. If, on the other hand, we use a sample that is "too short", the possibilities to identify potential systematic patterns are limited since a certain number of observations are generally needed to do this.

Data

In order to analyse the GDP growth revisions, we use data from Statistics Sweden's real-time database.[5] This database contains time series of GDP at different publication occasions. More specifically, quarterly data from the first publication for the second quarter of 1999 to the third quarter of 2008 are analysed. The revisions at nine different horizons are evaluated: quarters one to eight and "most recent", where "most recent" refers to the GDP time series published in March 2011. The revision of a growth estimate j quarters later ($j = 1, 2, ..., 8, s$) is defined as $R_t^j = x_t^j - x_t^f$, where x_t^j and x_t^f are revised GDP growth and the initial publication, respectively, and s stands for "most recent".[6] GDP growth is calculated using seasonally adjusted data and is given as the percentage change between two quarters, i.e. $x_t = 100(y_t / y_{t-1} - 1)$, where y_t is seasonally adjusted GDP at time t. Data are shown in Figure 2.

By using these data, we achieve 38 observations at all nine horizons. The time period is chosen such that the extreme values generated in the fourth quarter of 2008 (and to some extent in the first quarter of 2009) are not included. Because these quarters are not deemed to be representative observations, we believe that it is better not to include them in the analysis since they risk distorting the results.[7]

Statistical analysis of the predictability of the revisions

It is possible to investigate the presence of potential systematic patterns in the revisions in a number of ways. We here employ a standard framework that has been previously used for similar purposes, for example by Faust *et al*. (2005).[8] A simple test of unbiasedness can be conducted using the regression

$$R_t^j = \alpha + \varepsilon_t \qquad (1)$$

where the revision, R_t^j is defined as above and ε_t is an identically and independently distributed error term. The null hypothesis $H_0 : \alpha = 0$ is tested using a simple t-test and if this is rejected the conclusion is drawn that the initially published growth rate is not an unbiased estimate of the revised growth rate.

5. See http://www.scb.se/Pages/ProductTables____22918.aspx for more details and data.
6. It can thus be noted that the horizon for "most recent" is time varying. For the first observation the horizon is 46 quarters, for the second 45 quarters, and so on.
7. It could be interesting to use data prior to the second quarter of 1999 since this would provide more observations. However, the decision was made that this would be more of a hindrance than a help for two reasons. First, the national accounts underwent extensive revision in the spring of 1999. This means that the probability of a change in the historical pattern of adjustments is not insignificant. Second, it is difficult to obtain real-time GDP data for this period.
8. See also Mankiw *et al*. (1984), Mankiw and Shapiro (1986), Roodenburg and den Reijer (2006) and Aranki and Friberg (2010) for applications of both GDP growth and other macroeconomic variables.

It is also of interest to analyse whether the revisions at the different horizons are correlated with the initial publication, x_t^f, since the revisions where this is the case can also to some extent be forecasted. For example, if $\beta > 0$ higher values of the initial publication are linked to higher revisions. This can be tested with a classic forecast efficiency test (Mincer and Zarnowitz, 1969) using equation (2):[9]

$$R_t^j = \alpha + \beta x_t^f + \varepsilon_t . \qquad (2)$$

The null hypothesis $H_0 : \alpha = \beta = 0$ is tested using a Wald test. The efficiency test can also be generalised so that forecast efficiency is evaluated with regard to other information that was available at the time of the initial publication. The equation estimated in this case is given by

$$R_t^j = \alpha + \beta x_t^f + \gamma_1 z_{1,t} + \gamma_2 z_{2,t} + \cdots + \gamma_p z_{p,t} + \varepsilon_t \qquad (3)$$

where $z_{i,t} (i = 1, 2, \ldots , p)$ is a variable that is suspected to be able to forecast the revision. The null hypothesis $H_0 : \alpha = \beta = \gamma_1 = \gamma_2 = \cdots = \gamma_p = 0$ is tested, exactly as in the case with equation (2), using a Wald test. Here we analyse the efficiency of three variables in addition to the initial publication: the return of the OMX index ($z_{1,t}$), the interest rate of a three-month treasury bill ($z_{2,t}$) and the confidence indicator for the manufacturing industry from the National Institute of Economic Research's Economic Tendency Survey ($z_{3,t}$). We have chosen these variables since they all contain information about the economic cycle that could potentially explain the revisions.

Results

The results from the estimates of equations (1) to (3) are found in Table 1. The estimated constant in equation (1) is generally close to zero. The point estimate for horizons one to eight are negative, which implies downward revisions on average at each horizon; only when the "most recent" data are used is the point estimate positive. However, in none of the cases can the null hypothesis of unbiasedness be rejected at traditional significance levels.[10] The conclusion of this analysis is thus that no bias can be established.

With respect to the efficiency of the initial publication, the results in Table 1 show that at no horizon can the null hypothesis that both coefficients in equation (2) are zero be rejected. The model's inability to explain the variation in the revisions is also obvious when reviewing the adjusted multiple coefficient of determination – in all cases it is very close to zero. This implies that the initial publication cannot explain the revisions.

If we instead look at the results for the efficiency of a larger number of variables, the outcome is different. The coefficient on the return of the OMX index is significant at the five per cent level at all horizons except "most recent". The treasury bill interest rate is less successful in explaining the revisions, and the coefficient on the confidence indicator for the manufacturing industry is only significant at one horizon. The null hypothesis – that all coefficients in equation (3) are zero – is, however, rejected at the one percent level at all horizons except the fourth revision.

The results from equation (3) indicate that it should be possible to make better forecasts of revised GDP growth if systematic covariation with the explanatory variables was taken into account. This also means that Statistics Sweden should be able to improve its methods for producing the initial publication of GDP growth. However, it is not apparent that significance within the sample would result in the generation of better forecasts. One reason for this is that estimates of coefficients can be very uncertain, which tends to have an adverse effect on the forecasting ability of the models.

9. Forecast efficiency refers to the forecaster using available information in an efficient manner. This means that it should not be possible to explain the forecast error using information available at the time the forecast was generated. In this commentary, efficiency correspondingly refers to the inability to explain the revisions.

10. The residuals demonstrate significant autocorrelation at five of the revision horizons according to the Ljung-Box test. However, this is taken into consideration in the estimate of the standard errors by using the Newey-West standard errors.

A simulated real-time forecast exercise

In order to evaluate if, in practice, it would have been possible to generate better forecasts with the estimated versions of equation (3), we conducted a simulated real-time forecast exercise.[11] In this exercise, the model is estimated on a sample that is gradually increased and forecasts based on the model are generated at every point in time. We then analyse if these forecasts would lead to better forecasts of later revised growth rates than the initial publication.

More specifically, the exercise is carried out as follows. Equation (3) is estimated 19 times for each of the horizons one to eight.[12] The first time we assume that we are in the second quarter of 2004 and that a time series that contains GDP data up to and including the first quarter of 2004 has just been published. The eight models are estimated on data from the second quarter of 1999 to the quarter whose most recent revision has just been made available.[13] Based on the estimates of equation (3), an adjusted forecast is then calculated, $\tilde{x}_t^j = x_t^f + \hat{R}_t^j$. Thereafter, we note both the adjusted forecast's and the initial publication's deviation from the revised growth rate and denote these forecast errors $\eta_t^{a,j} = x_t^j - \tilde{x}_t^j$ and $\eta_t^{b,j} = x_t^j - x_t^f$, respectively.[14] The sample is then increased by one period and we repeat the exercise. This continues until we assume that we are in the fourth quarter of 2008 and a time series containing GDP data up to and including the third quarter of 2008 has been published. Based on these forecast errors, we then calculate the root mean square error (RMSE) for the two forecast methods at each horizon using $RMSE^{a,j} = \sqrt{n^{-1}\sum\left(\eta_t^{a,j}\right)^2}$ and $RMSE^{b,j} = \sqrt{n^{-1}\sum\left(\eta_t^{b,j}\right)^2}$, where the number of forecast errors for each horizon and method is $n = 19$.

11. Real-time forecast exercise means that the forecasts are generated in a manner that would have been possible in practice at each point in time. This means, for example, that the information used in the model must be the same as it was in reality at the point in time in question. This type of exercise becomes significantly more complicated if variables in the model are revised or seasonally adjusted.

12. The exercise cannot be carried out on the "most recent" revision since this revision was first known in March 2011.

13. The sample varies depending on the revision horizon. For example, at this point in time the fourth quarter of 2003 is revised for the first time and the model for horizon one is thus estimated on data from the second quarter of 1999 to the fourth quarter of 2003. Correspondingly, the third quarter of 2003 undergoes its second revision at this point in time. The model for horizon two is thus estimated on data from the second quarter of 1999 to the third quarter of 2003.

14. It can be noted that, in other words, $\eta_t^{b,j}$ is identical to R_t^j.

Table 1. Results for estimated equations

	Horizon								
	1	2	3	4	5	6	7	8	s
Eq(1)									
$\hat{\alpha}$	-0.05	-0.05	-0.06	-0.01	-0.03	-0.03	-0.01	-0.02	0.08
	(0.04)	(0.05)	(0.06)	(0.05)	(0.05)	(0.05)	(0.06)	(0.06)	(0.07)
LB(4)	1.19	10.19[b]	13.58[a]	10.44[b]	7.27	11.75[b]	12.80[b]	4.00	5.30
Eq (2)									
$\hat{\alpha}$	-0.08	-0.04	0.03	0.04	0.01	0.07	0.13	0.04	0.09
	(0.13)	(0.12)	(0.12)	(0.11)	(0.11)	(0.10)	(0.08)	(0.13)	(0.17)
$\hat{\beta}$	0.05	-0.02	-0.15	-0.07	-0.07	-0.16	-0.22[c]	-0.10	-0.02
	(0.16)	(0.15)	(0.14)	(0.17)	(0.15)	(0.13)	(0.11)	(0.15)	(0.23)
$\bar{R}^2$	-0.02	-0.03	0.01	-0.02	-0.02	0.02	0.05	-0.02	-0.03
χ^2	1.87	1.34	2.81	0.18	0.53	1.89	3.87	0.75	1.21
LB(4)	1.02	10.60[b]	16.62[a]	10.09[b]	7.28	13.37[a]	15.72[a]	4.34	5.31
Eq (3)									
$\hat{\alpha}$	0.17	0.19	0.29	0.35	0.43[b]	0.48[b]	0.59[b]	0.24	0.24
	(0.18)	(0.17)	(0.23)	(0.25)	(0.21)	(0.19)	(0.22)	(0.39)	(0.75)
$\hat{\beta}$	-0.07	-0.08	-0.17	-0.23	-0.28	-0.34[b]	-0.42[a]	-0.14	-0.11
	(0.17)	(0.16)	(0.21)	(0.22)	(0.17)	(0.16)	(0.14)	(0.35)	(0.63)
$\hat{\gamma}_1$	0.01[a]	0.01[a]	0.01[a]	0.01[b]	0.01[a]	0.01[b]	0.01[a]	0.02[b]	0.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
$\hat{\gamma}_2$	-0.06[c]	-0.07	-0.09[b]	-0.07	-0.09[c]	-0.10[c]	-0.11[c]	-0.07	-0.03
	(0.03)	(0.04)	(0.04)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)	(0.10)
$\hat{\gamma}_3$	-0.00	-0.01[b]	-0.01	0.00	0.00	-0.00	-0.00	-0.01	-0.00
	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.02)
$\bar{R}^2$	0.11	0.26	0.46	0.07	0.21	0.20	0.33	0.23	-0.06
χ^2	31.39[a]	43.50[a]	37.35[a]	10.61[c]	25.69[a]	17.55[a]	38.07[a]	23.44[a]	16.81[a]
LB(4)	0.71	7.12	7.61	8.81[c]	2.75	7.31	12.64[b]	2.48	6.42

Note: *s* refers to the most recently published time series. Newey-West standard errors in parentheses (). [a], [b] and [c] indicate significance at 1, 5, and 10 percent level, respectively. $\bar{R}^2$ is the model's adjusted multiple coefficient of determination. χ^2 gives the test statistics from the Wald test of $H_0: \alpha=\beta=0$ for equation (2) and $H_0: \alpha=\beta=\gamma_1=\gamma_2=\cdots=\gamma_p=0$ for equation (3). LB(4) gives the test statistics from the Ljung-Box test of the null hypothesis of no autocorrelation in the residuals up to and including the fourth order.

The results from this exercise are presented in Table 2. These results show that using an adjusted forecast instead of the initial publication leads to a lower RMSE at five out of eight horizons – even though during the estimations the model demonstrated significant results at the one percent level at all horizons except one. The benefits are also generally very small – at best the RMSE is lowered by seven-hundredths of a percentage point (at horizon seven).[15, 16] In other words, it is doubtful that the relationships estimated in equation (3) would be particularly useful in improving real-time forecasts of revised growth rates.[17, 18]

Table 2. Root mean square error for forecast based on equation (3) in a simulated forecast exercise

	Horizon							
	1	2	3	4	5	6	7	8
$RMSE^a$	0.27	0.27	0.30	0.36	0.28	0.26	0.24	0.41
$RMSE^b$	0.27	0.26	0.34	0.33	0.29	0.29	0.31	0.43

Note: $RMSE^a$ is the root mean square error for an adjusted forecast of GDP growth, $\tilde{x}_t^j = x_t^f + \hat{R}_t^j$, where x_t^f and $\hat{R}_t^j$ are the initial publication of the growth rate and the revision forecasted by equation (3), respectively. $RMSE^b$ is the root mean square error for x_t^f. The sample that is used spans the second quarter of 1999 to the first quarter of 2004/third quarter of 2008.

15. Since potential benefits are both small and uncertain, it is not particularly interesting to investigate whether the differences in forecasting precision are statistically significant. However, in principle this could be done using an adjusted Diebold-Mariano test; see Diebold and Mariano (1995) and Clark and McCracken (2005).

16. The results from the real-time forecast exercise are relatively robust with regard to the period used for the analysis. If the first forecast is instead generated for the first quarter of 2003 or the first quarter of 2005 – which result in 23 and 15 observations, respectively, for analysis – the results are similar. In all three cases the adjusted forecast is associated with a lower RMSE for horizons 3, 6, 7 and 8.

17. In addition to the specification of equation (3) presented in this commentary, many different combinations of variables in $z_{i,t}$ were evaluated in a sensitivity analysis. Both macroeconomic variables and variables based on survey data – for example the National Institute of Economic Research's Economic Tendency Survey – were used. The general conclusion from this analysis is that even if it is relatively easy to find variables that within the sample can explain revisions at different horizons, it is very difficult to find variables that in a reliable and quantifiably meaningful way can improve the forecasting ability. Since this sensitivity analysis was conducted on the most recently available data, the simulated real-time forecast exercise was not conducted entirely correctly and the results should therefore be treated accordingly.

18. All analysis of quarterly changes reported in this commentary was also carried out on annual percentage changes. The results provide some support for both bias and inefficiency at horizon eight and "most recent". However, also in the case of the annual percentage changes, it is difficult to reliably and substantially improve the forecast precision by using an adjusted forecast instead of the initial publication of the growth rate.

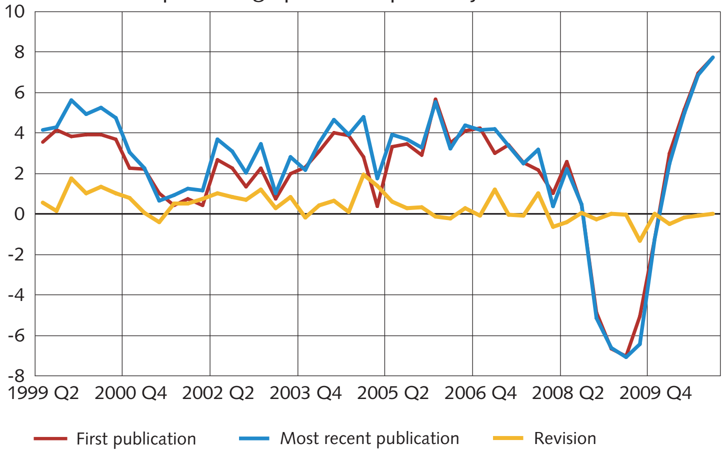
Summary and conclusions

In this economic commentary we investigated whether there are any systematic patterns in Statistics Sweden's GDP growth revisions at different horizons. The results show that the initial publication of the growth rate is not associated with any significant over- or underestimation. It is also not possible to find evidence that the revisions are correlated with the initial publication. When a number of macroeconomic variables are included in the model, the model's ability to explain the revisions is significant. This can be interpreted to mean that the initial publication of the growth rate is not an efficient forecast. This inefficiency means that forecasters in principle should be able to generate better forecasts of what growth in a given quarter will be according to later publications, but it also means that there is room for Statistics Sweden to improve its methods.

A simulated forecast exercise shows, however, that the improvements to the forecasting ability when using an adjusted forecast of the growth rate instead of the initial publication are minor and uncertain. As a result, it is our conclusion that even if there are some indications that the revisions systematically covary with the information that was available at the time of the initial publication of the growth rate, it would be difficult to make better forecasts by using this information. This also means that the production of statistics at Statistics Sweden does not demonstrate any obvious shortcomings in this respect.

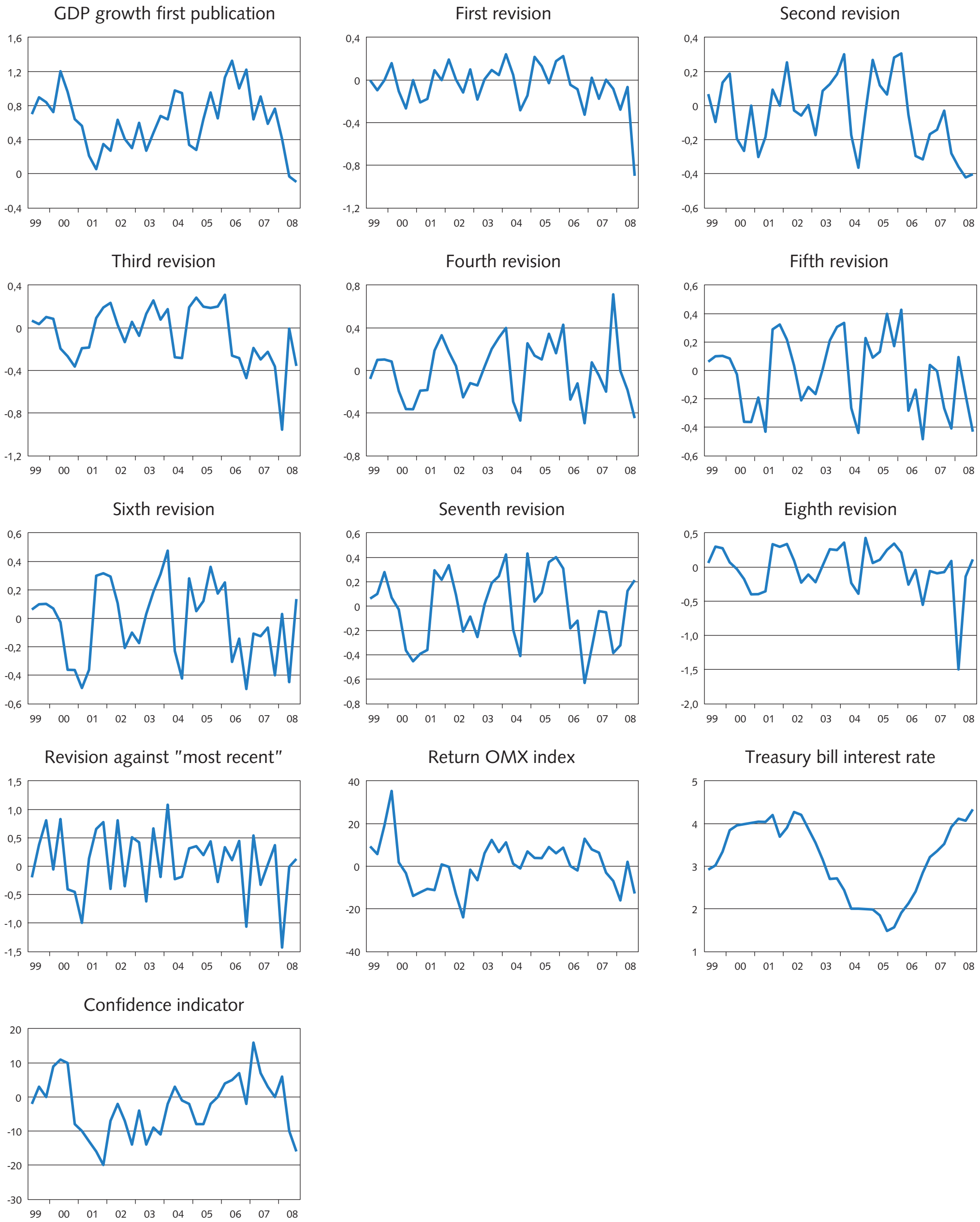
Figures

Figure 1. GDP growth and revisions
Percent and percentage points, respectively



Note: The revisions are calculated as the difference between GDP growth (measured as an annual percentage change) as given in the most recently published time series and the initial publication of GDP growth. The most recently published time series refers in this commentary to the data available in March 2011. The most recent quarter included in this time series is the fourth quarter of 2010, which means that the revision for this quarter by definition is zero.
Sources: Statistics Sweden and Sveriges Riksbank.

Figure 2. Data



Note: GDP growth, the return of the OMX index and treasury bill interest rate are measured in percent.
The revisions are stated in percentage points.
Sources: Statistics Sweden and Sveriges Riksbank.

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