A STATISTICAL ANALYSIS OF REVISIONS OF SWEDISH NATIONAL ACCOUNTS DATA*

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Abstract

In this paper, we study revisions of Swedish national accounts data. Three aspects of the revisions are considered: volatility, unbiasedness and forecast efficiency. Our results indicate that the properties of the revisions are more problematic for the production side than for the expenditure side. The high volatility of the revisions on the production side indicates that it is generally difficult to make clear cut statements concerning production across industries within the business sector based on the initial data release; it is also likely to make forecasting more difficult.

JEL Classification: E01

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1. Introduction

National accounts data are repeatedly revised for a number of reasons. Swedish national accounts data are normally first published approximately 60 days after the end of the quarter and are to a large extent based on information from limited samples.[1] Revisions then take place sequentially when new quarterly data are published. The information underlying the quarterly calculations is less detailed than that used for the annual calculations which are published 21 months after the end of the year.[2] The quarterly national accounts data are therefore also revised when the annual calculations are published. Apart from the quarterly revisions and the revisions made in connection with the annual calculations, there are also benchmark revisions approximately every five years due to new methods, new data sources and a general adaptation to requirements and recommendations from the European Union. These benchmark revisions also cause data to be revised, often far back in time.[3]

That national accounts data are revised is good practice and should mean that the data, as they are repeatedly revised, come to more closely reflect the actual state of the economy at a certain point in time. However, that the initial data release does not always accurately reflect current conditions complicates the work of forecasters and economic decision makers. Data revisions also complicate evaluations of economic policy. Revised data can paint a very different picture of the economy than the decision makers faced at the time of their decision; see, for example, Orphanides (2001), Orphanides and van Norden (2002), Clausen and Meier (2005) and Cimadomo (2012).

In this paper, we analyse historical revisions of Swedish national accounts data. The purpose of the analysis is to assess whether the data are revised in ways that could be problematic for the users of the data. With the exception of Statistics Sweden (2007), earlier studies of revisions of Swedish national accounts – such as Öller and Hansson (2004), Statistics Sweden (2010, 2011) and Österholm (2011) – have focused on GDP and the expenditure side. An important contribution of this paper is to extend standard evaluation methods to an analysis of historical revisions of both the expenditure and production side.[4] Three aspects of the revisions are studied: *i)* volatility, *ii)* unbiasedness and *iii)* forecast efficiency. Such traits are often put forward as desirable properties for revisions; see, for example, Aruoba (2008).

The first of these properties is that the volatility should be low. If the volatility of the revisions is low, later data vintages will resemble the first vintage and analysts, forecasters and decision makers can be reasonably confident that the picture of the Swedish economy initially painted by Statistics Sweden will not change dramatically over time. If the volatility instead is high, it becomes more difficult to make forecasts and statements concerning the economy since the data initially published tend to more poorly reflect the underlying state of the economy.

The second property is that the expected value of the revisions should be zero. If this is not the case, the data producer – in this case Statistics Sweden – makes systematic errors. Such bias is undesirable as it indicates that the initially published data could be improved. Finding that there is a bias is also of interest to forecasters and analysts who typically want to take such information into account. For example, known systematic biases enable better prediction of outcomes in later vintages.

The third property is that the revisions should be uncorrelated with information that

1 The first release of the second quarter is approximately 30 days after the end of the quarter.

2 Before 2012, the annual calculations were published 23 months after the end of the year.

3 In this paper, we make no distinction between the reasons for the revisions. It should be noted though that even if, for example, revisions due to changes in definitions at the benchmark revisions are problematic for the users of the national accounts data, they are largely inevitable since the data must be adjusted to a changing world and new methods. Potential shortcomings in the revisions due to the benchmark revisions are accordingly difficult to address.

4 The focus on the expenditure side is not only a feature of the studies that use Swedish data. It is uncommon in general to analyse the production side. See, for example, Rinne (1969) for an early study with a wide focus though.

was available at the time of the first data release. In a similar way to bias, correlation with information that was available at the time of the first release implies both that it should be possible to improve the initially published data so that it more closely resembles later data vintages and that there is information that forecasters and analysts should be able to exploit for various purposes.

Concerning the terminology used in this paper – but also generally in related literature – it can be noted that it typically is the properties of the revisions that are discussed. This is a bit ambiguous. It seems reasonable to describe a "good" revision as one which makes the data give a more accurate description of the economy. It is possible to consider a situation where each revision leads to this but that properties of the revisions nevertheless are found to be flawed. The problem in this case is that the initial data release has shortcomings and could be improved. This aspect of terminology should be kept in mind when the results are discussed.

Our results indicate that the properties of the revisions are more problematic for the production side than for the expenditure side. The volatility of the revisions of GDP and the majority of the analysed variables on the expenditure side is relatively low; it is primarily the volatility of the revisions of general government consumption, exports of services and imports of services that appear problematic. On the production side, the volatility is large for many aggregates, with the exception of the business sector as a whole and non-profit institutions serving households.[5] This indicates that, based on the initial data release, it is generally difficult to make clear cut statements concerning production in different industries within the business sector. Concerning unbiasedness, there appears to be a systematic underestimation of the growth numbers for GDP, household consumption, exports and imports on the expenditure side. On the production side there seems to be a systematic underestimation of growth numbers for the business sector as a whole, the manufacturing industry and the service sector. The first release of production in construction and in mining is, on the other hand, associated with systematic overestimation.

The rest of this paper is organised as follows. Section 2 gives a brief description of the data being analysed. In Section 3, we present the statistical methods employed. Section 4 describes the results and, finally, Section 5 concludes. All results are presented in tables in the appendix.

2. Data

Real-time data on a quarterly frequency were provided by Statistics Sweden and are analysed in fixed prices for variables on the expenditure side as well as the production side.[6] The analysis is conducted on the percentage change in the variable (relative to its value the same quarter one year earlier). 60 vintages of data have been used and data on revisions range from the second quarter 1999 to the fourth quarter 2013.[7,8]

For the expenditure side, the analysis is conducted at a fairly high level of aggregation (see Table 1).[9] Exports and imports have been divided into goods and services.

GDP from the production side shows how the production is distributed between different industries and sectors. The analysis is conducted for the production in general government, non-profit institutions serving households and the business sector. The production in the business sector is also divided into a number of industries (see Table 1). In 2011 the industry classification in the national accounts was al-

5 In this paper, "production" refers to value added.

6 By real-time data we mean a set of different vintages of data. For a further discussion, see, for example, Croushore and Stark (2001) and Croushore (2011).

7 Earlier vintages of real-time data than those employed here are not readily available.

8 For all quarters, the regular release has been used for analysis. That is, the first release for the second quarter (see footnote 1) is not used.

9 It can be noted that inventories have not been included in the analysis. The reason for this is that inventories – unlike all other variables in this paper – are normally discussed in terms of their contribution to GDP growth. It is problematic though to conduct analysis of contributions to growth since revisions can be due to revisions in both the numerator (that is, the change in inventories) and the denominator (that is, GDP). To analyse the growth rate, as we have done for the other variables, is not considered informative since it can vary extremely much since the denominator in some cases is very small.

Table 1 Variables included in the study

GDP and the expenditure side	Production side
GDP	General government production
Household consumption	Non-profit institutions serving households (NPISH)
General government consumption	Business sector (NACE A-U)
Gross fixed capital formation	Producers of goods (NACE A-F)
Exports	Agriculture, forestry and fishing (NACE A)
Exports of goods	Mining (NACE B)
Exports of services	Manufacturing (NACE C)
Imports	Construction (NACE F)
Imports of goods	Producers of services (NACE G-U)
Imports of services	Trade (NACE G)
	Financial services (NACE K)
	Real estate production (NACE L)

Sources: Statistics Sweden and the National Institute of Economic Research.

tered due to a new version of the European industrial activity classification (NACE Rev.2).[10] The new data were published in connection with the regular publication of the second quarter 2011. The production in the business sector as a whole was not affected by the change of NACE, but new industries within the business sector were added and within some existing industries the growth numbers were changed substantially, in particular within the service sector. To avoid revisions that largely are a result of the change of NACE, the analysis of the production side is only conducted for industries that were unaffected or only slightly affected by the change of NACE.

3. Methods

The revisions are defined according to

$$(1)\ r_{j,t} = x_{j,t} - x_{f,t}$$

where $x_{f,t}$ is the first release for quarter t for a particular variable and $x_{j,t}$ is the release for quarter t published j quarters later. We conduct our analysis for $j=(1,2,...,7,s)$, where s is the latest data vintage published by Statistics Sweden.[11] This means that for $j=(1,2,...,7)$, the "revision horizon" is fixed; for $j=s$, however, the revision horizon is different for each observation in a time series.[12]

As was pointed out in the introduction, we study three aspects of the revisions – volatility, unbiasedness and forecast efficiency – using methods which are commonly employed in the literature; see, for example, Mankiw *et al*. (1984), Faust *et al*. (2005), Roodenburg and den Reijer (2006) and Aruoba (2008).

We measure **volatility** with the standard deviation. For the revisions, we calculate one number for each variable and revision horizon. Since the volatility of the growth of different variables varies quite substantially, it is relevant to compare the volatility of the revisions to the volatility of the variable itself.[13] The volatility of the variables themselves is based on the latest vintage of the data. Since some variables were much more affected by the financial

10 NACE Rev.2 is a statistical classification of economic activity to various industries.

11 The latest data vintage in this study is the one published in February 2014 which contains data up to and including the fourth quarter 2013.
12 For j=s this means, for example, that the issue of benchmark revisions mentioned in footnote 3 becomes more problematic; see Arouba (2008) for a discussion.
13 It should be noted though that it is not necessarily the case that a variable with high volatility is revised more than a variable with low volatility.

crisis than others, the volatility for the variables themselves is calculated for two periods, both the full sample and a sample which ends in the third quarter of 2008.

A test for **unbiasedness** can be conducted by running the regression

$$(2)\ r_{j,t}=c+e_t$$

where e_t is an error term. The null hypothesis H_0:$c=0$ is tested using a simple *t*-test.[14] If the null hypothesis is rejected, it is concluded that the growth rate released initially for a certain quarter is not an unbiased estimate of later releases. In the cases where $c>0$, the first release has underestimated later ones; if $c<0$, it has overestimated.

Forecast efficiency implies that the revisions are uncorrelated with information which was available the time of the first release. If this is not the case, it might to some extent be possible to improve the data being published by Statistics Sweden. One way to test for forecast efficiency is to run the regression

$$(3)\ r_{j,t}=c+\beta x_{f,t}+e_t$$

and then test whether the null hypothesis H_0:$c=\beta=0$ can be rejected using a Wald test. If, for example, $\beta>0$ then higher values of the first release are associated with higher values of the revision. This means that the first release was not an efficient forecast.[15]

The efficiency test can also be generalised to take into account other information which was available at the time of the first release. In this paper, we consider two variables which are presumed to have information concerning the state of the business cycle, namely new export orders in the manufacturing industry (s_t) as measured in the *Economic Tendency Survey* and the three-month treasury bill rate (i_t).[16] The estimated equation is given by

$$(4)\ r_{j,t}=c+\beta x_{f,t}+\gamma_1 i_t+\gamma_2 s_t+e_t$$

and the null hypothesis H_0:$c=\beta=\gamma_1=\gamma_2=0$ is tested using a Wald test.[17]

4. Results

4.1. The expenditure side

A brief overview of the results can be found in Table 2. Tables with all results can be found in the appendix.

4.1.1 Volatility

As can be seen from Table 2 below and Table 4 to Table 13 in the appendix, the volatility of the revisions is larger the longer the revision horizon. For GDP, this is illustrated in Figure 1 and Figure 2 below. Figure 1 shows time series with the first and second release of GDP growth and the revision between these two series (*j=1)*. Figure 2 shows time series with the first and latest release (February 2014) and the revision between these two series (*j=s)*. That longer revision horizons are associated with higher volatility in the revisions is expected since the data should be revised more compared to the initial release as better sources become available.

14 Newey-West standard errors are used to address the serial correlation (and heteroskedasticity) in the residuals.

15 This is a traditional test of forecast efficiency; see, for example, Mincer and Zarnowitz (1969).

16 Data from the Economic Tendency Survey can be downloaded from http://statistik.konj.se/PXWeb/pxweb/en/KonjBar/.

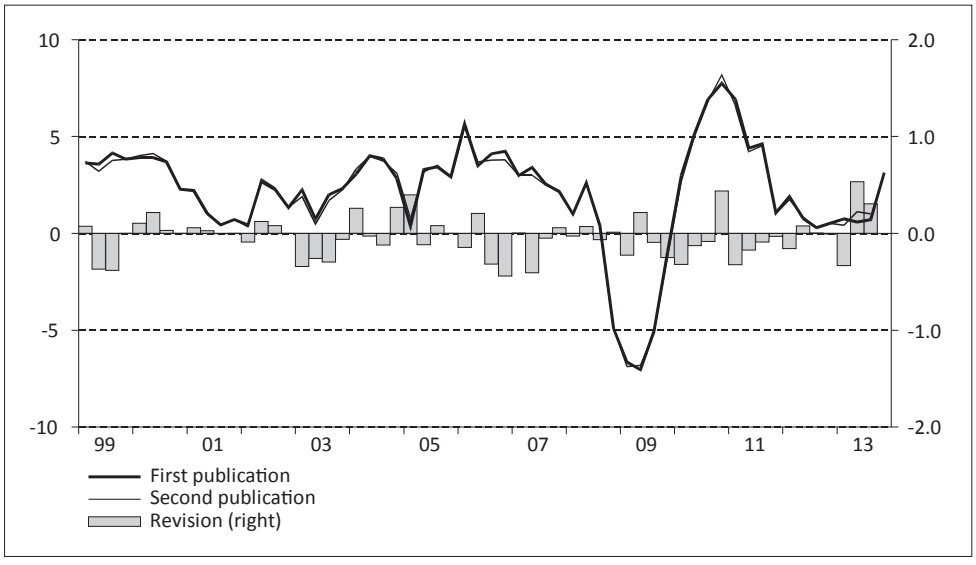
17 It can be noted that for both equation (3) and (4), the probability that the null hypothesis is rejected increases if bias has been established by finding that c≠0 in equation (2).

Table 2 Summary of results for the expenditure side

	Revision	Volatility ratio	Unbiasedness	Mincer–Zarnowitz	General efficiency
GDP	j=1	0.1	0.0	1.1	0.6
	j=s	0.2	0.3*	3.2*	3.9**
Household consumption	j=1	0.4	0.0	0.7	0.4
	j=s	0.4	0.5**	6.6**	4.9**
General government consumption	j=1	0.4	0.0	2.5	2.1
	j=s	0.7	–0.1	7.1**	4.2**
Gross fixed capital formation	j=1	0.2	–0.3	1.8	1.2
	j=s	0.3	0.4	0.9	0.6
Exports	j=1	0.1	0.4**	14.3**	7.3**
	j=s	0.2	0.6*	2.9	4.3**
Exports of goods	j=1	0.1	0.1	1.9	3.9**
	j=s	0.1	0.3	1.5	1.1
Exports of services	j=1	0.3	1.3**	12.4**	8.0**
	j=s	0.6	1.9*	3.7*	5.1**
Imports	j=1	0.1	0.4**	9.8**	10.2**
	j=s	0.2	0.7**	4.6*	5.9**
Imports of goods	j=1	0.1	0.4**	10.4**	5.3**
	j=s	0.1	0.8**	8.7**	7.2**
Imports of services	j=1	0.3	0.4	3.9*	4.4**
	j=s	0.6	0.2	0.7	3.5*

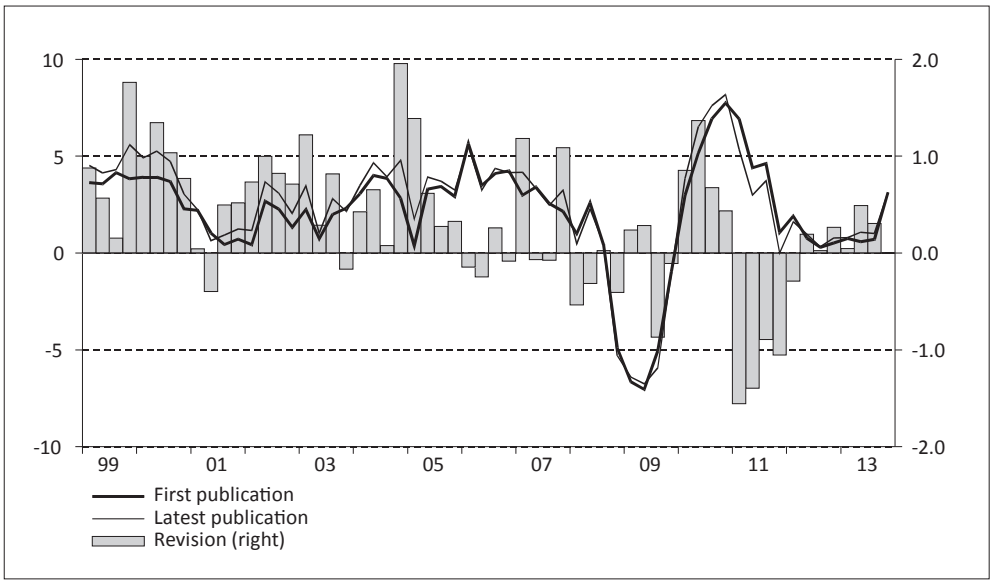
*Note: "Volatility ratio" is the standard deviation of the revision divided by the standard deviation of the variable (measured over the period 1999Q2-2013Q4). "Unbiasedness" gives the parameter estimate ĉ from equation (2), which is the same as the average revision at the horizon in question. "Mincer-Zarnowitz" gives the test statistic from the Wald test related to equation (3). "General efficiency" gives the test statistic from the Wald test related to equation (4). "**" and "*" indicate that the relevant null hypothesis can be rejected at the one and five percent level respectively.*
Sources: Statistics Sweden and the National Institute of Economic Research.

Figure 1 GDP: first and second publication
Percentage change and percentage points, respectively



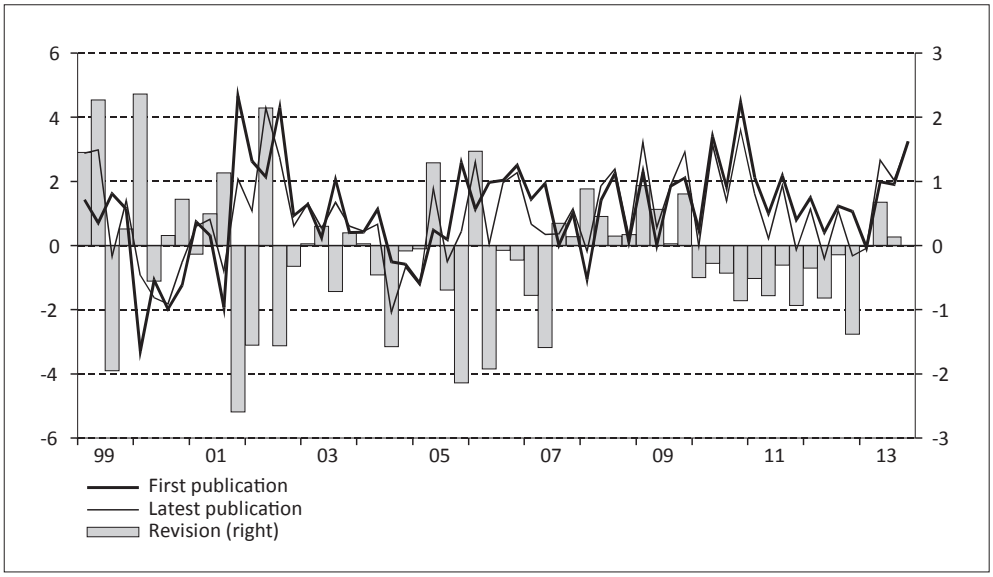
Sources: Statistics Sweden and the National Institute of Economic Research.

Figure 2 GDP: first and latest publication
Percentage change and percentage points, respectively



Sources: Statistics Sweden and the National Institute of Economic Research.

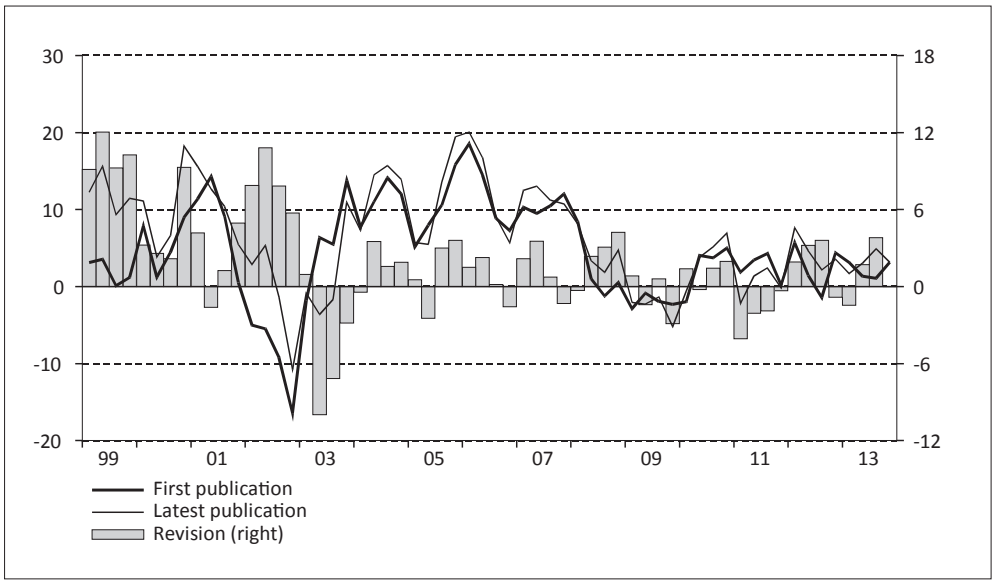
Figure 3 General government consumption: first and latest publication
Percentage change and percentage points, respectively



Sources: Statistics Sweden and the National Institute of Economic Research.

For a number of variables – GDP, gross fixed capital formation, exports, exports of goods, imports and imports of goods – the ratio between the volatility at the horizon $j=s$ and the volatility in the variable itself is only 0.3 or lower. The growth rate of some variables was more affected by the financial crisis than that of others. When comparing the volatility of the revisions (for the full period) to the volatility of the variable for the period 1999Q2 to 2008Q3 – that is, excluding the financial crisis and the period thereafter – the ratio for GDP and gross fixed capital formation rises to almost 0.5.

Figure 4 Exports of services: first and latest publication
Percentage change and percentage points, respectively



Sources: Statistics Sweden and the National Institute of Economic Research.

The variables that stand out when it comes to the volatility of the revisions are primarily general government consumption, exports of services and imports of services. At the horizon $j=s$, the ratio between the revisions and the volatility in the variable itself is over 0.7 for general government consumption and 0.6 for exports of services and imports of services. This magnitude of the ratio indicates that analysis of initially published data might be problematic. The revisions for general government consumption and exports of services at the horizon $j=s$ are shown in Figure 3 and Figure 4.

4.1.2 Unbiasedness

With respect to unbiasedness, general government consumption, gross fixed capital formation, exports of goods and imports of services appear to be the variables with the best properties. No statistically significant bias can be established for these variables.

For GDP and household consumption, significant results are found at horizon $j=s$. The positive estimated coefficient indicates that the initial release has underestimated the final release.

For both exports and imports, the test indicates – at all horizons – that the initial release is not an unbiased estimate of later releases. For exports, this bias turns out to have its origin in the exports of services where significance is established at all horizons. The bias in imports is due to the imports of goods; also in this case, significance is established at all horizons. The estimated coefficients are all positive, again indicating that the initial release has underestimated later releases.

4.1.3 Forecast efficiency

The results from the conducted efficiency tests indicate that only one variable passes all tests without remarks, namely gross fixed capital formation. For GDP, significance is established at the revision horizon $j=s$ for both the Mincer-Zarnowitz test and the more general efficiency test. This is not particularly surprising given the bias that was found at the same horizon. Looking at the estimated equations in more detail though, it turns out that in the general efficiency test, the coefficients on both i_t and s_t are significant (if only at the ten percent

level).[18] Also for household consumption both efficiency tests show significance at the revision horizon *j=s*.

More substantial shortcomings can be found for a number of variables. For general government consumption, significant results are found at all horizons except *j=1,2* for both tests.[19] For imports, both tests indicate shortcomings concerning efficiency at all horizons. The same is true for exports, except at the horizon *j=s*.[20] The results for imports are largely due to problems with the imports of goods. For imports of services significant results are found only for *j=1* and *j=1,2,s* for the two tests respectively. The results for exports are to a large extent driven by the exports of services where significant results are found at all horizons for both tests; the exports of goods show significant results only in a few cases.

It should be kept in mind though that the shortcomings concerning efficiency that have been identified are not necessarily easy to turn into improved initial data releases. The results above should – in the cases where significant results were found – therefore not be interpreted as if Statistics Sweden could have done a better job. Rather, significant results indicate where possible improvements could be made.

4.2. The production side

A brief overview of the results can be found in Table 3. Tables with all results can be found in the appendix.

4.2.1 Volatility

As can be seen from Table 3 below and Table 14 to Table 25 in the appendix, the volatility of the revisions of the production side – like the expenditure side – increases when the revision horizon is extended and better sources become available. The volatility of the revisions for general government production – a variable which makes up approximately 20 percent of GDP – is considerable at all revision horizons.

Figure 5 shows time series with the first and second release of general government production growth and the revision between these two series (*j=1)*. Figure 6 shows time series with the first and latest release (February 2014) and the revision between these two series (*j=s)*. The ratio between the first revision horizon (*j=1)* and the volatility of the variable itself is 0.3. The ratio between the latest revision horizon (*j=s)* and the volatility of the variable itself is 0.9, which means that it is difficult to draw any conclusion about production from the first data published. General government production was not affected that much by the financial crisis. The volatility of this variable is even smaller for the long period than for the short period that excludes the financial crisis and the subsequent period. The ratio between the latest revision horizon (*j=s)* and the volatility in the variable itself for the short period therefore falls to 0.8.

The volatility of the revisions of business sector production is smaller than that of general government production. The ratio between the volatility of the revisions for horizon *j=s* and the volatility of the variable itself is 0.3, which is the same as for non-profit institutions serving households. The volatility of the growth rate of the business sector, however, has been unusually large in the period after the financial crisis (see Figure 7). The ratio rises to 0.5 when calculated for the second quarter 1999 to the third quarter 2008.

The volatility of the revisions across industries is higher than that of the business sector as a whole. Figure 8 and Figure 9 show time series with the first and the latest release and the revision between these two series (*j=s)* for the producers of goods and the producers of services. The ratio between the volatility of the revisions at horizon *j=s* and the volatility of the variable itself is 0.4 for both aggregates. In a comparison with the volatility of the variable itself for the short period excluding the financial crisis and the subsequent period, the picture is different. The ratio between the volatil-

18 Results are not reported in detail here but are available from the authors upon request.
19 This result is generally due to the coefficient β being significant.
20 As was the case for GDP above, this was not unexpected given that bias had already been established.

Table 3 Summary of results for the production side

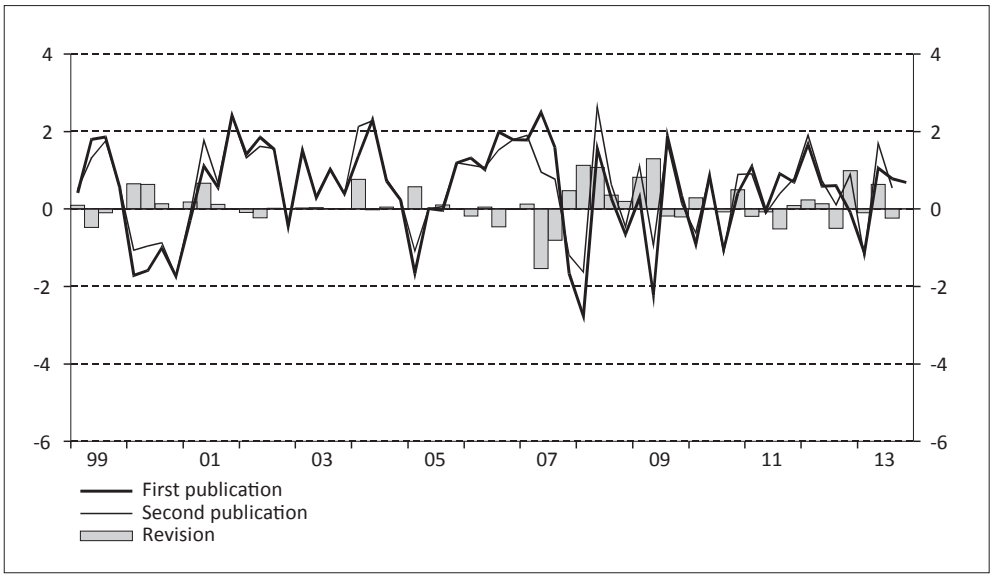
	Revision	Volatility ratio	Unbiasedness	Mincer–Zarnowitz	General efficiency
General government production	j=1	0.3	0.1	13.3**	8.5**
	j=s	0.9	–0.2	2.8	2.4
Non-profit institutions serving households	j=1	0.1	0.1	0.8	0.6
	j=s	0.3	–0.8	10.0**	5.6**
Business sector	j=1	0.1	–0.1	2.5	4.1**
	j=s	0.3	0.5**	4.0*	5.9**
Producers of goods	j=1	0.1	–0.1	2.7	2.9*
	j=s	0.4	0.6	1.1	3.1*
Agriculture, forestry and fishing	j=1	0.3	–0.1	0.1	1.2
	j=s	1.0	1.5	3.3*	6.2**
Mining	j=1	0.1	0.0	3.2*	1.8
	j=s	0.7	–3.8*	2.8	3.6*
Manufacturing	j=1	0.1	–0.1	1.0	1.1
	j=s	0.4	1.7*	3.3*	3.7**
Construction	j=1	0.2	–0.3*	3.0	1.7
	j=s	0.9	–2.9**	10.4**	7.2**
Producers of services	j=1	0.2	–0.0	0.3	0.4
	j=s	0.4	0.5*	3.6*	2.2
Trade	j=1	0.2	0.0	2.3	3.8**
	j=s	0.7	0.4	3.8*	10.6**
Financial services	j=1	0.8	0.0	3.6*	1.9
	j=s	1.1	1.5	21.7**	13.9**
Real estate services	j=1	0.2	0.0	7.0**	3.6*
	j=s	0.8	0.7	1.7	1.0

*Note: "Volatility ratio" is the standard deviation of the revision divided by the standard deviation of the variable (measured over the period 1999Q2-2013Q4). "Unbiasedness" gives the parameter estimate $\hat{c}$ from equation (2), which is the same as the average revision at the horizon in question. "Mincer-Zarnowitz" gives the test statistic from the Wald test related to equation (3). "General efficiency" gives the test statistic from the Wald test related to equation (4). "**" and "*" indicate that the relevant null hypothesis can be rejected at the one and five percent level respectively.*
Sources: Statistics Sweden and the National Institute of Economic Research.

ity of the revisions for $j=s$ and the volatility of the variable itself rises to 0.9 for the producers of goods and to 0.6 for the producers of services. The difference is mainly explained by the fact that it was primarily producers of goods, in particular manufacturing, that were hit by the financial crisis. Growth fell sharply at first then rose strongly, which means that the volatility is considerably higher if one includes the financial crisis and the subsequent period (see Table 17 and Table 22).

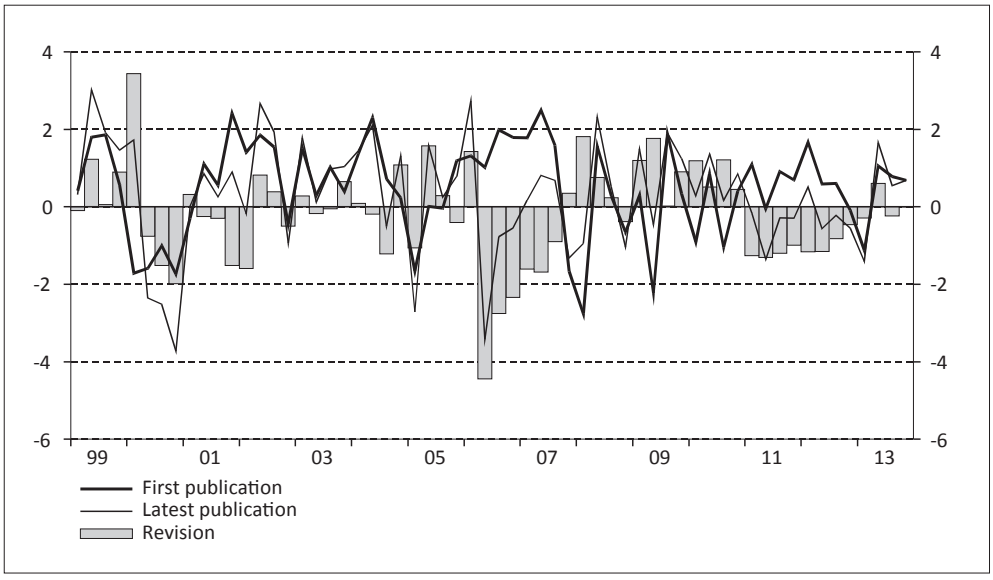
Across industries that produce goods, the ratio between the volatility at the horizon $j=s$ and the volatility in the variable itself is 0.4 for manufacturing and 0.7 for mining. The ratio for agriculture, forestry and fishing is 1.0. The ratio for construction is also considerable and amounts to 0.9. In a comparison with the volatility of the variable itself for the short period excluding the financial crisis and the subsequent period, the ratio is approximately 1.0 for manufacturing, mining, and agriculture, forestry and fishing. The corresponding figure for construction is 0.9. All the analysed industries within goods production are thus revised substantially.

Figure 5 General government production: first and second publication
Percentage change and percentage points, respectively



Sources: Statistics Sweden and the National Institute of Economic Research.

Figure 6 General government production: first and latest publication
Percentage change and percentage points, respectively

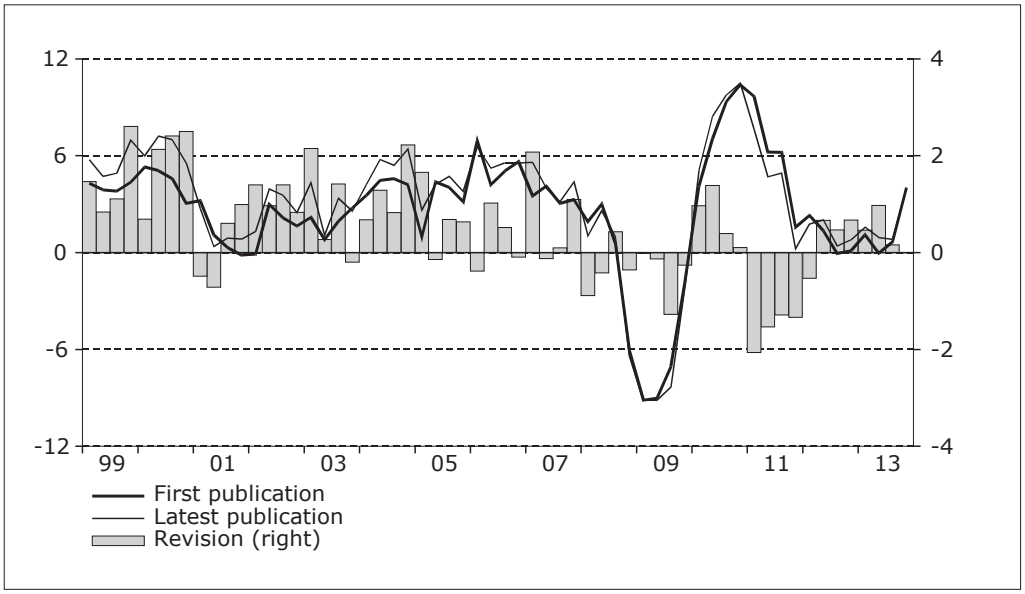


Sources: Statistics Sweden and the National Institute of Economic Research.

The volatility of the revisions across industries within the service sector shows that production of financial services is revised considerably already in the second publication (see Figure 10). The ratio between the volatility at the first revision horizon and the volatility in the variable itself is 0.8. Compared with the latest revision horizon the ratio rises to 1.1, which means that the volatility in the revisions is greater than the volatility in the variable itself.

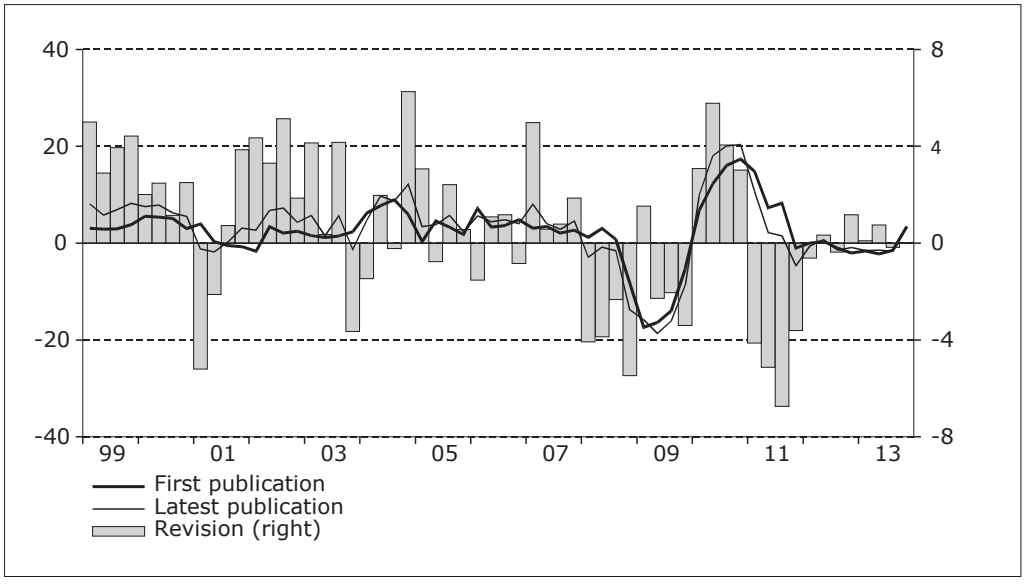
Revisions of growth numbers for trade and production of real estate services are also relatively large, but mainly at the latest revision

Figure 7 Business sector: first and latest publication
Percentage change and percentage points, respectively



Sources: Statistics Sweden and the National Institute of Economic Research.

Figure 8 Producers of goods: first and latest publication
Percentage change and percentage points, respectively

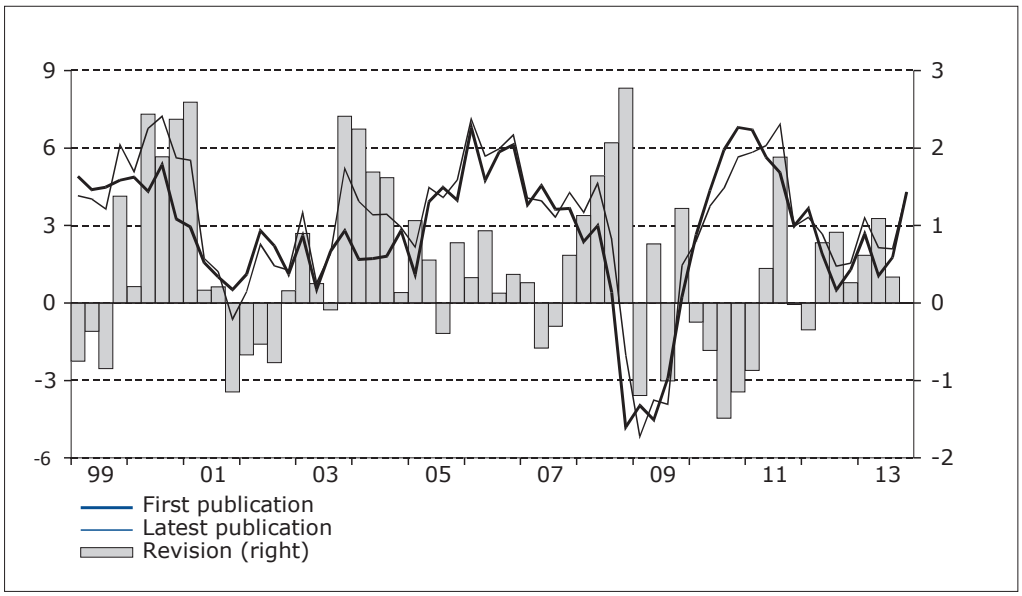


Sources: Statistics Sweden and the National Institute of Economic Research.

horizon. The ratio between the volatility at the first revision horizon (*j=1)* and the volatility in the variable itself is 0.2 for both industries, but gradually increases to 0.7 for trade and to 0.8 for real estate services.

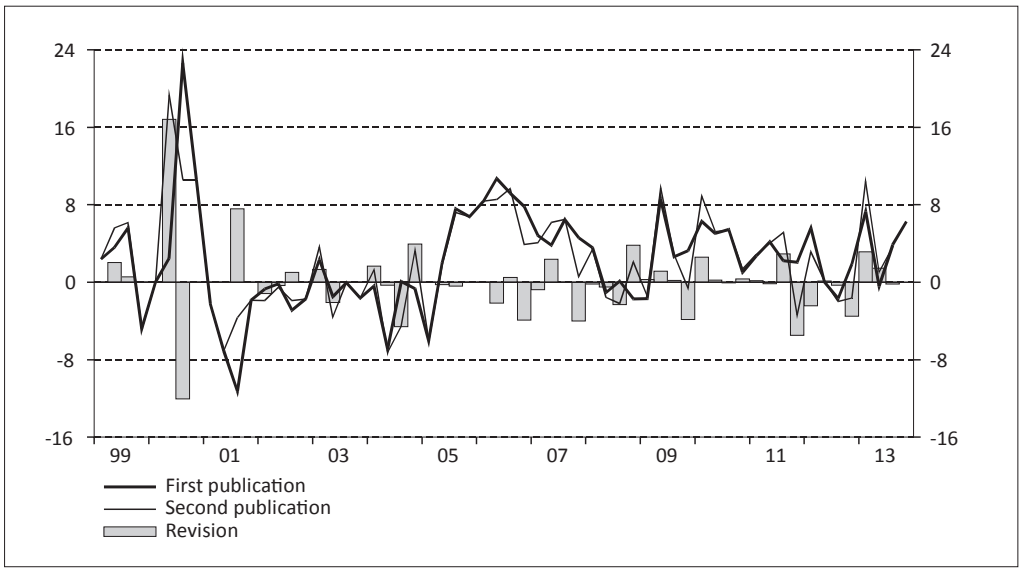
One potential explanation for the finding that revisions of the production side are more volatile than the revisions of the expenditure side is the important difference between the quarterly and annual estimates of the national accounts for the production side. More specifically, the quarterly estimates lack information on intermediate consumption in different industries, forcing Statistics Sweden to make

Figure 9 Producers of services: first and latest publication
Percentage change and percentage points, respectively



Sources: Statistics Sweden and the National Institute of Economic Research.

Figure 10 Financial services: first and second publication
Percentage change and percentage points, respectively



Sources: Statistics Sweden and the National Institute of Economic Research.

assumptions about input coefficients. The standard assumption is an unchanged input coefficient from the latest annual estimate. The revisions in connection with the annual estimates could therefore be considerable if the input coefficients change substantially. However, the detailed data required to assess this issue are not available.

4.2.2 Unbiasedness

The test for unbiasedness indicates that the initial release is not an unbiased estimate of the final release for the production in the business sector and the production of services. The positive coefficient indicates that the initial publication underestimates the latest publication. The production of goods, on the other hand, appears to be an unbiased estimate at all horizons. The production of services accounts for almost 70 per cent of business sector production and the bias in service production thereby explains the biased estimate of business sector production as a whole at horizon $j=s$.

Concerning the different industries within goods production, the test shows that the initial publications of manufacturing, mining and construction are associated with bias at horizons $j=s$, $j=7,s$ and $j=1,6,7,s$ respectively.[21] The coefficients across industries, however, largely cancel each other out such that the producers of goods as a whole still appear to be associated with an unbiased estimate at all horizons. The coefficient for agriculture, forestry and fishing amounts to 1.5 at the latest revision horizon and even though it is not significant, it could potentially be seen as a problem due to the size of the point estimate.

Across industries within the service sector there is less evidence of statistically significant bias. The coefficient for trade is not significant at any horizon. The coefficient for production of financial services is large and amounts to 1.5 at the latest revision horizon $j=s$, which indicates that the initial publication is an underestimation. The coefficient, however, is not significantly different from zero. The coefficient for production of real estate services is also positive and significant at revision horizon seven, but not at $j=s$. The test thus shows that the initial publication is an unbiased estimate of the latest publication.

4.2.3 Forecast efficiency

The results from the two efficiency tests indicate that no variable on the production side passes without remarks. For production in general government, significance is established at the first seven revision horizons when using the Mincer-Zarnowitz test (equation 3), but not at $j=s$. The more general test (equation 4) is significant at the first five revision horizons.

As for production in the business sector as a whole the Mincer-Zarnowitz test is only significant at the revision horizon $j=s$. This is not particularly surprising though given that bias was found at the same horizon. The more general test, however, is significant for both the first and the seventh revision horizon, which indicates that the revision of the production in the business sector is correlated with information available at the time of the first data release. The general test is also significant at revision horizon $j=s$. When interpreting this result one should keep in mind that, as with the Mincer-Zarnowitz test, bias was already established at the horizon $j=s$.

All industries within the business sector display shortcomings in terms of efficiency (see Table 17 to Table 25). The results for the main aggregates – producers of goods and producers of services – appear to be somewhat better than for the smaller industry aggregates. The general test is significant for the producers of goods at the revision horizons $j=1,7,s$, while only the Mincer-Zarnowitz test is significant for the producers of services and only at the revision horizon $j=s$. As was the case for the business sector, this result is not unexpected as bias has already been established at this horizon. For production of financial services the Mincer-Zarnowitz test is significant at all revi-

21 The high negative coefficient for construction is partly due to a single major revision made in September 2013, when growth in construction production in 2011 was revised down by more than 10 percentage points.

sion horizons and the general test is significant at all horizons except *j=1*. Regarding trade, the Mincer-Zarnowitz test is only significant at the revision horizon *j=s*, while the general test is significant at all horizons.

5. Conclusions

In this paper, we have studied revisions of Swedish national accounts data with respect to volatility, unbiasedness and forecast efficiency. Results indicate that the properties of the revisions are more problematic for the production side than for GDP and the expenditure side.

The volatility of the revisions of GDP and of most of the variables on the expenditure side is relatively low. There are exceptions though – general government consumption, exports of services and imports of services are associated with reasonably high volatility. As for the production side, the volatility in the revisions is relatively large for most aggregates except for the business sector as a whole and non-profit institutions serving households. The production of financial services stands out with substantial revisions even at the first revision horizon.

Concerning unbiasedness, there are signs of a systematic underestimation for GDP, household consumption, exports and imports. The production side also displays shortcomings. The first publication of business sector production is not an unbiased estimate of the final number – the growth rate has on average been revised up. This is largely because the initial release for service production tends to be an underestimate. The production of goods, on the other hand, appears to be an unbiased estimate, but there are indications that the initial publication is biased for several of the industries within the production of goods.

With respect to forecast efficiency, shortcomings are identified for a number of variables. Exports and imports appear most problematic on the expenditure side. Trade and the production of financial services seem to be the most problematic on the production side.

Taken together, our results indicate that there are problematic aspects of the properties of the revisions. The identified shortcomings concerning unbiasedness and forecast efficiency indicate possibilities to improve the production of the national accounts data. Systematic over- or underestimation is not desirable since it, for example, can make it harder for forecasters to generate high-precision forecasts. As far as possible, the causes of these shortcomings should be investigated so that they can be addressed. The high volatility which has been found in some of the revisions – particularly on the production side – is not a welcome feature either and leads us to conclude that it is difficult to make strong statements concerning the production in the smaller industry aggregates based on the initial data release; it also limits the possibility to make good forecasts at an industry level. There is a relatively high demand for detailed industry data and forecasts. Users of data and forecasts should be aware of the problems identified in this study though. The high volatility of revisions is not a desirable feature of the data but that said, it is not necessarily straightforward to address the problem because it likely owes largely to incomplete sources. A possible solution could be to expand the quarterly gathering of data. However, while more frequent data gathering could enhance industry statistics, the social benefit might be offset by the increased burden on respondents.

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Appendix

Table 4 GDP

	Volatility	Unbiasedness	Mincer–Zarnowitz	General efficiency
Revision j=1	0.2	0.0	1.1	0.6
Revision j=2	0.3	0.0	0.8	2.0
Revision j=3	0.3	0.0	0.2	2.1
Revision j=4	0.4	0.0	0.3	0.7
Revision j=5	0.4	0.0	0.6	1.3
Revision j=6	0.5	0.0	1.3	1.1
Revision j=7	0.6	0.1	1.7	1.8
Revision j=s	0.7	0.3*	3.2*	3.9**
Data 1999:2–2008:3	1.5	–	–	–
Data 1999:2–2013:4	3.0	–	–	–

*Note: "Volatility" is the standard deviation of the revision and the standard deviation of the variable itself measured over two different periods. "Unbiasedness" gives the parameter estimate $\hat{c}$ from equation (2), which is the same as the average revision at the horizon in question. "Mincer-Zarnowitz" gives the test statistic from the Wald test related to equation (3). "General efficiency" gives the test statistic from the Wald test related to equation (4). "**" and "*" indicate that the relevant null hypothesis can be rejected at the one and five percent level respectively.*
Sources: Statistics Sweden and the National Institute of Economic Research.

Table 5 Household consumption

	Volatility	Unbiasedness	Mincer–Zarnowitz	General efficiency
Revision j=1	0.7	0.0	0.7	0.4
Revision j=2	0.8	0.0	0.1	0.2
Revision j=3	0.6	0.0	0.2	0.1
Revision j=4	0.6	0.1	0.4	0.5
Revision j=5	0.6	0.1	0.2	0.8
Revision j=6	0.6	0.1	0.3	0.6
Revision j=7	0.7	0.1	0.6	0.5
Revision j=s	0.8	0.5**	6.6**	4.9**
Data 1999:2–2008:3	1.5	–	–	–
Data 1999:2–2013:4	1.8	–	–	–

Note: See Table 4 for explanations.
Sources: Statistics Sweden and the National Institute of Economic Research.

Table 6 General government consumption

	Volatility	Unbiasedness	Mincer–Zarnowitz	General efficiency
Revision j=1	0.5	0.0	2.5	2.1
Revision j=2	0.7	0.0	1.8	1.2
Revision j=3	0.9	0.0	5.6**	2.8*
Revision j=4	0.9	0.0	7.4**	3.7*
Revision j=5	1.0	0.0	5.9**	3.6*
Revision j=6	1.0	0.0	4.2*	4.1**
Revision j=7	1.0	0.0	10.5**	7.9**
Revision j=s	1.0	–0.1	7.1**	4.2**
Data 1999:2–2008:3	1.4	–	–	–
Data 1999:2–2013:4	1.4	–	–	–

Note: See Table 4 for explanations.
Sources: Statistics Sweden and the National Institute of Economic Research.

Table 7 Gross fixed capital formation

	Volatility	Unbiasedness	Mincer–Zarnowitz	General efficiency
Revision j=1	1.5	–0.3	1.8	1.2
Revision j=2	1.5	–0.2	0.9	1.2
Revision j=3	1.7	–0.3	1.2	0.8
Revision j=4	1.9	–0.3	1.2	0.6
Revision j=5	1.9	–0.3	1.2	0.6
Revision j=6	1.9	–0.3	1.3	0.7
Revision j=7	2.1	–0.2	0.5	0.3
Revision j=s	2.2	0.4	0.9	0.6
Data 1999:2–2008:3	4.6	–	–	–
Data 1999:2–2013:4	7.2	–	–	–

Note: See Table 4 for explanations.
Sources: Statistics Sweden and the National Institute of Economic Research.

Table 8 Exports

	Volatility	Unbiasedness	Mincer–Zarnowitz	General efficiency
Revision j=1	0.5	0.4**	14.3**	7.3**
Revision j=2	0.6	0.4**	15.1**	8.9**
Revision j=3	0.8	0.4**	8.1**	6.7**
Revision j=4	0.9	0.4**	5.8**	5.7**
Revision j=5	1.0	0.5**	5.7**	3.9**
Revision j=6	1.1	0.5**	6.1**	3.6*
Revision j=7	1.1	0.5**	4.9*	4.7**
Revision j=s	1.4	0.6*	2.9	4.3**
Data 1999:2–2008:3	4.2	–	–	–
Data 1999:2–2013:4	7.0	–	–	–

Note: See Table 4 for explanations.
Sources: Statistics Sweden and the National Institute of Economic Research.

Table 9 Exports of goods

	Volatility	Unbiasedness	Mincer–Zarnowitz	General efficiency
Revision j=1	0.6	0.1	1.9	3.9**
Revision j=2	0.7	0.0	1.9	1.5
Revision j=3	0.9	0.0	4.6*	2.0
Revision j=4	0.9	0.0	2.3	0.9
Revision j=5	1.0	0.0	0.0	0.4
Revision j=6	1.1	0.0	0.3	0.9
Revision j=7	1.0	0.0	0.4	1.1
Revision j=s	1.2	0.3	1.5	1.1
Data 1999:2–2008:3	4.6	–	–	–
Data 1999:2–2013:4	8.6	–	–	–

Note: See Table 4 for explanations.
Sources: Statistics Sweden and the National Institute of Economic Research.

Table 10 Exports of services

	Volatility	Unbiasedness	Mincer–Zarnowitz	General efficiency
Revision j=1	1.9	1.3**	12.4**	8.0**
Revision j=2	2.1	1.5**	18.1**	13.6**
Revision j=3	2.6	1.8**	10.4**	12.4**
Revision j=4	2.9	1.9**	8.9**	10.4**
Revision j=5	3.2	2.1**	8.4**	11.3**
Revision j=6	3.3	2.0**	6.2**	6.5**
Revision j=7	3.3	2.3**	7.7**	6.5**
Revision j=s	4.1	1.9*	3.7*	5.1**
Data 1999:2–2008:3	6.8	–	–	–
Data 1999:2–2013:4	6.6	–	–	–

Note: See Table 4 for explanations.
Sources: Statistics Sweden and the National Institute of Economic Research.

Table 11 Imports

	Volatility	Unbiasedness	Mincer–Zarnowitz	General efficiency
Revision j=1	0.6	0.4**	9.8**	10.2**
Revision j=2	0.7	0.4**	12.8**	7.4**
Revision j=3	0.8	0.5**	12.0**	7.1**
Revision j=4	0.9	0.5**	10.1**	7.1**
Revision j=5	0.9	0.5**	8.8**	5.9**
Revision j=6	1.0	0.4**	5.1**	3.5*
Revision j=7	1.0	0.6**	8.5**	5.9**
Revision j=s	1.2	0.7**	4.6*	5.9**
Data 1999:2–2008:3	4.9	–	–	–
Data 1999:2–2013:4	7.4	–	–	–

Note: See Table 4 for explanations.
Sources: Statistics Sweden and the National Institute of Economic Research.

Table 12 Imports of goods

	Volatility	Unbiasedness	Mincer–Zarnowitz	General efficiency
Revision j=1	0.6	0.4**	10.4**	5.3**
Revision j=2	0.7	0.4**	12.2**	5.8**
Revision j=3	0.8	0.6**	20.8**	13.8**
Revision j=4	1.0	0.6**	9.2**	5.3**
Revision j=5	1.1	0.6**	7.5**	4.6**
Revision j=6	1.2	0.6*	6.9**	4.1**
Revision j=7	1.3	0.7**	6.3**	3.4*
Revision j=s	1.2	0.8**	8.7**	7.2**
Data 1999:2–2008:3	5.7	–	–	–
Data 1999:2–2013:4	8.9	–	–	–

Note: See Table 4 for explanations.
Sources: Statistics Sweden and the National Institute of Economic Research.

Table 13 Imports of services

	Volatility	Unbiasedness	Mincer–Zarnowitz	General efficiency
Revision j=1	1.8	0.4	3.9*	4.4**
Revision j=2	1.9	0.2	3.0	3.1*
Revision j=3	2.5	0.2	2.7	1.7
Revision j=4	2.5	0.1	2.0	1.3
Revision j=5	2.8	0.2	1.3	0.8
Revision j=6	2.9	0.2	0.7	1.5
Revision j=7	2.8	0.3	1.0	1.6
Revision j=s	3.1	0.2	0.7	3.5*
Data 1999:2–2008:3	5.3	–	–	–
Data 1999:2–2013:4	5.7	–	–	–

Note: See Table 4 for explanations.
Sources: Statistics Sweden and the National Institute of Economic Research.

Table 14 General government production

	Volatility	Unbiasedness	Mincer–Zarnowitz	General efficiency
Revision j=1	0.5	0.1	13.3**	8.5**
Revision j=2	0.6	0.1	6.5**	4.8**
Revision j=3	0.8	0	7.3**	3.9**
Revision j=4	0.8	0	6.3**	3.3*
Revision j=5	1.1	–0.2	5.1**	2.7*
Revision j=6	1.1	–0.2	4.1*	2.1
Revision j=7	1.1	–0.2	3.2*	2.1
Revision j=s	1.3	–0.2	2.8	2.4
Data 1999:2–2008:3	1.7	–	–	–
Data 1999:2–2013:4	1.5	–	–	–

Note: See Table 4 for explanations.
Sources: Statistics Sweden and the National Institute of Economic Research.

Table 15 Non-profit institutions serving households

	Volatility	Unbiasedness	Mincer–Zarnowitz	General efficiency
Revision j=1	0.5	0.1	0.8	0.6
Revision j=2	0.7	0.2	1.6	1.8
Revision j=3	1.5	0.3	1.4	0.8
Revision j=4	2.1	0.4	2.3	1.4
Revision j=5	2.6	0.6	7.4**	5.7**
Revision j=6	3.0	0.8	108.0**	57.4**
Revision j=7	3.3	0.5	1.5	1.3
Revision j=s	2.8	–0.8	10.0**	5.6**
Data 1999:2–2008:3	10.3	–	–	–
Data 1999:2–2013:4	8.5	–	–	–

Note: See Table 4 for explanations.
Sources: Statistics Sweden and the National Institute of Economic Research.

Table 16 Business sector

	Volatility	Unbiasedness	Mincer–Zarnowitz	General efficiency
Revision j=1	0.3	–0.1	2.5	4.1**
Revision j=2	0.4	0.0	0.4	0.4
Revision j=3	0.4	0.0	0.0	0.5
Revision j=4	0.5	0.0	0.3	0.4
Revision j=5	0.5	0.0	0.6	1.1
Revision j=6	0.6	0.1	2.0	2.5
Revision j=7	0.7	0.2	1.4	2.8*
Revision j=s	1.0	0.5**	4.0*	5.9**
Data 1999:2–2008:3	1.9	–	–	–
Data 1999:2–2013:4	4.0	–	–	–

Note: See Table 4 for explanations.
Sources: Statistics Sweden and the National Institute of Economic Research.

Table 17 Producers of goods (NACE A–F)

	Volatility	Unbiasedness	Mincer–Zarnowitz	General efficiency
Revision j=1	0.6	–0.1	2.7	2.9*
Revision j=2	0.8	–0.1	2.3	1.3
Revision j=3	1.0	–0.1	2.8	1.4
Revision j=4	1.0	0.0	0.5	0.4
Revision j=5	1.0	0.0	0.0	0.4
Revision j=6	1.4	0.2	0.7	2.2
Revision j=7	1.9	0.3	0.7	2.9*
Revision j=s	3.1	0.6	1.1	3.1*
Data 1999:2–2008:3	3.5	–	–	–
Data 1999:2–2013:4	7.4	–	–	–

Note: See Table 4 for explanations.
Sources: Statistics Sweden and the National Institute of Economic Research.

Table 18 Agriculture, forestry and fishing (NACE A)

	Volatility	Unbiasedness	Mincer–Zarnowitz	General efficiency
Revision j=1	1.9	–0.1	0.1	1.2
Revision j=2	2.3	–0.1	0.1	0.8
Revision j=3	2.4	–0.1	0.1	0.4
Revision j=4	2.3	0.1	0.3	0.4
Revision j=5	3.3	0.4	0.9	1.6
Revision j=6	4.4	0.8	2.4	2.1
Revision j=7	4.7	1.3	3.4*	3.6*
Revision j=s	5.6	1.5	3.3*	6.2**
Data 1999:2–2008:3	5.8	–	–	–
Data 1999:2–2013:4	5.7	–	–	–

Note: See Table 4 for explanations.
Sources: Statistics Sweden and the National Institute of Economic Research.

Table 19 Mining (NACE B)

	Volatility	Unbiasedness	Mincer–Zarnowitz	General efficiency
Revision j=1	2.3	0.0	3.2*	1.8
Revision j=2	2.4	0.1	0.3	0.7
Revision j=3	3.4	0.7	0.9	1.5
Revision j=4	7.5	–0.1	7.1**	6.3**
Revision j=5	6.8	–0.3	8.7**	8.5**
Revision j=6	5.8	–0.8	14.2**	7.6**
Revision j=7	9.5	–2.5*	6.7**	4.1**
Revision j=s	10.8	–3.8*	2.8	3.6*
Data 1999:2–2008:3	9.7	–	–	–
Data 1999:2–2013:4	15.6	–	–	–

Note: See Table 4 for explanations.
Sources: Statistics Sweden and the National Institute of Economic Research.

Table 20 Manufacturing (NACE C)

	Volatility	Unbiasedness	Mincer–Zarnowitz	General efficiency
Revision j=1	0.9	–0.1	1.0	1.1
Revision j=2	1.2	–0.1	1.4	0.7
Revision j=3	1.4	–0.2	2.6	1.2
Revision j=4	1.6	0.0	0.2	0.2
Revision j=5	1.7	0.1	0.1	0.1
Revision j=6	2.5	0.5	1.2	1.2
Revision j=7	3.1	1.0	2.2	3.4*
Revision j=s	4.5	1.7*	3.3*	3.7**
Data 1999:2–2008:3	4.5	–	–	–
Data 1999:2–2013:4	10.8	–	–	–

Note: See Table 4 for explanations.
Sources: Statistics Sweden and the National Institute of Economic Research.

Table 21 Construction (NACE F)

	Volatility	Unbiasedness	Mincer–Zarnowitz	General efficiency
Revision j=1	1.3	–0.3*	3.0	1.7
Revision j=2	1.4	–0.2	0.8	1.0
Revision j=3	1.6	–0.2	0.5	0.6
Revision j=4	1.8	–0.5	1.9	1.2
Revision j=5	1.9	–0.6	2.1	1.5
Revision j=6	2.3	–1.0*	4.8*	5.4**
Revision j=7	3.3	–1.9**	10.3**	11.5**
Revision j=s	5.2	–2.9**	10.4**	7.2**
Data 1999:2–2008:3	5.8	–	–	–
Data 1999:2–2013:4	5.7	–	–	–

Note: See Table 4 for explanations.
Sources: Statistics Sweden and the National Institute of Economic Research.

Table 22 Producers of services (NACE G–U)

	Volatility	Unbiasedness	Mincer–Zarnowitz	General efficiency
Revision j=1	0.5	0.0	0.3	0.4
Revision j=2	0.5	0.0	0.1	0.6
Revision j=3	0.6	0.1	0.9	1.5
Revision j=4	0.6	0.1	2.8	1.9
Revision j=5	0.7	0.1	1.4	1.7
Revision j=6	0.8	0.1	0.7	1.6
Revision j=7	0.9	0.1	0.4	1.5
Revision j=s	1.1	0.5*	3.6*	2.2
Data 1999:2–2008:3	1.9	–	–	–
Data 1999:2–2013:4	2.6	–	–	–

Note: See Table 4 for explanations.
Sources: Statistics Sweden and the National Institute of Economic Research.

Table 23 Trade (NACE G)

	Volatility	Unbiasedness	Mincer–Zarnowitz	General efficiency
Revision j=1	0.9	0.0	2.3	3.8**
Revision j=2	1.1	0.0	2.4	8.2**
Revision j=3	1.2	0.1	1.4	6.2**
Revision j=4	1.4	0.1	0.3	4.4**
Revision j=5	1.7	0.1	0.3	4.9**
Revision j=6	2.0	–0.1	0.3	4.0**
Revision j=7	2.1	–0.3	0.6	4.0**
Revision j=s	2.8	0.4	3.8*	10.6**
Data 1999:2–2008:3	2.5	–	–	–
Data 1999:2–2013:4	3.8	–	–	–

Note: See Table 4 for explanations.
Sources: Statistics Sweden and the National Institute of Economic Research.

Table 24 Financial services (NACE K)

	Volatility	Unbiasedness	Mincer–Zarnowitz	General efficiency
Revision j=1	3.5	0.0	3.6*	1.9
Revision j=2	3.9	0.2	9.4**	5.0**
Revision j=3	4.0	0.3	21.7**	12.0**
Revision j=4	4.0	0.4	24.8**	14.1**
Revision j=5	4.3	0.3	20.9**	13.1**
Revision j=6	4.2	0.4	19.0**	12.6**
Revision j=7	4.6	0.5	17.4**	14.5**
Revision j=s	4.9	1.5	21.7**	13.9**
Data 1999:2–2008:3	4.5	–	–	–
Data 1999:2–2013:4	4.5	–	–	–

Note: See Table 4 for explanations.
Sources: Statistics Sweden and the National Institute of Economic Research.

Table 25 Real estate services (NACE L)

	Volatility	Unbiasedness	Mincer–Zarnowitz	General efficiency
Revision j=1	0.7	0.0	7.0**	3.6*
Revision j=2	0.9	0.1	6.5**	4.4**
Revision j=3	0.9	0.2	1.2	1.0
Revision j=4	0.9	0.2	1.2	1.2
Revision j=5	0.9	0.2	2.8	2.3
Revision j=6	1.2	0.2	8.2**	4.4**
Revision j=7	1.6	0.4*	14.5**	8.4**
Revision j=s	2.6	0.7	1.7	1.0
Data 1999:2–2008:3	3.0	–	–	–
Data 1999:2–2013:4	3.3	–	–	–

Note: See Table 4 for explanations.
Sources: Statistics Sweden and the National Institute of Economic Research.