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BACK TO BASICS: DATA REVISIONS

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Back to basics: Data revisions*

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Abstract

With few exceptions, most economic data undergo revisions. Although frequently neglected, data revisions may have implications, not only for economic analysis, but also for policy decisions, as revisions may alter current assessment and forecasts of economic developments. In this paper, we reassess data revisions analysis and its impact on forecasting, presenting an encompassing and unified perspective on this subject. For this purpose, we built a real-time database for Portuguese exports and imports of goods. We present a broad set of the measures typically used to gauge revisions and add to this discussion by clarifying the relations between revisions to different types of series (for example, revisions to month-on-month and year-on-year rates of change). Furthermore, regarding the (un)predictability of revisions, we suggest an alternative testing approach. The key feature of this approach is that it takes into account both in-sample and out-of-sample performances. We also discuss the impact of revisions on forecasting, focusing on short-term forecasting of first releases. Even though not accounting for data revision implications can lead to suboptimal results, our findings reinforce the need for a case by case analysis.

Keywords: Revision Analysis, Real-time Data, News and Noise, Forecasting.
JEL Codes: C53, C82

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1 Introduction

With few exceptions (e.g. interest rates, exchange rates, commodity prices and survey of forecasts), most economic data undergo revisions. First releases of official statistics are often (substantially) different from subsequent releases and the revision process may last for quite a long time.

Since revisions add uncertainty to data analysis, one may be tempted to see data revisions as a “bad thing”. However, this is not necessarily so. To understand why, one should bear in mind that the main goal of revisions is to improve the quality of preliminary figures, as latter estimates should move closer to the “truth”. Since there is a trade-off, inherent to statistical production, between the timeliness of releases and a more complete coverage of source data, one of the reasons for revisions of official statistics is the incorporation of new and more complete information, which only becomes available after the first release of the data. Moreover, subsequent releases also present an opportunity to correct errors, in the raw data or in computation.[1] Therefore, series that do not undergo revisions should not be seen, *a priori*, as of higher quality than series that are revised.

However, the existence of revisions may have implications, not only for economic analysis, but also for policy decisions, as revisions may alter current assessments and forecasts of economic developments. The potential effect of data revisions on economic analysis and forecasting is not a recent concern, being acknowledged since at least the late 1950’s. For example, Zellner (1958) recognises the importance of studying the statistical properties of provisional estimates, since, he argues, several economic policy decisions and forecasts are based on these preliminary figures. While studying the effects of measurement errors on parameter estimates and forecasts, Denton and Kuiper (1965) also identified revisions to preliminary releases as a potential source of changes in the relations between variables.

In spite of being deemed as relevant, the existence of revisions and its impact on economic analysis have frequently been neglected, as already noted by Denton and Kuiper (1965). Typically, most empirical analyses use data from the most recent release available at the time. One of the reasons (possibly, the main reason) for overlooking data revisions is that dealing with revisions is not easy. On the one hand, it requires collecting the data as they were released in each period (or vintage) - in other words, it requires compiling a *real-time* database - which can be a rather cumbersome and time-consuming task. On the other hand, as the existence of revisions to first estimates and subsequent releases poses challenges for forecasting and economic analysis, standard

[1] See McKenzie (2006) for a summary list of reasons for revisions of official statistics.

econometric tools and techniques are also called into question.

Although often disregarded, more recently, real-time data and revision analysis have been drawing more and more attention. This renewed interest, triggered by the work of Croushore and Stark (2001) on a readily available real-time data set for macroeconomists, is reflected in the development of multiple real-time databases (such as the Federal Reserve Bank of St. Louis' database for the United States, the real-time database co-ordinated by the Euro Area Business Cycle Network (EABCN) for the euro area, and OECD's real-time database) as well as in the rapidly expanding literature on this topic (see, for example, Stark (2002)).[2]

The literature on real-time data can be roughly divided in two major strands. One strand focuses on gauging data revisions (mean revision, mean absolute revision, relative mean absolute revision, and standard deviation of the revisions, to name a few of the measures typically used) and understanding its behaviour. For example, Croushore and Stark (2001) describe the properties of the revisions to several time series for the United States. For the United Kingdom, Meader (2007) and George (2005) present an analysis of revisions to GDP growth and its components, while Turner (2005) uses Balance of Payments quarterly data. McKenzie (2006) analyses the revisions to some economic activity indicators for OECD countries and a few selected non-member economies. Similarly, Kholodilin and Siliverstivs (2009) assess the quality of early releases of German national accounts data.

Instead of measuring accuracy (*i.e.*, how close early estimates are from the underlying "true" value), revision analysis examines the reliability of early releases as estimates of the final values. For first estimates to be reliable, revisions should be "well-behaved", as Aruoba (2008) put it. The main features of "well-behaved" revisions are: (i) the mean of the series should not change because of revisions, so revisions should have zero mean; (ii) the volatility of the series should not be greatly affected by the volatility of revisions, so the standard deviation of revisions should be small, compared to the standard deviation of the revised series; and (iii) given the information available at the time of the initial estimate, revisions should not be predictable, that is, revisions should add *news* instead of reducing *noise* (see, among others, Mankiw and Shapiro (1986) and Faust et al. (2005)).

The second strand of the literature deals with the impact of revisions on different areas, such as: model specification and forecasting (Koenig et al. (2003) consider

[2]The database presented in Croushore and Stark (2001) is available at the Federal Reserve Bank of Philadelphia's website and consists of quarterly snapshots, from November 1965 onwards, of several United States time series with monthly and quarterly frequency. See http://www.philadelphiafed.org/research-and-data/real-time-center/real-time-data/data-files/. See also http://alfred.stlouisfed.org/ for St. Louis Fed's database, http://www.eabcn.org/data/rtdb/index.htm for EABCN Real Time Database, and http://stats.oecd.org/mei/default.asp?rev=1 for OECD's database.

simple, single equation models, while a Kalman filter framework is used by Patterson (1995), Kishor and Koenig (2005) and Jacobs and van Norden (2007), among others); alternative detrending methods (Orphanides and van Norden (2002) and Döpke (2004)); information criteria for model selection (Stark and Croushore (2002)); and, robustness of well-established results reported on major macroeconomic studies to real-time databases (Croushore and Stark (2003)).

In this context, the aim of this paper is to reassess data revisions analysis and its impact on forecasting, merging both strands of the literature. For this analysis we built a real-time database for Portuguese exports and imports of goods. By stressing the fact that "revision" is a wide concept, we clarify the relations between revisions to different types of series (for example, revisions to month-on-month and year-on-year rates of change). We argue that these relations can influence the results of some measures typically used to gauge revisions (such as the relative mean absolute revision), which may turn out to be misleading. The (un)predictability of revisions is also tested. In particular, we add to this discussion by comparing the results obtained through the traditional testing framework (see, for example, Aruoba (2008)) with the results from the test recently proposed by Clark and McCracken (2009*a*), for in-sample testing of predictive ability. Furthermore, we discuss the impact of revisions on forecasting, focusing on short-term forecasting of first releases.

The remainder of this paper is organised as follows. In Section 2, we describe the real-time database used in the paper. In Section 3, we analyse data revisions. The implications of data revisions for forecasting are discussed in Section 4. Finally, Section 5 concludes.

2 Real-time database

The series under analysis in this paper refer to monthly data of total imports and exports of goods released by *Instituto Nacional de Estatística* (*INE*) on a monthly basis. These series cover both intra-community trade (data mainly obtained from the Intrastat questionnaire) and extra-community trade (data obtained from customs declarations). In order to analyse the revisions to these series, we constructed a real-time database containing a collection of *vintages* of import and export data. Following Croushore and Stark (2001), we call *vintage* the latest data series available at a particular date.

The first estimate of imports and exports for each month (only aggregates) is available 40 days after the end of the reference month, being released in the context of the Special

Data Dissemination Standard (SDDS).[3] The second estimate is released 70 days after the end of the reference month in the international trade statistics publication, which includes more detailed data disaggregated by product and by country. Subsequent estimates are available with an additional 30-day lag, as ensuing international trade statistics publications are released (the third estimate is released 100 days after the end of the reference month, the fourth estimate is released 130 days after the end of the reference month, and so on and so forth). Currently (since August 2009), the SDDS estimate is also released under the designation of *flash estimate* in the international trade statistics publication. This means that the first estimate for a given month (m) is released at the same time (and in the same publication) as the revised series up to the previous month ($m-1$).

The international trade statistics publication includes data for the reference year (t) and for the 12 months of the previous year ($t-1$). For example, flash estimates apart, the publication released in September 2007 includes data for the period from January 2006 to June 2007 and the publication released in April 2008 includes data since January 2007 up to January 2008 (Table 1).

Since data referring to the year t are usually no longer released from April $t+2$ onwards (when the second estimate for January $t+2$ is released), the monthly values for year t released in March $t+2$ are assumed to be the latest data for this period. Therefore, the number of potential revisions to figures for each month of the year varies according to the month of reference, ranging from a minimum of 13 times (in the case of December) to a maximum of 24 times (for January).

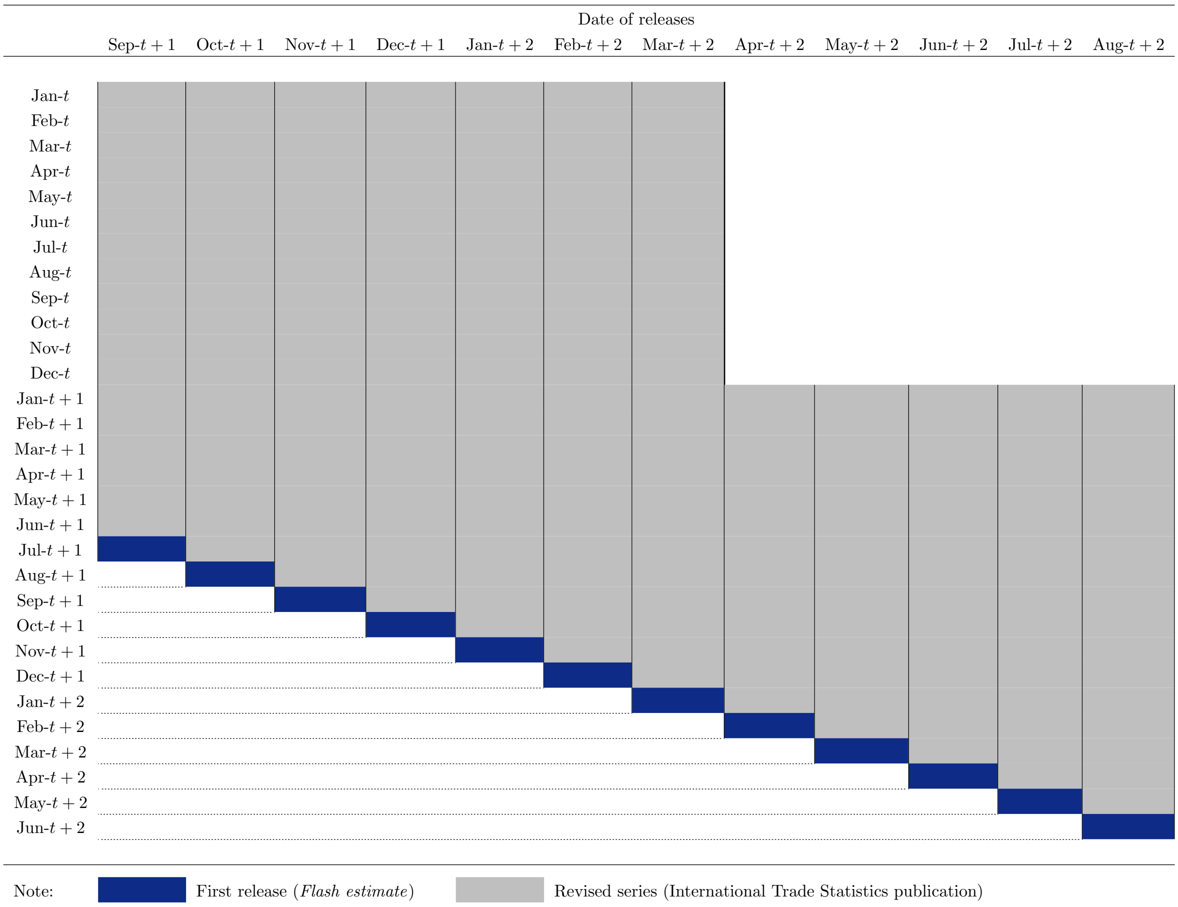
Our real-time data set includes vintages from March 2006 to August 2009, covering the period from January 2004 onwards.[4] The time series only go as far back as January 2004 because in September 2005 the methodology underlying the compilation of international trade statistics (namely its intra-community component) changed. The series compiled according to the new methodology are available only from January 2004 onwards.

Before this change in the methodology, the intra-community trade component consisted in values declared by firms, through the Intrastat declarations received until the closing date for publication. As more declarations were received, new data were incorporated in subsequent releases. This methodology hindered the use of rates of change implicit in each publication, as values for different periods were not comparable (in general, the

[3] The SDDS was established by the International Monetary Fund (IMF) in order to guide countries in the dissemination of their data to the public.

[4] Implicitly, in the following analysis, we consider data available in the March 2006 vintage (from January 2004 to January 2006) as first estimates. Although estimates from January 2004 to December 2005 are of a slightly different nature (in particular, when compared with January 2006 first estimate) including them in the analysis does not qualitatively change the results.

Table 1: Pattern of releases



values for more recent periods were underestimated, reflecting a shorter data collection period and a lower coverage).

The main changes introduced by the new methodology were the inclusion of non-response and *below-threshold*[5] estimates (for more details on the methodology, see INE (2007) and INE (2006)). So, instead of referring to declared figures only, international trade statistics have currently a broader coverage. Revisions to these figures may occur as non-response estimates are replaced by actual data reported by firms or additional information (for example, correcting errors) is included.

To sum up, our real-time database contains 42 vintages, the first one containing data for the period from January 2004 to January 2006, and the last one from January 2004 to June 2009.

[5]Intrastat declarations are not mandatory for firms with yearly transactions inferior to a certain threshold.

3 Data revisions

3.1 Which revisions?

Let X_t^i be the estimate for period t of vintage i. Then, the revision to the estimate for period t, after j vintages is as follows:

$$r_t^j = X_t^{i+j} - X_t^i \tag{1}$$

Given this general definition, several types of revisions can be calculated, depending on the kind of data considered (for example, levels, month-on-month rates of change or year-on-year rates of change), on its periodicity (monthly, quarterly, annual), and on the vintages used (from first estimate up to the latest vintage). Furthermore, the type of revisions is also determined by the events that give rise to the revisions. For example, regular or information-based revisions result from incorporating more (but less timely) source data, while benchmark revisions reflect methodological changes.

Assuming that current concepts, classifications and methodologies are the most relevant for economic analysis and policy decisions, in this paper we exclude benchmark revisions. Therefore, as mentioned in section 2, our database only covers the period from January 2004 onwards. Moreover, we focused on monthly revisions to rates of change. For assessing developments in exports and imports, one is usually more interested in rates of change than in levels. Also, using rates of change is a common procedure when series in levels are non-stationary.

For both month-on-month and year-on-year rates of change, summary statistics typically used to gauge revisions, such as mean revision, mean absolute revision, relative mean absolute revision, and standard deviation of revisions are presented in Tables A.1 to A.4 of the Appendix.[6] These statistics were calculated for revisions to previous vintage estimates (*i.e.*, previous month) and for the cumulated revisions since the first release. In order to ensure comparability and consistency throughout the analysis, all calculations were made considering a fixed window of estimates (that is, the same number of observations). Hence, the revision series used end in June 2008 (53 observations in the case of month-on-month rates, and 42 observations for year-on-year rates of change). Since our sample ends in June 2009, in order to ensure that all estimates had at least one year to undergo revisions, we consider revisions only up to June 2008.

Regarding total revisions (cumulated revisions up to the latest release) to month-on-month rates of change, the average revision was 0.5 percentage points (p.p.) for exports and 0.6 p.p. for imports. The average of revisions to year-on-year rates of change was

[6] For more details on the statistical measures, see McKenzie (2006) and Di Fonzo (2005).

1.7 p.p. for exports and 2.2 p.p. for imports. Furthermore, the results for the relative mean absolute revision (*i.e.*, the mean absolute revision scaled in terms of the size of the underlying series of vintage $i+j$) suggest that the first estimate of exports(imports) was revised by 6(12) per cent in the case of month-on-month rates of change, and by 20(28) per cent in the case of year-on-year rates of change.

In spite of being used for assessing the robustness of the different rates of change to the revision process (see, for example, McKenzie (2006) and McKenzie (2007)), we argue that the relative mean absolute revision is not an appropriate tool for this purpose. Direct comparisons of statistical measures (even in the case of the relative mean absolute revision) are hindered by the intrinsic difference in scale between month-on-month and year-on-year rates of change. Bearing in mind the relation between month-on-month (mom_t) and year-on-year (yoy_t) rates of change, the relation between revisions to both rates is as follows:

$$\begin{aligned} r_t^j &= yoy_t^{i+j} - yoy_t^i \\ &= \sum_{h=0}^{11} (mom_{t-h}^{i+j} - mom_{t-h}^i) . \frac{X_{t-(h+1)}^i}{X_{t-12}^i} + \sum_{h=0}^{11} mom_{t-h}^{i+j} . \left(\frac{X_{t-(h+1)}^{i+j}}{X_{t-12}^{i+j}} - \frac{X_{t-(h+1)}^i}{X_{t-12}^i} \right) \end{aligned} \quad (2)$$

So, revisions to yoy_t are equal to a weighted sum of revisions to mom_{t-h} ($h = 0, ..., 11$) plus a correction term accounting for the revisions to weights. If the relative weights of each month do not significantly change from vintage to vintage, then revisions to year-on-year rates of change can be roughly seen as weighted sums of revisions to month-on-month rates of change, from vintage i to vintage $i + j$. As a rule-of-thumb, the mean revision to yoy_t can be compared with 12 times the mean revision to mom_t.

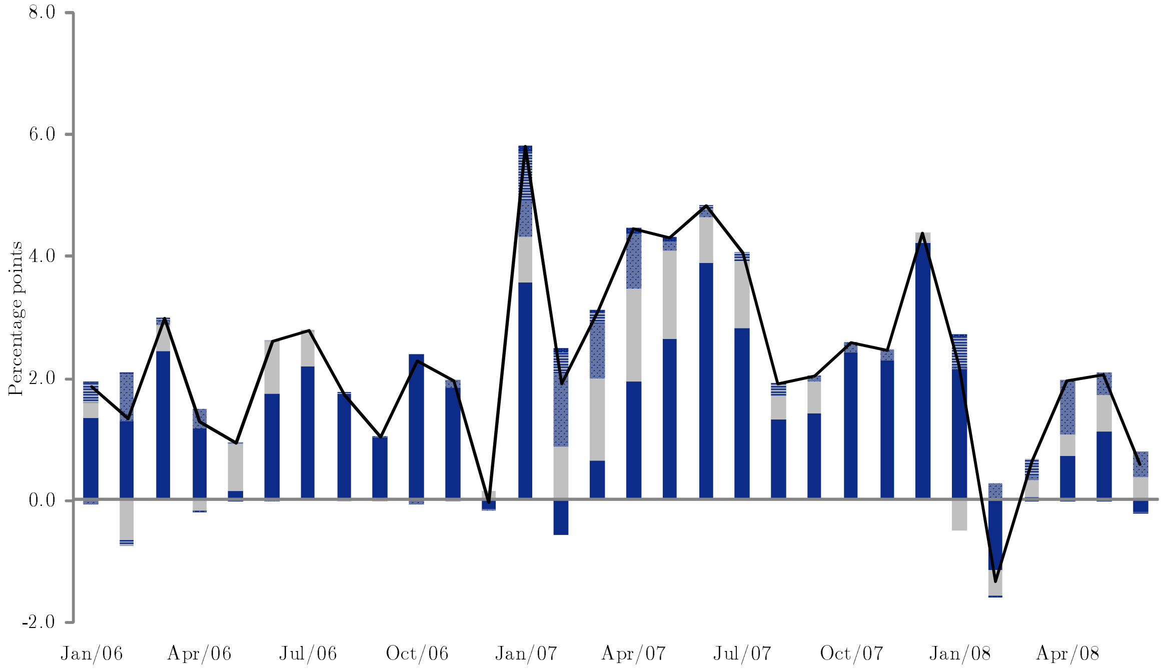
In the following analysis we focus on year-on-year rates of change. Year-on-year rates of change are commonly used in short-term economic analysis. This kind of rates are, *per se*, in an annual scale, smoothing seasonality and other monthly fluctuations. Moreover, using year-on-year rates of change also contributes to mute revisions because month-on-month rates of change implicit in yoy_t^i are obtained from series of vintage i. Although eleven of the twelve month-on-month rates of change relevant for yoy_t were already released in previous vintages, yoy_t^i actually reflects more mature versions of these rates (the ones implicit in series of vintage i). In terms of periodicity, the same reasoning explains why one would expect that using aggregated data (for example, quarterly or annual data) would contribute to smooth revisions.

Additionally, our results point to the fact that revisions are more significant in early releases (first months after the first release of data). More than half of total revision occurred in the first two months after the first release, both for export and import data (Tables A.2 and A.4 in the Appendix). The magnitude of revisions occurring from 9 to 12 months after the first release is quite small compared to the total revision (less than 10 per cent, both for exports and imports), and the revisions after one year are negligible (Figure 1). Therefore, since data in the latest vintage are in different stages of the revision process, from now on we will consider one-year estimates as final estimates.

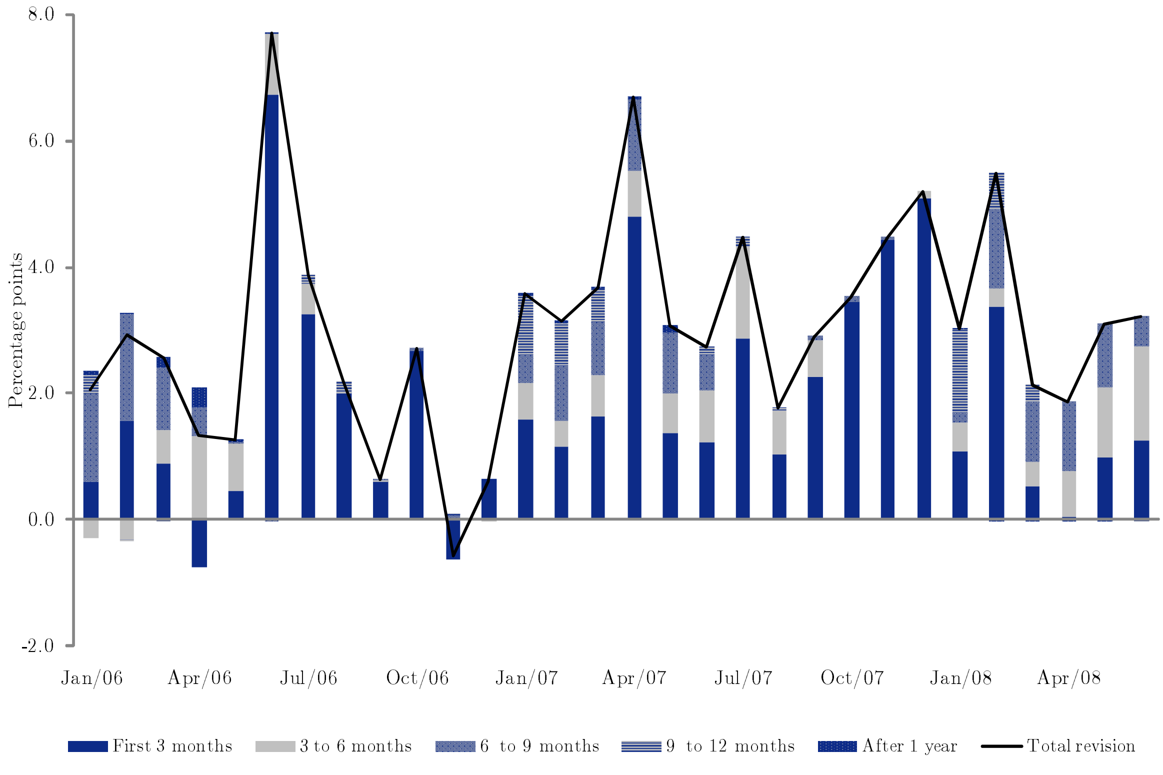
In the next subsection we provide further insights into revision analysis. In particular, we will focus on two series of revisions to monthly year-on-year rates of change: revisions from the first estimate (*flash estimate*) up to the one-year estimate; and revisions from the second estimate (the first time more detailed data is released) also up to the one-year estimate.

Figure 1: Revisions to year-on-year rates of change of exports and imports

(a) Exports



(b) Imports



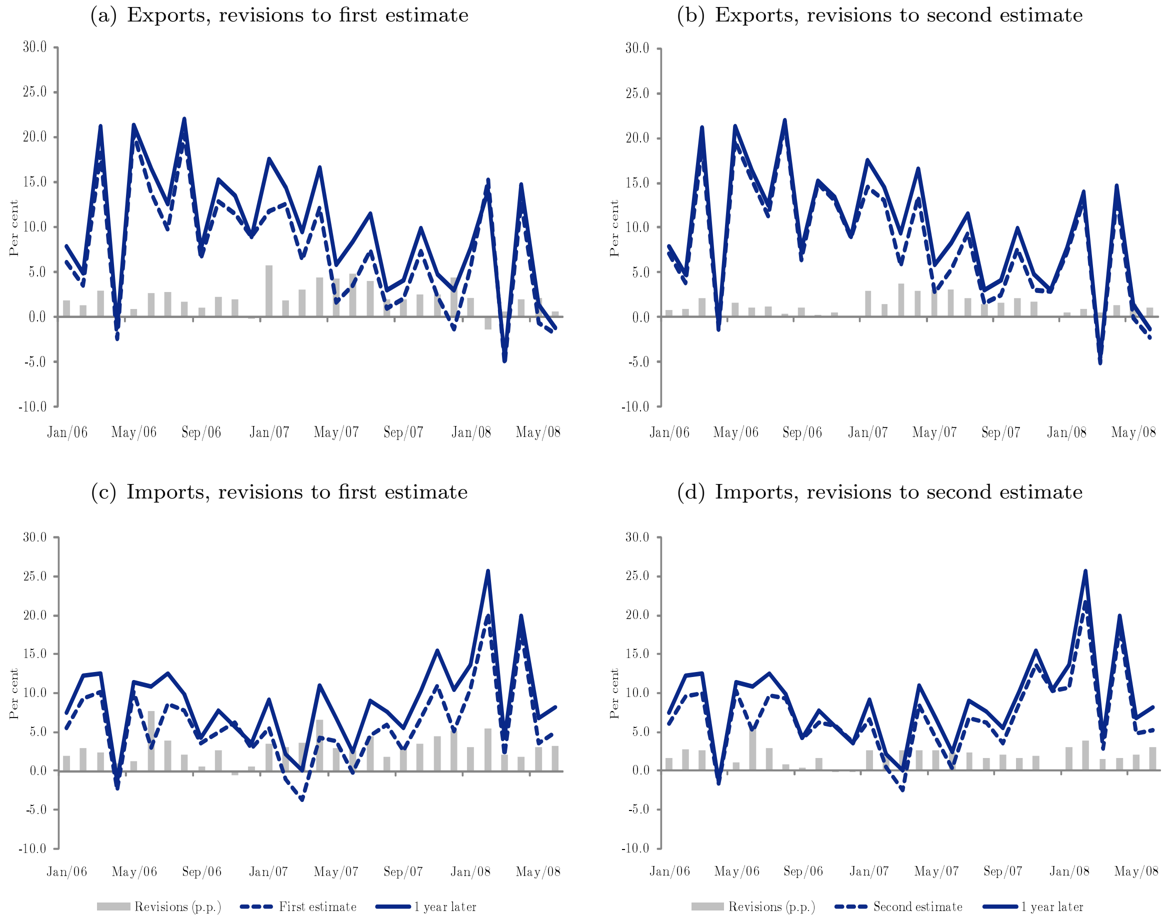
Sources: *INE* and authors' calculations.
Note: Revisions *vis-à-vis* previous estimates (vintage $i+1$ *vis-à-vis* vintage i).

3.2 Revision analysis

By assessing the reliability of early releases as estimates of the final values, revision analysis is an important tool for helping users to correctly interpret estimates released in different vintages. Figure 2 shows year-on-year rates of change of export and import data, as in first or second and final (one-year) releases, with revisions as the difference. It shows that early and final estimates have, in general, a similar evolution. Thus, export and import growth profiles do not seem to have been significantly affected by revisions. This evidence is in line with results for the impact of revisions on the sign and direction (acceleration/deceleration) of estimates (Table 2). For both exports and imports, more than 90 per cent of final estimates have the same sign as early estimates. In the case of direction, this number goes up to more than 95 per cent.

Furthermore, over the period analysed, the vast majority of revisions is strictly positive (more than 90 per cent in the case of exports, and more than 80 per cent for imports). As early estimates tend to be revised upwards, the mean of revisions is positive. These

Figure 2: Year-on-year rates of change of exports and imports: estimates and revisions



Sources: *INE* and authors' calculations.

Table 2: Summary statistics of revisions up to one year
Year-on-year rates of change, 2005:1 - 2008:6

	Exports		Imports	
	Since first release	Since second release	Since first release	Since second release
Min	−1.33	−0.04	−0.56	−0.26
Max	5.71	3.74	7.71	5.73
Mean	1.68**	1.09**	2.15**	1.38**
MAR	1.75	1.09	2.23	1.43
RMAR	0.20	0.13	0.28	0.18
St. Dev.	1.57	1.00	2.01	1.35
MSR	5.30	2.20	8.66	3.73
UM (%)	53.39	54.32	53.45	51.01
UR (%)	1.06	2.60	0.22	1.95
UD (%)	45.55	43.08	46.33	47.04
RMSR	2.30	1.48	2.94	1.93
% Positive	92.86	97.62	83.33	80.95
Jarque-Bera	2.59	6.28*	2.87	4.34
Doornik and Hansen	3.90	14.75**	3.99	4.35
Noise-to-Signal	0.23	0.14	0.40	0.27
St. Dev. yoy^i	6.56	6.66	4.50	4.61
St. Dev. yoy^{i+j}	6.97	6.97	5.06	5.06
Correlation (yoy^i, yoy^{i+j})	0.97**	0.99**	0.92**	0.97**
Correlation (r^j, yoy^{i+j})	0.37*	0.37*	0.46**	0.45**
Correlation (r^j, yoy^i)	0.15	0.24	0.07	0.20
% Sign(yoy^{i+j}) = Sign(yoy^i)	95.24	97.62	92.86	97.62
Direction	95.12	100.00	95.12	100.00

Notes: MAR - Mean Absolute Revision. RMAR - Relative Mean Absolute Revision. St. Dev. - Standard deviation of revisions. RMSR - Root Mean Squared Revision. % Positive - Percentage of strictly positive revisions. UM, UR and UD refer to the decomposition of the mean squared revision (MSR). Jarque-Bera and Doornik and Hansen (2008) refer to the results for the normality tests. Considering Equation 1, St. Dev. $yoy^i(yoy^{i+j})$ denotes the standard deviation of estimates for vintage $i(i+j)$. Correlation (yoy^i, yoy^{i+j}) - Correlation between estimates for vintages i and $i+j$. Correlation (r^j, yoy^i) - Correlation between revisions and estimates for vintage i. % Sign(yoy^{i+j}) = Sign(yoy^i) - Percentage of observations for which the sign of estimates for vintages $i+j$ and i is the same. Direction - Percentage of observations for which the direction (acceleration or deceleration) of estimates for vintage $i+j$ and vintage i is the same. ** denotes significance at a 1 per cent level and * at a 5 per cent level.

results were qualitatively invariant to the sign of estimates. The mean of revisions to year-on-year rates of change of exports and imports is 1.7 and 2.2 p.p., respectively, for revisions since the first release (1.1 and 1.4 p.p., respectively, for revisions since the second release). The results for the significance test, obtained using heteroskedastic and autocorrelation consistent (HAC) standard errors, suggest that mean revisions are statistically significantly different from zero (Table 2).[7] Considering a broader set of series, Aruoba (2008) and Faust et al. (2005) found similar results for other countries. Moreover, for the UK, Meader (2007) and George (2005) reported evidence of positive and statistically significant mean revisions to quarterly real growth rates of exports and imports.

The significance tests for the mean revision rely on the assumption that revisions are normally distributed. Hence, normality of revisions was also tested using Jarque-Bera and Doornik and Hansen (2008) tests (the latter adjusted for small samples). Considering a significance level of 5 per cent, the null hypothesis of normality is, in general, not rejected (Table 2).[8]

Since, in the case of the mean, revisions with opposite sign (partially or completely) cancel out, a measure typically used to assess the size of revisions is the mean absolute revision. As revisions to our data are, in general, positive, the mean absolute revision is very similar to the mean revision. Moreover, results for the relative mean absolute revision suggest that year-on-year growth rates are likely to be revised, within a year since the first estimate, in a proportion of about 20 per cent, in the case of exports, and 28 per cent, for imports.

Regarding volatility, standard deviations of revisions are also shown in Table 2. Taking into account the variability of the estimates, the volatility of revisions does not seem to be sizeable. This fact is illustrated by the noise-to-signal ratio, defined as the ratio of the standard deviation of revisions to the standard deviation of final estimates, following Orphanides and van Norden (2002). If this measure exceeds one, then *noise* (standard deviation of revisions) outbalances the *signal* (standard deviation of final data). The choice of additional benchmarks for assessing this measure is relatively ad hoc (for example, Döpke (2004) considered as 'small' values below 0.5). In light of our results, we consider that the noise-to-signal ratios are relatively small, especially for revisions to the second estimate (0.14 for exports and 0.27 for imports). Cunningham and Jeffery (2007) also found relatively low noise-to-signal ratios for UK data on trade accounts. So, given the volatility of the underlying series, the volatility of revisions does not seem significant. This evidence is in line with the conclusions drawn from Figure 2, as final estimates exhibit an evolution similar to early estimates and, consequently, correlation coefficients between early and final estimates are high (Table 2).

Bearing in mind the three properties of "well-behaved" revisions outlined by Aruoba (2008), so far, our results suggest that monthly revisions to year-on-year rates of change

[7] Considering a significance level of 5 per cent. Using standard t-tests would not qualitatively change the results. See, for example, Di Fonzo (2005) for a description of the modified t-test.

[8] The exception is revisions to the second estimate of exports.

of export and import data are, on average, positive and its volatility is rather small compared to the volatility of the underlying series. Next, we proceed into analysing the predictability of revisions, that is, whether revisions add *news* or reduce *noise* (Mankiw and Shapiro (1986) and Faust et al. (2005)). When revisions are *news*, early releases reflect all available information at that time, being efficient estimates of the final release. Thus, revisions are unpredictable, being attributable to the incorporation of new information (Fixler (2008)). Contrarily, when revisions are *noise*, early releases reflect both the final estimate and a measurement error, which decreases over time.

As the simple test to mean revisions suggests that revisions are, on average, positive, the *news* hypothesis is immediately ruled out. Nevertheless, we carried out a detailed analysis on the *news*/*noise* hypotheses, in order to provide further insights into this question. In particular, we assess whether revisions are strictly noise.

We start by looking at standard deviations of estimates. If revisions reduce *noise*, then the standard deviation of successive estimates should decline. Instead, if revisions add *news*, the standard deviation of successive estimates should increase (Croushore and Stark (2003)). As Tables A.2 and A.4 in the Appendix show, standard deviations slightly increase throughout the releases spanned, both for export and import data.

The analysis of correlations is also a helpful tool for addressing the *news*/*noise* question. If revisions were correlated with final estimates, then its evolution would be unpredictable (*news*). On the other hand, if revisions were correlated with earlier estimates, then its evolution would be predictable (*noise*), as the information available at the time of initial releases was not fully taken into account. In this case, the co-movement of revisions and growth rates of the underlying series would indicate that high (low) growth rates signaled greater (smaller) revisions.

According to our results, the correlation coefficients between revisions and preliminary estimates (first and second releases) are small, not statistically significant, and smaller than in the case of final estimates (after one year) (Table 2). Moreover, revisions do not seem to be persistent, as autocorrelations are low and, in general, not statistically significant.[9]

Before proceeding into formal testing of the *news*/*noise* hypothesis, consider the following equations (Mankiw and Shapiro (1986) and Faust et al. (2005)):

$$yoy_t^{i+j} = \delta_1 + \gamma_1 yoy_t^i + \nu_t^1 \tag{3}$$

$$yoy_t^i = \delta_2 + \gamma_2 yoy_t^{i+j} + \nu_t^2 \tag{4}$$

[9]Furthermore, evidence from Augmented Dickey Fuller (ADF) tests suggests that revisions are stationary.

In order to ease the interpretation, these equations can be transformed as follows:

$$r_t^j = \alpha_1 + \beta_1 yoy_t^i + u_t^1 \quad (5)$$

$$r_t^j = \alpha_2 + \beta_2 yoy_t^{i+j} + u_t^2 \quad (6)$$

where $\alpha_1 = \delta_1$, $\beta_1 = \gamma_1 - 1$, $\alpha_2 = -\delta_2$, and $\beta_2 = 1 - \gamma_2$. If $\alpha_1 = 0$ and $\beta_1 = 0$, then revisions have a zero mean and the early release is not statistically significant. Instead, if $\alpha_2 = 0$ and $\beta_2 = 0$, revisions have a zero mean and the final release is not statistically significant. Not rejecting the first set of hypotheses ($\alpha_1 = 0$ and $\beta_1 = 0$) while rejecting the second (for α_2 and β_2) implies that revisions would be *news*. Conversely, rejecting the first set of hypotheses and not rejecting the second implies that revisions would be *noise*.

As already mentioned, a simple test to mean revisions failed to reject the null hypothesis of zero mean. The evidence from decomposing the mean squared revision points in the same direction. Assume that the mean squared revision can be decomposed as $UM + UR + UD = 100$ (Di Fonzo (2005)). Considering Equation 3, UM can be interpreted as the proportion of mean squared revision associated to the mean revision (δ_1). Moreover, UR is the proportion associated to the slope γ_1 being different from one and, finally, UD can be interpreted as the disturbance proportion, *i.e.*, as the proportion that is not associated to systematic differences between preliminary and later estimates. If revisions were "well-behaved", then preliminary estimates would present low UM and UR, and high UD. In our case, for both imports and exports, UD is quite high and UR is very low, reflecting the high correlation between early and final estimates (Table 2). However, the UM proportion is large, reflecting a mean revision different from zero.

Using an estimation sample from January 2005 to June 2007, we clearly reject the joint hypotheses of $\alpha_1 = 0$ and $\beta_1 = 0$, and $\alpha_2 = 0$ and $\beta_2 = 0$, both for export and import data (Table 3). One caveat of these tests is that, as both sets of hypotheses are mutually exclusive but not exhaustive, a double rejection is an inconclusive result. This result is particularly common when the mean revision is not equal to zero. When we look at the coefficients individually, while always rejecting that $\beta_2 = 0$, in general, we do not reject that $\beta_1 = 0$.[10] This evidence suggests that the systematic behaviour of revisions is apparently due to the non-zero mean revision.

Another caveat of this approach is that it only includes a constant and initial and final estimates as relevant variables for testing the predictability of revisions. Following

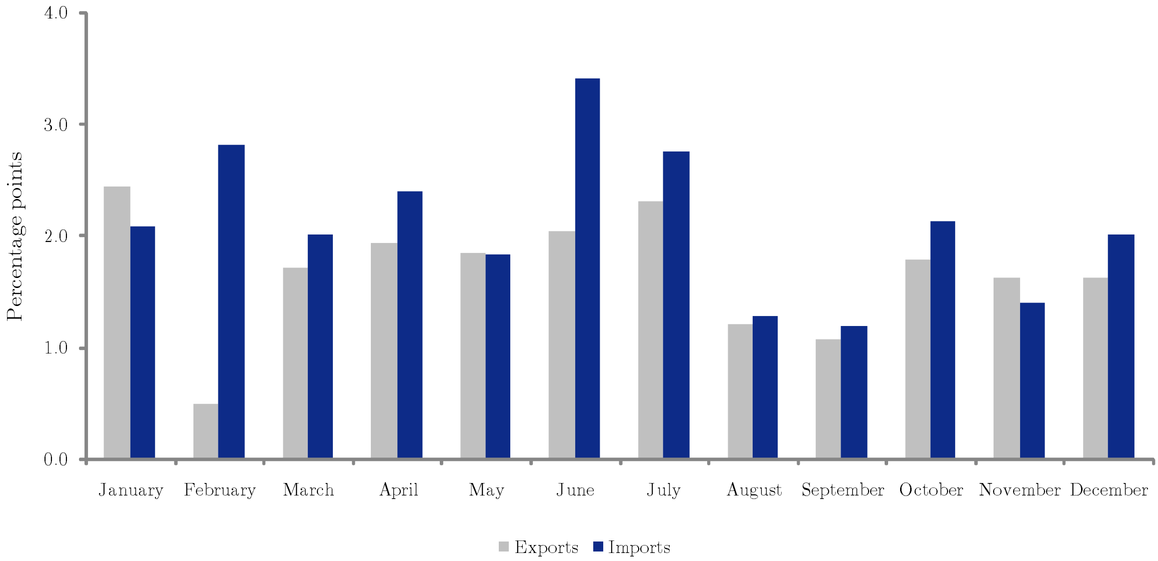
[10] In the case of revisions to first estimates of export data, the null hypothesis is not rejected for a significance level of 1 per cent.

Table 3: *News/noise* tests
Year-on-year rates of change, 2005:1 - 2007:6

	Exports			Imports		
	(1)	(2)	(3)	(1)	(2)	(3)
Revisions to first estimate						
Constant	1.021	0.591		2.145	0.365	
	(0.037)	(0.094)		(0.001)	(0.593)	
yoy_t^i	0.077			-0.104		
	(0.017)			(0.203)		
yoy_t^{i+12}		0.112			0.196	
		(0.000)			(0.013)	
F test	(0.000)	(0.000)		(0.002)	(0.000)	
Past revisions						
Traditional significance test			2.734			2.663
			(0.006)			(0.008)
C&M test			1.734			1.663
			(0.083)			(0.096)
Revisions to second estimate						
Constant	0.671	0.460		1.071	0.166	
	(0.049)	(0.059)		(0.022)	(0.745)	
yoy_t^i	0.045			0.009		
	(0.051)			(0.892)		
yoy_t^{i+12}		0.064			0.147	
		(0.002)			(0.017)	
F test	(0.000)	(0.000)		(0.005)	(0.000)	
Past revisions						
Traditional significance test			2.522			2.448
			(0.012)			(0.014)
C&M test			1.522			1.448
			(0.128)			(0.148)

Notes: (1) Traditional *news* test equation (Equation 5). (2) Traditional *noise* test equation (Equation 6). (3) Significance tests for past revisions (test regressions also including a constant). P-values in brackets. In (1) and (2) are presented equation coefficients, while in (3) are presented test statistics. The past revisions included in the analysis are the following: r_{t-3}^3 for revisions to first estimate of exports; r_{t-1}^1 for revisions to first estimate of imports; r_{t-3}^2 for revisions to second estimate of exports; and, r_t^1 for revisions to second estimate of imports. 'C&M' test refers to Clark and McCracken (2009*a*) test.

Figure 3: Mean revisions to first estimate by month of reference



Sources: *INE* and authors' calculations.

Aruoba (2008), we extended Equation 5 to include other variables, available at the time vintage i was released.[11] We start by adding seasonal dummies. If some months are systematically more revised than others then different patterns of revisions across months could be relevant. Figure 3 presents the mean revision to first estimates by month. Apparently, the mean revision varies from month to month. In the case of exports, January and July have higher mean revisions, while for imports June is the month with the highest mean revision. However, when testing the equality of the means for the 12 sub-samples (one for each month of reference) using the Analysis of Variance (ANOVA) framework, the null hypothesis of equal means is clearly not rejected. Moreover, in a regression context with revisions as the dependent variable, seasonal dummies do not reveal to be statistically significant, for both exports and imports.[12]

Past revisions known at the time of early releases (r_{t-m}^{j} with $m = 0, 1, 2, ...$ and $j = 1, 2, ...$) were also included in the test regressions. Regarding the revisions to first estimates, in the case of exports, only the revisions up to three months, lagged three periods (r_{t-3}^{3}) are statistically significant, while the revisions up to one month, lagged one period (r_{t-1}^{1}) are relevant for imports (Table 3). Similar results were obtained for the revisions to second estimates. In the case of exports, the only relevant variable is the revisions up to three months, lagged two periods (r_{t-2}^{3}), while the revisions up to one month (r_{t}^{1}) are significant in the test equation for imports. So, these results

[11]In the context of inflation expectations, this analysis aims at assessing strong efficiency of expectations, as opposed to testing weak efficiency (for more details, see Dias et al. (2008)).

[12]This evidence may be conditioned by the sample size.

suggest that, in addition to the positive mean revision, information on past revisions is significant for explaining current revisions.

However, inferring the predictability of revisions from this evidence is not straightforward. First of all, as the equations estimated are test regressions and not the "best" models for revisions, other variables could have been included, and could reveal to be relevant, as noted by Fixler (2008). Moreover, the potential for predicting future revisions only holds insofar as one assumes that past revisions provide helpful insights into the future. In fact, test approaches typically used to assess the (un)predictability of revisions focus on in-sample significance, which does not necessarily imply improvements in forecast accuracy.

We performed a simple exercise for forecasting revisions in real-time, using data from July 2007 to June 2008. Table 4 presents the relative root mean squared forecast errors, considering the *news* hypothesis model ($r_t^j = \varepsilon_t$, where ε_t is $iid \sim (0; \sigma_\varepsilon^2)$) as benchmark. For both export and import data, using the mean of previous revisions as the best guess for future revisions clearly outperformed the *news* hypothesis (zero mean). However, adding past revisions to the regression (the ones statistically significant in-sample) does not improve forecast accuracy.[13]

Having identified this situation, which can result from using small samples to estimate regression parameters, Clark and McCracken (2009*a*) recently proposed an in-sample test for predictive ability. Consider two models, a restricted model which only includes a constant, and an unrestricted model including a constant and an additional variable. The purpose of this test is to assess whether the contribution of the additional variable is estimated with enough precision to improve the accuracy of forecasts obtained from the restricted model. Under the null hypothesis (the difference between the mean squared errors of both models is zero), the test statistic is as follows:[14]

$$\text{t}-sign(\lambda) \overset{a}{\sim} N(0,1) \qquad (7)$$

where t denotes the t-ratio associated to the additional variable in the unrestricted model, $sign(.)$ is a function that returns 1 if (.) is greater than zero and -1 if (.) is less than zero, and λ is the coefficient associated to the additional variable in the unrestricted model. Based on the results drawn from this test, we conclude that past revisions do not improve our predictive ability, both for export and import data (Table 3).

Summing up, our results suggest that the revisions, on average, are positive, implying a systematic component in revisions to export and import data. Furthermore, we

[13]Due to sample constraints, formal tests for evaluating forecast accuracy are not presented.
[14]Considers HAC standard errors.

Table 4: Forecasting revisions to year-on-year rates of change of exports and imports
Relative root mean squared forecast errors

	Exports	Imports
	Revisions to first estimate	
$r_t^j = \varepsilon_t$	1.000	1.000
$r_t^j = \alpha + u_t$	0.620	0.538
	(38.0)	(46.2)
$r_t^j = \alpha + \lambda\text{Past revisions} + u_t$	0.719	0.538
	(28.1)	(46.2)
	Revisions to second estimate	
$r_t^j = \varepsilon_t$	1.000	1.000
$r_t^j = \alpha + u_t$	0.467	0.541
	(53.3)	(45.9)
$r_t^j = \alpha + \lambda\text{Past revisions} + u_t$	0.608	0.795
	(39.2)	(20.5)

Notes: Root mean squared forecast errors, for the period 2008:7 to 2009:6. ε_t is *iid* $\sim (0; \sigma_\varepsilon^2)$. The past revisions included in the analysis were the following: r_{t-3}^3 for revisions to first estimate of exports; r_{t-1}^1 for revisions to first estimate of imports; r_{t-3}^2 for revisions to second estimate of exports; and, r_t^1 for revisions to second estimate of imports. Percentage of gain *vis-à-vis* the benchmark in brackets.

highlight the potential pitfalls associated to the assessment of the predictability of revisions. In particular, test results may not be clear-cut. In our case, both *news* and *noise* hypotheses are rejected. Moreover, using the traditional test approach, past revisions seemed to be relevant for prediction. Nevertheless, this approach only takes into account the in-sample performance. Models with the best fit in-sample are not necessarily the best models for forecasting, as our out-of-sample exercise shows. Alternatively, we suggest a testing approach which also accounts for the out-of-sample performance. Using the in-sample test for predictive ability recently proposed by Clark and McCracken (2009*a*), we do not find evidence that past revisions are significant for prediction.

4 Implications for forecasting

In empirical analysis, one typically uses data of the most recent vintage (both for in-sample estimation and out-of-sample forecasting). However, several authors have questioned whether this choice is the most suitable for modelling and forecasting purposes when data undergo revisions. Stark and Croushore (2002) pointed out that revisions can influence forecasting through (at least) three different channels: (i) revisions to data on independent variables (*direct channel*); (ii) changes in coefficient estimates (*indirect channel*); and, (iii) changes in model specification (for example, by affecting information criteria results). Furthermore, incorporating data revisions into the analysis also casts doubts on the choice of which data to be used as reference (*actuals*), which is critical for assessing forecast accuracy.

First attempts to deal with revisions and real-time databases consisted in estimating and forecasting through a *rolling vintage* procedure (Croushore and Stark (2001) and Stark and Croushore (2002), among others). As the sample period for estimation increases, data series of previous vintages are replaced by data series of end-of-sample vintages. Within this recursive framework, Clark and McCracken (2009*b*) extended the tests of equal predictive ability to deal with real-time data.

Empirical results suggest that, in general, model specification and forecasting performance are sensitive to the choice between latest vintage and rolling vintage data (Stark and Croushore (2002)). Moreover, Croushore and Stark (2001) found evidence that using latest vintage data, as opposed to using rolling vintage data, did not necessarily lead to better forecasting results, even when latest vintage data are used as reference.

The rolling vintage procedure is probably the most common practice to incorporate real-time data into forecasting. Nevertheless, this procedure fails to take into account the different nature of data within the same vintage. Using Kishor and Koenig (2005) terminology, each vintage is a mix between more mature (or final) data that appear early in the sample (*apples*) and more preliminary (or first release) data towards the end of the sample (*oranges*). Koenig et al. (2003) showed that using end-of-sample vintages for model estimation (that is, mixing *apples* and *oranges*) typically leads to inconsistent parameter estimates.

Therefore, prior to setting up a forecasting procedure, choosing the nature of data to forecast is crucial. The literature on this topic usually gives priority to forecasting the *truth* (or the best possible approximation to it), *i.e.*, *apples*. For example, assuming that initial estimates of dependent variable are efficient, Koenig et al. (2003) suggested forecasting the *truth* using first releases. These authors argued that, for the sake of consistency, in each data series the number of vintages should equal the sample size. So, in other words, if revisions to the dependent variable are *news*, meaning that *oranges* are efficient estimates of *apples*, *orange* forecasts should be obtained through a model estimated with *orange* data.

Alternatively, other authors suggested casting the data into a state-space form (see, for example, Patterson (1995)). In a nutshell, this procedure consists in filtering early releases (through Kalman filter) to obtain the corresponding *true* estimates, which are then used in the forecasting model. Metaphorically, *oranges* are transformed into *apples* before being used to forecast more *apples*. This "applesation" implies defining the properties of the revision process (*news*, *noise* or something in between), which can be a rather difficult task (as shown in section 3.2). To circumvent this limitation, some authors, like Kishor and Koenig (2005) and Jacobs and van Norden (2007), suggested more flexible models. Another caveat of this approach is that the most recent vintages have to be left out of the analysis for comparison purposes.

Although forecasting the final version of data is undeniably relevant, as early assessments of economic developments may change due to data revisions, information from first releases should not be altogether discarded. Typically, first releases make the headlines, conditioning agents' decisions and expectations. In this paper, we focus on short-term forecasting of first releases, or *oranges*. In particular, having defined first releases as the reference, we assessed whether making full use of a real-time database could improve forecast accuracy. Our strategy for exploiting real-time data follows Koenig et al. (2003).

Therefore, for both export and import data, we compared the forecasting performance of using as dependent variable the latest vintage (traditional approach) or the first release data, within a univariate and a multivariate framework. Model selection was based on information criteria, namely Schwartz Information Criterion. The multivariate models include qualitative series, from the European Commission opinion surveys (assessment of export order-book levels for exports, and consumer confidence and economic sentiment indicator for imports), which are not subject to revisions. This analysis could be extended in order to include variables that are revised in the right-hand side of the equations (see Koenig et al. (2003)). Our choice was guided by results of previous works, namely in the case of exports (Cardoso and Duarte (2006)). Indeed, other variables could have been included in the forecasting equations. However, this exercise does not aim at finding the best forecasting models for export and import data. Instead, we intend to assess whether using real-time data could improve the accuracy of first release forecasts, conditional on model specification. So, within each framework (univariate or multivariate), forecasting models differ only in the data vintages used

Table 5: Forecasting year-on-year rates of change of exports and imports
Relative root mean squared forecast errors

	Exports	Imports
Univariate - Latest vintage	1.000	1.000
Univariate - First releases	0.986 (1.4)	0.952 (4.8)
Multivariate - Latest vintage	0.919 (8.1)	0.896 (10.4)
Multivariate - First releases	0.909 (9.1)	0.784 (21.6)

Notes: Root mean squared forecast errors, for the period 2008:7 to 2009:6. The univariate model includes autoregressive terms of order 2 and 3 and a moving average term of order 1, in the case of exports, and autoregressive terms of order 2, 3 and 12, in the case of imports. The multivariate model for imports includes the autoregressive term of order 2, the consumer confidence (contemporaneously and lagged one period) and the economic sentiment indicator lagged one period. In the case of exports, the model includes autoregressive terms of order 2 and 3 and the assessment of export order-book (contemporaneously). Percentage of gain *vis-à-vis* the benchmark in brackets.

for estimation - latest vintage or first releases.

The estimation sample starts in January 2005 and ends in June 2008. Since our aim is to forecast first releases (reference variable), it immediately followed that using real-time data series (first releases) improves in-sample performance (on average, by the amount of the mean revision). One-step ahead forecast series were obtained recursively for the period from July 2008 to June 2009. Table 5 presents the relative root mean squared forecast errors, considering the univariate model estimated with latest vintage data as benchmark. The results obtained suggest that using real-time data (first releases), instead of latest vintage data (traditional approach) to forecast first releases improves forecast accuracy, both in univariate and multivariate models. Although the real-time approach always outperforms the traditional approach, in some cases the differences between both approaches are quite small.[15]

We find evidence that not accounting for data revision implications can lead to suboptimal results on short-term forecasting of first releases. On the other hand, our results also reinforce the need for analysing whether the benefits from dealing with real-time data worth the costs, in a case by case basis (Croushore (2008)). Gains from using real-time data in the analysis may not always outbalance costs, especially when the predictability of revisions is small relative to forecasting errors. At the end of the day, this is an empirical question.

[15]A word of caution is needed on the interpretation of our results, given the size of the sample used. Moreover, due to these sample constraints, formal tests for evaluating forecast performance are not presented.

5 Conclusions

In this paper, we revisited the literature on data revisions, presenting an encompassing analysis of revisions and its implications for forecasting. For this purpose, we built a real-time database for Portuguese exports and imports of goods. Focusing on monthly year-on-year rates of change, we started by gauging data revisions, resorting to a broad set of statistical measures. We concluded that early estimates, although correctly indicating the sign and direction of changes, on average underestimated final releases. Therefore, early releases tended to be revised upwards. Moreover, small noise-to-signal ratios suggested that the potential challenges in analysing the data were associated to the volatility of the underlying series, rather than to the volatility of revisions.

In the context of the *news/noise* analysis, our results suggested that assessing the predictability of revisions is not a straightforward task. Test results were inconclusive, as both *news* and *noise* hypotheses were rejected. Moreover, *news/noise* test equations were extended to include additional variables, namely past revisions. Using the traditional test approach, past revisions seemed to be relevant for prediction. Nevertheless, this approach only takes into account the in-sample performance. Alternatively, we suggested a testing approach which also accounts for the out-of-sample performance. Using this alternative approach we do not find evidence that past revisions are significant for prediction. Thus, conditional on the information set considered, the systematic behaviour of revisions is apparently due to the non-zero mean revision.

Finally, we discussed the impact of revisions on forecasting, focusing on short-term forecasting of first releases. The results from a simple out-of-sample forecasting exercise suggest that not accounting for data revision implications can lead to suboptimal results on short-term forecasting of first releases. However, in some circumstances, the benefits from using real-time data in the analysis can be outbalanced by the costs, especially when the predictability of revisions is small relative to forecasting errors.

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Appendix

Table A.1: Exports, month-on-month rates of change

Months after first release:	1month	2 months	3 months	4 months	5 months	6 months	7 months	8 months	9 months	10 months	11 months	1 year	Latest
Revisions to previous estimates													
Min	−2.51	−0.75	−0.89	−0.41	−0.32	−0.26	−0.46	−0.14	−0.17	−0.21	−0.12	0.00	−0.06
Max	2.72	1.11	0.85	0.72	0.56	0.33	0.36	0.32	0.23	0.61	0.12	0.37	0.10
Mean	0.18	0.16	0.03	0.04	0.01	0.01	0.01	0.00	0.01	0.02	0.00	0.01	0.00
MAR	0.44	0.23	0.14	0.10	0.08	0.06	0.05	0.03	0.02	0.03	0.01	0.01	0.01
RMAR	0.04	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
St. Dev.	0.77	0.37	0.25	0.17	0.14	0.10	0.12	0.06	0.05	0.10	0.03	0.05	0.02
RMSR	0.79	0.40	0.26	0.17	0.14	0.11	0.12	0.06	0.05	0.10	0.03	0.05	0.02
% Positive	37.74	39.62	30.19	41.51	22.64	35.85	33.96	18.87	33.96	13.21	11.32	7.55	11.32
St. Dev. mom^i	16.30	16.35	16.46	16.48	16.50	16.53	16.55	16.54	16.54	16.54	16.55	16.55	16.56
St. Dev. mom^{i+j}	16.35	16.46	16.48	16.50	16.53	16.55	16.54	16.54	16.54	16.55	16.55	16.56	16.57
% Sign(mom^{i+j}) = Sign(mom^i)	98.11	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Direction	98.08	98.08	96.15	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Revisions to first estimate													
Min	−2.51	−1.70	−1.56	−1.44	−1.35	−1.42	−1.41	−1.39	−1.36	−1.57	−1.69	−1.69	−1.75
Max	2.72	3.62	3.57	4.00	4.16	4.20	4.56	4.66	4.78	5.39	5.47	5.59	5.69
Mean	0.18	0.35	0.38	0.42	0.43	0.44	0.45	0.46	0.47	0.48	0.49	0.50	0.50
MAR	0.44	0.53	0.57	0.63	0.63	0.65	0.64	0.65	0.65	0.67	0.67	0.68	0.69
RMAR	0.04	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
St. Dev.	0.77	0.86	0.87	0.90	0.92	0.94	0.94	0.95	0.96	1.02	1.03	1.06	1.07
RMSR	0.79	0.93	0.95	1.00	1.01	1.04	1.05	1.05	1.07	1.13	1.14	1.17	1.18
% Positive	37.74	43.40	43.40	56.60	54.72	56.60	54.72	54.72	56.60	56.60	56.60	56.60	56.60
St. Dev. mom^i	16.30	16.30	16.30	16.30	16.30	16.30	16.30	16.30	16.30	16.30	16.30	16.30	16.30
St. Dev. mom^{i+j}	16.35	16.46	16.48	16.50	16.53	16.55	16.54	16.54	16.54	16.55	16.55	16.56	16.57
% Sign(mom^{i+j}) = Sign(mom^i)	98.11	98.11	98.11	98.11	98.11	98.11	98.11	98.11	98.11	98.11	98.11	98.11	98.11
Direction	98.08	96.15	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Notes: MAR - Mean Absolute Revision. RMAR - Relative Mean Absolute Revision. St. Dev. - Standard deviation of revisions. RMSR - Root Mean Squared Revision. % Positive - Percentage of strictly positive revisions. Considering Equation 1, St. Dev. $mom^i(mom^{i+j})$ denotes the standard deviation of estimates for vintage $i(i+j)$. % Sign(mom^{i+j}) = Sign(mom^i) - Percentage of observations for which the sign of estimates for vintages $i+j$ and i is the same. Direction - Percentage of observations for which the direction (acceleration or deceleration) of estimates for vintage $i+j$ and vintage i is the same. 'Latest' refers to the vintage released in August 2009.

Table A.2: Exports, year-on-year rates of change

Months after first release:	1month	2 months	3 months	4 months	5 months	6 months	7 months	8 months	9 months	10 months	11 months	1 year	Latest
Revisions to previous estimates													
Min	−2.30	−0.94	−1.03	−0.40	−0.23	−0.38	−0.24	−0.09	−0.04	−0.21	−0.01	−0.02	−0.02
Max	4.20	1.61	1.39	0.97	0.59	0.75	0.61	0.61	0.59	0.61	0.26	0.32	0.11
Mean	0.59	0.35	0.16	0.13	0.08	0.12	0.08	0.05	0.05	0.04	0.02	0.01	0.01
MAR	0.80	0.42	0.24	0.19	0.12	0.15	0.10	0.06	0.06	0.05	0.02	0.01	0.01
RMAR	0.10	0.05	0.03	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00
St. Dev.	1.05	0.53	0.39	0.27	0.19	0.21	0.17	0.12	0.12	0.13	0.05	0.05	0.03
RMSR	1.20	0.63	0.42	0.30	0.20	0.24	0.18	0.13	0.13	0.13	0.06	0.06	0.03
% Positive	57.14	52.38	52.38	64.29	33.33	66.67	42.86	38.10	40.48	21.43	16.67	11.90	21.43
St. Dev. yoy^i	6.56	6.66	6.74	6.80	6.84	6.88	6.89	6.91	6.91	6.95	6.95	6.96	6.97
St. Dev. yoy^{i+j}	6.66	6.74	6.80	6.84	6.88	6.89	6.91	6.91	6.95	6.95	6.96	6.97	6.98
% Sign(yoy^{i+j}) = Sign(yoy^i)	97.62	97.62	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Direction	95.12	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Revisions to first estimate													
Min	−2.30	−1.34	−1.17	−1.38	−1.36	−1.59	−1.56	−1.51	−1.33	−1.54	−1.33	−1.33	−1.34
Max	4.20	4.20	4.20	4.20	4.49	4.63	4.75	4.77	4.90	5.51	5.59	5.71	5.81
Mean	0.59	0.94	1.10	1.24	1.32	1.43	1.51	1.56	1.61	1.65	1.67	1.68	1.69
MAR	0.80	1.05	1.20	1.32	1.39	1.51	1.59	1.64	1.68	1.73	1.74	1.75	1.76
RMAR	0.10	0.13	0.15	0.16	0.17	0.18	0.19	0.19	0.20	0.20	0.20	0.20	0.20
St. Dev.	1.05	1.20	1.27	1.35	1.42	1.46	1.48	1.50	1.51	1.56	1.56	1.57	1.59
RMSR	1.20	1.53	1.68	1.83	1.93	2.04	2.12	2.17	2.21	2.27	2.28	2.30	2.32
% Positive	57.14	59.52	61.90	85.71	90.48	92.86	92.86	92.86	92.86	92.86	92.86	92.86	92.86
St. Dev. yoy^i	6.56	6.56	6.56	6.56	6.56	6.56	6.56	6.56	6.56	6.56	6.56	6.56	6.56
St. Dev. yoy^{i+j}	6.66	6.74	6.80	6.84	6.88	6.89	6.91	6.91	6.95	6.95	6.96	6.97	6.98
% Sign(yoy^{i+j}) = Sign(yoy^i)	97.62	95.24	95.24	95.24	95.24	95.24	95.24	95.24	95.24	95.24	95.24	95.24	95.24
Direction	95.12	95.12	95.12	95.12	95.12	95.12	95.12	95.12	95.12	95.12	95.12	95.12	95.12

Notes: MAR - Mean Absolute Revision. RMAR - Relative Mean Absolute Revision. St. Dev. - Standard deviation of revisions. RMSR - Root Mean Squared Revision. % Positive - Percentage of strictly positive revisions. Considering Equation 1, St. Dev. $yoy^i(yoy^{i+j})$ denotes the standard deviation of estimates for vintage $i(i+j)$. % Sign(yoy^{i+j}) = Sign(yoy^i) - Percentage of observations for which the sign of estimates for vintages $i+j$ and i is the same. Direction - Percentage of observations for which the direction (acceleration or deceleration) of estimates for vintage $i+j$ and vintage i is the same. 'Latest' refers to the vintage released in August 2009.

Table A.3: Imports, month-on-month rates of change

Months after first release:	1month	2 months	3 months	4 months	5 months	6 months	7 months	8 months	9 months	10 months	11 months	1 year	Latest
Revisions to previous estimates													
Min	−1.73	−2.47	−1.03	−0.77	−0.38	−0.62	−0.64	−0.25	−0.15	−0.10	−0.05	−0.01	−0.32
Max	3.03	1.52	3.95	0.48	0.43	0.40	0.52	1.19	0.22	0.61	0.39	0.42	0.15
Mean	0.33	0.10	0.11	0.00	0.01	0.00	−0.01	0.05	0.01	0.02	0.01	0.01	0.00
MAR	0.49	0.26	0.20	0.08	0.06	0.10	0.06	0.06	0.02	0.03	0.02	0.01	0.02
RMAR	0.07	0.04	0.03	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
St. Dev.	0.81	0.53	0.59	0.16	0.12	0.16	0.14	0.18	0.05	0.10	0.06	0.07	0.06
RMSR	0.88	0.54	0.60	0.16	0.12	0.16	0.14	0.19	0.05	0.10	0.06	0.07	0.06
% Positive	41.51	32.08	30.19	33.96	24.53	30.19	28.30	24.53	33.96	11.32	11.32	7.55	13.21
St. Dev. mom^i	9.51	9.37	9.51	9.57	9.56	9.55	9.58	9.57	9.58	9.58	9.59	9.59	9.60
St. Dev. mom^{i+j}	9.37	9.51	9.57	9.56	9.55	9.58	9.57	9.58	9.58	9.59	9.59	9.60	9.59
% Sign(mom^{i+j}) = Sign(mom^i)	98.11	98.11	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Direction	100.00	98.08	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Revisions to first estimate													
Min	−1.73	−1.96	−1.96	−1.96	−1.96	−1.96	−1.93	−1.93	−1.93	−1.93	−1.93	−1.93	−1.93
Max	3.03	3.37	5.69	5.87	6.00	5.99	5.99	5.99	5.99	5.99	5.99	5.98	5.98
Mean	0.33	0.43	0.53	0.53	0.54	0.54	0.53	0.58	0.59	0.61	0.62	0.64	0.64
MAR	0.49	0.66	0.81	0.81	0.81	0.82	0.82	0.86	0.87	0.89	0.90	0.91	0.90
RMAR	0.07	0.09	0.11	0.11	0.11	0.11	0.11	0.12	0.12	0.12	0.12	0.12	0.12
St. Dev.	0.81	1.02	1.27	1.30	1.29	1.31	1.31	1.32	1.33	1.35	1.36	1.38	1.38
RMSR	0.88	1.10	1.38	1.40	1.40	1.42	1.41	1.44	1.45	1.48	1.50	1.52	1.52
% Positive	41.51	45.28	41.51	54.72	56.60	49.06	49.06	52.83	54.72	54.72	54.72	54.72	54.72
St. Dev. mom^i	9.51	9.51	9.51	9.51	9.51	9.51	9.51	9.51	9.51	9.51	9.51	9.51	9.51
St. Dev. mom^{i+j}	9.37	9.51	9.57	9.56	9.55	9.58	9.57	9.58	9.58	9.59	9.59	9.60	9.59
% Sign(mom^{i+j}) = Sign(mom^i)	98.11	96.23	96.23	96.23	96.23	96.23	96.23	96.23	96.23	96.23	96.23	96.23	96.23
Direction	100.00	98.08	98.08	98.08	98.08	98.08	98.08	98.08	98.08	98.08	98.08	98.08	98.08

Notes: MAR - Mean Absolute Revision. RMAR - Relative Mean Absolute Revision. St. Dev. - Standard deviation of revisions. RMSR - Root Mean Squared Revision. % Positive - Percentage of strictly positive revisions. Considering Equation 1, St. Dev. $mom^i(mom^{i+j})$ denotes the standard deviation of estimates for vintage $i(i+j)$. % Sign(mom^{i+j}) = Sign(mom^i) - Percentage of observations for which the sign of estimates for vintages $i+j$ and i is the same. Direction - Percentage of observations for which the direction (acceleration or deceleration) of estimates for vintage $i+j$ and vintage i is the same. 'Latest' refers to the vintage released in August 2009.

Table A.4: Imports, year-on-year rates of change

Months after first release:	1month	2 months	3 months	4 months	5 months	6 months	7 months	8 months	9 months	10 months	11 months	1 year	Latest
						Revisions to previous estimates							
Min	−0.51	−0.42	−1.68	−0.41	−0.76	−0.41	−0.12	0.00	−0.06	0.00	0.00	0.00	0.00
Max	5.08	1.84	4.47	0.58	0.92	0.84	0.70	1.28	0.84	0.65	0.53	0.43	0.32
Mean	0.77	0.33	0.23	0.12	0.12	0.09	0.13	0.14	0.08	0.06	0.04	0.02	0.02
MAR	0.81	0.41	0.33	0.15	0.16	0.20	0.15	0.14	0.09	0.06	0.04	0.02	0.02
RMAR	0.12	0.06	0.05	0.02	0.02	0.03	0.02	0.02	0.01	0.01	0.00	0.00	0.00
St. Dev.	1.11	0.55	0.77	0.18	0.26	0.26	0.22	0.28	0.18	0.15	0.11	0.08	0.06
RMSR	1.35	0.64	0.80	0.22	0.29	0.28	0.25	0.31	0.20	0.16	0.12	0.08	0.06
% Positive	66.67	50.00	52.38	76.19	47.62	47.62	52.38	40.48	45.24	21.43	16.67	11.90	23.81
St. Dev. yoy^i	4.50	4.61	4.80	4.95	4.96	4.94	4.91	4.94	4.93	5.01	5.03	5.05	5.06
St. Dev. yoy^{i+j}	4.61	4.80	4.95	4.96	4.94	4.91	4.94	4.93	5.01	5.03	5.05	5.06	5.04
% Sign(yoy^{i+j}) = Sign(yoy^i)	95.24	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	97.62	100.00	100.00	100.00
Direction	95.12	100.00	100.00	97.56	97.56	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
						Revisions to first estimate							
Min	−0.51	−0.64	−0.74	−0.64	−0.64	−0.64	−0.56	−0.56	−0.56	−0.56	−0.56	−0.56	−0.56
Max	5.08	5.08	6.71	7.18	7.68	7.68	7.68	7.68	7.68	7.68	7.68	7.71	7.71
Mean	0.77	1.11	1.34	1.46	1.58	1.67	1.80	1.95	2.03	2.09	2.13	2.15	2.17
MAR	0.81	1.15	1.40	1.52	1.61	1.76	1.88	2.02	2.10	2.17	2.20	2.23	2.25
RMAR	0.12	0.16	0.19	0.20	0.21	0.23	0.24	0.26	0.27	0.27	0.28	0.28	0.28
St. Dev.	1.11	1.36	1.67	1.75	1.78	1.84	1.88	1.89	1.95	1.97	2.00	2.01	2.01
RMSR	1.35	1.75	2.14	2.28	2.39	2.49	2.60	2.71	2.81	2.87	2.92	2.94	2.96
% Positive	66.67	66.67	66.67	95.24	97.62	78.57	78.57	78.57	83.33	83.33	83.33	83.33	83.33
St. Dev. yoy^i	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50
St. Dev. yoy^{i+j}	4.61	4.80	4.95	4.96	4.94	4.91	4.94	4.93	5.01	5.03	5.05	5.06	5.04
% Sign(yoy^{i+j}) = Sign(yoy^i)	95.24	95.24	95.24	95.24	95.24	95.24	95.24	95.24	95.24	92.86	92.86	92.86	92.86
Direction	95.12	95.12	95.12	92.68	95.12	95.12	95.12	95.12	95.12	95.12	95.12	95.12	95.12

Notes: MAR - Mean Absolute Revision. RMAR - Relative Mean Absolute Revision. St. Dev. - Standard deviation of revisions. RMSR - Root Mean Squared Revision. % Positive - Percentage of strictly positive revisions. Considering Equation 1, St. Dev. $yoy^i(yoy^{i+j})$ denotes the standard deviation of estimates for vintage $i(i+j)$. % Sign(yoy^{i+j}) = Sign(yoy^i) - Percentage of observations for which the sign of estimates for vintages $i+j$ and i is the same. Direction - Percentage of observations for which the direction (acceleration or deceleration) of estimates for vintage $i+j$ and vintage i is the same. 'Latest' refers to the vintage released in August 2009.

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