

DATA REVISIONS: THE CASE OF PORTUGUESE EXPORTS AND IMPORTS*

Fátima Cardoso**

Cláudia Duarte**

1. INTRODUCTION

Export and import data are of paramount importance for macroeconomic analysis on different areas (such as national accounts or balance of payments) and even more so in a small open economy as Portugal. As most economic data, international trade statistics undergo revisions. The existence of revisions may have implications, not only for economic analysis, but also for policy decisions, as revisions may alter the current assessment and forecasts of economic developments. In this article we analyse revisions to total goods export and import series, in nominal terms, released by *Instituto Nacional de Estatística (INE)*. Assessing these revisions required collecting the underlying series as they were released in each period (or *vintage*) - in other words, it required compiling a *real-time* database.

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 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. Therefore, series that do not undergo revisions should not be seen, *a priori*, as of higher quality than series that are revised.

Revision analysis consists in gauging data revisions 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. BCE (2009) presents summary measures for revisions to first GDP estimates and its components, for the euro area and the six largest euro area economies. Similarly, Kholodilin and Siliverstovs (2009) assess the quality of early releases of German

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** Banco de Portugal, Economics and Research Department.

national accounts data. For Portugal, José (2004) presented a set of summary statistics of revisions to quarterly national accounts data.

Instead of measuring accuracy (i.e., how close early estimates are from the underlying “true” values), revision analysis examines the reliability of early releases as estimates of the final values (Meader (2007)). 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)).

This analysis is a crucial step for assessing the impact of revisions on different areas, such as: model specification and forecasting (Koenig *et al.* (2003) and Cardoso and Duarte (2009) consider simple, single equation models, while a Kalman filter framework is used by 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)).

As “revision” is a wide concept, there are different types of revisions, 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 (see McKenzie (2006) for a summary list of reasons for revisions of official statistics). Assuming that current concepts, classifications and methodologies are the most relevant for economic analysis and policy decisions, benchmark revisions were not included in this analysis. In particular, this article aims at describing regular revisions to Portuguese export and import data, being presented some empirical evidence on revisions to year-on-year rates of change, from the first release to one year after.

The remainder of this article is organised as follows. In Section 2, we describe the real-time database used. In Section 3, data revisions to export and import data are analysed. Finally, Section 4 concludes.

2. REAL-TIME DATABASE

The series under analysis in this article refer to monthly data of total exports and imports of goods released by *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 export and import data. Following Croushore and Stark (2001), we call vintage the latest data series available at a particular date.

The first estimate of exports and imports 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).¹ 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.² 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 values for more recent periods were underestimated, reflecting a shorter data collection period and a lower coverage).

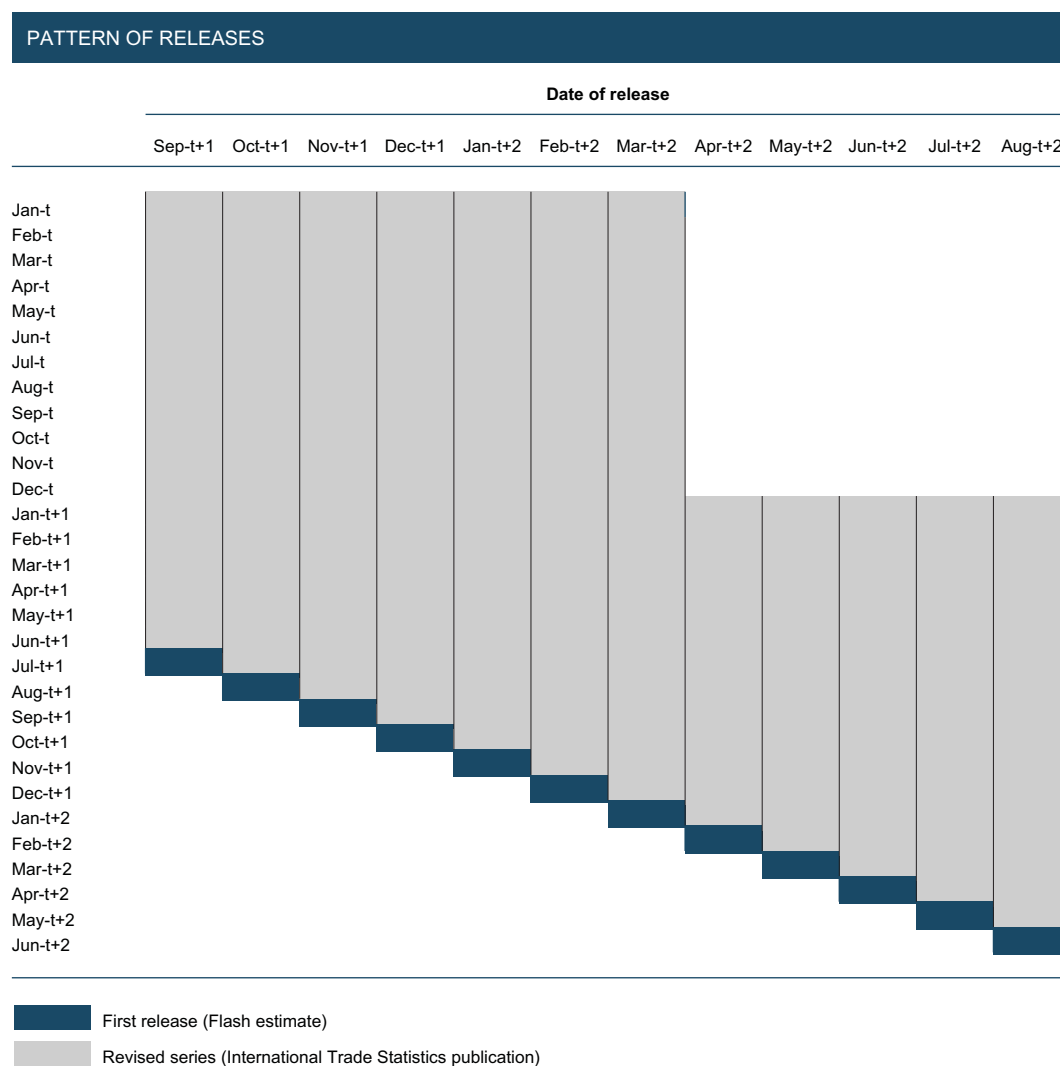
The main changes introduced by the new methodology were the inclusion of non-response and *below-threshold*³ estimates (for more details on the methodology, see *INE (2007)* and *INE (2006)*). So, instead of referring to declared figures only, international trade statistics have currently a broader cov-

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

(2) Implicitly in the following analysis, we consider data available in 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.

(3) Intrastat declarations are not mandatory for firms with a yearly transaction value inferior to a certain threshold.

Table 1



erage. 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.

3. REVISION ANALYSIS

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:

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

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 rates, 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).

In particular, this article focuses on revisions of year-on-year rates of change. First of all, using rates of change is a common procedure when series are non-stationary. Moreover, year-on-year rates of change are typically used in Portuguese short-term economic analysis, in particular for the assessment of developments in exports and imports. The year-on-year rates of change smooth seasonality and other monthly fluctuations. Adding to the monthly frequency (which is the release frequency of the data) quarterly data are also analysed. Quarterly frequency is widely used for the assessment of global economic developments and forecasting, especially on short-term analysis, as many summary indicators are calculated on a quarterly basis. Another argument in favour of including the quarterly frequency in the analysis is that, in the case of a small open economy like Portugal, export and import developments play a central role on the evolution of economic activity, which is depicted in the main aggregates of quarterly national accounts.

As year-on-year rates of change contribute to mute revisions when compared to month-on-month rates of change (for more details, see Cardoso and Duarte (2009)), revisions to year-on-year rates of change of quarterly data are also smoother than revisions to monthly year-on-year rates of change. Bearing in mind the relation between quarterly year-on-year rates of change ($yoyq_{\tau}$) and monthly year-on-year rates of change ($yoym_t$), the relation between revisions to both rates is as follows:

$$\begin{aligned}
 r_{\tau}^{i,j} &= yoyq_{\tau}^{i+j} - yoyq_{\tau}^i \\
 &= \sum_{m=0}^2 \left(yoym_{t-m}^{i+j} - yoym_{t-m}^i \right) \cdot \frac{X_{t-12-m}^i}{\sum_{h=0}^2 X_{t-12-h}^i} \\
 &+ \sum_{m=0}^2 yoym_{t-m}^{i+j} \cdot \left(\frac{X_{t-12-m}^{i+j}}{\sum_{h=0}^2 X_{t-12-h}^{i+j}} - \frac{X_{t-12-m}^i}{\sum_{h=0}^2 X_{t-12-h}^i} \right)
 \end{aligned} \tag{2}$$

where τ refers to quarters and t to months. So, revisions to $yoyq_{\tau}$ are equal to a weighted average of revisions to the respective $yoym_{t-m}$ ($m=0,1,2$) plus a correction term accounting for the revisions of the weights of each month in the respective quarter. If the relative weights of each month in the quarter of reference do not significantly change from vintage to vintage, then revisions to quarterly year-on-year rates of change can be roughly seen as weighted averages of revisions to monthly year-on-year rates of change of the three months of the respective quarter, from vintage i to vintage $i+j$.

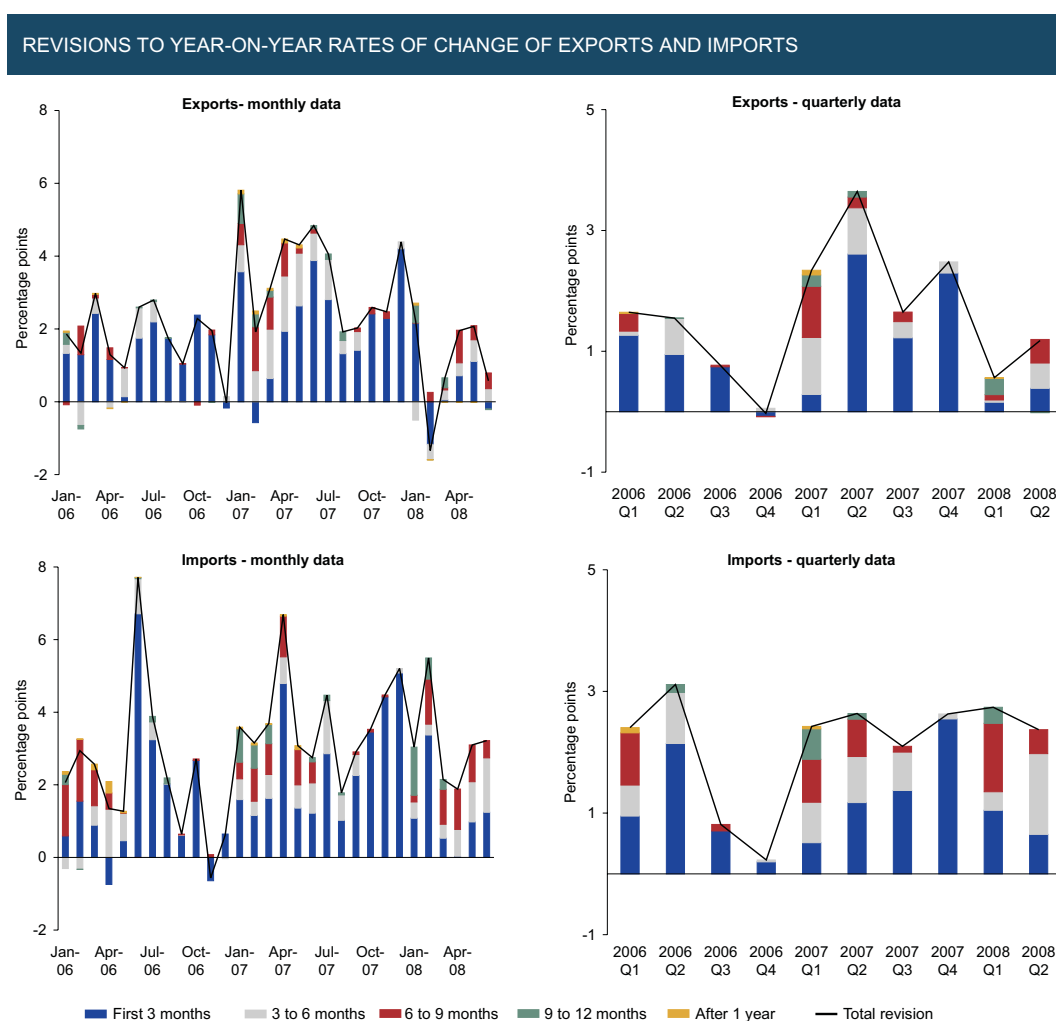
In the case of quarterly data, the first estimate for each quarter is obtained from data for the vintage released when the last month of that quarter is released, the second estimate corresponds to data for the vintage released 3 months later, and so on. This means that only the vintages with data up to March, June, September and December (first releases) are considered. Therefore, the first quarterly estimate results of more mature versions than the corresponding aggregation of monthly first estimates for that quarter as it includes revised values for the first and second months of the quarter. In addition to the ag-

gregation process, this also helps to explain why it is reasonable to expect revisions to quarterly data to be smoother than revisions to monthly data.

Chart 1 displays revisions to previous estimates (previous month, in the case of monthly data, and previous quarter, for quarterly data). This plot shows that the majority of revisions takes place in early releases. On average, both for monthly and quarterly data, at least 60 per cent of total revision occur in the first three months after the first release, both for export and import data. The magnitude of monthly and quarterly 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. Therefore, since data in the latest vintage are in different stages of the revision process, we considered one-year estimates as final estimates.

Now, we proceed into the characterization of the cumulated revisions to year-on-year rates of change since the first release, up to the "final" estimate (one year later). In order to ensure comparability and consistency throughout the analysis, all calculations were made considering a fixed window of esti-

Chart 1



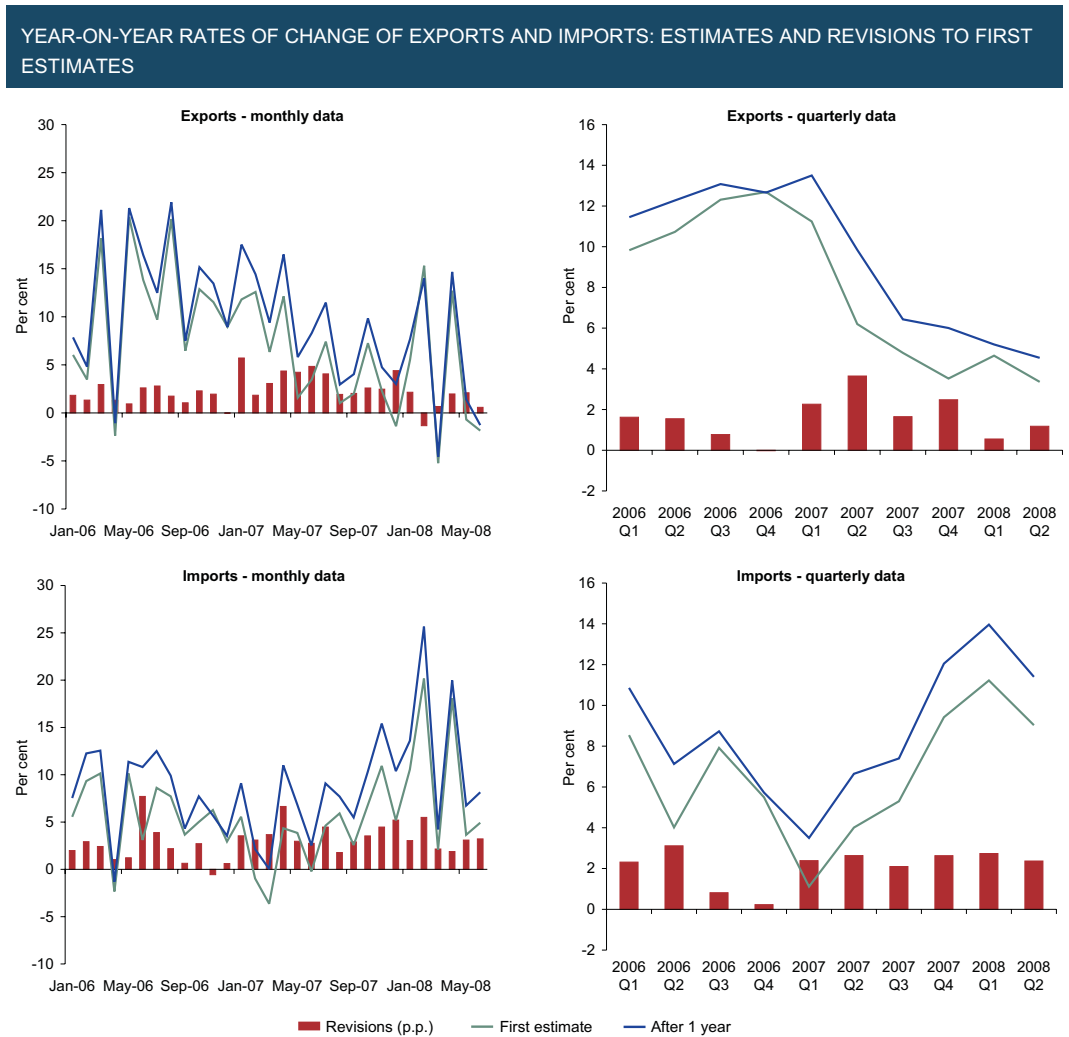
Sources: INE and authors' calculations.
 Note: Revisions vis-à-vis previous estimates.

mates (that is, the same number of observations). Hence, the revision series used end in June 2008 (42 observations in the case of monthly data, and 14 observations for quarterly data). 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 to data only up to June 2008.⁴

- *Sign and size of revisions*

Chart 2 displays monthly and quarterly year-on-year rates of change of export and import data, as in first and final (one year later) 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

Chart 2



Sources: INE and authors' calculations.

(4) For a more detailed analysis, including revisions to previous and first estimates, both for month-on-month and year-on-year rates of change, see Cardoso and Duarte (2009).

Table 2

SUMMARY STATISTICS OF REVISIONS UP TO ONE YEAR TO FIRST ESTIMATES				
Year-on-year rates of change, January 2005 - June 2008				
	Exports		Imports	
	Monthly data	Quarterly data	Monthly data	Quarterly data
Min	-1.33	-0.03	-0.56	-0.23
Max	5.71	3.65	7.71	3.11
% Positive	92.86	92.86	83.33	78.57
% Sign(yoy^{i+j}) = Sign(yoy^i)	95.24	100.00	92.86	100.00
Direction	95.12	76.92	95.12	100.00
Mean	1.68	1.18	2.15	1.52
Significance test (ratio-t)	4.98 ***	3.44 ***	4.91 ***	3.65 ***
Mean Absolute Revision	1.75	1.18	2.23	1.56
Relative Mean Absolute Revision	0.20	0.16	0.28	0.20
Normality test statistics				
Jarque-Bera	2.59	1.42	2.87	1.83
Doornik and Hansen	3.90	2.28	3.99	9.45 ***

Notes: % Positive - Percentage of strictly positive revisions. % 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 1 per cent, ** at 5 per cent level and * at a 10 per cent level.

imports, more than 90 per cent of final estimates have the same sign as early estimates. Regarding direction (acceleration/deceleration), in a high percentage of cases the evolution of export and import growth rates is the same in first and final estimates.

Furthermore, over the period analysed, the vast majority of revisions is strictly positive (more than 90 per cent in the case of exports, and about 80 per cent for imports). As early estimates tend to be revised upwards, the mean of revisions is positive.⁵ Considering monthly estimates, the mean of revisions to year-on-year rates of change of exports and imports is 1.7 and 2.2 percentage points (p.p.), respectively. For quarterly data, these values are smaller (as expected) but also positive (1.2 p.p. in the case of exports, and 1.5 p.p. for imports).

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, both for monthly and quarterly data (Table 2).⁶ 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. For Portugal, José (2004) concluded that real year-on-year rates of change of most components of quarterly national accounts were on average revised upwards (in particular, the international trade variables) but, in general, the revisions were not significantly different from zero.

(5) The results for the mean revisions are qualitatively invariant to the sign of estimates.

(6) 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.

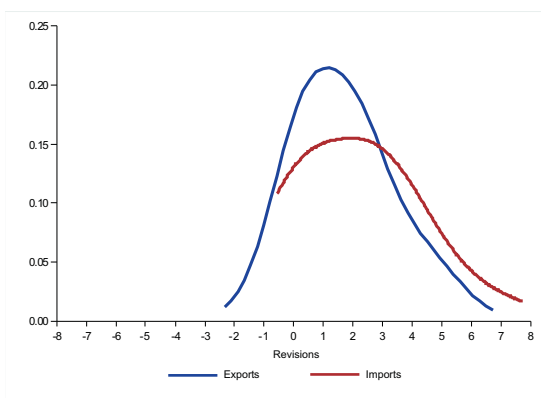
The significance tests for the mean revision rely on the assumption that revisions are normally distributed. Hence, normality of revisions was also tested using Jarque-Bera and Doonik and Hansen (2008) tests (the latter adjusted for small samples). Considering a significance level of 5 per cent, the null hypothesis of normality is not rejected (Table 2). Empirical distributions also favour the existence of normality (Chart 3).

Seasonality in revisions is also analysed, in order to assess whether there is evidence that some months are more revised than others. Chart 4 presents the mean revisions to first estimates by month of reference. 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 not rejected. Moreover, in a regression context with revisions as the dependent variable, for both exports and imports, the coefficients associated to seasonal dummies are not statistically significant.⁷

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 the data are, in general, positive, the mean absolute revision is very similar to the mean revision (Table 2). Moreover, 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 $i + j$) suggested that monthly 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 in the case of imports. Considering quarterly data, the results are quite similar (16 per cent in the case of exports and 20 per cent for imports).

Chart 3

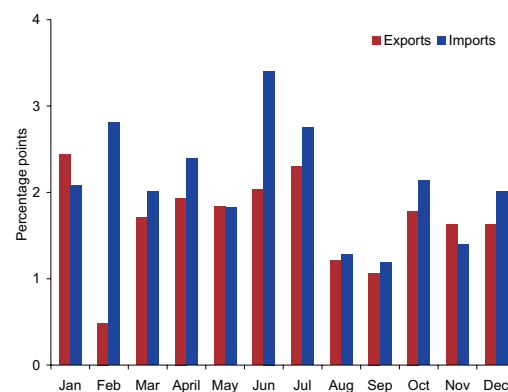
EMPIRICAL DISTRIBUTIONS OF REVISIONS



Source: Authors' calculations.

Chart 4

MEAN REVISIONS TO FIRST ESTIMATE BY MONTH OF REFERENCE



Sources: INE and authors' calculations.

(7) This evidence may be conditioned by the sample size.

- *Volatility of revisions*

Regarding volatility, standard deviations of revisions are shown in Table 3. 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 (ratio of the standard deviation of revisions to the standard deviation of final estimates, as in 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 (about 0.25 for imports and 0.40 for exports). Cunningham e 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 Chart 2, as final estimates exhibit an evolution similar to early estimates and, consequently, correlation coefficients between early and final estimates are high (Table 4).

- *(Un)Predictability of revisions*

Another important question is the (un)predictability of revisions. 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, some further insights into the *news/noise* discussion are presented, resorting to additional measures, such as correlation coefficients and the decomposition of the mean squared revision.

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 predict-

Table 3

VOLATILITY STATISTICS OF REVISIONS UP TO ONE YEAR TO FIRST ESTIMATES

Year-on-year rates of change, January 2005 - June 2008

	Exports		Imports	
	Monthly data	Quarterly data	Monthly data	Quarterly data
St. Dev.	1.57	1.05	2.01	1.22
Noise-to-Signal	0.23	0.25	0.40	0.39
St. Dev yoy^i	6.56	3.97	4.50	2.73
St. Dev yoy^{i+j}	6.97	4.27	5.06	3.12

Notes: St. Dev. - Standard deviation of revisions. Noise-to-Signal - ratio of the standard deviation of revisions to the standard deviation of final estimates. Considering Equation 1, St. Dev. yoy^i (yoy^{i+j}) denotes the standard deviation of estimates for vintage i ($i + j$).

Table 4

(UN)PREDICTABILITY OF REVISIONS UP TO ONE YEAR TO FIRST ESTIMATES				
Year-on-year rates of change, January 2005 - June 2008				
	Exports		Imports	
	Monthly data	Quarterly data	Monthly data	Quarterly data
Mean Square Revision (MSR)	5.30	2.49	8.66	3.78
Decomposition of MSR				
UM (%)	53.39	55.44	53.45	60.82
UR (%)	1.06	1.19	0.22	0.57
UD (%)	45.55	43.37	46.33	38.62
Root Mean Square Revision	2.30	1.58	2.94	1.94
Correlation tests				
Correlation (yoy^i, yoy^{i+j})	0.97 ***	0.97 ***	0.92 ***	0.92 ***
Correlation ($r^{i,j}, yoy^{i+j}$)	0.37 **	0.40	0.46 ***	0.50 *
Correlation ($r^{i,j}, yoy^i$)	0.15	0.16	0.07	0.12

Notes: Considering Equation 3, UM can be interpreted as the proportion of mean squared revision associated to the mean revision (α), UR as the proportion associated to the slope β being different from one and, finally, UD can be interpreted as the disturbance proportion. For more details on this decomposition, see Di Fonzo (2005). Correlation (yoy^i, yoy^{i+j}) - Correlation between estimates for vintages i and $i + j$. Correlation ($r^{i,j}, yoy^i$) - Correlation between revisions and estimates for vintage i . Correlation ($r^{i,j}, yoy^{i+j}$) - Correlation between revisions and estimates for vintage $i + j$. *** denotes significance at 1 per cent, ** at 5 per cent level and * at a 10 per cent level.

able (*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 higher (lower) growth rates signalled greater (smaller) revisions. According to our results, the correlation coefficients between revisions and preliminary estimates are small, not statistically significant, and smaller than those for final estimates (Table 4). This suggests that revisions reflect the incorporation of new information. Moreover, revisions do not seem to be persistent, as autocorrelations are low and, in general, not statistically significant.⁸

Additionally, results from decomposing the mean squared revision are also presented (Table 4). Assume that the mean squared revision can be decomposed as $UM+UR+UD=100$ (Di Fonzo (2005)). This decomposition can be better understood if one considers the following regression:

$$yoy_t^{i+j} = \alpha + \beta yoy_t^i + u_t \quad (3)$$

where UM can be interpreted as the proportion of mean squared revision associated to the mean revision (α), UR as the proportion associated to the slope β being different from one and, finally, UD can be interpreted as the disturbance proportion, i.e., 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 this case, for both imports and exports, UD is quite high and UR is very low, reflecting the high correlation between early and final estimates. However, the UM proportion is large, reflecting a mean revision different from zero.

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

Thus, these results suggest that the existence of a positive mean revision induces a systematic behaviour on revisions. However, inferring the predictability of revisions is not a straightforward task, as argued by Cardoso and Duarte (2009), who further discuss this topic.

4. CONCLUSIONS

This article characterises data revisions to Portuguese export and import data. Focusing on monthly and quarterly year-on-year rates of change, revisions were gauged, resorting to a broad set of statistical measures. The results suggest that revisions are, on average, positive, which implies a systematic component in the behaviour of revisions. Therefore, although correctly indicating the sign and direction of changes, early estimates tend to underestimate final releases. The positive mean does not seem to be significantly different by month of reference.

Moreover, the standard deviation of revisions is quite small compared to the standard deviation of the underlying series. Thus, the small noise-to-signal ratios suggest that the potential challenges in analysing the data are associated to the volatility of the underlying series, rather than to the volatility of revisions. Overall, early and final estimates show a similar evolution, as indicated by the high correlation between both series.

Revision analysis is a crucial step for assessing the impact of revisions on forecasting. In empirical analysis, one typically uses data of the most recent *vintage* (both for in-sample estimation and out-of-sample forecasting). However, this choice has been questioned, as model specification and forecasting performance may be sensitive to the data *vintage* used. Therefore, prior to setting up a forecasting procedure, a key decision is to choose the nature of data to forecast (first release, final estimates or something in between), conditional on one's purposes and also on the behaviour of revisions. The results presented in this article for data on Portuguese exports and imports reinforce the importance of this choice for forecasting purposes.

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