

Seasonality in investments, investment plans and their revisions

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Seasonality in investments, investment plans and their revisions

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Abstract

This paper deals with application of seasonal adjustment methods to solve certain forecasting problems with data on realized and planned investments in the Business Enterprise sector collected by Statistics Sweden. The problems stem from the fact that the timing of investment surveys does not always correspond well to the demands of Ministry of Finance, EURO-STAT and other important users and therefore a need emerges for short-term forecasts. The *revisions* by the enterprises of their planned quarterly investments display strong seasonality, which has undesirable effects on the published statistics. We correct for the seasonality present in revisions, so that, for example, the preliminary national budget and the early estimates of GDP would not need to be substantially revised when final figures arrive. We also extract the seasonal components from the *annual* investment forecasts and their revisions, and use them to correct the quarterly forecasts.

Keywords: official statistics, seasonality, forecasting, revisions.

Subjects:

- Applications of seasonal adjustment techniques in official statistics
- Seasonal adjustment and revision
- Forecasting seasonal time series

1 Introduction

The term “investments” refers to the gross value (i.e. excluding VAT) spent by an enterprise on acquisition of tangible assets with an estimated service life of at least one year, reconstruction and improvement work. Three time a year Statistics Sweden collects the data on realized and planned investments as well as their revisions. These figures are published and used, among others, by the National Accounts Unit for calculating the GDP, by the Ministry of Finance for planning the preliminary and final national budgets, by the Institute of Economic Research and by the industry unions for business cycle and market analysis. It is known that investments dominate the economic growth, both for individual industries and the economy as a whole.

The needs of users, however, do not always concur in time with the timing of the publications, and therefore a necessity emerges to make reliable one quarter-ahead forecasts. There exist elaborate models for forecasting various types of investments (Assarsson, Berg, and Jansson (2004), Chacra and Kichian (2004), etc.). Forecasting seems to be even more straightforward as long as both the data on realized and on planned investments are collected.

In general, investments are highly seasonal. In addition to that, we observed that due to a time schedule used in the data collection procedure at Statistics Sweden, not only the *levels* of realized and planned investments, but also their *revisions* by the enterprises, exhibit strong seasonal behavior. That is, when the enterprises revise their investments plans and report the revisions, the latter turn out to be of different magnitude for different quarters. By accounting for the seasonality in revisions one is able to make a better use of preliminary figures, so that the estimates would not be substantially revised when final (never more revised) figures come. In other words, our goal is to correct the enterprise investment plans by forecasting the revisions.

In Section 2 we describe the data material, its quality and timing. In Section 3 the two forecasting problems which are the concern of the paper, are stated. In Section 4 we present and evaluate solutions to these two problems. The approaches taken are based on seasonal adjustment by TRAMO/SEATS (e.g. Gomez and Maravall (2001)) and utilize both the historical outcomes, the forecasts and the revisions.

2 Data

Statistics Sweden collects data on investments by sending out the questionnaires to a sample of enterprises, three times a year: in May, October and February. Each time, the enterprises are asked to provide *quarterly* figures (realized or planned) for all quarters of the year. In October and February, they are also requested to make *whole-year* forecasts for the coming year.

We note here that although there exist certain differences in trends and seasonality between industries and between types of investments, the problems and the proposed solutions are common. In the following, we shall use the investments in machinery and equipment in extracting and manufacturing industries to illustrate our ideas.

In the following notations, we use superscripts $p1$, $p2$ and $p3$ for the first preliminary figures, the revised figures and the final figures, respectively. Superscripts $f0$, $f1$ and $f2$ stand for zero, one and two-quarters ahead forecasts (plans), respectively, where by the zero-quarter ahead forecast we mean the “nowcast” of the ongoing quarter. Superscripts f,I and f,II stand for the first (October) and the second revised (February) forecasts of the annual investments, respectively.

In May year T , the respondents are asked to provide preliminary figures $Q1_T^{p1}$ for the first quarter of T , and forecasts $Q2_T^{f0}$, $Q3_T^{f1}$ and $Q4_T^{f2}$ for the remaining quarters. In October, the respondents send in the revised figures $Q1_T^{p2}$ and $Q2_T^{p2}$ for the first two quarters, a preliminary figure $Q3_T^{p1}$ for the third quarter, a forecast $Q4_T^{f0}$ for the fourth quarter and a forecast $Y_{T+1}^{f,I}$ of the investments for the whole of year $T + 1$. In February year $T + 1$, the respondents are asked to provide the investment figures $Q1_T^{p3}$, $Q2_T^{p3}$, $Q3_T^{p3}$ and $Q4_T^{p3}$, i.e. the “final” figures for each quarter of year T , together with a forecast $Y_{T+1}^{f,II}$ of the investments for the whole of year $T + 1$. This set-up is displayed in Figure 1.

Although the data collected on any of three occasions are actually a mixture of forecasts, preliminary and final figures, they do exhibit stable albeit different, seasonal patterns (see Figures 2 - 4).

3 Problems

3.1 Correcting the nowcasts

As was mentioned, the investment figures are needed by the Ministry of Finance for planning the preliminary budget. This planning is done in August when the most recent data available are those from the May questionnaires

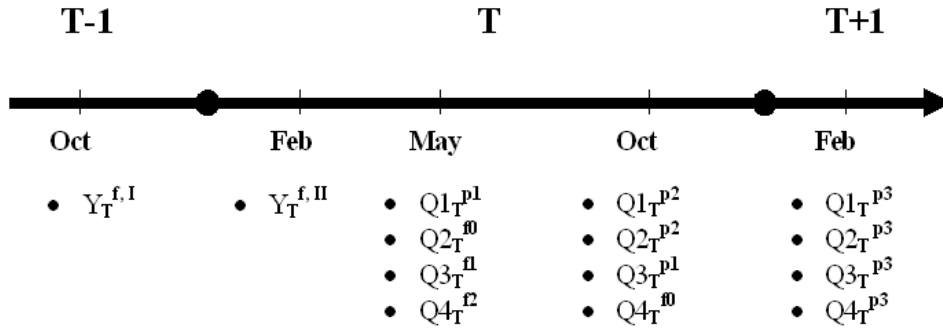


Figure 1: Investment surveys for year T

(Figure 5). This necessitates, for example, the use of the forecast $Q2_T^{f0}$ when estimating the second quarter's investments. It has been noted, however, that in May enterprises tend to misjudge the planned investments, even when making nowcasts for the ongoing second quarter. Figure 6 displays the discrepancies for each quarter, between the investments reported in May and October and their final values reported in February next year. Observe that the second quarter is systematically significantly overestimated. Clearly, a correction is necessary, preferably one which would not lead to large revisions in final budget planning in October. Hence we put forward our first problem:

Problem 1 *How to correct the nowcasts and thus produce early estimates of the investments, which would not deviate too much from the revised and final figures?*

3.2 Producing the forecasts

Data on investments are used for calculation of GDP. The EU demand to publish an early “flash” estimate of GDP, gives rise to additional complications which can be seen from Figure 7. In order to produce the “flash” estimates of GDP for the second and the fourth quarters, one again needs to solve Problem 1. Moreover, by the time of publication of the “flash” estimate for the first quarter, the May questionnaires have not yet arrived. Therefore, there exist no investment data for the first quarter whatsoever. The only figures regarding the current year are the initial full-year investment plans collected in October and the revised plans collected in February.

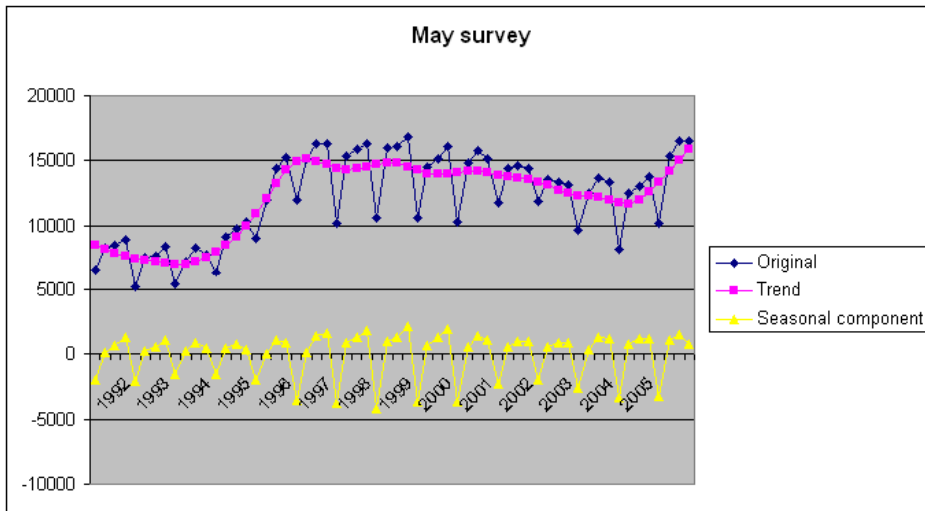


Figure 2: Investments. Q1 - preliminary, Q2, Q3 and Q4 - planned

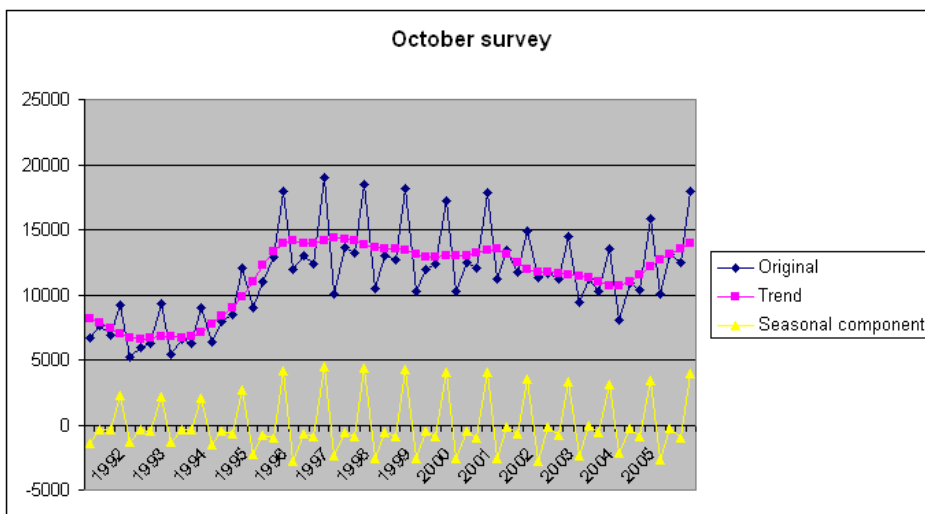


Figure 3: Investments. Q1 and Q2 - revised, Q3 - preliminary, Q4 - planned

Hence our second problem:

Problem 2 *How to produce a forecast for the first quarter taking into ac-*

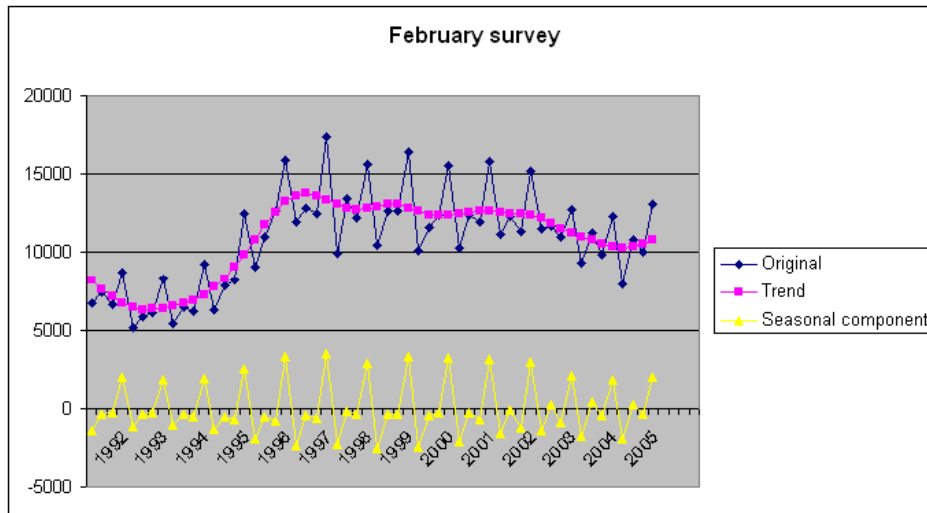


Figure 4: Investments. Q1, Q2, Q3 and Q4 - “final”

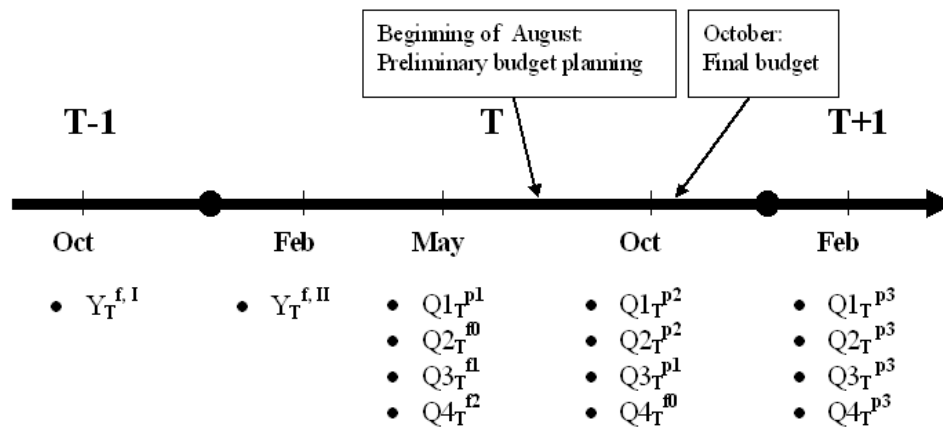


Figure 5: Budget planning

count the full-year plans?

The problem of forecasting the seasonal time series is thus complemented with one of disaggregation of annual data. Contrary to the usual case, it is not the definite data which is to be disaggregated but forecasts.

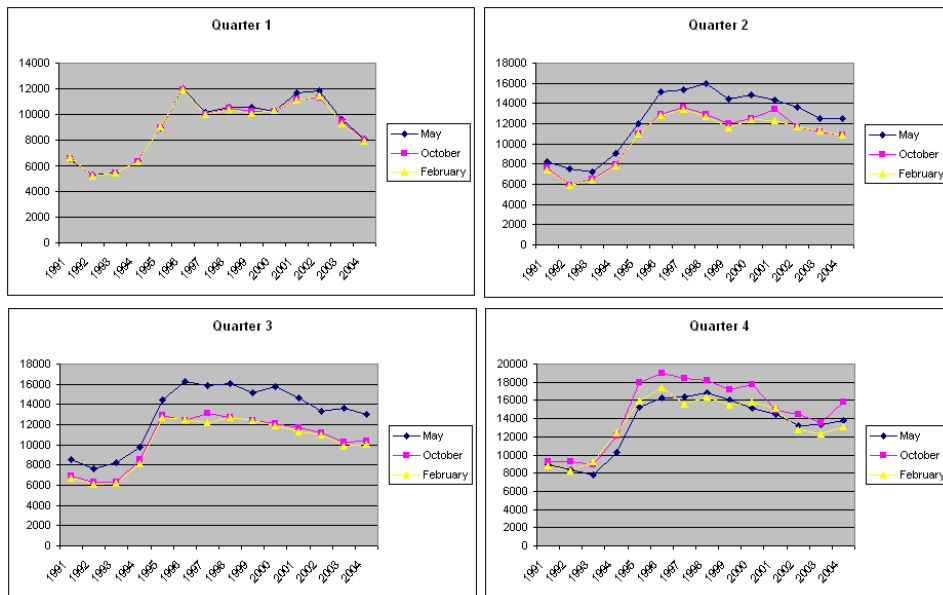


Figure 6: Discrepancies between planned and realized investments

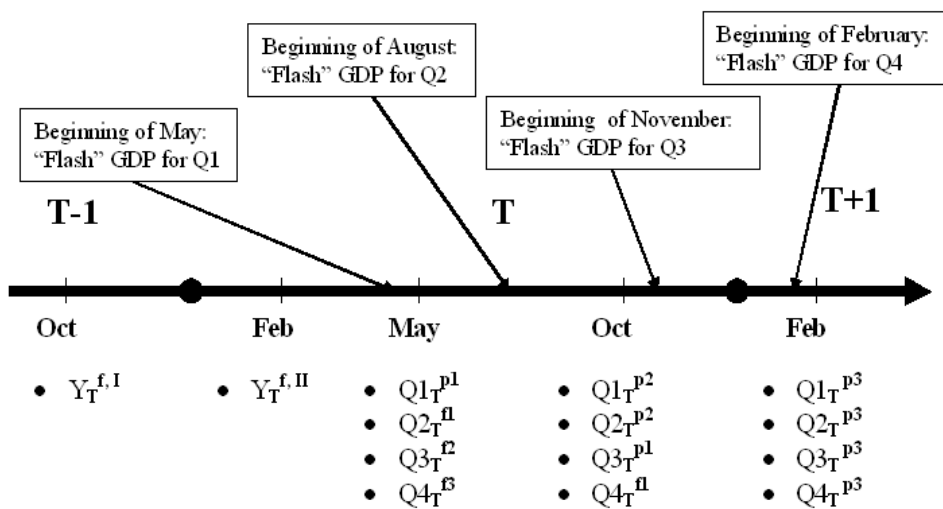


Figure 7: "Flash" GDP timing

It must be noted that for both problems the solutions are needed on a rather detailed level regarding industries and types of investment. It seems therefore next to impossible to find leading indicators which would give satisfactory forecasts for all components.

Below we describe our solutions which are based on seasonal adjustment.

4 Solutions

4.1 Problem 1: correcting the nowcasts

Let us take the second quarter and the May questionnaires. As we have seen in Figure 6, in May the investments for the second quarter are regularly overestimated. However, the magnitude of this error can be better assessed when taking into consideration the errors of the investment figures for the remaining quarters, and the economic situation in industry. This becomes clear if one realizes that the errors are autocorrelated, e.g. a large underestimation of the investment for a certain quarter typically leads to overestimation for remaining ones. Besides, enterprises tend to overestimate the planned investments when the economic situation is favorable and vice versa.

Consider the differences between the final February figures and the ones from the May questionnaires: $\dots, Q1_T^{p3} - Q1_T^{p1}, Q2_T^{p3} - Q2_T^{f0}, Q3_T^{p3} - Q3_T^{f1}, Q4_T^{p3} - Q4_T^{p2}, Q1_{T+1}^{p3} - Q1_{T+1}^{p1}, \dots$. These differences constitute a time series with an easily graspable seasonal component: the first quarter refers to the revisions of the preliminary figures, the second quarter - to the errors of the nowcasts, and the third and fourth quarters - to the forecast errors. The trend of these series, if it exists, should be closely linked with the *level* of investments, since we expect a) the magnitude of forecast and revision errors of the variable to be proportional to the variable in question and b) the economic situation (expressed in, for example, growth of investments, capacity utilization or industrial production) to have an effect on forecast errors. We decompose the series to obtain the trend and the seasonal components (Figure 8). These components per quarter together with the original data are displayed in Figure 9.

Note that for the first quarter the estimated trend and the seasonal component of the differences practically take out each other, so that no correction is needed. Obviously, the preliminary figures for the first quarter we have in May are very close to the final figures. Not so for other quarters. The second quarter's May nowcasts are to be corrected by first adding the

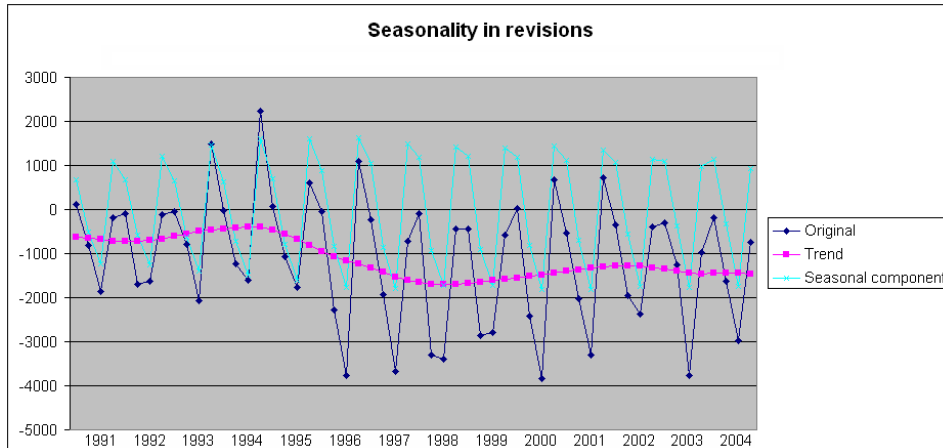


Figure 8: Decomposition of differences between the February and May figures

estimated seasonal component and then by extrapolating and adding the trend.

On Figure 10 we plot the (linearly transformed) estimated trend of the second quarter revisions together with planned investments and the (linearly transformed) capacity utilization. The correction factor for the trend is obtained by regressing the trend of the nowcast errors (for the second quarter) on these variables.

The root mean squared percentage error (RMSPE) of the second quarter investments (levels) estimate obtained after this correction is 4.6% compared to RMSPE of 18.4% for the nowcasts. Even more important is the fact that the systematic (i.e. seasonal) error component is removed. In Figure 11 we plotted the original nowcasts, the corrected values and the true outcomes.

4.2 Problem 2: producing the forecasts

Let us now turn our attention to Problem 2. Until the end of May, there exist no preliminary investment figures to use for the first quarter. The only data we have at the beginning of May, when the “flash” GDP for the first quarter is published, are the two *whole-year* forecasts $Y_T^{f,I}$ and $Y_T^{f,II}$ (see Figure 7) which are used by the Institute of Economic Research to make annual forecasts for T and $T + 1$. In order to produce an early estimate of GDP for the first *quarter* already in the beginning of May, we must somehow

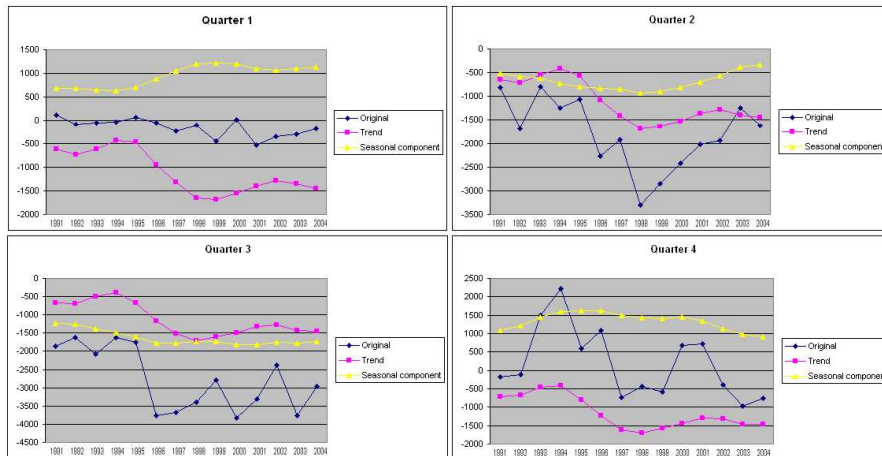


Figure 9: Seasonal decomposition results per quarter

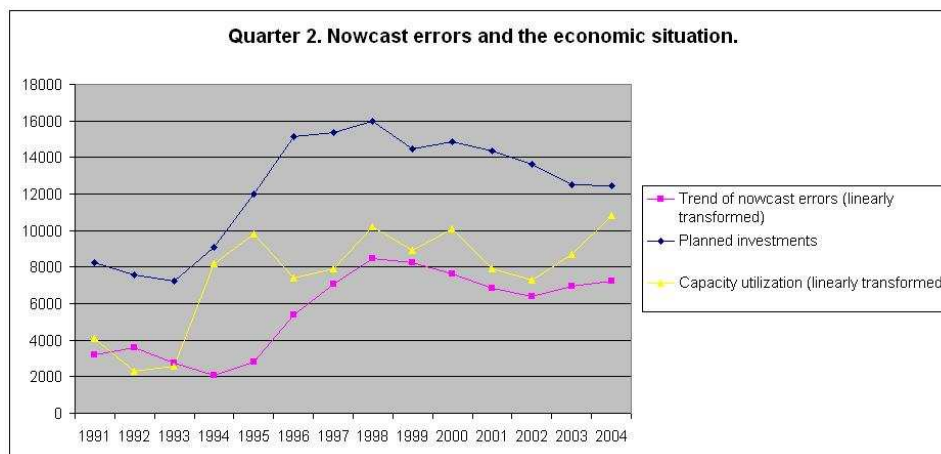


Figure 10: Trend of May nowcast errors and the economic indicators

utilize these data, since there exist no other sources the investment estimates could be based upon. We can also look at the problem in the following light: revisions of the investment plans are the early indicators for the investments growth and as such should not be disregarded.

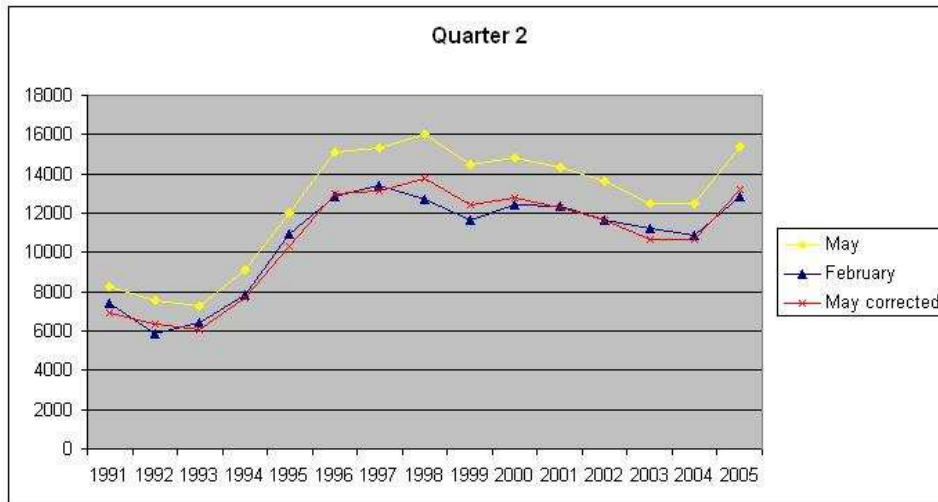


Figure 11: Corrected nowcasts

Our plan is to start off with ARIMA forecasts of the first quarter's investments, and then correct them by taking into account the revisions in whole-year investment plans. In other words, the revisions in whole-year plans are seen as an aggregate of the (non-reported) quarterly revisions, and our goal is to extract the first-quarter component from this aggregate.

We obtain a forecast of the investment growth for the first quarter by pooling the following two forecasts: the ARIMA forecast of the *level* of realized investments and the ARIMA forecast of the first-quarter *share* of the realized whole-year investments (the product of it and $Y_T^{f,II}$ is a forecast of the level). The root mean squared error (RMSE) of such pooled forecast is 3.8. Had we chosen to simply use the preceding (fourth) quarter's growth rate as a forecast for the first quarter, we would get a RMSE of 4.4. Although the improvement is not very large we are obviously on the right track.

Let us ponder how much information on the investments for the first quarter we have by the time the whole-year plans are revised in February. We note that $Y_T^{f,II}$ comes in February when the investments for the first quarter have become more clear. But an upward revision of the whole-year investment plans does not necessarily mean that the first quarter's investments should be expected to grow. On the contrary, the *share* of the first quarter in the whole-year investments can well decrease. The simple regression studies show that the revisions of the whole-year investments are in fact

better predictors of investment growth for quarters two (RMSE=2.5), three (RMSE=1.8) and four (RMSE=3.5) than for quarter one (RMSE=4.5)!

However, if we decompose the revisions into the quarterly figures using the true shares of the quarters, we are able to get the RMSE of the simple linear regression forecast for the first quarter down to 3.6 and by pooling it with the above-named ARIMA forecasts, further down to 3.4. Since in reality the true share of the first quarter we are predicting is not known, we have to rely on the ARIMA forecasts of the shares, which we have already obtained.

We must note that finding a solution to this problem is complicated by the fact that the available annual time series that we used are short, and the evaluation should not be expected to be completely trustworthy. However, the presented RMSE of the forecasts are calculated out-of-sample, i.e. with models reestimated each year as in a real production process.

If we denote the ARIMA forecast of the level as AL and the ARIMA forecast of the share as AS, then the final pooled forecast of the investment growth for the first quarter of the year T will be:

$$\frac{\frac{AL}{Q1_{T-1}^{p3}} - 1 + \frac{AS \cdot Y_T^{f,II}}{Q1_{T-1}^{p3}} - 1 + \alpha(Y_T^{f,II} - Y_T^{f,I})AS + \beta}{3}},$$

where α and β are the coefficients estimated from regressing the first quarter growth rates on the decomposed revisions of the whole-year plans.

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