The influences of bridging days, school holidays and weather on German time series

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Abstract

Traditionally, seasonal adjustment also involves the elimination of average calendar influences. By contrast, no separate adjustment usually takes place for bridging days, school holidays and weather-induced effects. These effects are investigated in the paper based on RegARIMA models. It will be shown that the three variables have a significant influence on the German production index. However, problems are apparent, these being that the adjusted results are not always plausible, the magnitude of the influences may depend on the business cycle, and catch-up effects are probable but impossible to quantify. Hence, it is argued that the decision on which variables should be used for the calendar adjustment of officially published data should take into account criteria other than those of purely statistical significance.

Keywords: Seasonal adjustment, calendar adjustment, calendar variables

1. Introduction

The seasonal adjustments traditionally also cover the elimination of average calendar influences. This normally includes the effects of differences in the number of working days or in the number of the individual weekdays (Mondays, Tuesdays,…), leap year influences and/or the impact of the date on which certain public holidays fall, such as Easter or Whitsun. By contrast, no separate adjustment usually takes place for bridging days, school holidays and weather-induced influences. Below, some approaches to estimating such influences are introduced, as well as their associated problems.

2. Estimation model

For estimating these effects, a regression model with stationary ARMA residuals is used which is also the basis for the calendar adjustment in the seasonal adjustment program X-12-ARIMA. The regression model is estimated for the differenced unadjusted series (Y_{ij}), where the regression error (W_{ij}) is assumed to follow an ARMA model:[1]

$$(1-\mathrm{B})^d(1-\mathrm{B}^s)^D Y_{ij} = (1-\mathrm{B})^d(1-\mathrm{B}^s)^D \sum_{k=1}^{n} \beta_k (x_{kij} - \overline{x}_{ki}) + W_{ij} \text{ and}$$

$$\phi_p(\mathrm{B})\Phi_P(\mathrm{B}^s)W_{ij} = \theta_q(\mathrm{B})\Theta_Q(\mathrm{B}^s)a_{ij}$$

with

- i=1,…,4 for quarterly data (s=4) or i=1,…,12 for monthly data (s=12) and j for the year;

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[1] For an account of ARIMA modelling, see Box, G.E.P. and G.M. Jenkins (1970). For more information on integrating the regression analysis in ARIMA models, see Bell, W.R. (1992) and US Bureau of the Census (2001), pp 15-22.

- the expression $(1-\mathrm{B})^d(1-\mathrm{B}^s)^D$ defining a non-seasonal differencing of order d and a seasonal differencing of order D using the backshift operator B (where $\mathrm{B}Y_{ij} = Y_{i-1j}$);

- $x_{kij} - \bar{x}_{ki}$ as the k-th regressor, which is given as the deviation of the value in month i of year j from its long-run average in month i. β_k denotes the respective regression coefficient;

- the polynomials of the ARMA model (line 2 of the equation), which are defined as follows: $\phi_p(\mathrm{B}) = (1-\phi_1\mathrm{B}-\phi_2\mathrm{B}^2-...-\phi_p\mathrm{B}^p)$ is the non-seasonal (regular) autoregressive (AR) operator to the p-th degree, $\Phi_P(\mathrm{B}^s) = (1-\Phi_1\mathrm{B}^s-...-\Phi_P\mathrm{B}^{Ps})$ the seasonal AR operator to the P-th degree, $\theta_q(\mathrm{B}) = (1-\theta_1\mathrm{B}-...-\theta_q\mathrm{B}^q)$ the non-seasonal moving average (MA) operator to the q-th degree and $\Theta_Q(\mathrm{B}^s) = (1-\Theta_1\mathrm{B}^s-...-\Theta_Q\mathrm{B}^{Qs})$ the seasonal MA operator to the Q-th degree;

- a_t denotes the residuum or innovation which is uncorrelated in time with the other values and is identically normally-distributed (iid), with mean value 0 and a constant variance (white noise).

3. Adjusting for bridging days

Bridging days are days lying between a public holiday and a weekend. They are counted in purely calendar terms as full working days, but the fact that they lie between a public holiday and a weekend means that such days can be used to “work off” overtime that has been accumulated or for taking a long weekend. In this sense, they would be expected to have a negative influence on, for instance, industrial production.

It may be assumed that the quantitative impact of bridging days depends on a variety of circumstances.

- If there is precisely one day between a public holiday and a weekend, I refer to its impact as a “single bridging day effect”. If, by contrast, there are two days between a public holiday and a weekend, this may lead to a “two bridging days effect”. Empirical studies (not included in this paper) reveal that the influence exerted by two bridging days on German industrial output cannot be demonstrated with statistical significance. The following investigation is hence restricted to the impact of single bridging days.

- The influence of single bridging days may differ according to whether they fall within the Christmas period or during the rest of the year. Companies are temporarily closed or more leave is taken at the end of the year, irrespective of the day on which Christmas and New Year’s Eve happen to fall, with the result that the additional effect of bridging days is less pronounced in this case than at other times of the year. Thus, separate calculations were carried out for the months from January to November and for December respectively.

The results obtained using data on German (before 1991: western German) industrial output since 1962 for different lengths of estimation periods indicate that the importance of single bridging days from January to November is likely to have increased over the decades. In the very recent past, an additional bridging day in a month has led, on average, to a 1.3% decrease in monthly output.

Period	Bridging day semi-elasticity as a percentage	t-value
1970-1980	-0.2	-0.6
1981-1990	-1.1	-3.4
1991-2000	-1.3	-4.3
2001-March 2007	-1.3	-3.6

The estimate of the impact of single bridging days in December has a much greater uncertainty than for the other months because a total of only seven values with bridging day effects are available for December since 1962 (a shorter estimation period is hence not practicable). According to the results, an additional bridging day in December causes a fall in production of about 0.8 % in the month concerned.

Period	Bridging day semi-elasticity as a percentage	t-value
1962-2006	-0.8	-4.3

Of course, the seasonally, working day and bridging day-adjusted series has to be smoother than the series adjusted only for seasonal and working day variations, because some variance is assigned to the bridging day effects and filtered out.

However, the chart also points to problems in some places.

- The RegARIMA approach customarily used in seasonal adjustments supposes that, in a month with an additional two single bridging days, their effect is precisely twice as great as that of one additional single bridging day. The few values for the impact of two single bridging days (for instance, May 2003 and January 2004) nonetheless indicate that the link is likely to be smaller. Hence, the approach shown would tend to lead to an overadjustment in months which have two single bridging days. A separate estimate for these months is impractical, however, because there are too few observation values.

- Use made of single bridging days could depend on the prevailing economic situation. In times when the economy is weak, bridging days could be used, in particular, to stop production temporarily, whilst, in times of considerable growth, there would be a tendency to continue working. This hypothesis cannot, however, be easily put to an empirical test with the aid of RegARIMA models. To this end, in each case at least five-year periods of uninterrupted upturn or downturn would have to exist. What is more, the estimate of the economic dependency of bridging day elasticity should not be influenced by the ascertained effect of the increased use of bridging days over the decades. I have no authoritative empirical investigation for Germany on the reactibility of bridging day elasticity to economic factors.

- Insofar as the impact of a single bridging day results in (more) leave being taken on these days – annual leave remaining unchanged – fewer free days are available during the rest of the year. If the effect of the concentration of leave on single bridging days is eliminated, the countermovement of less leave should actually also be adjusted over the rest of the year so that no distortion of the business cycle occurs. We cannot estimate the exact time spread and amount of this countermovement with any statistical certainty, however. This also applies if the impact of a single bridging day results from "working off" previously collected overtime.

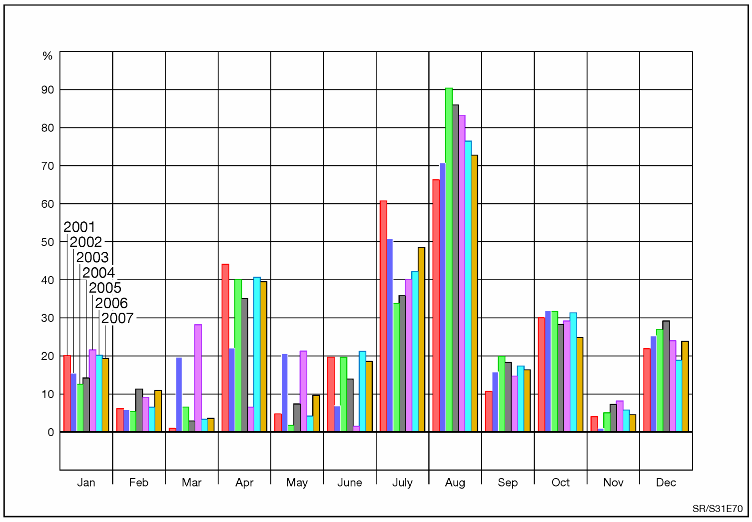
To conclude, the impact of single bridging days on industrial output is quantifiable on average, but tends to depend in almost all individual cases on the relevant circumstances (accumulation of single bridging days in a month, economic factors and dates of the other non-working days) so that considerable need for explanation may remain, even after additionally adjusting for single bridging days.

4. Vacation adjustment

The basic idea of the vacation adjustment is that the economic activity in a month/quarter is likely to depend on the timing of the school holidays. Workers with school-age children take leave above all during the school holidays, and hence interrupt their work. Since the dates of the school holidays in the individual federal states change from one year to another, their effects do not always occur at the same time and with the same intensity in Germany. It would therefore seem prudent to measure the influences of shifts in the dates of the school holidays in the context of a RegARIMA model.

The regressor used in this model takes into account that capital-intensive ongoing production processes are also maintained during the school holidays; the impact of the school holidays focuses on those production operations which are carried out from Monday to Friday. Therefore, the loss of working days (as a percentage) is taken for the quantification of the influences of the school holidays which would emerge mathematically if leave were to be taken by all workers in industry in the federal states where the schools are on holiday.

Working days with school holidays as a percentage of total working days



According to the results in the following table, the influence of the school holidays in the months of January to April, November and December cannot be shown with statistical certainty. The greatest holiday influences emerge in July, September and October.

Regressor	Parameter as a percentage	Standard error	t-value
Working days with holidays as a percentage of the total working days of the month…			
January	-0.07	0.06	-1.12
February	0.01	0.13	0.12
March	0.01	0.03	0.40
April	-0.03	0.02	-1.50
May	-0.07	0.03	-2.35
June	-0.09	0.03	-2.69
July	-0.18	0.03	-5.63
August	-0.08	0.04	-2.14
September	-0.14	0.07	-2.00
October	-0.15	0.07	-2.00
November	-0.04	0.10	-0.37
December	-0.00	0.06	-0.03

Estimation period: January 1992 – June 2007

If an adjustment is made for the seasonal influences, for the calendar effects as well as for the significant average school holiday influences, the resulting German production index for industry is, of course, smoother than the series that has been adjusted only for seasonal and calendar effects.

However, there are specific problems.

- Monthly-specific estimates of the effects of the school holidays are based in each case only on a very limited number of observations. A small number of values can hence exert a relatively major influence on the result. What is more, the addition of new values may lead to tangible changes.

- Since more holidays in a month always correspond to fewer holidays in other months, one might theoretically anticipate that the estimated positive and negative holiday effects roughly balance each another out throughout the year. This is not the case, however.

  For instance, the summer holidays in Germany are always six weeks long, but in some years they are concentrated in July, in some other years they are concentrated more in August. Because a holiday in July has a bigger influence on production than a holiday in August, the production of a year depends on the summer holiday schedule. This is an implausible conclusion.

The conclusion is that, on average, some holiday effects can be shown in the German production index. In some cases, the results are relatively implausible and uncertain, however.

5. Weather adjustment

In a similar way to the effects of the school holidays on the production index for industry, the weather-induced effects on the German production index for the construction industry do not occur repeatedly with the exact same intensity in the same month of each year either. Rather, the impairment of construction activity in the cold season depends on the intensity and, above all, on the length of the period of frost. In this sense, one may also attempt to model the weather dependency of, for instance, construction output using suitable regressors in order to make it easier to draw conclusions as to economic developments.

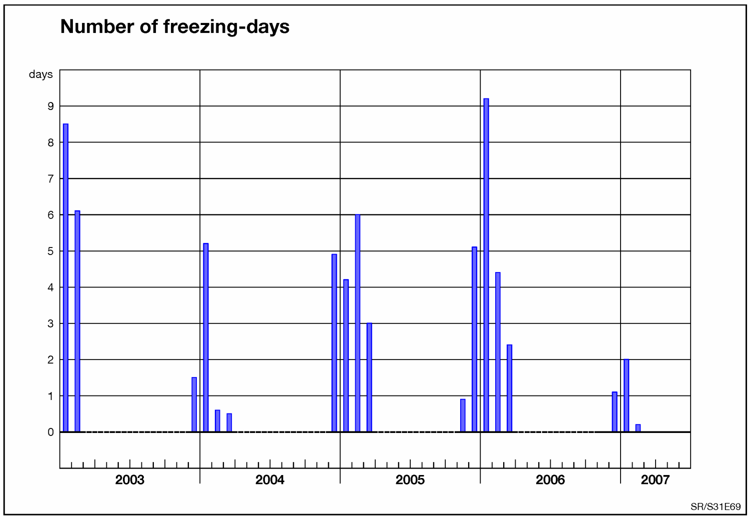
The Deutsche Bundesbank has made several attempts in the past to explain the impact of the weather in the cold season in terms of model analysis by introducing independent variables.[2] Weather indicators considered here consisted of information such as that surveyed among enterprises by the Ifo Institute "Impairment of construction activity owing to weather influences" or information relating to days with ice or snow.

Since, an evaluation of weather-related construction impairment by the construction companies may incorporate subjective judgments, however, and it cannot be ruled out that companies will consider "normal" winters to be less "impaired" in an upswing than in an downswing, the Ifo indicator appears, in principle, to be less well suited to explaining the fluctuations in production in the construction industry than objective weather information.

The following weather indicators can be considered, for instance.

- Number of freezing days in a month (days with a maximum temperature below freezing point)
- Number of days with snow in a month (days with more than 1 cm of snow on the ground at 7 a.m.)

The information for Germany is formed from series which relate to individual measuring stations, the regional employment structure in the construction sector being used for weighting purposes.



The results of an adjustment for freezing days are presented below, representing the results with such weather regressors.

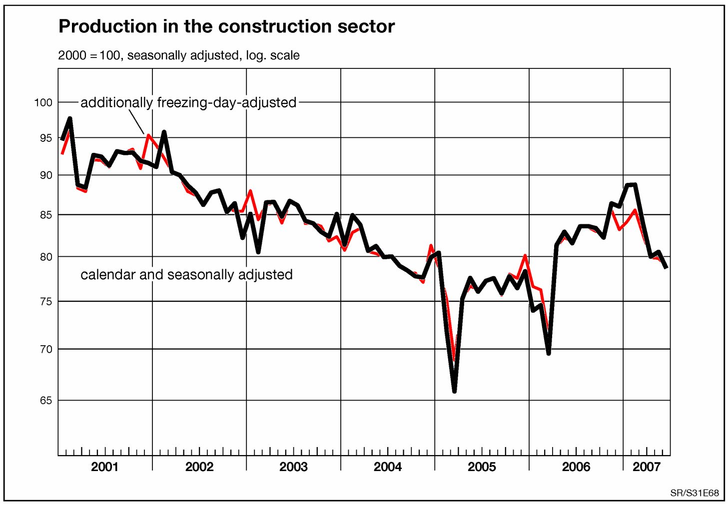
[2] See Kirchner, R. (1999), p 56.

According to the following table, an additional freezing day in a month leads to an average fall in production in the construction industry of almost 2%.

Regressor	Freezing day semi-elasticity as a percentage	Standard error	t-value
No. of freezing days	-1.84	0.182	-10.2

Estimation period: January 1992 – July 2007

Of course, the series that is additionally adjusted for freezing days is smoother than the results that are adjusted only for seasonal and working-day variations.



However, many problems are still apparent.

- Despite the adjustment for the weather, considerable fluctuations remain apparent in the cold part of the year. (There are presumably some overadjustments and some underadjustments).
- The information on the freezing days is only approximately linked to construction output. The derivation of the number of freezing days is based not on the detailed regional differentiation actually needed, but only on the values for a small number of locations.
- What is more, it is not the distribution of the freezing days within one month that is considered, although it is material to construction activity how many such days fall on a weekend or whether, for instance, a freezing period falls in the first half of December, or in the Christmas period when there is, in any case, largely no production in the construction sector.
- Furthermore, the difficulty arises that a kind of normal temperature is presumed for each cold month (measured as a month-specific average) which applies from the beginning to the end of the time series, since – according to the above – only the derogations from the month-specific average are incorporated into the estimate of the impact on construction production. The precondition of a constant average weathering effect, and, hence, the simple transfer of circumstances from earlier times to the current end, is, however, to be questioned as a result of possible global warming. At the end of the series, it is therefore not possible to estimate with certainty which global warming-related weather impact is to be regarded as permanent – meaning that it should be attributed to the season – and which is not.
- Exceptionally severe weather-related production impairments in the cold season frequently lead to positive catch-up effects in the spring. If the winter shortfall is adjusted, the indirect knock-on effect could also be removed from the calculation in order not to unilaterally distort the business cycle picture. Eliminating the catch-up movement is, however, even more problematic than carrying out a direct weather adjustment.

To conclude: on average, statistically significant weather influences in the German production index can be proven for the construction industry. However, the interpretation of information that is adjusted for seasonal, weather-related and working-day variations remains a problem in almost each individual case (overadjustment and underadjustment of weather influences, not taking into account the catch-up effects).

6. Summary

In principle, the average impact of additional working, bridging, school holiday and frost days can be quantified and adjusted. However, this frequently leads to new problems.

The question therefore arises as to the criteria to be met for an official adjustment.

Criterion	Adjustment of average impact of		
	Bridging days	School holiday	Weather
Estimated regression coefficient - significant - plausible	 X X	 X -	 X X
Adjusted results in the overriding number of individual cases plausible	X	?	-
No systematic overadjustment or under-adjustment in certain cases	-	?	?
No catch-up effects probable or catch up effects quantifiable	-	?	-

From my point of view, an official adjustment of certain effects should be performed if the estimation meets all the criteria mentioned. This is currently not the case for the effects discussed in this paper, although it is for normal seasonal and calendar influences on German time series.

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