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Abstract

National accounts are subject to major revisions. To improve the reliability of the first release data, it is important to know whether these revisions show systematic patterns, or in other words, whether national accounts are informational efficient in the sense that they incorporate all information available in the data. This paper tests three dimensions of informational efficiency: weak efficiency, strong efficiency, and Nordhaus efficiency. The tests on weak efficiency find systematic patterns in the revisions. Tests on strong efficiency, however, do not provide a clear-cut picture, which kind of information can be used to reduce the extent of revisions. Finally, the tests on Nordhaus efficiency indicate that the revisions do not follow a time path.

JEL-Code: C82, E01, E66

Keywords: National account; data revision; informational efficiency

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1. Introduction

After their first release, National Accounts (NA) are revised several times until the data are designated as “final”, which typically is the case three and a half years after the end of the reported year. The changes associated with these revisions are substantial. In Germany, e.g., the mean absolute revision of the year over year growth rate of quarterly real GDP was 0.47 between 1994 and 2013 (Zwijnenburg, 2015), which is at the lower end among OECD countries. Particularly in small countries, the extent of revisions is much larger. Seemingly, also little progress is made in reducing the extent of revisions over time. For earlier episodes almost the same results were found as today (Ahmad, Bournot, & Koechlin, 2004; York & Atkinson, 1997).

Revisions of NA stem from two sources. The first are so called benchmark revisions. They are typically internationally coordinated and are made in a five year’s turn as a rule. They are deemed to introduce new concepts, new definitions, new calculation approaches, and additional data sources into the NA. The second source are current revisions. They result from the fact that many data sources are not yet available when the first release of NA is published. Therefore, some of the raw data must be estimated in the beginning, and these estimates are replaced by observations later, as soon as the initially missing data source becomes available.

Since benchmark revisions are guided prevalently by methodological considerations, there is little reason to assume they change the data systematically. Therefore, trying to reduce the extent of benchmark revisions is not a reasonable goal. Current revisions, on the contrary, can be reduced by improving the estimates of initially missing data. Searching for systematic components in NA revisions, therefore, may hint at opportunities for such improvements.

Analyses of data revisions show some similarities to forecast evaluations. Forecasts should ideally be efficient in the sense, that all information available when making a forecast is used appropriately. The same holds for the NA, which also should incorporate all information known at the time of data production. Thus, methods and concepts to evaluate forecasts can be applied to data revisions accordingly.

However, applying the concept of efficiency to NA revisions is a difficult task. One reason is that the number of available information at a given time is tremendously large, making an encompassing test whether 'all available information' is used impossible. Another, not less important reason is that it is empirically difficult to separate the impact of benchmark from the consequences of current revisions. Since benchmark revisions take place each fifth year on average, the revision cycles, i.e. the period between publishing the first release and the final data, are influenced by both types of revisions in most years. Whereas there is no fixed rule how to solve the first problem, the second problem can be treated in an intuitive way which will be presented subsequently.

This paper focusses on the German NA and analyzes whether they are efficient. The research approach is analyzing the revisions over time for a systematical component. Identifying the latter may hint at lacking efficiency in producing NA figures, or in other word, that the need for revisions could be reduced by making a better use of available data. Before doing so, Section 2 will scrutinize the term 'efficiency' in the context of forecasts and revisions. It will distinguish weak and strong efficiency, and it will propose tests of the properties of data revisions. In Section 3, the data are presented. Furthermore, it describes the way, how current revisions are separated from benchmark revisions. Section 4 conducts various tests for efficiency, in a first part for weak, in a second part for strong efficiency, and in a third part, Nordhaus-efficiency is addressed following Nordhaus (1987). Section 5 summarizes and provides some recommendations for the producers of NA.

2. Measuring efficiency

Acceptable forecasts should meet three conditions. Firstly, they should be accurate, i.e. show a small forecast error. Secondly, they should be unbiased. Thirdly, they should be efficient, some authors prefer the term rational. Whereas there is no controversy about the metric of the two first properties, the last is more difficult to measure. The same holds if these conditions are analogously applied to revisions.

The difficulties in defining and measuring efficiency already start with the wording. Zarnowitz (1992, pp. 464-466) defines three properties of forecast errors that are desirable: The mean forecast error should be unbiased, the forecast error should be uncorrelated with the variable forecasted, and the forecast error should be uncorrelated with past forecast errors. A forecast complying with these requirements is called rational in his terminology. Nordhaus (1987) introduced the distinction between weak and strong efficiency. However, he applies the concept to revisions of forecast – an idea we will come to later. He defines weak efficiency as a situation "under which a forecast contains information about all current and past forecasts". Under this condition, forecast errors as well as forecast revisions should be uncorrelated with past forecast revisions. Strong efficiency goes further: Forecasts should contain all information available. Stekler (2002, p. 223) combines both terminologies when writing: "Weak rationality means that forecasts are conditionally unbiased, so that forecasters make no systematic errors. Strong rationality has also been called efficiency. The forecast is efficient if it is unbiased and if the forecast errors are not correlated with any other information known at the time a forecast is prepared." In some papers (e.g. Berger & Krane, 1985) this also is addressed as informational efficiency.

This is not the place to discuss these various aspects and definitions of efficiency in detail. Subsequently these concepts will be applied to revisions of NA and some measures will be developed that give indication, whether NA are (informational) efficient, or whether a better use of available information can reduce the need of later revisions.

Following from the brief discussion above, three dimensions of efficiency of NA will be distinguished

Weak efficiency

As weak efficiency, the three criteria mentioned by Zarnowitz (1992: 265) will be applied. Firstly, it will be tested whether revisions are unbiased. A widely used descriptive measure is mean revision, which is defined as

(1) $$\mathrm{MR} = \frac{1}{\mathrm{T}}\sum_{\mathrm{t}} \mathrm{F_t} - \mathrm{P_t}$$

with F_t and P_t being the annual growth rates of the final and of the preliminary (first release) data for observation period t and T the number of observations. As a test for biasedness the regression

(2) $F_t - P_t = c + \varepsilon_t$

is run using a t-test to judge whether c differs significantly from zero. However, this test only is a partial view. A bias detected here can also be the consequence of violating the second of Zarnowitz's criteria. An encompassing test is the Mincer-Zarnowitz regression, which augments (2) by adding the growth rate of the preliminary data as a regressor (Faust, Rogers, & Wright, 2005, p. 406; Glass, 2018, p. 10).

(3) $F_t - P_t = c + ß\, P_t + \varepsilon_t$

If the NA data are efficient c as well as ß should be zero. Whether both restrictions are met can be tested by a F-Test. The residuals of (3) should be uncorrelated to meet Zarnowitz's third criterion. This will be tested employing Ljung-Box Q-statistic for first degree autocorrelation.

Strong efficiency

As a test for strong efficiency, the standard test proposed by Holden and Peel (1990) will be applied accordingly. It augments the Mincer-Zarnowitz equation to

(4) $F_t - P_t = ß_0 + ß_1\, P_t + ß_2\, X_t + \varepsilon_{t.}$

For normalized X_1 the Null is $ß_0=ß_1=ß_2=0$. As Holden and Peel (1990) point out, the results of the traditional Mincer-Zarnowitz-Test can be spoilt in cases when a correlation of the revisions with X exists. Hence, $ß_0$ and $ß_1$ in the augmented equation my differ from c and ß in (3).

However, the problem of testing strong efficiency results from choosing the X-variable. Faust et al. (2005) test an influence of the Oil price, Stock returns and the short-term interest rate.[2] For Germany they reject the efficiency-hypothesis for the augmented equations. But there are more variables that are worth being considered, e.g. surveys among companies or consumers.

Nordhaus-efficiency

[2] They furthermore include dummies for the quarters and the lagged preliminary data.

The Nordhaus (1987) approach to efficiency testing deviates from the one followed hitherto. In the case of forecasts Nordhaus considers the fact that forecasts are revised several times before the outcome for the targeted variable gets known. Efficiency means in this setup that forecasters do not stick to their previous forecast but take into account new information immediately. This is tested by regressing the forecast revision made at time t on the revision made at time t-1. If there is a significant correlation this is interpreted as a sign of stickiness and thus of inefficiency.

In the context of NA revisions, the situation is similar, since revisions are made stepwise, too. Faust et al. (2005) take this aspect into account by differentiating between short-term and long-term revisions. However, they do not analyze whether short- and long-term revisions are interlinked. If this would be the case, this could hint at an inefficient use of newly arriving information. The interpretation is that statistical offices stick to the data they published first and adjust them only piecemeal.

To test for Nordhaus efficiency in the context of NA revisions, one must differentiate between various vintages of preliminary data. $P_{t|n}$ denotes the n[th] vintages of preliminary data for year t, and $v_{t|n}$ the change of the preliminary data in vintage n compared to vintage n-1. The total number of vintages is N, and vintage N is identical to the final data F. Thus the following restriction holds:

(5) $$F_t - P_{t|N} = \sum_2^n v_{t|n}$$

The test for Nordhaus efficiency then is

(6) $$v_{t|n} = ß_1 \cdot v_{t|n-1}$$

Following Nordhaus (1987) this equation does not contain a constant because a bias in the change revisions seems not plausible. In the case of Nordhaus efficiency $ß_1$ should be zero.

3. Data

Unlike Faust et al. (2005); Garatt, Kopp, and Vahey (2008); Glass (2018); York and Atkinson (1997), who used quarterly data in their studies, we will analyze annual data. The choice of the frequency is owed to the typical revision process in the German statistical office. The information that become available late and trigger the revision process are mostly annual data. Value added, e.g., is defined as the difference between production and the inputs acquired. Production is estimated from turnover, which is available on a monthly base in industry and quarterly in the service sector. However, the data are taken from a census covering only large companies. Thus, the contribution of small companies must be estimated, mostly from annual data. For inputs, only annual data are available, and they are published with some delay. As long as no other information exists, the share of inputs in production will be held constant at the last observed value. One and a half year after publishing the first release of NA, annual data on production of all companies and the relation of inputs to production become available. Now the Statistical Office will revise its first estimate on an annual base, and it will break down these annual figures to a quarterly profile thereafter. Hence, with respect to information content the annual level is important.[3]

Of course, compared to quarterly data the use of annual data is associated with a loss of observations. This disadvantage is overcome partially by the size of the sample. The study covers the revisions for the years 1993 to 2015, i.e. a sample of 23 years.[4] The start is marked by the first year for which the full set of revisions can be traced for unified Germany. 2015 is currently the last year for which the final data have been published. In Germany, final data are released 44 months after the end of the year that is reported in the data. All later revisions result from benchmark revisions.

As already said, the lever to reduce revisions are the current revisions, whereas benchmark revisions follow different considerations. Most papers mix up both effects, which makes it difficult to draw conclusions for the work of the Federal Statistical Office. Here an approach described in Döhrn (2019) is used to separate current revisions from benchmark

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[3] Döhrn (2019) shows that there is a high positive autocorrelation of revisions of quarterly data. This means, quarters of a given year are mostly revised in a similar way. That confirms the importance of the annual level for revision analyses.

[4] The analysis of Faust et al. (2005) covers 17 years for Germany, York and Atkinson (1997) analyze 14 years, and Zwijnenburg (2015) uses data for 20 years.

revision. First, all data are transformed to year over year growth rates. Then, the entire change of the growth rate in the month a benchmark revision takes place is ascribed to the benchmark revision. In case, the benchmark revision is followed by additional current revisions, these changes of growth rates are linked to the rates before the benchmark revision. This procedure, of course, can provide a rough approximation only. However, it is an open question in which direction the current revisions are biased by the adjustment, since it is unknown – at least to outsiders – how both types of revisions interact.

Table 1: Descriptive statistics of NA revisions in Germany, 1993-2015

	total revisions			**current revisions**		
	MAR	MSR	NSR	MAR	MSR	NSR
Gross Domestic Product	0.37	0.21	0.06	0.30	0.13	0.04
Private consumption	0.37	0.25	0.28	0.39	0.27	0.28
Government consumption	0.60	0.48	0.51	0.54	0.46	0.47
Investment, total	1.20	2.22	0.12	0.92	1.30	0.07
Investment in equipment	1.53	3.64	0.06	1.28	2.93	0.04
Investment in construction	1.51	3.29	0.28	1.22	2.13	0.19
Change in stocks[1]	0.50	0.36	0.97	0.39	0.22	1.02
Domestic demand	0.45	0.27	0.11	0.31	0.15	0.07
Exports[2]	0.88	1.10	0.03	0.80	1.10	0.03
Imports[2]	1.10	1.90	0.08	0.92	1.81	0.07
Net exports[1]	0.19	0.05	0.04	0.17	0.05	0.04
Employment	0.29	0.21	0.28	0.20	0.10	0.12
GDP per employee	0.56	0.60	0.22	0.40	0.24	0.10

Author's computations. – [1]Contribution to growth. – [2]Goods and services.

This paper looks at GDP, at the demand side components of GDP, at employment, and at productivity, defined here as GDP per employee. Table 1 provides some descriptive statistics for total revisions and for the estimated current revisions. It shows the mean absolute revisions (MAR), the mean squared revisions (MSR) and the noise to signal ratio (NSR), defined as MSR relative to the variance of the observed growth rates. For all variables current revisions are considerably smaller than total revisions. Particularly large are the revisions of investment and external trade. However, since the growth rates of this variables are highly volatile, the NSR is not large. On the other hand, private consumption and government consumption show lower revisions, but are less volatile, so that the NSR is relatively large. Change of stocks is the only variable for which NSR is above 1.

An issue raised by Glass (2018) and Öller and Hansson (2005) are the statistical properties of the revision. Most statistical tests are built on the assumption of normal distribution of the residuals. Non-normally distributed revisions would have consequences for the tests. As table 2 shows, the revisions are mostly skewed, and the kurtosis is below 3 in many cases. However, Jarque-Bera-tests do not reject the null of normal distribution for most variables. There are three exceptions: private consumption expenditure, imports, and employment, the last two at a high level of significance. Therefore, additional to the OLS estimates also a least absolute deviation (LAD) estimator will be presented, which is more robust to outliers.[5]

Table 2: Skewness, Kurtosis, and test for normality of NA revisions in Germany, 1993-2015

	Skewness	Kurtosis	J-B-Statistic
Gross Domestic Product	0.01	2.37	0.38
Private consumption	1.01	3.92	4.72*
Government consumption	0.44	3.37	0.88
Investment, total	0.07	2.67	0.12
Investment in equipment	0.26	3.24	0.31
Investment in construction	0.28	2.21	0.90
Change in stocks[1]	0.32	2.53	0.61
Domestic demand	-0.17	2.33	0.54
Exports[2]	0.68	3.27	1.82
Imports[2]	1.70	6.70	24.26***
Net exports[1]	-0.11	2.59	0.21
Employment	1.57	4.60	11.92***
GDP per employee	-0.13	2.80	0.10

*Author's computations. J.-B.: Jarque-Bera. */**/*** indicates significance at a 10/5/1%-level – [1]Contribution to growth. – [2]Goods and services.*

4. Estimation results

4.1 Weak efficiency

As outlined above, three tests for weak efficiency will be employed. Table 3 shows the results of the test for (partial) biasedness according to (2). Both approaches confirm biasedness for exports and imports. For private consumption and employment, the OLS-estimate only exhibits a bias.

[5] The variance-covariance matrix of the LAD regression was estimated by bootstrapping making 1000 draws. The OLS regression used a heteroscedasticity and autocorrelation consistent estimator.

Seemingly, the result is strongly influenced by outliers, whereas the median is not significantly different from zero. For GDP per employee the opposite result is rendered: Seemingly outliers mask a bias contained in the data.

Table 3: Test for biasedness of NA revisions in Germany, 1993-2015

	OLS-Regression		LAD-Regression	
	BIAS[3]	t-Value	BIAS[4]	t-Value
Gross Domestic Product	0.04	0.4	-0.06	-0.5
Private consumption	0.23	2.4**	0.19	1.2
Government consumption	0.14	0.8	0.16	0.9
Investment, total	0.10	0.3	0.29	1.0
Investment in equipment	0.48	1.2	0.14	0.4
Investment in construction	-0.26	-0.7	-0.13	-0.2
Change in stocks[1]	-0.16	-1.4	-0.23	-1.6
Domestic demand	0.02	0.3	0.01	0.1
Exports[2]	0.75	4.8***	0.66	2.8***
Imports[2]	0.80	3.5***	0.54	1.9*
Net exports[1]	0.02	0.5	-0.00	-0.1
Employment	0.18	2.2**	0.07	1.8*
GDP per employee	-0.15	-1.5	-0.25	-1.9*

*Author's computations. OLS: Heteroscedasticity and autocorrelation consistent estimators. */**/*** indicates significance at a 10/5/1%-level – [1]Contribution to growth. – [2]Goods and services. – [3]Arithmetic mean of revisions. – [4]Median of revisions.*

As said above, correlations of revisions with the preliminary data may distort the results of the partial test. Table 4 shows the results of the Mincer-Zarnowitz equation (3) which tests both dimensions of weak efficiency – biasedness and correlation between revisions and preliminary data.

Again, the results differ between the OLS and the LAD estimates to some extent. For government consumption, change in stocks, and exports both estimates hint into the same direction. For government consumption, bias and a negative correlation of the revisions with the preliminary data interact. For change in stocks, revisions are negatively correlated with the preliminary data, for exports biasedness is the problem. For imports, only the OLS regression shows a bias, but for the LAD-regression the null of both coefficients being zero is rejected, in spite of both coefficients differing not significantly from zero. For employment, only the OLS regression exhibited signs of inefficiency, for GDP per employee the LAD estimate only.

Table 4: Test for Mincer-Zarnowitz efficiency of NA revisions in Germany, 1993-2015

	OLS-Regression					LAD-Regression				
	c	t-value	ß	t-value	F-Test[3]	C	t-value	ß	t-value	F-Test[3]
Gross Domestic Product	0.04	0.5	-0.00	-0.1	0.12	0.03	0.2	-0.04	-0.6	0.21
Private consumption	0.15	1.1	0.12	0.7	2.69*	0.19	1.1	0.06	0.3	1.02
Government consumption	0.44	2.3**	-0.25	-2.5**	3.72**	0.38	2.6**	-0.26	-2.1**	3.78**
Investment, total	0.08	0.2	0.04	0.8	0.39	0.20	0.6	0.03	0.4	0.33
Investment in equipment	0.43	1.0	0.05	1.5	1.49	0.49	1.1	0.07	1.0	0.72
Investment in construction	-0.26	-0.8	-0.13	-1.5	1.22	-0.65	-1.6	-0.21	-1.8*	1.85
Change in stocks[1]	-0.10	-1.3	-0.47	-3.6***	12.03***	-0.06	-0.5	-0.47	-2.4**	3.05*
Domestic demand	-0.01	-0.1	0.03	0.5	0.24	0.11	0.6	-0.07	-0.7	0.25
Exports[2]	0.73	3.6***	0.00	0.2	11.66***	0.62	1.9*	0.01	0.2	3.48**
Imports[2]	0.75	3.1***	0.01	0.8	6.25***	0.40	1.3	0.04	0.9	2.63*
Net exports[1]	-0.01	-0.2	0.06	1.8*	1.75	-0.01	-0.2	0.04	0.6	0.17
Employment	0.20	2.4**	-0.08	-1.5	3.07*	0.11	1.9*	-0.06	-1.2	1.91
GDP per employee	-0.03	-0.3	-0.11	-1.6	1.41	-0.17	-1.4	-0.07	-0.7	3.91**

*Author's computations. OLS: Heteroscedasticity and autocorrelation consistent estimators. */**/*** indicates significance at a 10/5/1%-level – [1]Contribution to growth. – [2]Goods and services. – [3]c=0 and ß=0*

Finally, the residuals of the Mincer-Zarnowitz equation are tested for autocorrelation. As indicated by table 5, revisions of total investment and of employment are significantly autocorrelated. The coefficients are positive which shows that revisions in year t are likely to be followed by revisions in the same direction in year t+1. The result for employment is mirrored in GDP per employee which suggests that new information on employment does not lead to revisions of GDP.

Table 5: Autocorrelation of residuals of the Mincer-Zarnowitz equation, 1993-2015

	OLS-Regression		LAD-Regression	
	AC 1.Ord.	Q-Stat	AC 1.Ord.	Q-Stat
Gross Domestic Product	0.202	1.07	0.228	1.36
Private consumption	-0.101	0.27	-0.099	0.26
Government consumption	0.195	1.00	0.184	0.88
Investment, total	0.394	4.05**	0.390	3.97**
Investment in equipment	0.309	2.49	0.279	2.04
Investment in construction	0.162	0.69	0.081	0.17
Change in stocks	-0.154	0.62	-0.155	0.63
Domestic demand	-0.167	0.72	-0.021	0.01
Exports[2]	-0.011	0.00	-0.011	0.00
Imports[2]	-0.012	0.00	-0.019	0.01
Net exports[1]	-0.081	0.17	-0.132	0.46
Employment	0.665	11.58***	0.676	11.94***
GDP per employee	0.339	3.00*	0.419	4.58**

*Author's computations based on the regressions in table 4. */**/*** indicates significance at a 10/5/1%-level – [1]Contribution to growth. – [2]Goods and services.*

Summing up, there is evidence of lacking informational efficiency at least for the first release data of some NA components. Revisions of government consumption, exports, imports, and employment show a bias, revisions of government consumption and of the change in stocks are correlated with the preliminary data, and finally revisions of investment and employment seem to be autocorrelated. However, this only indicates room for improvement, but does not tell how to utilize it. Here, tests for strong efficiency can give some hints.

4.2 Strong efficiency

Testing for strong efficiency faces various problems. It has already been said that there is no rule, which additional variable should be included in equation (4). Thus, the selection of indicators is arbitrary. Furthermore, the estimates are prone to show spurious results, given the limited number of observations. Third, augmenting the Mincer-Zarnowitz equation by an additional indicator might also influence the estimates of $ß_o$ (less likely) and (more likely) $ß_1$ in (4). However, a representative selection of indicators should give some hints whether additional information may contribute to smaller revisions.

The indicators selected to enter (4) are shown in table 6. The enter (4) as annual averages. If necessary, the indicators are transformed to stationary series either by calculating growth rates or first differences. Furthermore, all variables are transformed to a mean of zero, to make sure that $ß_2$ in (4) is zero if an indicator does not covariate with the revision.

Table 6: Indicators entering the strong efficiency test

Short name	Definition	Source	Transformation
BCIT	Business climate industry and trade	ifo institute	none
BCMGF	Business climate manufacturing	ifo institute	none
CCI	Consumer climate index	EU, DG ECFIN	none
CDAX	Share price index CDAX	Deutsche Börse	growth rate
CUCON	Capacity untilization construction	ifo institute	none
CUMFG	Capacity untilization manufacturing	ifo institute	none
DOLLAR	Exchange rate Dollar per Euro	ECB	growth rate
HWWI	Raw material price index, dollar base	HWWI	growth rate
INSOLV	Insolvencies	Destatis	growth rate
NODOM	New orders in manufacturing, domestic	Destatis	growth rate
NOFOR	New orders in manufacturing, foreign	Destatis	growth rate
NOTOT	New orders in manufacturing, total	Destatis	growth rate
TREND	Time trend	-	-
UNEMPL	Unemployment rate	BA	Difference
WT	World imports	CPB	growth rate

Table 7a shows the result of the test for strong efficiency shown in (4) using in OLS estimator, table 7b for the LAD estimator. Only results are shown that meet two conditions: First, $ß_2$ differs significantly from zero; second, an F-test rejects the Null of $ß_0=ß_1=ß_2=0$

Table 7a: Test for strong efficiency of NA revisions in Germany, 1993-2015, OLS estimate

Indicator[1]	$ß_0$	t-stat	$ß_1$	t-stat	$ß_2$	t-stat	F
			Gross Domestic Product				
CUCON	0.05	0.8	-0.01	-0.3	0.03	3.9 ***	7.9 ***
BCIT	0.18	4.6 ***	-0.12	-5.9 ***	0.02	5.8 ***	29.7 ***
BCMFG	0.20	5.3 ***	-0.13	-6.0 ***	0.04	7.4 ***	21.6 ***
CCI	0.12	3.2 ***	-0.07	-3.0 ***	0.04	7.8 ***	22.8 ***
INSOLV	0.08	1.2	-0.04	-1.5	-1.50	-3.1 ***	3.4 **
TREND	0.02	0.3	0.00	0.2	0.03	4.2 ***	8.8 ***
			Private Consumption				
HWWI	0.13	1.2	0.13	1.0	1.07	3.0 ***	5.8 ***
CUMFG	0.16	1.4	0.09	0.6	0.04	2.9 ***	5.5 ***
UNEM	0.16	1.9 *	0.08	0.6	-0.23	-2.6 **	6.7 ***
			Government Consumption				
HWWI	0.49	2.7 **	-0.29	-3.0 ***	-1.15	-2.1 **	3.9 **
			Investment, total				
CUMFG	0.10	0.4	-0.03	-0.6	0.12	2.5 **	2.8 *
NOTOT	0.16	0.7	-0.10	-1.6	9.54	3.2 ***	5.1 ***
NODOM	0.18	0.9	-0.15	-2.1 **	13.66	3.5 ***	5.7 ***
NOFOR	0.13	0.5	-0.06	-0.9	6.25	2.4 **	3.5 **
INSOLV	0.11	0.4	-0.02	-0.4	-3.98	-3.0 ***	4.2 **
			Investment in equipment				
WT	0.51	1.2	-0.02	-0.4	15.48	1.8 *	2.5 *
CUMFG	0.49	1.3	-0.02	-0.7	0.19	2.4 **	3.0 *
			Investment in construction				
NOTOT	-0.26	-0.9	-0.16	-2.1 **	5.20	3.1 ***	6.8 ***
NODOM	-0.26	-0.9	-0.17	-2.4 **	7.10	3.1 ***	9.0 ***
NOFOR	-0.26	-0.9	-0.15	-1.9 *	3.71	2.7 **	5.1 ***
			Change in stocks[2]				
HWWI	-0.10	-1.5	-0.42	-3.9 ***	-0.57	-2.0 *	9.5 ***
CDAX	-0.09	-1.2	-0.54	-4.0 ***	0.56	1.7 *	9.5 ***
CUCON	-0.11	-2.2 **	-0.35	-2.2 **	0.04	3.5 ***	32.1 ***
CUMFG	-0.10	-1.4	-0.43	-3.8 ***	-0.03	-2.0 *	11.1 ***
			Domestic demand				
CUCON	0.02	0.2	0.01	0.2	0.03	3.3 ***	4.2 **
BCIT	0.07	0.7	-0.06	-0.8	0.02	2.7 **	3.1 **
BCMFG	0.07	0.7	-0.06	-0.8	0.03	3.2 ***	4.1 **
CCI	0.07	0.9	-0.06	-1.0	0.04	4.9 ***	9.0 ***
INSOLV	0.03	0.3	-0.01	-0.1	-1.22	-2.7 **	2.9 *
TREND	-0.02	-0.2	0.03	0.6	0.02	3.1 ***	3.2 **
			Exports[3]				
WT	1.23	8.3 ***	-0.10	-3.8 ***	13.92	3.6 ***	25.7 ***
CUCON	0.75	4.6 ***	-0.00	-0.1	-0.06	-2.5 **	13.6 ***
CUMFG	0.52	1.9 *	0.05	1.4	-0.10	-2.1 **	25.0 ***
BCIT	0.52	3.5 ***	0.05	1.7	-0.04	-2.9 ***	18.0 ***
BCMFG	0.54	3.4 ***	0.05	1.7 *	-0.05	-2.9 ***	16.7 ***
CCI	0.66	4.1 ***	0.02	0.9	-0.04	-2.0 *	16.2 ***
NOTOT	1.23	5.0 ***	-0.10	-2.7 **	8.30	2.4 **	9.4 ***
NODOM	1.07	4.1 ***	-0.07	-2.1 *	6.80	1.8 *	7.3 ***
NOFOR	1.16	6.0 ***	-0.09	-2.3 **	6.13	1.9 *	14.8 ***
INSOLV	0.64	4.1 ***	0.02	1.0	2.38	2.5 **	21.3 ***
TREND	0.75	5.7 ***	0.00	0.1	-0.04	-2.7 **	14.1 ***

Table 7a (continued)

Imports[3]							
WT	1.19	3.4 ***	-0.10	-1.6	13.22	2.0 *	10.7 ***
CUCON	0.75	3.5 ***	0.01	0.7	-0.07	-2.5 **	9.4 ***
BCIT	0.45	2.5 **	0.09	3.3 ***	-0.05	-4.1 ***	10.8 ***
BCMFG	0.52	3.0 ***	0.07	2.7 **	-0.06	-2.7 **	7.2 ***
UNEMPL	0.66	2.8 **	0.04	1.8 *	0.44	2.2 **	14.9 ***
INSOLV	0.57	3.2 ***	0.06	1.9 *	3.45	2.0 *	7.8 ***
TREND	0.76	3.9 ***	0.02	0.7	-0.07	-3.2 ***	10.2 ***
Employment							
DOLLAR	0.20	2.7 **	-0.08	-1.7	-0.97	-2.0 *	2.8 *
TREND	0.19	2.7 **	0.02	0.3	-0.02	-2.0 *	2.5 *
GDP per employee							
CUCON	-0.06	-0.8	-0.08	-1.5	0.05	3.8 ***	7.1 ***
BCIT	0.02	0.3	-0.15	-3.9 ***	0.02	4.0 ***	9.5 ***
BCMFG	0.02	0.5	-0.16	-4.2 ***	0.04	5.1 ***	13.9 ***
CCI	-0.03	-0.5	-0.11	-2.5 **	0.03	3.5 ***	9.2 ***
NOTOT	0.16	1.6	-0.28	-4.4 ***	4.65	3.7 ***	7.4 ***
NODOM	0.14	1.4	-0.26	-4.5 ***	5.01	3.4 ***	7.4 ***
NOFOR	0.16	1.4	-0.28	-3.9 ***	3.78	3.1 ***	5.8 ***
UNEMPL	-0.05	-0.5	-0.10	-1.8 *	-0.19	-2.4 **	5.5 ***
INSOLV	-0.04	-0.5	-0.10	-1.8 *	-1.41	-1.9 *	3.0 *
TREND	-0.14	-2.2 **	-0.03	-0.7	0.04	3.8 ***	6.6 ***

*Author's computations. */**/*** indicates significance at a 10/5/1%-level – [1]For abbreviations see table 6. - [2] Contribution to growth. – [3]Goods and services.*

Table 7b: Test for strong efficiency of NA revisions in Germany, 1993-2015, LAD estimate

Indicator[1]	$ß_0$	t-stat	$ß_1$	t-stat	$ß_2$	t-stat	F
Gross Domestic Product							
WT	-0.16	-1.7	0.16	2.3 **	-6.56	-2.7 **	2.6 *
CUCON	0.05	0.6	0.02	0.5	0.05	3.3 ***	3.8 **
BCMFG	0.15	1.5	-0.15	-2.8 **	0.04	3.5 ***	5.5 ***
CCI	0.11	1.2	-0.08	-1.8 *	0.05	4.0 ***	6.6 ***
Change in stocks[2]							
CUCON	-0.08	-0.8	-0.33	-1.7	0.04	1.8 *	4.0 **
BCIT	-0.19	-1.6	-0.39	-1.9 *	0.02	1.9 *	3.3 **
BCMFG	-0.25	-2.0 *	-0.30	-1.5	0.03	2.0 *	3.7 **
Exports[3]							
WT	1.27	3.4 ***	-0.13	-2.3 **	19.71	2.6 **	5.0 ***
CUCON	0.75	3.1 ***	-0.01	-0.4	-0.07	-2.0 *	6.7 ***
BCIT	0.41	1.7	0.05	1.4	-0.04	-2.7 **	7.0 ***
BCMFG	0.51	2.2 **	0.04	1.3	-0.07	-2.9 ***	8.8 ***
CCI	0.48	2.0 *	0.02	0.6	-0.07	-2.5 **	8.6 ***
UNEMPL	0.66	3.1 ***	0.02	0.8	0.53	2.4 **	6.1 ***
Imports[3]							
CUCON	0.49	1.6	0.03	0.7	-0.08	-2.1 **	4.3 **
BCIT	0.54	1.6	0.09	1.6	-0.04	-2.1 **	7.4 ***
GDP per employee							
CUCON	-0.09	-0.7	-0.07	-0.8	0.04	1.7 *	4.5 **
CCI	0.01	0.1	-0.08	-1.0	0.04	2.5 **	4.8 **
TREND	-0.12	-0.9	-0.01	-0.1	0.05	2.1 **	2.4 *

*Author's computations. */**/*** indicates significance at a 10/5/1%-level – [1]For abbreviations see table 6. - [2] Contribution to growth. – [3]Goods and services.*

The OLS estimate provides many significant co-variations of the indicators considered and NA accounts revisions (Table 7a). Some seem plausible: In years world trade grows strongly, e.g., export growth tends to be revised upward. Furthermore, if the number of insolvencies is growing, GDP growth tends to be revised downward. The latter may be owed to the fact, that the companies which are part of the monthly census may lose representativity when many companies go bankrupt. In other cases, it is hard to explain the correlation between indicators and revision. Why, e.g., should revisions of government consumption be correlated with raw material prices? All in all, many results seem to be spurious.

This is underpinned by the fact, that the LAD estimator results in a considerably smaller number of significant co-variations. The correlation of world trade growth and revisions of export growth can be found also for this estimator. Furthermore, a positive business climate and a high capacity utilization correlate with upward revisions of GDP growth. However, at the same time these variables show a negative correlation with revisions of export growth.

All in all, this kind of analyses may give some hints but does not lead to clear cut results. However, the indicators tested here represent only a small fraction of the indicators available. Thus, more research is advised.

4.3 Nordhaus-Efficiency

Different from the analyses hitherto, Nordhaus efficiency looks at the timeline of revisions from the first release to the final data. In a nutshell, revisions are classified as efficient, if the first revision does not help to forecast the following revision.

In Germany, the first release of annual data for year t is published in February of year t+1. In May, a first revision of the annual data is published. However, the German Statistical Office uses this opportunity to revise data only in rare cases; in the sample analyzed here only in 7 out of 23 years. The following revisions are all made in August, the first one in 1+1, the last one in t+4. In the quarterly publications in-between, annual figures are left unchanged. Thus, there are five harvest of revisions.

Table 8 shows the estimates of (6) for these harvests of revisions. Since the first revision was only made in some years the third revision is not only compared to the second revision but also to the sum of the first and the second. As the table shows, revisions are Nordhaus-efficient in on overwhelming share of cases. For GDP, a correlation the first revision seems to indicate scope and direction of the second revision, and the forth and the fifth revision correlate. For government consumption, upward revisions seem to be systematically followed by downward revisions in the next step in some cases. The means, that growth rates are meandering around the final value. However, all this is observed at a low level of significance.

Table 8: Test for Nordhaus-efficiency of NA revisions in Germany, 1993-2015

	R2 vs R1	R3 vs R2	R3 vs R1+R2	R4 vs R3	R5 vs R4
Gross Domestic Product	1.82*	0.67	0.66	1.31	1.82*
Private consumption	0.42	-0.22	-0.30	1.13	0.77
Government consumption	0.10	-2.00*	-1.85*	-0.13	0.26
Investment, total	0.11	0.41	0.90	0.29	-0.40
Investment in equipment	-0.53	-0.25	-0.23	1.46	-0.68
Investment in construction	1.55	1.21	1.36	0.64	-0.67
Change in stocks[2]	0.05	0.06	0.22	0.39	-0.28
Domestic demand	0.29	0.22	0.19	1.60	0.13
Exports[1]	-0.61	1.34	1.69	-0.25	-0.06
Imports[1]	-0.10	1.30	1.46	-1.25	1.21
Net exports[2]	0.12	0.12	-0.28	-0.12	0.64
Employment	0.32	1.34	1.33	0.79	0.50
GDP per employee	0.64	-0.14	-0.13	2.60**	1.11

*Author's computations. */**/*** indicates significance at a 10/5/1%-level –[2]Contribution to growth. – [2]Goods and services.*

5 Conclusions

National accounts are the most important basis for macroeconomic analyses and forecasts. However, since the data are subject to major revisions, trusting in the initially published data may lead to faulty conclusions and may increase forecast errors (Döhrn 2019). Thus, there is need to reduce revisions.

One way to do so would be incorporate additional data sources when calculating the national accounts. However, establishing new surveys would put additional reporting duties in the economy. And the use of big data, i.e. data found as byproducts of business and administrative systems, social networks, and the internet of things, offers many opportunities, but is still evolving (for an overview: Hammer et. al. 2017)

Another way to reduce revisions is making a better use of data that already exist. The present paper translates this second option into the question, whether national accounts are informational efficient. The latter is assumed to be the case if revisions do not show any systematics and if they are not correlated with information available when national accounts are calculated.

The results are not as clear-cut as one would have liked. Tests for weak efficiency show that there is a systematic component in the revisions of government consumption, exports, imports and in the change of stocks. Tests on strong efficiency suffer from the fact that the section of indicators included is arbitrary. In case of the indicators analyzed here some show a covariation with the revisions. Revisions of exports, e.g., seem to covariate with changes of world trade. Furthermore, revisions of GDP seem to covariate with the results of business surveys. However, some results seem to be spurious.

The tests on Nordhaus efficiency extent the analyses to the time path of revisions. They fail to indicate that revisions follow a time path, i.e., that the first revision hints at the direction of the second etc. There is, however, one remarkable exception which is government consumption.

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