Paradoxes of seasonal adjustment

Igor Pelipas

German Economic Team Belarus/IPM Research Center

Berlin/Minsk, November 2014
1. First, we will discuss why do we need seasonal adjustment and what is wrong with Belarusian seasonally adjusted real GDP data in 2013Q1

2. Secondly, the general overview of seasonal adjustment procedures will be resented

3. Thirdly, the dynamic characteristics of real GDP data will be considered.

4. Fourthly, the novel approach for seasonal adjustment of real GDP data will be discussed and used for practical seasonal adjustment.

5. Finally, policy recommendations and practical implementation of the approach will be demonstrated.
Why do we need seasonal adjustment?

• Various time series of economic indicators have a seasonal pattern and demonstrate yearly regular fluctuations.

• Seasonal variations make it difficult to analyze the raw data and do not allow getting explicitly an idea about short term dynamics of the indicator and its trend.

• Therefore, to analyze the dynamics of economic indicators without the influence of seasonal factor, different methods of seasonal adjustment are used.

• In practice, year-to-year growth rates of corresponding indicator are often used. This approach is a very rough methods of seasonal adjustment.

• Statistical methods of seasonal adjustment provide more accurate results.
What’s wrong with Belarusian seasonally adjusted real GDP in 2013Q1 (NBB data)?

In accordance with the presented below data, annualized growth rate of real GDP in 2013Q1 was 37% (!) that is explained in the commentary by the low base effect of 2012Q4 and changes in tax legislation.

... but what about the IMF data?

Similar results were presented by the IMF. In the corresponding figure in the Country Report one can see that quarter-to-quarter growth rate of real GDP in 2013Q1 is above 8%. At annualized rate it will be equal approximately to the same 37%.

Where are the paradoxes?

• The growth rates of Belarusian real GDP in 2013Q1 do not correspond to both, common sense and real economic situation in the country.

• However, in this case the standard statistical methods of seasonal adjustment are applied. In particular, the NBB made seasonal adjustment using standard procedure TRAMO/SEATS. The IMF, most likely, used methods of seasonal adjustment based on X-11 seasonal filter without any additional settings.

• Additionally, modern statistical software for seasonal adjustment makes it possible to obtain quite acceptable results using appropriate methods virtually automatically. Worldwide practice of statistical agencies on unification of seasonal adjustment procedures and introducing standard software is to large extend based on this fact.
Working hypothesis

• Since the quality of seasonal adjustment depends on the quality of real GDP raw data, and statistical methods used,

• The raw data of real DGP is possibly contaminated, at least for 2012Q4 and 2013Q1. Under contaminated data we mean the errors or inaccuracy in the data that distort the historical seasonal pattern in time series.

• The usage of the standard statistical method for seasonal adjustment in the presence of contaminated data can lead to inadequate results of seasonal adjustment, especially at the end of sample.

• To resolve this problem one need to identify the contaminated observations using econometric techniques and then to correct seasonally adjusted real GDP to return it back on the “right” path.
Practical importance of the results

• The main objective of our study is to propose an approach for seasonal adjustment of economic indicators under data contaminations. We also have attempted to resolve the problem of incredibly high growth rates of Belarusian GDP in 2013Q1 in the framework of econometric analysis and conventional methods of seasonal adjustment.

• Our aim is not to reevaluate official statistical data on real GDP, the proposed approach is an econometric one and it is based on available official data. Nevertheless, the problems in seasonal adjustment of the real GDP data and inadequate results for 2013Q1, derived from applying standard statistical methods, can indicate the possible statistical problems with original data.

• The results are practically useful for statistical agencies, central banks, economic analysts and academic researchers.
What is seasonal adjustment?

Seasonal adjustment can be defined as the processes of seasonal effects estimation and removing them from the original data. In other words, seasonal adjustment is the process of data simplification without the losses of important information contained in the raw data, so that it could be easier to interpret them.

Two common methods of seasonal adjustment:

• Application of the year-to-year growth rates;
• Statistical methods of seasonal adjustment decomposing the original time series into its unobservable components: seasonal component, trend (cycle) component, and irregular component. The seasonal factor is used for getting seasonal adjusted time series without any seasonal variation.
Shortcomings of the year-to-year growth rates approach

• Although this approach permits to reduce constant annual seasonal effect, the complete elimination of seasonality is not always possible, as seasonal factor may gradually change within a year.

• It cannot take into account the other calendar-related effects and changes of the seasonal factor associated with changes in level of economic indicator.

• This method is sensitive to the various random effects. For instance, if an economic indicator in the previous period significantly decreased, as a result of an unexpected shock, then in the corresponding quarter of the following year one can observe an unusually large rate of growth (so-called base effect).

• The usage of year-to-year growth rates can lead to incorrect determination of the turning points in the dynamics of an economic indicator.
Statistical methods of seasonal adjustment: general overview (1)

Let $Y_t$ is original observations of time series at time $t$, which can be represented as a product of three unobservable components, namely seasonal component ($S_t$), trend component ($T_t$), and irregular (random) component ($I_t$):

$$ Y_t = S_t \cdot T_t \cdot I_t. $$  \hspace{1cm} (1)

In accordance with (1), seasonal adjustment of original data conducted as follows:

$$ Y_t^{sa} = Y_t / S_t, $$ \hspace{1cm} (2)

where $Y_t^{sa}$ is a seasonally adjusted value of time series at time $t$. 
Statistical methods of seasonal adjustment: general overview (2)

Seasonally adjusted data are used for calculations of the period-to-period indexes $i_y^{sa}$:

$$ i_y^{sa} = Y_t^{sa} / Y_{t-1}^{sa} . \quad (3) $$

Seasonally adjusted data can be used for computation of annualized indexes which demonstrate what the growth would be if the current period rate continued for all period of the year (index is raised to power of $n$, equals the periodicity of the data):

$$ (i_y^{sa})^n = (Y_t^{sa} / Y_{t-1}^{sa})^n . \quad (4) $$
Statistical methods of seasonal adjustment: general overview (3)

Dynamics of seasonally adjusted data depends on two factors, namely changes of trend and irregular that immediately follows from (2) and (1). Since $Y_{t}^{sa} = Y_{t}/S_{t} = T_{t} \cdot I_{t}$, the expressions (3) and (4) can be represented as follows:

$$i_{y}^{sa} = (T_{t} \cdot I_{t})/(T_{t-1} \cdot I_{t-1}) \quad (5a)$$

$$\left(i_{y}^{sa}\right)^{n} = (T_{t}^{n} \cdot I_{t}^{n})/(T_{t-1}^{n} \cdot I_{t-1}^{n}) \quad (5b)$$

If the influence of irregular component is quite strong, the growth rates calculated on the basis of seasonally adjusted data reflect not so much the systematic factors behind the dynamics of an indicator, as it changes due to random factors. The problem is amplified while using annualized growth rates, sine irregular component in this case is raised to power of four or twelve for quarterly or monthly data, respectively.
Statistical methods of seasonal adjustment: general overview (4)

The relationship between seasonally adjusted time series, trend and irregular can be presented as follows:

\[ T_t = \frac{Y_{t,sa}}{I_t}. \]  

(6)

The expressions (1)–(6) will be taken into consideration further in conducting seasonal adjustment of Belarusian real GDP under possible data contaminations.

The analysis of seasonality and appropriate seasonal adjustment is usually performed by of-the-shelf software.
Currently, the two most popular methods of seasonal adjustment are used by statistical agencies and central banks:

- X-12ARIMA from the US Census Bureau
  [http://www.census.gov/srd/www/x12a](http://www.census.gov/srd/www/x12a);

- TRAMO/SEATS from the Bank of Spain

Now the US Census Bureau offers new software X-13ARIMA-SEATS which combines the capabilities of two mentioned above method of seasonal adjustment, and makes it possible to compare them
X-12ARIMA: brief overview

- X-12ARIMA is an iterative procedure. At first, it determines the trend and cycle component in the first approximation;
- Then, trend and cycle is removed from the original data. On the basis of the detrended data, seasonal component is derived for each period using the moving average filters;
- After that, the irregular component is determined by removing the seasonal component from the detrended data. The irregular is used to identify the extreme observations (outliers). As a result, the preliminary seasonally adjusted data is calculated by dividing the original data on the seasonal component, adjusted for extreme observations;
- Within the X-12ARIMA this procedure is repeated several times, until a final decomposition of the original time series into its unobserved components is achieved.
TRAMO/SEATS: brief overview

TRAMO/SEATS consists of two consecutive procedures:

• In the first step TRAMO (Time series regression with ARIMA noise, missing observations, and outliers) provide automatic ARIMA modeling;
• In the second step SEATS (Signal Extraction in ARIMA Time Series) decomposes the time series into unobserved components using the signal extraction technique based on ARIMA model.
X-13ARIMA-SEATS (1)

• We utilized brand new X-13ARIMA-SEATS software, allowing for comparison of the methods and models used.

• Although X-12ARIMA and TRAMO/SEATS methods of seasonal adjustment are differ significantly methodologically, they are based on the ARIMA (autoregressive integrated moving average) model of the following form: ARIMA\((p, d, q)(P, D, Q)\), where \(p\) is the number of AR parameters, \(d\) is the order of integration, \(q\) is the number of moving average parameters, \(P\) is number of seasonal autoregressive parameters, \(D\) is the order of seasonal integration, \(Q\) is the number of seasonal moving average parameters.

• Determination of the parameters of the ARIMA model can be done either automatically or manually.
X-13ARIMA-SEATS (2)

X-13ARIMA-SEATS software allows getting the diagnostics of the obtained models for seasonal adjustment using common criteria for assessing the quality of models:

- the appropriate tests for presence of seasonality,
- absence of residual seasonality in the seasonally adjusted data,
- absence of anomalies in residuals distribution for ARIMA model,
- stability of the seasonal adjustment procedure.

Eventually, the model with the best diagnostics is selected.

Seasonal adjustment using X-13ARIMA-SEATS can be done by:

- Original software X-13ARIMA-SEATS from the U.S. Census Bureau;
- Eviews 8;
- JDemetra+ from Eurostat.
The quarterly data of real GDP in average 2009 prices for the period 1995Q1–2013Q2 (74 quarters) have been used. While applying statistical methods for seasonal adjustment, it is desirable to use fairly long time series (7-10 years or more). Nevertheless, the usage of the longest available time series is not always appropriate because of possible changes in the methodology and comparability of the data, significant structural breaks, etc. Therefore, a shorter period (2002Q1–2013Q2, 46 quarters) is also considered.
Belarusian real GDP: dynamic characteristics (2)

• To obtain seasonally adjusted data of high quality, it is necessary to specify correctly the model ARIMA(p, d, q)(P, D, Q). In particular, the determination of the order of integration of the data is of great importance, since the statistical methods of decomposition of the time series into the unobservable components are applied only to the stationary data.

• Seasonal adjustment with ARIMA (p, d, q)(P, D, Q) raises the question of whether it will be enough to use the only seasonal differences to make the original time series stationary, or additionally the regular differences are needed.

• Within X-13ARIMA-SEATS the choice of d and D can be done automatically. However, the order of integration of data determined in the automatic mode is sometimes not consistent with the actual dynamic characteristics of the time series.
Testing for seasonal unit root (1)

The following regression is used to conduct HEGY seasonal unit root test:

\[ \Delta_4 y_t = \pi_1 z_{1,t-1} + \pi_2 z_{2,t-1} + \pi_3 z_{3,t-1} + \pi_4 z_{3,t-2} + \sum_{j=1}^{p-4} \alpha_i \Delta_4 y_{t-j} + \epsilon_t, \]

where \( \Delta_4 y_t = (1 - L^4) = y_t - y_{t-4}; \) \( z_{1,t} = (1 + L + L^2 + L^3)y_t; \) \( z_{2,t} = (-1 + L + L^2 + L^3)y_t; \) \( z_{3,t} = -(1 - L^2)y_t \) with \( L \) being the lag operator; \( \epsilon_t \) are residuals. The number of lagged seasonal differences is chosen so to eliminate residual autocorrelation. The null hypotheses \( H_0: \pi_1 = 0, \) \( H_0: \pi_2 = 0 \) and \( H_0: \pi_3 = \pi_4 = 0 \) corresponds to test for regular, semiannual and annual unit root, respectively. The above mentioned regression is estimated by OLS and the hypotheses are tested using corresponding \( t \)-test for the first two hypotheses \( (t_{\pi_1}, t_{\pi_2}) \) and \( F \)-test for the third one \( (F_{34}). \)
## Testing for seasonal unit root (2)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model specification</th>
<th>Deterministic terms</th>
<th>Number of lags</th>
<th>$H_0$</th>
<th>Test</th>
<th>Test statistics</th>
<th>Critical values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1%</td>
</tr>
<tr>
<td>Log RGDP</td>
<td>Constant, Trend, Seasonals</td>
<td>1</td>
<td>$H_0: \pi_1 = 0$</td>
<td>$t_{\pi_1}$</td>
<td>$-1.47$</td>
<td>$-3.96$</td>
<td>$-3.39$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$H_0: \pi_2 = 0$</td>
<td>$t_{\pi_2}$</td>
<td>$-2.19$</td>
<td>$-3.41$</td>
<td>$-2.82$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$H_0: \pi_3 = \pi_4 = 0$</td>
<td>$F_{34}$</td>
<td>$1.93$</td>
<td>$8.76$</td>
<td>$6.55$</td>
</tr>
<tr>
<td></td>
<td>Constant, Trend</td>
<td>1</td>
<td>$H_0: \pi_1 = 0$</td>
<td>$t_{\pi_1}$</td>
<td>$-1.46$</td>
<td>$-3.98$</td>
<td>$-3.40$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$H_0: \pi_2 = 0$</td>
<td>$t_{\pi_2}$</td>
<td>$-2.03$</td>
<td>$-2.53$</td>
<td>$-1.93$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$H_0: \pi_3 = \pi_4 = 0$</td>
<td>$F_{34}$</td>
<td>$0.54$</td>
<td>$4.76$</td>
<td>$3.05$</td>
</tr>
<tr>
<td></td>
<td>Constant, Seasonals</td>
<td>1</td>
<td>$H_0: \pi_1 = 0$</td>
<td>$t_{\pi_1}$</td>
<td>$-1.64$</td>
<td>$-3.41$</td>
<td>$-2.84$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$H_0: \pi_2 = 0$</td>
<td>$t_{\pi_2}$</td>
<td>$-2.18$</td>
<td>$-3.41$</td>
<td>$-2.83$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$H_0: \pi_3 = \pi_4 = 0$</td>
<td>$F_{34}$</td>
<td>$1.91$</td>
<td>$8.79$</td>
<td>$6.57$</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
<td>1</td>
<td>$H_0: \pi_1 = 0$</td>
<td>$t_{\pi_1}$</td>
<td>$-1.82$</td>
<td>$-3.42$</td>
<td>$-2.85$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$H_0: \pi_2 = 0$</td>
<td>$t_{\pi_2}$</td>
<td>$-2.02$</td>
<td>$-2.53$</td>
<td>$-1.93$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$H_0: \pi_3 = \pi_4 = 0$</td>
<td>$F_{34}$</td>
<td>$0.57$</td>
<td>$4.83$</td>
<td>$3.08$</td>
</tr>
<tr>
<td>$\Delta_4 \text{Log RGDP}$</td>
<td>Constant, Seasonals</td>
<td>0</td>
<td>$H_0: \pi_1 = 0$</td>
<td>$t_{\pi_1}$</td>
<td>$-3.04$</td>
<td>$-3.41$</td>
<td>$-2.84$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$H_0: \pi_2 = 0$</td>
<td>$t_{\pi_2}$</td>
<td>$-3.76$</td>
<td>$-3.41$</td>
<td>$-2.83$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$H_0: \pi_3 = \pi_4 = 0$</td>
<td>$F_{34}$</td>
<td>$35.71$</td>
<td>$8.79$</td>
<td>$6.57$</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
<td>0</td>
<td>$H_0: \pi_1 = 0$</td>
<td>$t_{\pi_1}$</td>
<td>$-3.08$</td>
<td>$-3.42$</td>
<td>$-2.85$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$H_0: \pi_2 = 0$</td>
<td>$t_{\pi_2}$</td>
<td>$-3.74$</td>
<td>$-2.53$</td>
<td>$-1.93$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$H_0: \pi_3 = \pi_4 = 0$</td>
<td>$F_{34}$</td>
<td>$38.21$</td>
<td>$4.83$</td>
<td>$3.08$</td>
</tr>
</tbody>
</table>
Testing for seasonal unit root (3)

• For real GDP the null hypothesis of regular unit root and seasonal unit roots is not rejected for any of examined test specifications. Consequently, real GDP is a non-stationary variable having both regular and seasonal (semiannual and annual) unit roots.

• The seasonal differences eliminates seasonality and correspondently the seasonal unit roots. Herewith, the hypothesis of a regular unit root is rejected at the 5% significance level, but not rejected at the 1% level.

• The dynamics of seasonal differences demonstrates several shifts of the mean. In addition to HEGY-test we used ADFGLS-test, where original data is demeaned by using a generalized least squares and the demeaned data are used for unit root testing. The results of this test support the view that seasonal differences are not a stationary variable.

• The visual representation of data and a formal econometric analysis suggests that the real GDP is non-stationary variable and contains the regular and seasonal unit roots. To ensure the stationary one has to use also the first difference. Based on these results, we apply both an automatic selection of ARIMA(p, d, q)(P, D, Q) and semi-automatic selection fixing parameters d=1 and D=1, while performing seasonal adjustment.
Why is seasonally adjusted growth rate for 2013Q1 incredibly high?

- If we look at the graph of the original real GDP data, it is easy to see that in 2012Q4 and 2013Q1 there is an unexpected short term alteration of historical seasonal pattern. This alteration has had a negative impact on the quality of the seasonal adjustment.

- Let's consider the behavior of the irregular component. It demonstrates very large deviations from its mean equal to one (0.961 in 2012 and 1.042 in 2013).

- The observations for 2012Q4 and 2013Q1 that are unrepresentative for historical seasonal pattern, is the main reason of artifact in seasonal adjustment of real GDP at the end of the sample. An application of annualized growth rate substantially aggravates the problem.

- Since there is no satisfactory explanation of the situation with original data of real GDP, we consider this problem as a consequence of data contaminations.
Detection of contaminated data (1)

• Generally, outliers in irregular component reflect extraordinary events and, if they have the proper economic interpretation, should be included into seasonally adjusted data. In the case of data contaminations we have to fix the inverse problem, namely to identify abnormal observations and eliminate their influence from seasonally adjusted data.

• Within X-11 and X-12ARIMA, a table C17 from the software output presents the final weight for irregular component. Normal observation is assigned a weight of 100, and all sorts of outliers take a value less than 100, up to 0 for the most significant extreme values.

• The results from table C17 are used in other auxiliary table E2, which contains modified seasonally adjusted data. These data are seasonally adjusted time series (D11), wherein the observation with the weights of irregular component in table C17 are equal to zero, are replaced by corresponding values of trend (D12).
Detection of contaminated data (2)

- Such a method of identification of the outliers is available only in X-12ARIMA. To resolve the problem with contaminated data, we need a more general approach that corresponded to table C17 in X-12ARIMA, and at the same time would be applicable for the analysis of irregular component while using TRAMO/SEATS method of seasonal adjustment.

- For this purpose, we propose to use the method of impulse indicator saturation (IIS), which allows identifying the structural breaks, outliers and data contaminations (see Hendry, et al. (2008); Johansen, Nielsen (2009)).

- The essence of this method applying to our problem is as follows. For irregular components ($I_t$), deriving from the decomposition of time series, the following regression is used:

$$I_t = \mu + \sum_{s=1}^{T} \delta_s D_{s,t} + \epsilon_t, \quad (7)$$

where $\mu$ is a constant; $D_{s,t}$ is impulse indicator variable equal to 1 for periods, and 0 otherwise; $\delta_s$ is the coefficient at impulse indicator variable; regression residuals is $\epsilon_t \sim iid(0, \sigma^2); t = 1, ..., T$. 

German Economic Team Belarus

27
Detecting data contaminations in real GDP

Red line on the first graph depicts deviations of final weights for irregular from normal observations (weight = 1); any deviation from 1 means extreme value; the most sizable extreme values have the weight, which is equal to 0. Red lines on the second and third graphs represent the extreme values as the deviations from the mean, which is equal to 1. Alpha = 1% and 0.01% are significance levels for impulse indicator saturation (IIS) procedure.

The most significant outliers are observed at the end of the sample and correspond to 2012Q4 and 2013Q1.

Impulse indicator saturation allows to identify extreme observation which may be due to data contamination. This method does not contradict with the results of table C17 from X-12ARIMA, and can be used while using TRAMO/SEATS.

Impulse indicator saturation technique confirms our working hypothesis about data contamination in 2012Q4 and 2013Q1, distorting the historical seasonal pattern.
Correcting for contaminated data

- Since the extreme observations, that are far away from the current period, has no significant effect on the results of seasonal adjustment, only the most recent outliers should be taken into account. In our case, there are the values for 2012Q4 and 2013Q1, and possibly for 2011Q2.

- Taken into account these considerations, we can replace the extreme values of the irregular component of the regression with the constant $\mu$ from (7), which is almost equal to 1 ($I_{t=iis}^\mu$). Then, based on (5a), seasonally adjusted data for the contaminated observations $Y_{t=iis}^{sa}$ will be equal to the value of trend component for the appropriate observation:

$$Y_{t=iis}^{sa} = T_{t=iis} \cdot I_{t=iis}^\mu = T_{t=iis},$$

(8)

where $t = iis$ is observation in time series, identified as extreme by impulse indicator saturation techniques.
Choosing the model for seasonal adjustment: X-12ARIMA or TRAMO/SEATS?

We ran X-12ARIMA and TRAMO/SEATS in automatic mode. A following specification of ARIMA model is used: \((0, 1, 1)(0, 1, 0)\) for both models.

As for stability of the models, TRAMO/SEATS method is preferred. The values of the average absolute revisions of seasonally adjusted data and trend components are smaller for TRAMO/SEATS than for X-12ARIMA.

The volatility of irregular components for the first one is substantially higher than for the second approach. In the first case there are several very large outliers, while in the second case irregular components seem more homogenous. Impulse indicator saturation at 1% significance level identifies only 4 extreme observations for TRAMO/SEATS methods. At the same time, for X-12ARIMA methods 13 extreme observations are found.

Utilization of X-12ARIMA provides seasonally adjusted quarter-to-quarter growth rate of real GDP in 2013Q1 equal to 1.060 or 6.0% and corresponding annualized rates becomes 1.263 or 26.3%. TRAMO/SEATS gives more adequate results: 1.016 or 1.6% for quarter-to-quarter growth, and 1.063 or 6.3% for annualized growth rates.
Seasonally adjusted Belarusian real GDP: final results

- TRAMO/SEATS was used with following ARIMA specification: $(0, 1, 1)(0, 1, 0)$.
- Impulse indicator saturation identifies 4 extreme observations, one of which is related to 2013Q1.
- Seasonally adjusted data for contaminated observations were replaced by appropriate trend component. On the basis of this data, year-to-year and annualized seasonally adjusted growth rates of real GDP were calculated by using equations (3), (4) and (8).
- Without accounting for data contaminations, growth rate of real GDP in 2013Q1 is 1.55% and 6.44% for quarter-to-quarter and annualized growth rate, respectively. The result are considerably changed when corrections for data contamination in 2013Q1 is undertaken. In such a case a quarter-to-quarter growth rate is equal to 0.79% for quarter-to-quarter, and 3.21% for annualized value. The growth rate of real GDP in 2013Q2, according to our estimates, is -0.51% and -2.01% for quarter-to-quarter and annualized values, respectively.
### Seasonally adjusted growth rate of real GDP, % (1995Q1–2013Q2)

<table>
<thead>
<tr>
<th>Year/quarter</th>
<th>TRAMO/SEATS, ARIMA (0, 1, 1)(0, 1, 0) without corrections</th>
<th>TRAMO/SEATS, ARIMA (0, 1, 1)(0, 1, 0) with corrections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>quarter to quarter</td>
<td>annualized</td>
</tr>
<tr>
<td>2009Q1</td>
<td>−1.17</td>
<td>−4.61</td>
</tr>
<tr>
<td>2009Q2</td>
<td>−0.43</td>
<td>−1.72</td>
</tr>
<tr>
<td>2009Q3</td>
<td>1.44</td>
<td>5.90</td>
</tr>
<tr>
<td>2009Q4</td>
<td>0.94</td>
<td>3.83</td>
</tr>
<tr>
<td>2010Q1</td>
<td>2.19</td>
<td>9.05</td>
</tr>
<tr>
<td>2010Q2</td>
<td>2.51</td>
<td>10.42</td>
</tr>
<tr>
<td>2010Q3</td>
<td>3.19</td>
<td>13.40</td>
</tr>
<tr>
<td>2010Q4</td>
<td>2.56</td>
<td>10.62</td>
</tr>
<tr>
<td>2011Q1</td>
<td>0.78</td>
<td>3.18</td>
</tr>
<tr>
<td>2011Q2</td>
<td>1.63</td>
<td>6.67</td>
</tr>
<tr>
<td>2011Q3</td>
<td>1.27</td>
<td>−4.99</td>
</tr>
<tr>
<td>2011Q4</td>
<td>1.59</td>
<td>6.51</td>
</tr>
<tr>
<td>2012Q1</td>
<td>−0.48</td>
<td>−1.90</td>
</tr>
<tr>
<td>2012Q2</td>
<td>1.35</td>
<td>5.51</td>
</tr>
<tr>
<td>2012Q3</td>
<td>0.21</td>
<td>0.84</td>
</tr>
<tr>
<td>2012Q4</td>
<td>−0.99</td>
<td>−3.92</td>
</tr>
<tr>
<td>2013Q1</td>
<td>1.55</td>
<td>6.34</td>
</tr>
<tr>
<td>2013Q2</td>
<td>−1.25</td>
<td>−4.89</td>
</tr>
</tbody>
</table>
Seasonal adjustment of real GDP with TRAMO/SEATS and corrections for data contaminations
Does the analyzed time span matter?

Seasonally adjusted growth rate of real GDP, %
(limited sample 2002Q1–2013Q2)

<table>
<thead>
<tr>
<th>Year/quarter</th>
<th>ARIMA (0, 1, 1)(0, 1 , 0) without corrections</th>
<th>ARIMA (0, 1, 1)(0, 1, 0) with corrections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>quarter to quarter</td>
<td>annualized</td>
</tr>
<tr>
<td>2009Q1</td>
<td>−1.18</td>
<td>−4.65</td>
</tr>
<tr>
<td>2009Q2</td>
<td>−0.44</td>
<td>−1.73</td>
</tr>
<tr>
<td>2009Q3</td>
<td>1.44</td>
<td>5.91</td>
</tr>
<tr>
<td>2009Q4</td>
<td>0.95</td>
<td>3.84</td>
</tr>
<tr>
<td>2010Q1</td>
<td>2.19</td>
<td>9.04</td>
</tr>
<tr>
<td>2010Q2</td>
<td>2.51</td>
<td>10.44</td>
</tr>
<tr>
<td>2010Q3</td>
<td>3.20</td>
<td>13.42</td>
</tr>
<tr>
<td>2010Q4</td>
<td>2.56</td>
<td>10.63</td>
</tr>
<tr>
<td>2011Q1</td>
<td>0.79</td>
<td>3.18</td>
</tr>
<tr>
<td>2011Q2</td>
<td>1.62</td>
<td>6.64</td>
</tr>
<tr>
<td>2011Q3</td>
<td>−1.27</td>
<td>−5.00</td>
</tr>
<tr>
<td>2011Q4</td>
<td>1.58</td>
<td>6.49</td>
</tr>
<tr>
<td>2012Q1</td>
<td>−0.47</td>
<td>−1.88</td>
</tr>
<tr>
<td>2012Q2</td>
<td>1.32</td>
<td>5.53</td>
</tr>
<tr>
<td>2012Q3</td>
<td>0.20</td>
<td>0.80</td>
</tr>
<tr>
<td>2012Q4</td>
<td>−0.99</td>
<td>−3.90</td>
</tr>
<tr>
<td>2013Q1</td>
<td>1.55</td>
<td>6.36</td>
</tr>
<tr>
<td>2013Q2</td>
<td>−1.24</td>
<td>−4.86</td>
</tr>
</tbody>
</table>
Conclusions and policy recommendations (1)

- For seasonal adjustment of real GDP it is advisable to implement TRAMO/SEATS methods in automatic mode. This method allows us to get a model with good diagnostics. Additionally, the dynamic characteristics of the data and its order of integration should be taken into account. Appropriate econometric test have to be used for this purpose at the preliminary stage of analysis.

- Short-term alteration of seasonal pattern in the real GDP dynamics without explicit economic explanations can give evidence about possible data contaminations. To identify the extreme observations and possible data contaminations, we suggest investigating the behavior of an irregular component from decomposition of time series, and applied impulse indicator saturation techniques for this purpose. This methods permit to detect abnormal observation quite accurately. Impulse indicator saturation technique is implemented in econometric package OxMetrics.
Conclusions and policy recommendations (2)

• When calculating seasonally adjusted growth rate of real GDP under data contaminations, identified extreme observations should be replaced by appropriate values of trend component taken from decomposition of time series. This allows getting adequate estimates of economic growth.

• Time span for seasonal adjustment of real GDP actually does not influence the final results. This fact permits to obtain long enough time series that is of great importance for econometric modeling and forecasting.

• It should be taken into account that the usage of annualized growth rate under the data contaminations can increase the error of estimation manifold. If one faces a situation similar to those of 2013Q1, it is advisable to make correction proposed in this paper or temporary suspend the publication of seasonally adjusted data (supposedly within one year).

• In addition to the publication of seasonally adjusted growth rate of real GDP it is desirable to present corresponding data about trend component, which reflects the mid- and long-run tendencies of economic dynamics.
Practical implementation

This methodology and recommendations is taken into account by the National Bank while preparing of the revised seasonally adjusted quarterly growth rate of real GDP for the first half of 2013. The results presented bellow are comparable with those presented earlier.

Dr. Igor Pelipas
pelipas@research.by

German Economic Team Belarus
c/o BE Berlin Economics GmbH
Schillerstr. 59, D-10627 Berlin
Tel: +49 30 / 20 61 34 64 0
Fax: +49 30 / 20 61 34 64 9
E-mail: info@get-belarus.de
Follow us on Twitter @BerlinEconomics