

Miroljub Labus
Belox Advisory Services, Belgrade

GDP REVISIONS AND NOWCASTING IN SERBIA¹

Revizije i brze procene BDP-a u Srbiji

Abstract

This paper addresses the issues of Quarterly National Accounts compilation and Gross Domestic Product (GDP) revisions as well as GDP short-term forecasting based on available monthly series of economic and financial indicators. If GDP is promptly and properly measured, policy makers and the general public can closely monitor implementation of the fiscal consolidation program. Reputation of the program depends on achievements that should be beyond any doubt. Since figures on quarterly GDP and its components are provisional until autumn of next year, and subject for revision over the next two years – which is a standard ESA 2010 methodology – accuracy of data might interfere with prompt availability. Additionally, nowcasting can provide timely estimates of current GDP. Figures on this quarter GDP are available two months after the end of the quarter. Flash estimates of GDP are available one month after the end of the quarter. The nowcasting technique can substantially shorten this gap. However, the challenging issue is related to a choice of the monthly series that should be included in Mixed Data Sampling econometrics. We address both of these issues in this paper.

Keywords: *GDP compilation, implicit price deflators, nowcasting*

Sažetak

Mi se bavimo u ovom članku pitanjima vezanim za obračun kvartalnih računa, njihovu reviziju i instant procenu bruto domaćeg proizvoda (BDP) na bazi raspoloživih mesečnih ekonomskih i finansijskih indikatora. Ako se BDP pravovremeno i tačno meri, tada nosioci ekonomske politike i javnost mogu pouzdano da prate šta se dešava sa primenom programa fiskalne konsolidacije. Reputacija ovog programa, između ostalog, zavisi od njegovih rezultata u koje javnost neće da sumnja. Kako su, međutim, konačni podaci o BDP i njegovim komponentama poznati tek najesen iduće godine, a podložni su revizija ne samo do tada nego i u naredne dve godine – što je standardna metodologija ESA 2010 koju primenjuje Evrostat u Evropskoj uniji – pouzdanost ocena BDP može da trpi štetu zbog potrebe da ocene budu napravljene što hitnije. A što se tiče potrebe za brzim informacijama, brza procena BDP može da bude od koristi. Preliminarni podaci o BDP iz tekućeg kvartala raspoloživi su tek dva meseca po njegovom završetku. Brza procena BDP može da skрати taj period, čak i u odnosu na fleš ocenu BDP koja je raspoloživa mesec dana nakon završetka kvartala. Naravno, pravi izazovi kod brze procene BDP postoje kod pitanja koje mesečne serije uključiti u njenu analizu. Naš članak posvećen je svim ovim navedenim pitanjima.

Cljučne reči: *obračun BDP-a, implicitni BDP deflator, brze procene BDP-a*

¹ The author thanks Mirjana Smolčić, Katarina Stančić and Milena Stevović from the Statistical Office of Serbia for providing data and very useful comments on the first draft of this paper. Of course, the author is responsible for any potential errors and conclusions.

Introduction

The ruling orthodoxy is that fiscal policy, at the macro level, can contribute to attaining macroeconomic stability, which is one of the essential prerequisites for long-term growth. At the micro level, fiscal policy can boost growth by altering work and investment incentives, improving labor market functioning, and enhancing total factor productivity [15]. We discussed potential micro effects of fiscal policy on growth at three earlier occasions within the Kopaonik Business Forum [17], [18], [19]. The Government, however, adopted an alternative policy to the one we recommended, which was not aimed at enhancing total factor productivity, but to improve tax collection and reducing some public spending. That policy had some success in 2016. General government revenue increased by 1.9% of GDP, while corresponding expenditure reduced by 0.4%, which together pushed down fiscal deficit to 1.4% of GDP. On the other side, expected growth increased from the initial estimate of 0.5% to the final estimate of 2.7%. Hence, both the fiscal deficit reduced and growth accelerated in 2016 beyond any expectation.

The question remains whether this was an outcome of macroeconomic stability, fiscal consolidation or of some other factors. The importance of having the right answer is obvious. If growth can continue without fiscal reforms that have micro consequences, there is no need to optimize tax and expenditure policies, since other driving factors will promote recovery and long-term development. Alternatively, fiscal reform is still on the table. The purpose of this paper is not to discuss fiscal policy stance, but to address some technical issues related to compiling, estimating and forecasting GDP. The motivation is twofold. Firstly, if GDP is promptly and properly measured, policy makers and the general public can closely monitor fiscal development and react on time to potential challenges and deviations from the target. Secondly, implementation of the fiscal consolidation program in 2016 surprised with early positive achievements and elevated expectations about growth. Official revisions of GDP figures, which would be routinely accepted under other circumstances, raised some doubts about whether the growth was authentic or artificial. That puts on the table the issue of reliability of statistical figures

parallel to sustainability of the fiscal consolidation policy. Since reliable estimates of GDP and its components are indispensable for conducting any fiscal policy, we believe it is worth writing a few pages on compilation and revision of GDP figures in Serbia. Additionally, we address the issue of short-term forecasting, i.e. nowcasting in order to show how useful as well as challenging it is to forecast GDP in a timely manner.

The paper is organized in the following way. In the first part we discuss methodology of compiling GDP and how accurate the revisions of GDP were in the past three years. In the second part, we extend this discussion to Implicit Price Deflators (IPD) and compare them with the Consumers Price Index (CPI) that is a headline measure of inflation. In the third part we present alternative ways of compiling real GDP growth rates. And finally, in the fourth part, we provide an example of nowcasting GDP based on the MIDAS econometric technique (Mixed Data Sampling). Finally, we conclude in the last part.

GDP revisions

Annual National Accounts (ANA) are compiled by using three independent methods of collecting and processing source data: output or production method (the supply side), final expenditure method (the demand side) and income method (the distribution side). However, GDP is not independently estimated using the income approach in the Serbian national accounts. The reason for this is that there are no direct data on or independent estimates of the operating surplus, which is instead derived from the output approach as a residual after all corrections to business accounts have been made, including necessary balancing of accounts. The final expenditure method is widely used for QNA, but it is also not complete since quarterly data on changes in inventories are not available. Hence, QNA have to compile GDP only from the output or production side. To this end, QNA collect and use data on value-added at the current prices created in the economy. The Statistical Office of the Republic of Serbia (SORS) surveys 88 divisions according to NACE Rev 2 classification of activities, which are later aggregated into 21 sections. Data are further combined into 10 high-level

aggregates for publication in QNA². We index them as $i = 1, \dots, n$. The gross value-added ($GVA_{i,t}$) of each aggregate is defined as the difference between output value ($Y_{i,t}$) and intermediate consumption ($Z_{i,t}$):

$$(1) \quad GVA_{i,t} = Y_{i,t} - Z_{i,t}$$

where subscript t indicates annual frequency. Intermediate consumption at quarterly frequency is not available, and instead of this, the following formulae is used for its estimation (the second term in equation (2)):

$$(2) \quad GVA_{i,t}^q = Y_{i,t}^q - \frac{Z_{i,t-1}}{Y_{i,t-1}} Y_{i,t}^q$$

under the constraint of accounting balance:

$$(3) \quad GVA_{i,t} = \sum_{q=1}^4 GVA_{i,t}^q$$

where superscript q indicates quarterly frequency. The quarterly GDP obtained in this way at current market prices is a sum of all sectoral gross value added corrected for net indirect taxes ($tax_{i,t}^q$):

$$(4) \quad GDP_{i,t}^q = \sum_{i=1}^n (1 + tax_{i,t}^q) GVA_{i,t}^q \quad i = 1, 2, 3, \dots, n$$

The SORS collects data on output through a survey known as the *Enterprise quarterly structural report on doing business* (SBS-03 formulary)³. Those data are complemented with a set of indicators that are regularly obtained by the statistical system on the value of construction work, sale and purchase of agricultural products, retail trade and wholesales, catering services, registered employment and wages, CPI and prices of production. The National Bank of Serbia (NBS) supplies data on deposits, credits, and insurance premium. The Ministry of Finance (MoF) provides data on fiscal revenue and expenditure, including custom tariffs and subsidies. All those indicators are monthly data that are further aggregated into quarterly

series⁴. They are used for improving estimates of GDP compiled from the output or value-added side.

Estimates of quarterly GDP at current prices obtained in this way are provisional. The sum of four quarters of GDP represents provisional annual GDP for that year. It is, however, available no earlier than in February of the following year. In the very same next year the SORS is able to collect and process *Annual Financial Reports* of undertakings (AFR) instead of *Enterprise quarterly structural report on doing business*, which were processed during the current year. It is important to underline that only AFR provide accurate data on value-added for the previous year and facilitate correct and final estimates of the annual GDP. When the accurate annual GDP is compiled or the provisional annual aggregate is revised, the annual benchmarking is applied to revise the corresponding quarterly figures. The more accurate annual GDP are published in September next year for the previous year. According to ESA 2010, the SORS has to revise GDP series backward for the current year and two preceding years. November of the next year is the time when the final quarterly GDP series for this year will be available, as well as the provisional estimates for the next year. We can compare at that time the final and provisional QNAs for this year. Differences are inevitable due to accuracy of data sources, extended coverage and additional statistical information. For sure, the size of differences is a test of how well ANA and QNA are compiled.

We keep record of the sequential releases of QNA high-level aggregates for Serbia in the past several years⁵. This facilitates comparisons of provisional and final estimates of GDP. Table 1 reports differences between provisional and final estimates of nominal and real

2 A Agriculture, forestry and fishing; B, C, D and E Manufacturing, mining and quarrying and other industry; F Construction; G, H and I Wholesale and retail trade, transportation and storage, accommodation and food service activities; J Information and communication; K Financial and insurance activities; L Real estate activities; M and N Professional, scientific, technical, administration and support service activities; O, P and Q Public administration, defence, education, human health and social work activities; R, S, T and U Other services. See [5, p.43].

3 The SBS-03 formulary collects the following data: proceeds from selling commodities and services; returns on investments, proceeds from insurance premium, subsidies, donations and similar revenue (rents, interest payments, membership fees etc.), purchasing value of commodities subsequently sold, raw material and energy costs, labor costs and other employment compensations, costs of providing business services, costs of intangible assets. See [21].

4 However, there are few series, as construction, purchase and sale of agricultural products, wholesales and insurance revenue that are compiled in the opposite way as temporal disaggregation of the annual estimates. Temporal disaggregation is a method of interpolation applied to flow variables. The interpolated series at a higher-frequency (monthly or quarterly) is obtained by relating a higher-frequency indicator series to a lower-frequency benchmark series (quarterly or annual) by minimising the first difference function under constrain that sum of interpolated series over the specified period is equal to the benchmark for that period. If the reference series is absent (strictly speaking it is replaced with 1 in the interpolation process) this procedure is termed benchmarking.

5 Up-to-date QNAs are available at the official web site of the SORS, which always overwrite the previously published data.

GDP since the first quarter of 2014. The release of GDP for the third quarter of 2016 is taken as the benchmark against which all differences are calculated. As a rule the further back the year, the lower the adjustment required. The most recent estimates of GDP are subject to larger modifications. The size of difference for real GDP falls in the interval between + 0.4% and – 0.3%. The error interval for nominal GDP is wider: between + 0.4% and – 2.4%. On average, all real GDP revisions had a positive sign, while nominal GDP revisions had a negative sign. That means, the recent revisions slightly increased real GDP growth and reduced nominal GDP growth, which points to the conclusion that GDP IPD were overestimated.

We report in the annex Tables 1A to 5A where corresponding figures are provided for each component of the GDP. Slightly larger differences are recorded for real imports, which were initially overvalued⁶, and real investments, that were originally underestimated, but all of them are within the accepted statistical error corridor.

Parallel with the estimation of QNA at the current prices, an estimation of national accounts at the constant prices is compiled. As for GDP at constant prices, a similar data compilation is applied, but prices from the previous year are used instead of the current prices. A few notes

are useful here. Agriculture production is split into crops production and livestock production. Data for the livestock production are approximated by the series of sale and purchase of agricultural production deflated by the prices of production in agriculture. The crops production is highly seasonal with the harvest in the third quarter. Temporal disaggregation of the annual output in agriculture at constant prices is based on quarterly dynamics of the sales and purchase of agricultural products at constant prices, and fixed proportions of production costs over the quarters (20% in the first quarter, 25% in the second quarter, 30% in the third quarter and 25% in the fourth quarter, according to international recommendations). The more accurate the prediction of the annual agricultural output, the better the compilation of GDP. Also, value added in the real estate sector is obtained by imputed annual rentals that have to be temporally disaggregated using the number of employed persons in real estate as the reference series. Outputs of government sector, health and education in terms of the previous year prices are temporal disaggregates of the corresponding annual output at production costs (compensations of employees plus intermediate consumption plus consumption of fixed capital plus other taxes on production paid) by using the number of employed persons in those sectors as reference series for benchmarking.

There are regular revisions of QNA with slightly different figures on real and nominal quarterly GDP, but these provisional estimates of GDP and growth fit ESA 2010 standards. Let's quote it: "The purpose of quarterly national accounts is different from that of annual national accounts. Quarterly national accounts focus on the short-term movements of the economy and provide a coherent measure of such movements within the national accounts framework. Emphasis is placed on growth rates and their characteristics over time such as acceleration, deceleration or change in sign. The annual national accounts' emphasis is on levels and the structure of the economy, as well as growth rates." [6, p. 313]. The main purpose of QNA is to provide a picture of current economic developments sooner than that provided by the ANA and more comprehensive than that provided by individual short-term indicators.

Table 1: Percentage difference between final and provisional GDP estimates

Time	Real GDP			Nominal GDP		
	Dates of revision			Dates of revision		
	Q4Y15	Q1Y16	Q2Y16	Q4Y15	Q1Y16	Q2Y16
Q1Y2014	0.4%	0.3%	0.3%	0.1%	0.4%	0.4%
Q2Y2014	0.2%	0.1%	0.1%	0.2%	0.3%	0.3%
Q3Y2014	-0.3%	-0.1%	-0.1%	0.0%	0.0%	0.0%
Q4Y2014	-0.2%	-0.3%	-0.3%	-0.3%	-0.7%	-0.7%
Q1Y2015	0.3%	0.3%	0.3%	-1.4%	-1.1%	-1.1%
Q2Y2015	0.1%	0.0%	0.0%	-2.0%	-1.8%	-1.8%
Q3Y2015	-0.3%	-0.1%	-0.1%	-1.6%	-1.7%	-1.7%
Q4Y2015	-0.1%	-0.2%	-0.2%	-2.0%	-2.4%	-2.4%
Q1Y2016		0.0%	0.3%		-1.7%	-1.5%
Q2Y2016			0.1%			-1.8%
Average	0.00%	0.00%	0.04%	-0.88%	-0.96%	-1.03%

Source: SORS, author's calculation based on the own database

⁶ A part of the problem is related to the fact that the SORS does not have data on import prices by export countries, and has to estimate them by relying on many second-source indicators.

Implicit Price Deflators

As we already mentioned QNA are subject to regular revisions during the accounting year and the next two years. Revisions are performed twice in-the-year and twice after-the-year. Each revision updates the previous ones and slightly changes estimated quantities and implicit price deflators at the high frequency level. This creates uncertainties and doubts that users would like to avoid. They need robust figures on GDP and its components in order to analyse economic structure and business fluctuations as well as to forecast future developments. Since QNA revisions are inevitable, it would be useful to assess whether there is a regularity in relation between implicit National account deflators and closely related inflation measures or there are differences between them as a result of compilation errors. Figure 1 below compares the inflation rates based on Consumers Price Indices (CPI), which is a measure of the headline inflation, and the inflation rates based on the implicit price deflator of GDP for the period 2007-2016.

The implicit quarterly GDP deflator is not obtained as a ratio between nominal and “real” GDP, since there is no “real” GDP in ESA2010 methodology. Instead of this, it is obtained by a means of volume measures of the economy’s Gross Value Added (GVA). We term $GDP_{t|t}^q$ quarterly GDP at the current prices as a sum of the volume measures of $GVA_{t|t}^q$, presented in monetary terms, in the quarter q at the current prices in t year (hence the subscript is $t|t$) and net indirect taxes. $GDP_{t|t=base}^q$ are the chain-linked volume measures of GVA, presented in monetary terms, at quarterly frequency referenced to the nominal level in the base year 2010 (the subscript is $t|t=base$) corrected for net indirect taxes⁷. Hence, the implicit price deflators (IPD) are:

7 In equation (5) the most important part is denominator $GDP_{t|t=base}^q$. In order to explain how it is compiled, we have to start with $GDP_{t|t-1}^q$, which is the volume measures of GDP presented in monetary terms in the q quarter at the prices of the previous year $t-1$. It is obtained by deflating $GDP_{t|t}^q$. In order to start chain-linking, we need to create indices. The corresponding index of GDP ($I_{t|t-1}^q$) in the quarter q at t time is expressed in terms of the average GDP at the prices of the previous year:

$$I_{t|t-1}^q = \frac{GDP_{t|t-1}^q}{\frac{1}{4} \sum_{q=1}^4 GDP_{t-1|t-1}^q} \cdot 100$$

For the index of the starting year ($t = first$), it has to refer to the previous year ($t = first-1$):

$$(5) \quad IPD_{t|t=base}^q = \frac{GDP_{t|t}^q}{GDP_{t|t=base}^q}$$

Equation (5) points out to the implicit inflation rates as:

$$(6) \quad \pi_{t|t=q}^{GDP} = \left(\frac{IPD_{t|t=base}^q}{IPD_{t-4|t=base}^q} - 1 \right) \cdot 100$$

It is clear from Figure 1 that we have had in Serbia considerable differences in inflation indicators for the past ten years. Table 2 summarizes these differences in terms of RMSE (Root Mean Squared Error), co-movements in terms of coefficients of correlation, and volatility in terms of coefficients of variation. Headline inflation was very closely related to consumption IPD with the coefficient of correlation of 0.9522 and RMSE of 1.5757. Its movement with GDP IPD was similar, but not so close. Coefficient of correlation between headline inflation and GDP IPD is 0.8552 with RMSE 2.2368. This might be a subject of misuse. For example, success of fiscal consolidation depends on fiscal deficit reduction. Fiscal revenue and expenditure are reported in nominal terms. If policy makers need to know what the corresponding fiscal deficit is as a percent of GDP, they should know the corresponding level of nominal GDP. In order to avoid inflationary bias and non-stationarity of data, they estimate GDP in terms of real growth rate. Then they have to go back to the price level for

$$I_{t=first|t=first-1}^q = \frac{GDP_{t=first-1|t=first-1}^q}{\frac{1}{4} \sum_{q=1}^4 GDP_{t=first-1|t=first-1}^q} \cdot 100$$

In the case of Serbian data series, the starting year is 1996, while the previous year is 1995. The index is a transformation of the index in the sense that it is chain-linked to its average value from the previous year. Before we define it, let’s note that there is no a value of this index in the first year of the chain-linking. Therefore, we apply the following identity in the first year:

$$\tilde{I}_{t=first|t=first}^q \equiv I_{t=first|t=first-1}^q$$

After the first year, the index is regularly chain-linked to its average value from the previous year:

$$\tilde{I}_{t|t}^q = I_{t|t-1}^q \cdot \frac{1}{4} \cdot \sum_{q=1}^4 I_{t-1|t-2}^q / 100$$

Then it is additionally linked to the base year (2010) as:

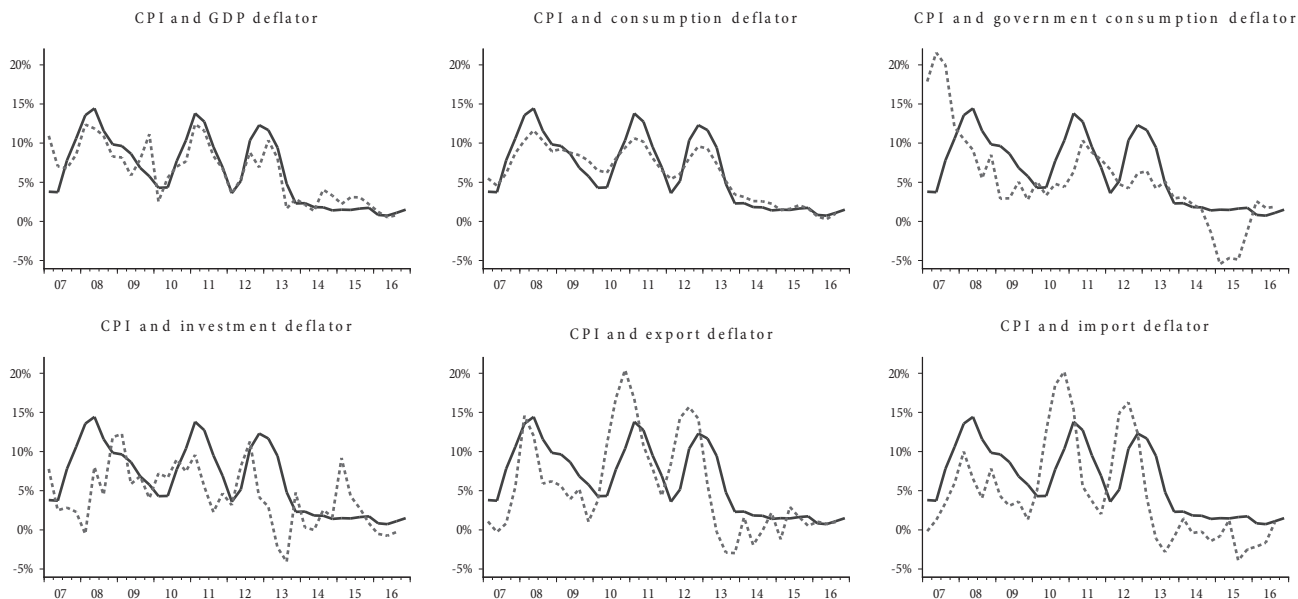
$$\tilde{I}_{t|t=base}^q = \frac{\tilde{I}_{t|t}^q}{\frac{1}{4} \cdot \sum_{q=1}^4 \tilde{I}_{t=base|t=base}^q} \cdot 100$$

This finally gives:

$$GDP_{t|t=base}^q = \frac{\tilde{I}_{t|t=base}^q \cdot \frac{1}{4} \cdot \sum_{q=1}^4 GDP_{t=base|t=base}^q}{100}$$

which is the quarterly chain-linked volume GDP series. IMF uses a different method to index GDP series [14].

Figure 1: CPI (solid line) and implicit price deflators of QNA components (dotted lines)



which they usually use forecast of headline inflation. If the economy is stable and inflation is low, CPI and GDP IPD are close to each other as Figure 1 shows. In this case the approximation of GDP IPD by CPI is correct. However, for higher inflation, this approximation might be misleading. In the periods of high inflation in Serbia, GDP IPD was lower than corresponding IPC and the estimated fiscal deficit, as a percent of GDP, was lower than it really was.

As already mentioned, final estimates for ANAs (QNAs) for this year are available in September (November) next year. As it happened in praxis, data are not timely available, there are measurement errors, some figures are subject to revisions. Hence, differences are present and they should be eliminated by a statistical reconciliation.

Under an ideal situation, changes in GDP IPD ($\pi_{q|t-q}^{gdp}$) are a weighted average of changes in GDP IPD's components. This is represented in equation (7), where symbol lambda (λ) represents shares of corresponding components in the GDP, symbol pi (π) changes in IPDs, respectively, t stands for time and C, G, I, X, M and IE for private and government consumption, investment, export, import and changes in inventory cum errors and omissions.

$$(7) \quad \pi_t^{GDP} = \lambda_t^C \cdot \pi_t^C + \lambda_t^G \cdot \pi_t^G + \lambda_t^I \cdot \pi_t^I + \lambda_t^X \cdot \pi_t^X - \lambda_t^M \cdot \pi_t^M + \lambda_t^{IE} \cdot \pi_t^{IE}$$

However, this is not exactly the case for QNA in Serbia for two reasons. Firstly, there is a missing component of quarterly GDP that is not compiled in a direct way.

This is change in inventories or the term ($\lambda_t^{IE} \cdot \pi_t^{IE}$) in equation (7). Data on quarterly changes in inventories are still not directly estimated by the statistical system⁸. Inventories are treated as a residual after nominal and real GDP is compiled from the production side and the final use side. Due to residual property, this estimate encompasses not only inventories, but measurement errors as well, corrected for disposals of valuables and potential statistical discrepancy. Secondly, GDP IPD is obtained in QNA from the production side dividing the nominal GDP at current prices with the chain-linked volume of GDP series. ESA 2010 has replaced estimates of real GDP by using the constant prices with estimates of GDP at the prices of the previous year that should be chain-linked to a reference year by applying the annually-averaged chain Laspeyres formula. It has the consequence that additivity is missed, except for the reference year and the following year (Eurostat, 2013). That effects calculation of shares ($\lambda_t^C, \lambda_t^G, \lambda_t^I, \lambda_t^X$ and λ_t^M). Additionally, CPI is a Paasche-type index, and it is well known that it gives a different result comparing to the Laspeyres-type index.

CPI and the household final consumption expenditure implicit price deflator (HFCE IPD) both relate to household

8 There is a cell in the SBS-03 formulary on the inventory level, but this information is not sufficient for direct compilation of changes in inventories. Additional source data are needed in order to allocate changes in inventories to a specific quarter, since the level of inventories can last for several accounting periods.

Table 2: Differences and co-movements between CPI and IPD

Indicators	Coefficients of Correlation		Root Mean Squared Error		Coefficient of Variation
	GDP deflator	CPI	GDP deflator	CPI	Percentage
CPI	0.8552	1.0000	2.2368	0.0000	69%
GDP deflator	1.0000	0.8552	0.0000	2.2368	58%
Consumption deflator	0.8689	0.9522	1.7896	1.5757	54%
Government consumption deflator	0.5301	0.4292	4.9006	5.6226	110%
Investment deflator	0.4175	0.3557	4.4896	5.1326	92%
Export deflator	0.5467	0.6720	5.2091	4.6603	114%
Import deflator	0.4665	0.5918	5.8059	5.4153	140%

Source: Statistical Office RS, author's calculation

consumption, but the definitions, scope and index formulae of the two price indices differ: CPI is constructed as a Laspeyres-type index and HFCE IPD is a Paasche-type index; CPI measures the prices of expenditures in the domestic territory, while HFCE IPD measures the prices of consumption by residents wherever it occurs (for our tourist who purchase touristic services abroad the weighted average of CPIs of the five leading destination countries is used); HFCE IPD includes the prices of goods and dwelling services produced by households for their own use, but the CPI only measures the prices of market transactions; CPI measures the prices of actual explicit payments made for financial and insurance services, while the HFCE IPD measures the prices of financial and insurance services provided, including those for financial services indirectly measured (FISIM)⁹.

Export and import implicit price deflators have a huge distance from CPI with RMSE of 4.6603 and 5.4153, respectively. Therefore their coefficients of correlation are rather low: 0.6720 and 0.5918, respectively. They are also very volatile with coefficients of variation of 114% and 149%, respectively. All these results are mostly, but not exclusively the consequence of a very volatile nominal exchange rate. Of course, export IPD does not cause changes in CPI, but import IPD influences CPI through the channel of imported consumer goods. It is interesting to notice that the distance between export and import IPDs and GDP IPD is even further away than the corresponding distance with CPI. RMSE are 5.2091 and 5.8059, respectively and coefficients of correlation are 0.5467 and 0.4665, respectively.

Investment implicit price deflator is very peculiar for measuring. Underlying quantities are split into three categories: real estate and buildings, productive equipment and remaining investment in fixed assets. Each category is further subject to statistical and mathematical techniques of compiling data known as temporal disaggregation or benchmarking. Temporal disaggregation means that the annual accounts data are extrapolated for the current year by using quarterly reference indicators. The applied technique should minimize the forecast error for the current year providing that the provisional annual estimates correspond as closely as possible to the final figures. The common property of different investment processes is that they last for several accounting periods. Hence, the compilation cannot go from the bottom to the top, but vice versa, from the annual estimates to quarterly data.

The quarterly reference indicator for the IPD of real estate is the value of construction work at current prices compared to the same level in the previous year. Investment in real estate compiled at constant prices uses benchmarked nominal investment quarterly data and deflated them by a special composite price index, which encompasses prices of production of related industrial commodities for domestic market and average gross wage rate in the construction sector. *Mutatis mutandis* IPD for productive equipment and remaining investment in the fixed assets are compiled. Finally, all quarterly data should fulfil the time consistency requirement - the sum of the four quarters of a year should be equal to the corresponding annual figure for investment. When ANA provide the accurate annual figures on investment, the

⁹ [7, p. 287], [21, str. 14].

entire benchmarking procedure should be repeat using those data instead of the preliminary source data.

Having said this, there is no surprise that investment time series with quarterly frequency were subject to considerable revision each year¹⁰. Notice that the final adjustment in this process should be done when the accounting requirements are checked - the sum of the quarterly components, including investments, should be equal to the corresponding quarterly value for GDP both on the expenditure and output side.

Government consumption implicit price deflator is obtained by dividing nominal non-market output of the general government sector with its output at constant prices. The nominal non-market output is the sum of the public wage bill, government purchases of goods and services (public intermediate consumption), amortisation of public fixed assets, transfer payments in kind and other taxes on production minus revenue received from the public output that has market value. The nominal non-market output is the annual figure that should be temporally disaggregated according to the above defined benchmarking procedure in order to get corresponding quarterly figures. The reference series are appropriate quarterly data for each input cost category. For example, the reference series for government consumption is quarterly compensation for public employees. The average public wage rate is used for deflating nominal government consumption in order to compile the same output at constant prices. The government IPD is not well correlated with GDP IPD since the coefficient of correlation is 0.5301 and RMSE 4.9006. Surprisingly, it is highly volatile with the coefficient of variation of 110%.

This analysis explains why implicit price deflators of GDP components change as regular revisions of QNA are performed. It also demonstrates that CPI is a good proxy of GDP IPD, but it is not a perfect substitute. This proxy can be used whenever proper GDP deflator is not available. However, policy makers should be aware of its properties and potential assessment errors.

It is not a rare case that GDP IPD and CPI substantially differ. If this is the case, it is difficult to decide which rate a central bank should target in the inflation targeting

monetary system. A World Bank study emphasised that the GDP deflator measures the price change of value-added, and does not include the rise of import prices or exchange rate devaluation¹¹. Hence, there might be substantial differences between the GDP IPD and CPI. For example, CPI outperformed GDP deflator for 9.5% and 4.2% in 2015 in Russia and Norway, respectively, or underperformed for 4.3% and 3.9% in Iceland and Ireland, respectively [23, p.20].

When inflation was high in Serbia (between 2007 and 2013) CPI was higher than the GDP deflator. In the moderation time (between 2014 and 2015) the GDP deflator was higher than CPI. In the last year both measures of inflation were rather close to each other¹².

Real Growth rates

The estimated annual growth rate for 2016 was 2.7%, which was much higher than the initial expectation of 0.5%. The year started with the unexpected high growth rate of 3.7% at the first quarter. This immediately raised expectations for the whole year based on annualizing the seasonally unadjusted quarterly growth rate, on one side, and doubts about the official statistical estimates, on the other. For sure, that particular figure of 3.7% is subject to revision, similar to anyone quarterly estimates. In the meantime, it will be useful to clarify methodology, which provides the estimation.

GDP quarterly growth rates (g_t^q) are obtained by the following equation (8), which is based on the quarterly chain-linked volume GDP ($GDP_{t|t=base}^q$):

$$(8) \quad g_t^q = \left(\frac{GDP_{t|t=base}^q}{GDP_{t|t=base}^{q-4}} - 1 \right) \cdot 100$$

11 This is not quite correct. If we recall equation (2), it is evident that intermediate productive use of resources includes imported goods not only domestically produced goods. Hence, exchange rate movements indirectly influence value-added in the country domestically produced. This is the reason that ESA 2010 requires double deflating value-added, i.e. one deflator for output and the other for intermediate goods consumption. However, QNA use only the single deflator for practical purposes.

12 Of course, CPI is calculated as a quarter average value in order to compare it with GDP IPD that has quarterly frequency. Kovačević and Stamenković [16] claim that the GDP deflator should be in-between CPI and the foreign trade deflator. This was mostly the case in the period 2008-16 but not completely, since there were some sub-periods in which GDP IPD was outside the corridor outlined by those measures of inflation.

10 However, estimates of real import series are even more revised.

The quarterly chain-linked volume GDP series correspond to the “real GDP” series according to ESA2010 methodology. We explained its compilation in footnote 7. It is a rather complex compilation and, according to ESA 2010, can be done by applying other index formulae, not only the Laspeyres index. However, the said compilation is recommended by the Eurostat as the best practice, and consequently applied by the SORS. The reason for complexity is that GDP series are not compiled at the constant prices from the base year, but instead of it at the current prices and the prices from the previous year. Therefore there is a need for serially linking QNA from different years to the same prices and making a volume chain index that refers to the referent year.

If someone is not satisfied with the way the chain-linked volume index of GDP is compiled, he/she can use data on GDP at the current prices and at the prices from the previous year, and compile an alternative growth rate that we termed the unchained growth rate¹³. The unchained growth rates do not reference a base period, and can be obtained in the following way:

$$(9) \quad \gamma_t^q = \left(\frac{GDP_{t|t-1}^q}{GDP_{t-1|t-1}^q} - 1 \right) \cdot 100$$

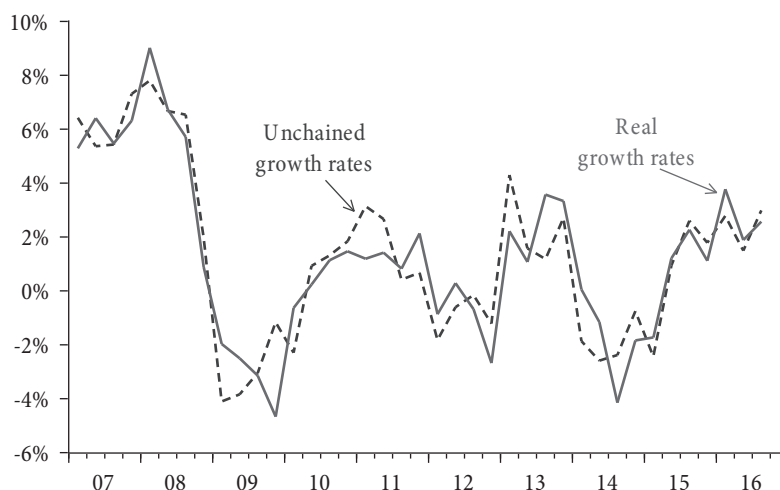
For compiling the unchained GDP growth rate (γ_t^q), where t refers to time in terms of years, one needs the series of GDP volume measures at the prices of the previous year (nominator in equ.9) and the series of quarterly GDP volume measures at time $t-1$ measured at the current prices at that

time, i.e. $t-1$ (denominator in equ.9). Since prices are the same, a ratio between the volume measures provides the base for compiling “real” growth rates. The series are not seasonally adjusted, and the estimates of unchained GDP growth rate are highly seasonally volatile. Therefore, the series should be seasonally adjusted before equation (9) is applied¹⁴. Hats over the variables in equation (9) indicate that series are seasonally adjusted. Results are plotted in Figure 2 and compared the unchained growth rates (γ_t^q) to the real GDP growth rates derived from the chain-linked volume indices (g_t^q). Both series of “real” GDP growth rates are rather close to each other with some discrepancies over the quarters. Those discrepancies are offset during the year, and the annual average growth rates overlap one another. Hence, whatever method of compiling real quarterly growth rates is applied, there is always a level of uncertainty. We need to notice again that QNA is designed for detecting trends and turning points in a business cycle, not for a point estimate that is robust and beyond any modification.

Nowcast

QNA are available two months after the end of the quarter. This is a considerable delay for policy makers if they want to steer the economy between Scylla and Charybdis of the business cycle. There are few econometric technique that might be useful to bridge the gap between official figures

Figure 2: Quarterly GDP chain-linked and unchained real growth rates



13 The SORS regularly publishes all underlying data.

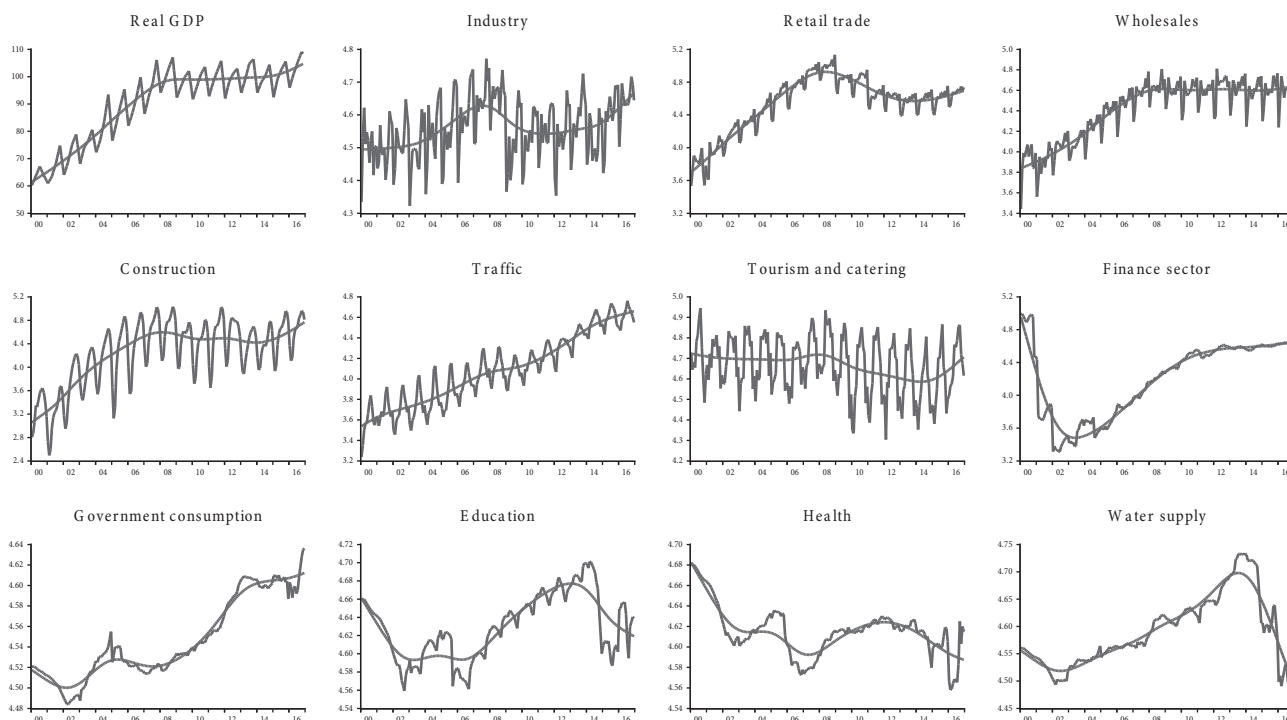
14 Alternatively, a 4-quarter moving average filter may be applied to seasonally not adjusted growth rates.

and urgent needs to have GDP updates. All they refer as nowcasting. We will demonstrate how to nowcast GDP growth rates of the current quarter by using monthly data on various GDP components available before the SORS officially releases corresponding figures. Data in general might be hard data on real business activity collected by the SORS or soft data obtained through business surveys. Data, also, may refer to the supply side of GDP or the demand side of GDP. We will demonstrate in this paper how monthly indicators from the supply side of GDP can be used for nowcasting. They are selected according to their timely publication in order to get early information for the quarter of interest. Those data are monthly indices on: industrial production, construction activity, retail trade, wholesales, government activity, traffic and telecommunication, tourism and catering, education, financial sector, health and the water supply¹⁵.

We report in Figure 3 monthly time series for the period 2000-2016 that are used for MIDAS estimation. In order to compare the time series of real GDP at quarterly frequency with the supplementary monthly series, we indexed GDP to 100 for 2015 year and benchmarked

it according to Denton [4]. The GDP trend line had a break in 2008. Before that time growth was strong, but afterwards it considerably slowed down until somehow recovered in the last two years. Industry strongly declined between 2008 and 2012 and resumed growth in the last three years. The trend line of the wholesales was flat since 2008, while the retail trade suffered much and not yet fully recovered. Construction was following the trend pattern of the GDP, while traffic and communication, contrary to all other series, had a strong growth all the time. General government increased since 2008 as a consequence of the policy stimulates designed to cure recession. It temporarily shrank during the fiscal consolidation, but expanded at the end of 2016. The financial sector suffered even before the Great Recession, but since then it was slowly and steadily recovering. Education, health and water supply had downside trends in the recent years. As expected, tourism and catering had a strong seasonal component with a positive short-time trend. These supply-side indicators are differently correlated with the GDP and had conflicting effects on GDP growth. Construction strictly correlated with GDP (0.75), while slightly weaker correlation have tourism and

Figure 3: Monthly time series from GDP supply side: Original series as zig-zag line, trend series as smoothed line



15 As we already mentioned, few of those monthly series are compiled by benchmarking quarterly or annual estimates.

catering and industry (0.65), and wholesales, traffic and communication (0.55). Retail trade, general government and financial activity have positive, but low correlation with GDP (between 0.18 and 0.22). Water supply, health and education have low and negative correlation with GDP (between -0.03 and -0.18). That makes nowcasting a little bit more complex than otherwise it would be.

One of the early approaches to deal with mixed-frequency data focuses on bridge equations, which link the low-frequency variables (quarterly), such as real GDP, to high frequencies time-aggregated indicators (monthly), such as industrial production or retail sales [1]. Forecasts of the high-frequency indicators are provided by specific high-frequency time series models, then the forecast values are aggregated and plugged into the bridge equations to obtain the forecast of the low-frequency variable. The bridge model technique allows computing early estimates of the low-frequency variables by using high frequency indicators. They are not standard macroeconomic models, since the inclusion of specific indicators is not based on any theoretical relations, but on the statistical fact that they contain timely updated information. Therefore, the bridge model to be estimated is represented by two alternative equations:

$$(10) \quad y_t^q = \alpha + \sum_{i=1}^j \beta_i x_{i,t}^q + \varepsilon_t^q$$

and

$$(11) \quad y_t^q = \alpha + \sum_{i=1}^j \sum_{k=1}^n \beta_{i,k} (L)x_{i,t}^q + \varepsilon_t^q$$

where (L) is a lag polynomial of length k , and $x_{i,t}^q$ are the selected monthly indicators ($i= 1, \dots, j$) aggregated at quarterly frequency. Equation (10) is a simple linear model where time-aggregated high frequency series are related to GDP as a low frequency time series. In equation (11) we use distributed lag polynomial of length k in order to reduce the number of parameters to be estimated.

The bridge equations set the ground for MIDAS approach. In order to take into account mixed-frequency data, Ghysels et al. (2004) introduce the Mixed-Data Sampling approach, which is closely related to the distributed lag model, but in this case the dependent variable y_t^q , sampled at a lower-frequency (quarterly), is

regressed on a distributed lag of $X_{t,S}^m$, which is sampled at a higher-frequency (monthly). A general representation of MIDAS model looks like this [10], [8]:

$$(12) \quad y_t^q = X_t^q \beta + f(\{X_{t,S}^m\}, \theta, \lambda) + \varepsilon_t^q$$

where

- y_t^q is the dependent variable, sampled at a low frequency, such as quarterly frequency, at the time t ,
- X_t^q is a n -dimensional transposed matrix of regressors sampled at the same low frequency (quarterly) as y_t^q , at time t ; it may include lagged dependent variables $y_{t-1}^q, y_{t-2}^q, \dots$, as well as other regressors,
- $\{X_{t,S}^m\}$ is a set of regressors sampled at a higher frequency (monthly) with S values for each corresponding low frequency unit; the S values may include values corresponding to lagged low frequency values as well ,i.e. at time, $t, t-1, t-2, t-3, \dots$

f is a function describing the effect of the higher frequency data (monthly) in the lower frequency (quarterly) regression; it may take the form of a distributed lag polynomial or some other forms (for instance, step functions, where the distributed lag pattern is approximated by a number of discrete steps),

- β, θ, λ are vectors of parameters to be estimated,
- ε_t^q is the vector of estimation errors.

It is possible to augment the MIDAS regressions with the factors extracted from a large dataset to obtain a richer family of models that exploit a large high-frequency dataset to predict a low-frequency variable. While the basic MIDAS framework consists of a regression of a low-frequency variable on a set of high-frequency indicators, the Factor-MIDAS approach exploits estimated factors rather than single or small groups of economic indicators as regressors. In the basic Factor-MIDAS approach the explanatory variables used as regressors are estimated factors.

We applied the MIDAS regression to nowcast GDP growth rate for the fourth quarter of 2016, and consequently, for the whole year 2016. In equation (12) vector y_t^q is logarithms of seasonally not adjusted quarterly GDP levels. Vectors X_t^q are logarithms of seasonally not adjusted quarterly GDP levels lagged for one and four quarters, and seasonally dummies variables elsewhere. $\{X_{t,S}^m\}$ is the set of monthly growth rates of eleven indicators from the supply side that were presented in Figure 2. Quarterly GDP levels

are transformed into logarithms in order to remove the underlying linear trend. That series is stationary and does not need any further transformation. However, logarithms of the supply side indicators are non-stationary and needed to be transformed into first differences, which approximate monthly growth rates. All these series are lagged for one month in order to create a dynamic regression model fit for doing out-of-the-sample forecast. The actual and forecasted GDP series are presented in Figure 4. Nowcast for the growth rate for the fourth quarter is 2.4%, which gives 2.8% for the entire year of 2016. Mean absolute forecast error for the entire period is 0.94.

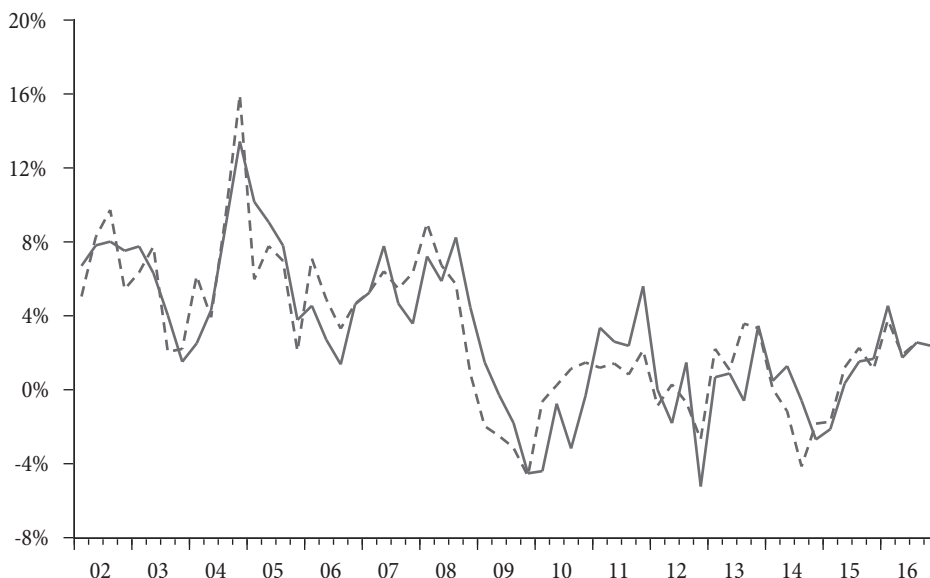
Nowcast is one out of many econometrics techniques for short-term forecasting GDP. What is usually missing is the awareness that forecast results depend on the methodology for compiling QNA. Let us take one simple example. One can use ARIMA procedure to forecast GDP in the fourth quarter in 2016. The best-fitted ARIMA model for forecasting quarterly “real” GDP based on data in the period Q1Y1996:Q3Y2016 is (4,3)(0,0). The forecasted GDP growth rate in the fourth quarter 2016 is 1.01%. However, the chain-linking methodology for compiling the “real” GDP, as it was explained in footnote 7, would require ARIMA forecasting GDP at the current prices and GDP at the prices of the previous year. The best-fitted ARIMA models for those two nominal GDP series are (4,0)(0,0) and (4,3)(0,0). If one did that, he/she should proceed with the

chain-linking these series in order to compile the “real” GDP. Based on these models and the chain-linking, the forecasted “real” GDP growth rate in the fourth quarter 2016 is 2.01%. This figure is much closer to the one we obtained by using nowcasting technique, than what can be get by a direct ARIMA forecasting method.

Conclusion

The paper addresses the issues of QNA compilation and GDP revisions as well as its short-term forecasting based on prompt available monthly series of economic and financial indicators. Our conclusion is that official figures on QNA are fairly reliable, including their revisions, and estimated in accordance with ESA 2010 standards. Users of these statistics, however, expect that they are more robust and invariant. Short-term QNA are made to provide data for assessing acceleration and deceleration in GDP growth rates as well as to detect turning points in the business cycle. Their accuracy is lower than ANA figures, and this is the price that must be paid for getting early indicators of business cycle fluctuations. Our finding on differences between provisional and final estimates of real GDP falls in the interval between + 0.4% and – 0.3% for the last three years (from Q1Y2014 to Q3Y2016). The error interval for nominal GDP is slightly wider: between + 0.4% and – 2.4%. On average, all real GDP revisions had a positive

**Figure 4: Estimation errors:
Actual growth rates (dashed line) and forecasted growth rates (solid line)**



sign, while nominal GDP revisions had a negative sign. This means that recent revisions slightly increased real GDP growth and reduced nominal GDP growth since the GDP deflator was overestimated.

We also provide an example showing how to perform nowcasting in Serbia, and conclude that this is a useful econometric technique for assessing current GDP two months before the SORS releases official figures and one month before flash estimates are available. As always, the real challenge is which monthly series should be included in the MIDAS equation. In Serbia, there are still a limited number of business surveys and stock exchange data that might improve GDP nowcast, and nowcasting must rely on monthly series from the real sector of economy, not all of which have high correlation with GDP.

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Mirosljub Labus

was Full Professor of Economics at the Faculty of Law, University of Belgrade, until he retired in October 2015, and former Deputy Prime Minister of Serbia. He received BA in Law and PhD in Economics from the University of Belgrade. Professor Labus' current research is focused on dynamic macroeconomics, and economic analysis of antitrust cases. He has valuable experience in statistics and applied general equilibrium modelling (CGE and DSGE). He set up statistical journal *Economic Trend*, business survey *Market Barometer*, and served as editor of the *Annals of the Faculty of Law in Belgrade*. As Deputy Prime Minister, Mirosljub Labus was instrumental in negotiating Serbia's return to international financial institutions after a period of sanctions, settling the country's huge foreign debts, and promoting the SAA with the EU. After resigning from politics, he founded in 2007 consulting firm Belox Advisory Services. He was since 2010 a Senior Advisor to the *PricewaterhouseCoopers* in Belgrade.

Annex

Table 1A: Differences between provisional and final QNA estimates

	Real consumption			Nominal consumption		
	Q4Y15	Q1Y16	Q2Y16	Q4Y15	Q1Y16	Q2Y16
Q12014	-0.1%	0.1%	0.1%	-0.1%	0.0%	0.0%
Q22014	0.2%	0.3%	0.3%	0.2%	0.2%	0.2%
Q32014	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Q42014	-0.1%	-0.4%	-0.4%	-0.1%	-0.3%	-0.3%
Q12015	-1.1%	-0.9%	-0.9%	-1.2%	-1.1%	-1.1%
Q22015	-0.8%	-0.7%	-0.7%	-1.1%	-1.0%	-1.0%
Q32015	-1.0%	-0.9%	-0.9%	-1.3%	-1.2%	-1.2%
Q42015	-0.8%	-1.2%	-1.2%	-1.0%	-1.2%	-1.2%
Q12016		-1.1%	-0.9%		-1.5%	-1.3%
Q22016			-0.4%			-0.9%
Average	-0.47%	-0.53%	-0.50%	-0.58%	-0.67%	-0.68%

Table 4A: Differences between provisional and final QNA estimates

	Real export			Nominal export		
	Q4Y15	Q1Y16	Q2Y16	Q4Y15	Q1Y16	Q2Y16
Q12014	2.5%	0.5%	0.5%	-0.1%	-0.1%	-0.1%
Q22014	-0.2%	0.4%	0.4%	-0.1%	-0.1%	-0.1%
Q32014	-0.7%	-0.1%	-0.1%	0.0%	0.0%	0.0%
Q42014	-1.4%	-0.8%	-0.8%	0.2%	0.2%	0.2%
Q12015	-1.3%	-1.4%	-1.4%	0.4%	0.6%	0.6%
Q22015	-2.4%	-2.4%	-2.4%	0.2%	0.2%	0.2%
Q32015	-2.4%	-2.4%	-2.4%	0.5%	0.2%	0.2%
Q42015	-2.6%	-2.6%	-2.6%	0.5%	0.4%	0.4%
Q12016		-2.0%	-1.9%		0.7%	0.8%
Q22016			-3.3%			-0.7%
Average	-1.05%	-1.18%	-1.38%	0.20%	0.24%	0.16%

Table 2A: Differences between provisional and final QNA estimates

	Real investment			Nominal investment		
	Q4Y15	Q1Y16	Q2Y16	Q4Y15	Q1Y16	Q2Y16
Q12014	0.1%	0.9%	0.9%	-0.1%	0.7%	0.7%
Q22014	-0.4%	0.1%	0.1%	-2.1%	-1.5%	-1.5%
Q32014	-0.7%	-0.7%	-0.7%	0.0%	-0.1%	-0.1%
Q42014	1.0%	-0.1%	-0.1%	1.8%	0.8%	0.8%
Q12015	1.0%	1.8%	1.8%	-3.2%	1.2%	1.2%
Q22015	2.5%	2.8%	2.8%	0.4%	0.0%	0.0%
Q32015	2.3%	2.6%	2.6%	1.9%	1.2%	1.2%
Q42015	3.7%	2.6%	2.6%	2.9%	0.7%	0.7%
Q12016		2.7%	3.2%		2.8%	2.5%
Q22016			3.3%			0.6%
Average	1.18%	1.41%	1.63%	0.21%	0.66%	0.62%

Table 5A: Differences between provisional and final QNA estimates

	Real import			Nominal import		
	Q4Y15	Q1Y16	Q2Y16	Q4Y15	Q1Y16	Q2Y16
Q12014	3.4%	0.9%	0.9%	0.0%	0.0%	0.0%
Q22014	0.1%	0.6%	0.6%	0.0%	0.0%	0.0%
Q32014	-0.7%	0.0%	0.0%	0.0%	0.0%	0.0%
Q42014	-2.3%	-1.3%	-1.3%	0.0%	0.0%	0.0%
Q12015	0.5%	-2.6%	-2.6%	0.0%	-0.2%	-0.2%
Q22015	-4.6%	-3.6%	-3.6%	0.0%	0.2%	0.2%
Q32015	-4.9%	-4.1%	-4.1%	0.0%	-0.2%	-0.2%
Q42015	-5.2%	-4.1%	-4.1%	0.1%	0.2%	0.2%
Q12016		-2.8%	-2.8%		-0.2%	-0.2%
Q22016			-2.7%			-0.2%
Average	-1.73%	-1.89%	-1.96%	0.01%	-0.02%	-0.03%

Table 3A: Differences between provisional and final QNA estimates

	Real government consumption			Nominal government consumption		
	Q4Y15	Q1Y16	Q2Y16	Q4Y15	Q1Y16	Q2Y16
Q12014	-0.2%	0.0%	0.0%	-0.8%	-0.6%	-0.6%
Q22014	-0.1%	0.0%	0.0%	-0.6%	-0.4%	-0.4%
Q32014	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%
Q42014	0.2%	0.0%	0.0%	1.1%	0.8%	0.8%
Q12015	0.2%	0.4%	0.4%	1.8%	2.0%	2.0%
Q22015	0.3%	0.5%	0.5%	2.5%	2.6%	2.6%
Q32015	0.4%	0.4%	0.4%	3.0%	3.0%	3.0%
Q42015	0.3%	0.0%	0.0%	2.8%	2.7%	2.7%
Q12016		1.0%	1.0%		2.4%	2.1%
Q22016			1.0%			2.5%
Average	0.14%	0.24%	0.33%	1.25%	1.39%	1.47%