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Approved By
European Department

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POTENTIAL OUTPUT AND THE OUTPUT GAP IN RUSSIA

Estimating potential output in Russia is difficult because its economy is large and complex, in transition, and dependent on oil. First, Russia presents large territorial and sectoral heterogeneity. Second, structural issues are difficult to estimate in transition economies. Third, the energy sector dominates exports and GDP, making Russia vulnerable to large terms of trade shocks. This paper estimates potential output taking into account these challenges and using a variety of methodologies. Policy advice should also take into account the inherent uncertainty of output gap estimates.

A. Introduction

1. **Output gap is relevant for policy recommendations.** Output gaps' estimates are often at the core of macroeconomic stabilization policy discussions. Whether the economy is above or below full capacity should guide the appropriateness of consolidation or stimulus policies to smooth macroeconomic fluctuations. Potential output growth is also relevant to assess the cyclicality of macroeconomic policies.

2. **In practice, it is very hard to estimate potential output.** The main challenge is that potential output is not observable. A large variety of methods can be used, and it is complicated to assess which one is more reliable and accurate. For emerging open economies, the challenges are even bigger due to several elements. Large exogenous fluctuations and structural breaks often imply sizeable growth reversals. Implementation of structural reforms, sometimes over a prolonged period of time, adds an extra layer of complication. Hence, accurate identification of long run drivers, underlying structural -long term- growth is challenging.

3. **There are different methods to estimate potential output.** Statistical methods, econometric methods, and methods based on economic models are widely used in academic and policy circles. This paper focuses on statistical and model-based methods.[1] Estimations are conducted using HP filters, a production function, and Okun's law.

B. Pros, Cons, and Pitfalls when Estimating Potential Output

4. **Statistical methods are based on different statistical and "filtering" techniques.** Among these, there are univariate and multivariate filters. Univariate filters are usually simple and easy to estimate. Furthermore, they can be thought as a particular case of multivariate filters which are usually enhanced by equations capturing economic relationships (i.e., a Phillips curve).

[1] For econometric methods (SVARs) see Blanchard and Quah, (1989). Cooley and Dwyer (1998) observe that results from SVARs are sensitive to the identifying assumptions which cannot be tested.

5. **Univariate filters' simplicity makes them appealing, easy to interpret and communicate.** Hodrick and Prescott (1997), Baxter and King (1999), Christiano Fitzgerald (2003), Clark (1987), Marcet and Ravn (2004), are some examples. However, as appealing and easy to use as they are, they are not free of pitfalls.

6. **The Hodrick and Prescott (HP) filter has some conceptual shortcomings.** It assumes that fluctuations (driven mainly by total factor productivity, TFP) are symmetric around a smooth and relatively stable –though time varying– trend. Furthermore, it assumes that deviations from the trend are, on average, relatively small and corrected relatively fast. And, due to the particular algorithm used, it also suffers from the "end-point problem," which implies large revisions at the end of the sample due to forecasting uncertainty. The direct consequence of this limitation is that (sometimes large) revisions to output gap estimations may arise not only for the last year of the sample, but for many years in the past.

7. **"Band pass" filters capture cyclical fluctuations.** Baxter and King (BK), or Christiano and Fitzgerald (CF) methodologies discard very high and low frequency fluctuations to compute the business cycle. Computing the trend, as the difference between the observable GDP series and the cyclical component, is conceptually problematic as very high frequency (i.e., noise) would be included as part of the trend.

8. **Univariate filters rely on exogenous parameters.** Parameterizations are needed to determine the smoothness of a time varying trend and to define the amplitude of cyclical fluctuations. There are alternative ways to choose these parameters based on standard practice and data frequencies, but not necessarily based on specific evidence or economic intuition. The choice of a particular parameterization matters because it affects the size of booms and busts around the trend. There is usually no solid economic theory behind alternative parameterizations when using different filtering techniques.

9. **Multivariate filters enhance univariate filters.** Benes et. al. (2010), and Fuentes et. al. (2007) are examples of enhancing univariate filters, in order to explicitly capture observable economic relationships between relevant variables, and address the end-point problem of univariate filters.

10. **Multivariate filters have relatively good revision properties.** In some cases, multivariate filters can reduce the size of ex-post revisions, but they still share some of the conceptual shortcomings from univariate filters. For example, the HP filter is a particular case of the Kalman filter. Implicitly, even after enhanced by adding economic relationships, the underlying mechanics and assumptions of multivariate filters remain similar to the ones from univariate filters.[2] In the case

[2] Fuentes et. al. (2007) provide a good explanation of key parameters affecting the amplitude of the cycle around the trend. Orphanides & van Norden (2002) also point out that multivariate filters are not more reliable than their univariate counterparts.

of Russia, standard relationships such as a Phillips curve, or an IS curve are less stable than in other countries. This is partly due to the fact that Russia is a transition economy subject to (large and unanticipated) commodity prices fluctuations.

11. **Some methods combine economic theory with observable data.** The production function approach, widely used in academic and policy circles, relies on labor and capital inputs estimates. The basic assumption is that production can be modeled by a neoclassical production function which combines labor, capital, and total factor productivity (TFP). As intuitive as it is, this approach also exhibits a practical pitfall. In order to estimate potential GDP, estimates of trend employment and TFP are needed. Relying on univariate or multivariate filters to conduct these calculations poses the same problems as discussed above.

12. **Output gaps can be estimated based on unemployment gaps.** A less popular method, based on Okun's (1962) seminal paper, provides a very simple, yet appealing approach to compute potential output. It combines actual GDP and unemployment data with an assumption or estimation of the natural rate of unemployment (NAIRU). One drawback of this method, for emerging economies (and for Russia), is that Okun's law appears to be somewhat weaker (i.e., smaller Okun's coefficient), and less stable than in advanced economies.

13. **Uncertainty and (in)accuracy in measuring output gaps is well documented.** Orphanides and van Norden (2002, 2006), Cayen and Norden (2005), and Massimiliano and Musso (2011) show that output gap estimates are uncertain due to a number of reasons. In general, it is very hard to estimate the end-of-sample output trend, there is no broad consensus on which approach (among several alternative methods) should be adopted, and unobserved parameters may change over time due to structural reforms.

C. Potential Output and Output Gap Estimations for Russia

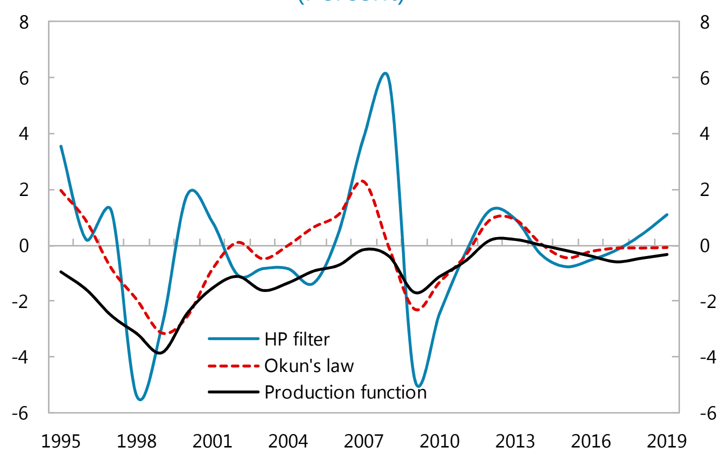
14. **Estimating potential output in Russia is more challenging than in other countries.** The lack of long time series, size and amount of ongoing structural reforms, and unanticipated (and often) large terms of trade shocks complicate identification of a stable long run trend. The size of the country necessarily entails heterogeneity across regions (diversity in terms of natural resources, skills in the labor force, trade linkages, demographic trends, and unemployment). Diversity across sectors, especially given the dominant role of energy is another obstacle. The lack of oil and non-oil GDP estimates prevents to isolate exogenous – terms of trade –fluctuations, hence blurring the estimates and making almost impossible to identify the drivers of domestic aggregate demand – and potential growth. Productivity measures may also be inaccurate, partly capturing exogenous fluctuations driven by commodity prices.

15. **Parameterizations and assumptions matter.** All methodologies discussed in this paper need assumptions and choices of parameters. In order to capture uncertainty arising from alternative methodologies, and assumptions on specific structural parameters or trends, it is useful to assess the sensitivity of different output gap estimates, under each method, to different parameterizations.

16. **Alternative methodologies yield different output gap point estimates.** Estimations based on a standard HP filter, a production function (PF) estimation, and Okun's law approach (OL) give different results. The HP filter captures well the 1998 and 2009 financial crisis, but at the cost of overestimating the 1999-2000 recovery as well as the 2006-2008 boom. This is mainly due to the "symmetry," and "fast corrections" assumptions described above. Both the PF and the OL approaches relying, at least partially, on observable data, present a different picture. They both track booms and busts more closely. The biggest difference is the way in which each of these methods characterizes the post 1998 crisis recovery, and the 2006-2008 boom.[3]

Figure 1. Output Gap

(Percent)



Source: IMF staff calculations.

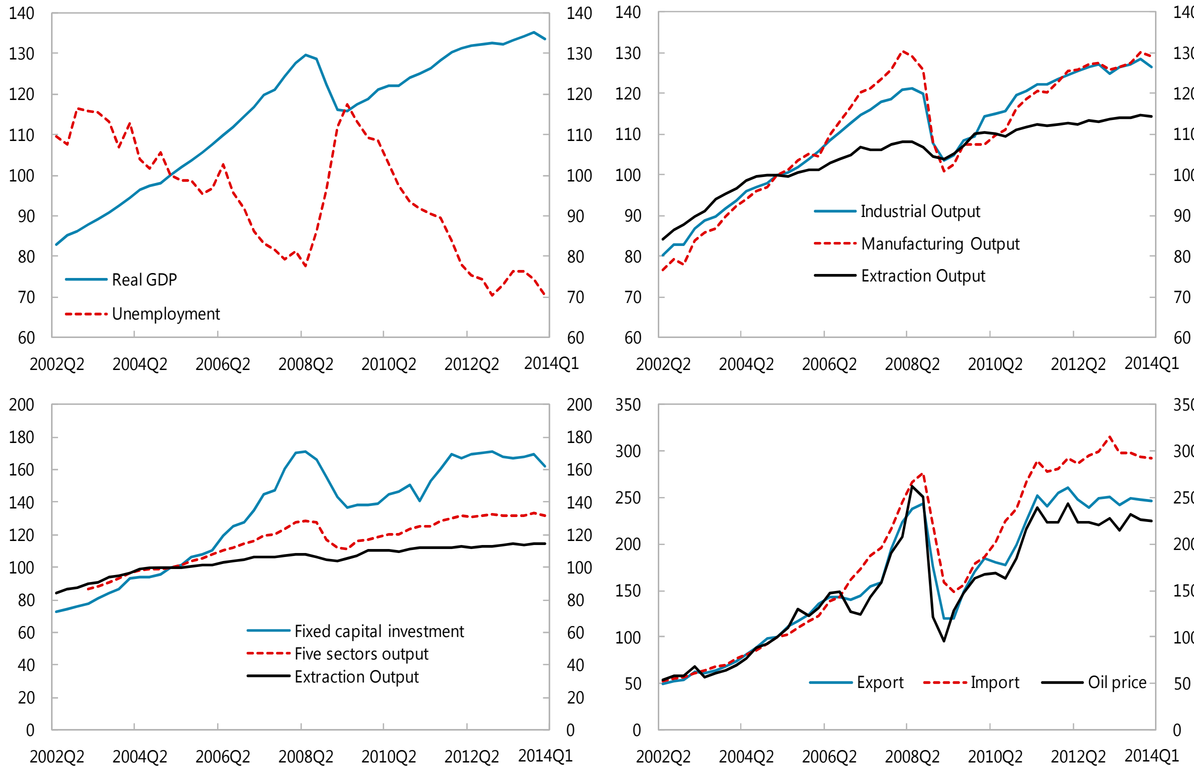
D. Observable Indicators and a Probabilistic Approach

17. **Capacity utilization and employment help assess which method is more realistic.** Relative to 2005, real GDP, industrial, and manufacturing output in 2013 seem to be at a slightly higher level than in 2008. The unemployment rate in 2013 was lower than its pre-crisis level. Furthermore, extraction output, a measure of the 5 most important economic sectors' output, and imports are at similar (if not higher) levels in 2013 and in 2008. Fixed capital investment and exports appear at the same level in 2013 as in 2008.

[3] Details on alternative assumptions and parameterizations for the production function, and Okun's law approach are provided in the appendix.

Figure 2. Real Sector Indicators

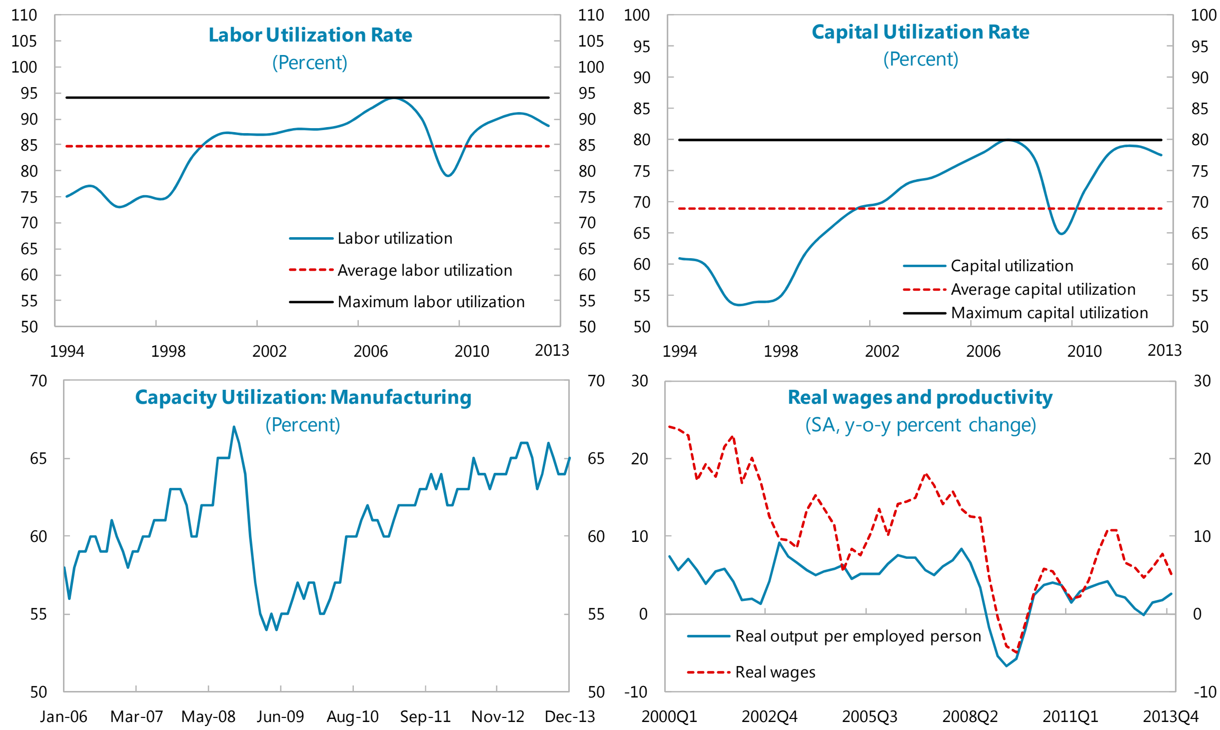
(Indices, 2005=100)



Sources: Haver Analytics; and IMF staff calculations.

18. **Capacity utilization measures give some indication of over (under)-heating.** Labor and capital capacity utilization measures display similar levels in 2008 and 2013. Manufacturing capacity utilization shows the same pattern. The relationship between real wages and productivity growth suggests more tension in the labor market in 2005-2008 than in 2012-2013.

Figure 3. Capacity Utilization and Labor Market Indicators



Sources: Haver Analytics; and IMF staff calculations.
Note: The concept of labor utilization can be interpreted as the ratio of actual hours worked to potential hours worked given the number of employees.

19. **The pre-Global Financial Crisis (GFC) "boom" might not have been such.** Based on observable evidence (as opposed to output gap estimates) the pre-GFC boom does not appear 6 times larger than the post-GFC recovery as suggested by the HP filter. Two possible interpretations emerge from the evidence. If there was an overheating of the Russian economy before the GFC, it may have been slightly larger than the post-GFC recovery, but probably not 6 times larger. An alternative interpretation is that the Russian economy reached full capacity in 2008, after i) a prolonged catch-up process, and ii) a long and persistent oil boom. Due to the sharp rebound in oil prices after the crisis, it went back to full capacity relatively quickly. At present, the Russian economy appears to be operating close to full capacity, amid weak investment, and low growth.

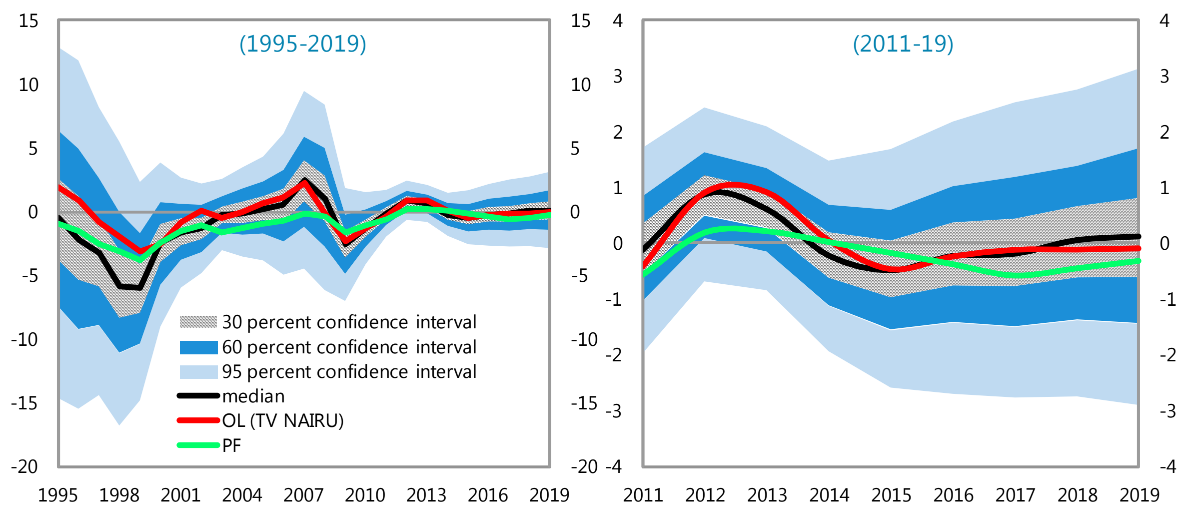
20. **A probabilistic approach highlights methodological uncertainty.** There are two main sources of uncertainty when computing potential output and output gaps—forecast uncertainty and methodological uncertainty. Forecast uncertainty appears because it is hard to predict size, timing, and nature of shocks in the future. Methodological uncertainty appears when, for a given forecast, it

is complicated to assess which methodology is more appropriate, or provides a more accurate description of reality.[4]

21. **Variations of three methods give a sense of how wide (narrow) is the range of estimates.** Based on three different methods (HP filter, PF, and OL), and alternative assumptions and parameterizations within each method, it is possible to compute point estimates for potential output and the output gap.[5] Building a distribution of point estimates enables to put confidence bands around the median and give a sense of methodological uncertainty. Then, the discussion can be cast in terms of the probability of the estimates to be within a particular range. The Russian economy appears to be close to full capacity, as the output gap is estimated to be (with 30 percent confidence) between 0.2 and 1 in 2013, and -0.6 and 0.2 in 2014.

Figure 4. Output Gap in Russia

(Percent)



Source: IMF staff calculations.

22. **The size of revisions is reduced when relying on a wide battery of methods.** One advantage of building a probability distribution for the output gap, and using the median as a point estimate is that it reduces the size of revisions. Changes to the median of the distribution are likely to remain small, especially if the number of statistical filters (multivariate and univariate, which are typically the ones subject to large revisions) is relatively small relative to other methods.

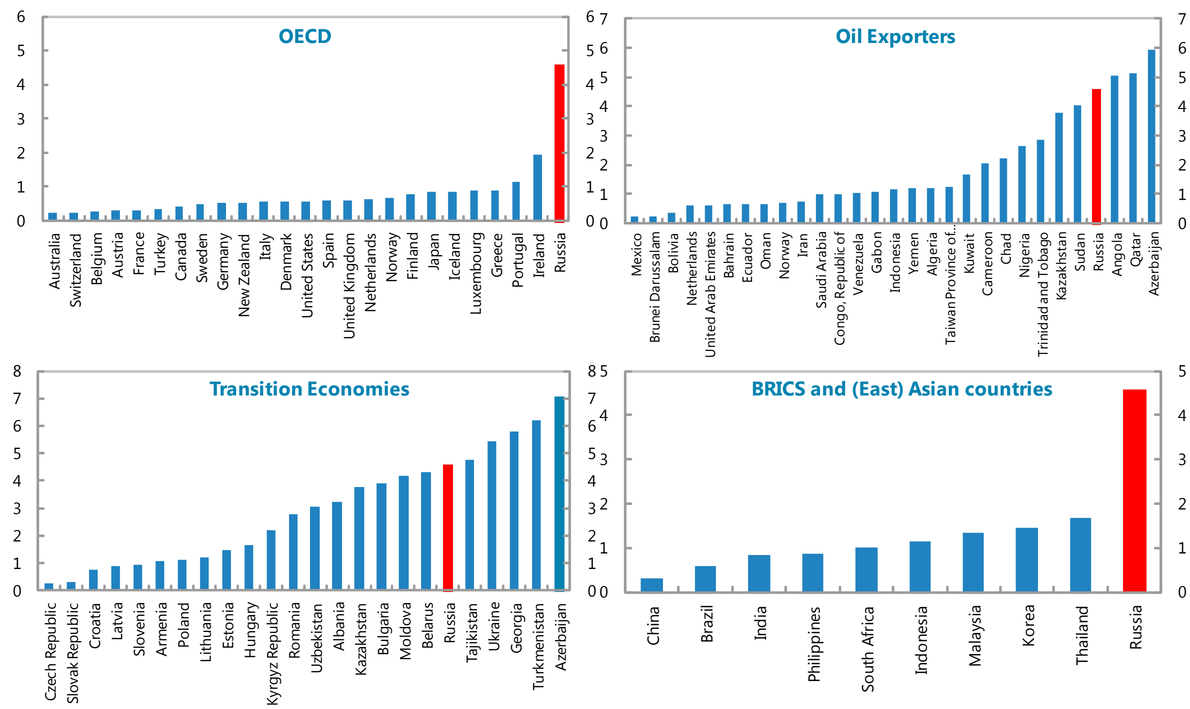
[4] For details on this, see Orphanides and van Norden (2002, 2006), Cayen and Norden (2005), and Massimiliano and Musso (2011).

[5] For details on each method, and different assumptions within and across methods, see appendix. OL (TV NAIRU) refers to "Okun law with time varying NAIRU".

23. **Trend growth in Russia is volatile.** Computing a time-varying trend using an HP filter for a sample of 24 advanced, 23 transition, 28 oil exporters and other 9 emerging economies, it is possible to see that Russia displays a very volatile trend. This is due to the fact that several structural reforms occurred during the first 8 years after the dissolution of the Soviet Union. In 1998 the economy suffered a severe financial crisis coupled with a sovereign default. After the recovery, Russia, and the world experienced the longest and possibly largest oil boom in recent history. As a result, given the short sample, and some extreme events (i.e., the transition from a centrally planned economy to a market economy, followed by a financial crisis and default, and an enormous oil boom), it is hard to think about structural, long term, 'normal times' growth in Russia.

Figure 5. Trend Volatility

(1990-2007)



Source: World Economic Outlook.

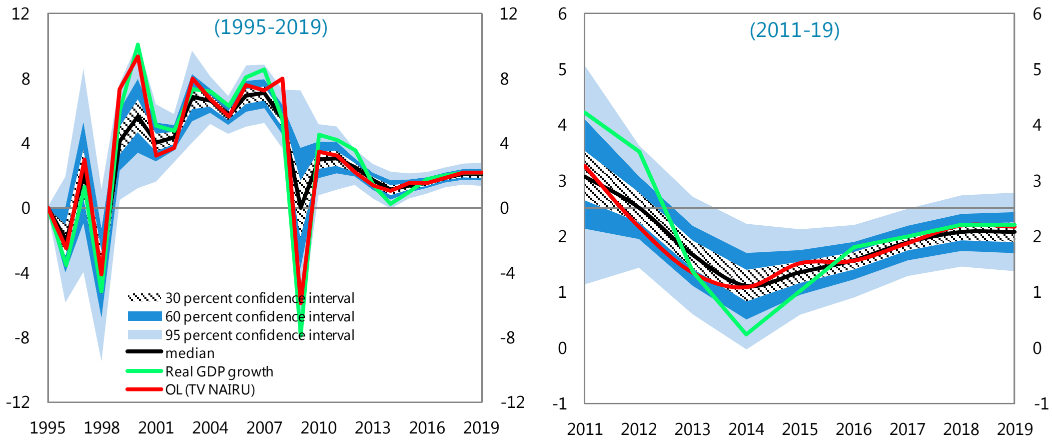
Note: Volatility is computed as the standard deviation (in percent) of the real GDP hp trend growth.

24. **It is difficult to pin down potential growth in Russia.** The inability to differentiate between oil and non-oil GDP poses significant challenges to identify potential growth. Intuitively, it is hard to think about negative potential growth rates. A possible explanation for this outcome is that potential growth rates are "contaminated" by fluctuations in oil GDP (which is affected by oil prices fluctuations), and possibly reversals in terms of trade, hence blurring the "true" (but

unobserved) underlying structural growth rate. A similar challenge arises when trying to decompose potential growth into capital, labor and TFP contributions.[6]

Figure 6. Potential Growth

(Percent)

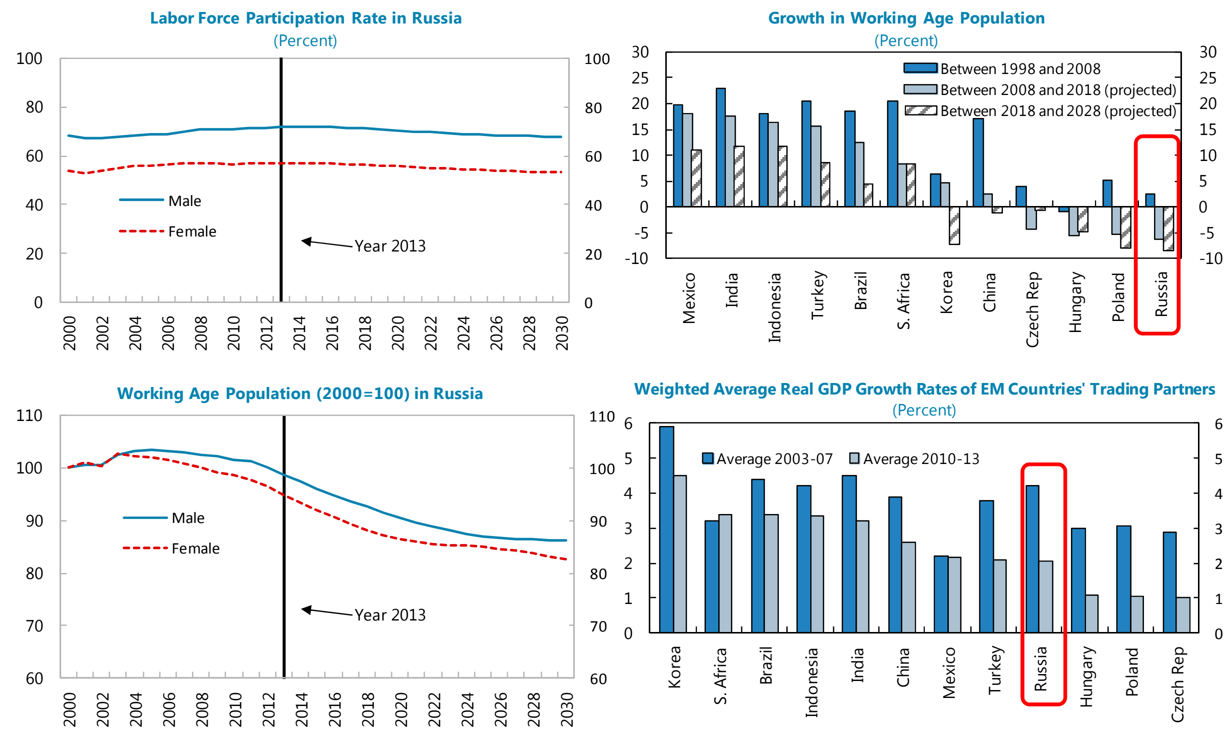


Source: IMF staff calculations.

25. **Estimating potential growth for Russia is challenging.** The decline in investment, and productivity, during the last 3 years, coupled with adverse demographics, and slower trading partners' growth, are a drag for actual and potential growth. Current projections for investment and working age population do not paint a bright picture. These facts highlight the need to speed up the implementation of structural reforms to boost productivity, as well as actual and potential growth.

[6] See appendix for an exposition of potential growth decomposition under alternative methods.

Figure 7. Population Dynamics and Trading Partner's Growth



Sources: International Labor Organization; and Credit Suisse.

E. Conclusion

26. **Russia's trend growth is volatile.** The transition from a centrally planned to a market economy started in 1991, hence time series are relatively short compared to other countries. The size and depth of structural reforms during the 1990's, the financial crisis and default in 1998, followed by the oil boom in the 2000's, and subsequent GFC, make identification of a stable "long run" growth trend a very hard task. Hence, it is complicated to pin down an accurate estimate of potential growth and the output gap.

27. **The output gap in Russia exhibits high uncertainty.** A sensible approach to compute potential output in Russia (and other emerging markets) should explicitly acknowledge, and highlight, the real and methodological challenges of conducting this exercise. The lack of oil and non-oil GDP estimates, short time series data, and high exposure to terms of trade shocks introduce a large degree of uncertainty. Consequently, a probabilistic approach should help interpreting point estimates with caution.

Appendix

This appendix provides a detailed description of the alternative methods used to compute potential output and the output gap for Russia. A list (and a brief description) of each method, and corresponding assumptions is provided below. A probability distribution of output gaps and potential growth is built based on variations of alternative methods.

In order to have a benchmark, potential output is computed using a standard HP filter, with smoothing parameter 1600.

A. Production function approach (PF)

This method is based on a standard neoclassical growth model. Output is obtained after combining three inputs in a production function. Labor, physical capital and total factor productivity (TFP).

Real GDP is defined as: $Y_t = A_t K_t^{\alpha} L_t^{1-\alpha}$.

Potential GDP is defined as: $Y_t^* = A_t^* \left(K_t^*\right)^{\alpha} \left(L_t^*\right)^{1-\alpha}$.

The output gap is: $OG_t = \frac{Y_t - Y_t^*}{Y_t^*} * 100$.

Different assumptions can be used to calculate the "structural/potential" levels of capital, labor and TFP. A standard practice in the literature is to use an HP filter to compute the trend of labor and TFP and assume that there is no (or very little) cyclical movements in the stock of capital. A different alternative is to use capacity utilization shares as in Oomes and Dynnikova (2005), where both labor and physical capital inputs are adjusted by its corresponding capacity utilization shares. Another possibility is to build the potential level of employment based on econometric estimations of the natural rate of unemployment (NAIRU).

Five alternatives to estimate the production function

PF 1. Potential levels of labor, capital, and TFP are computed using an HP filter.
PF 2. Same as in PF1, but assuming that most fluctuations in TFP are cyclical.
PF 3. Same as in PF1, but assuming almost no cyclical fluctuations in TFP.
PF 4. Same as in PF1, but assuming that most fluctuations in employment are cyclical.
PF 5. Same as in PF1, but assuming almost no cyclical fluctuations in employment.

There is some merit in considering different cyclicality assumptions to reflect the nature (permanent vs. transitory) of labor market and productivity shocks/developments.

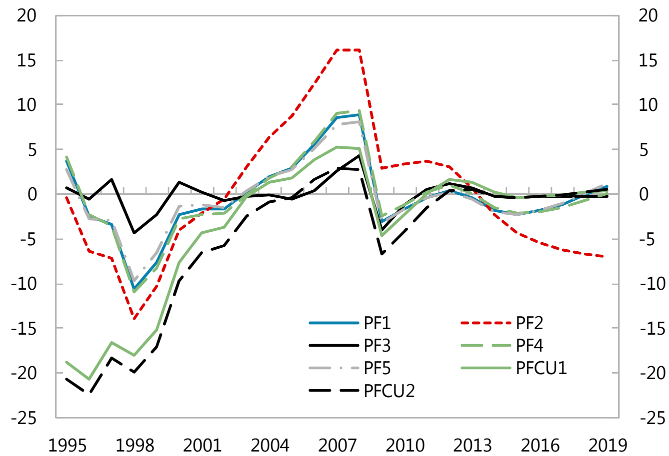
Two alternatives to estimate the production function with capacity utilization shares

PFCU1. Capital and labor are adjusted by capacity utilization shares, and potential levels of capital and labor are adjusted by a constant (structural) capacity utilization shares.

In this case "structural" capacity utilization shares are assumed to be equal to the average capacity utilization share between 2002 and 2007. A small cyclical component (using an HP filter) in TFP is also assumed.
PFCU2. Same as PFCU1. In this case "structural" capacity utilization shares are assumed to be equal to the average capacity utilization share between 2010 and 2012.

Figure A1. Output Gap Using the Production Function Approach

(Percent)



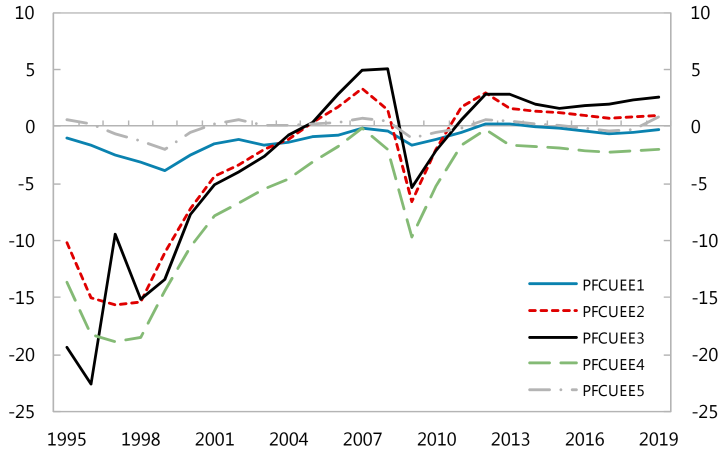
Source: IMF staff calculations.

Five alternatives to compute the production function with capacity utilization shares, and estimated employment

Using this approach, total employment is computed as the product of total working age population, labor force participation and [1- the unemployment rate].
PFCUEE1. Capital is adjusted for capacity utilization. Trend capital is not adjusted for "trend" capacity utilization and is assumed to be equal to the actual (adjusted) capital stock. The potential level of total employment is computed as the product of three elements: total working age population, labor force participation, and (1- NAIRU). The NAIRU is estimated using a Kalman filter based on 2 equations: an equation for unemployment, and a Phillips curve.
Neither labor (employment), nor its trend, is adjusted for capacity utilization.
PFCUEE2. Same as PFCUEE1, except for: Trend capital is adjusted also assuming a fixed capacity utilization rate (average 2000-2008). Trend TFP is equal to actual TFP, assuming no cyclical component in TFP.
PFCUEE3. Same as PFCUEE2, but assuming a small cyclical component in TFP.
FCUEE4. Same as PFCUEE1, except for: Trend capital is adjusted assuming a fixed capacity utilization rate (max 1994-2012).
PFCUEE5. Same as PFCUEE1, except for: Capital is unadjusted for capacity utilization. The NAIRU is estimated using an HP filter with smoothing parameter equal to 100.

Figure A2. Production Function with Capacity Utilization Shares and Estimated Employment

(Percent)



Source: IMF staff calculations.

B. Okun's law (OL)

This approach is based on the following formula:[1]

$$Y_t^* = Y_t\left[1 + 0.011\left(U_t - U_t^*\right)\right]$$

Where Y_t is actual real GDP, U_t is the actual unemployment rate, 0.011 is the estimated Okun's coefficient for Russia, U_t^* is the NAIRU, and Y_t^* is potential output.

When the unemployment rate coincides with the NAIRU the output gap is zero, and when the unemployment rate exceeds the NAIRU by 1 percent, the output gap is around -1 (and vice versa).

Seven alternatives for the NAIRU

OL1. Assuming a fixed NAIRU for the full sample.
OL2. Assuming a time varying NAIRU, computed using an HP filter (with smoothing parameter equal to 1600).
OL3. Assuming a time varying NAIRU, computed using an HP filter (with smoothing parameter equal to 6).
OL4. Assuming a time varying NAIRU, computed using a 1 year moving average of the actual unemployment rate.
OL5. Assuming a time varying NAIRU, computed using a 2 year moving average of the actual unemployment rate.

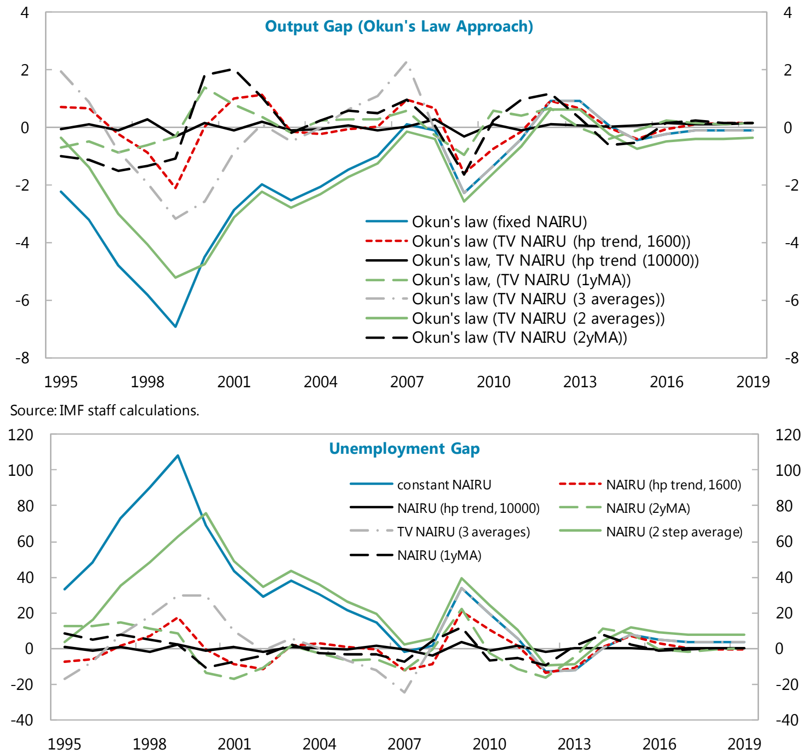
[1] Okun coefficient is derived from a standard OLS regression, similar to Okun's 1962. The dependent variable is the change in the unemployment rate, and the explanatory variables are: contemporaneous real GDP growth rate, lags 1 and 2 of real GDP growth, and lags 1 and 2 of the change in the unemployment rate.

OL6. Assuming a time varying NAIRU, computed as the average of the unemployment rate for two different periods. So, the NAIRU is assumed to be constant during the period 1995 to 1999, at 8 percent, and constant during the period 2000 to 2019, at 6 percent.

OL7. Assuming a time varying NAIRU, computed as the average of the unemployment rate for three different periods. So, the NAIRU is assumed to be constant during the period 1995 to 1999, at 10.1, constant during the period 2000-2007, at 8.2, and constant during the period 2008-2019, at 6.3.

Figure A3. Output Gap and Unemployment Gap

(Percent)



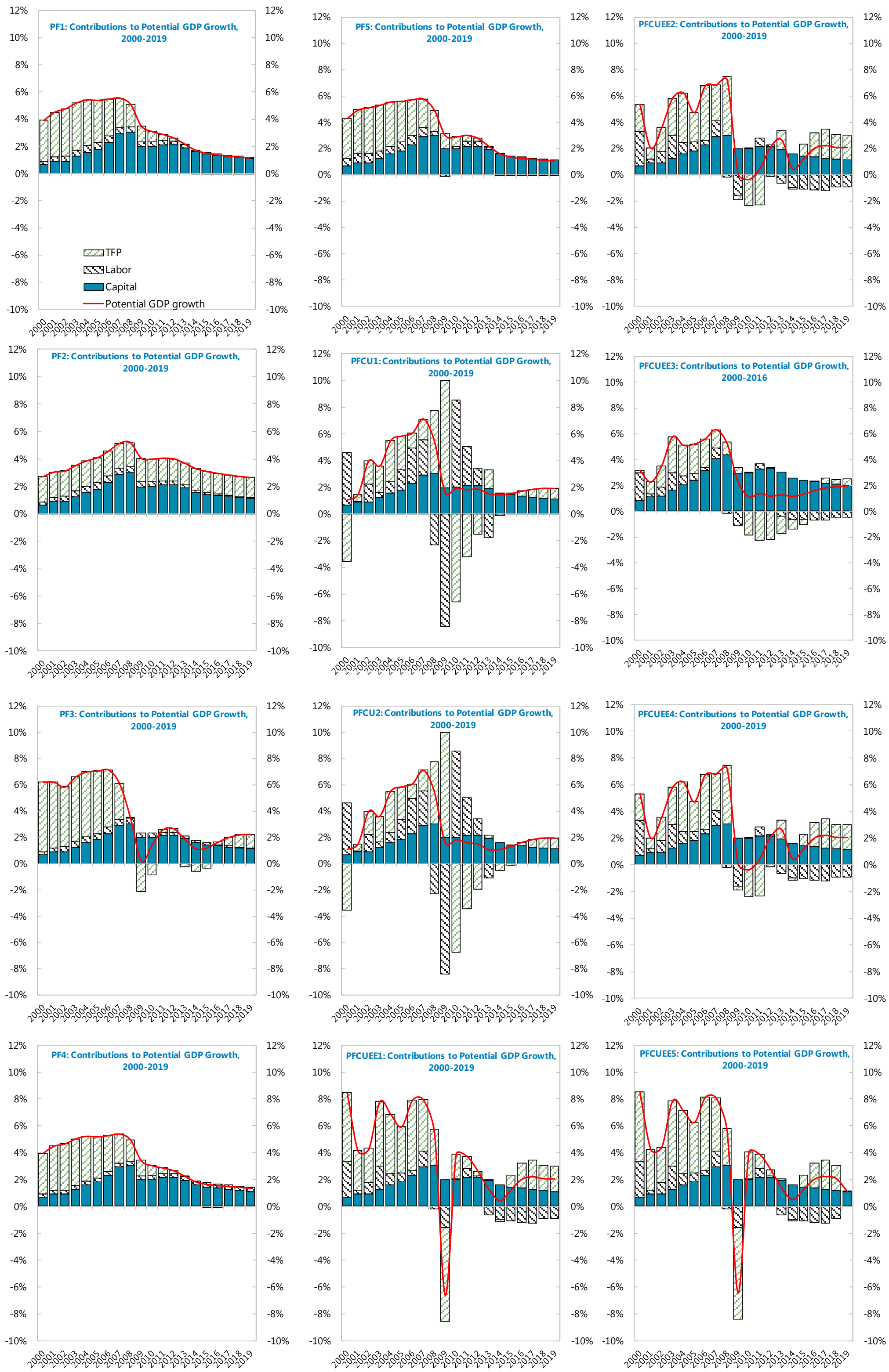
Source: IMF staff calculations.

Source: IMF staff calculations.

C. Probability Distribution for the Output Gap

For each point in time (i.e., year) 20 different estimates for the output gap are available. Assuming that these estimates are normally distributed, it is possible to draw 1 of the estimates, and repeat the experiment 3000 times. This provides a probability distribution for the output gap. For robustness, it is also possible to assume that the set of point estimates is uniformly distributed, so they all have the same probability to be selected in a random draw. One advantage of assuming a normal distribution is that the values closer to the average, and/or the median of the distribution are more likely to be selected in a random draw. Differences between using a normal distribution and a uniform distribution are immaterial.

Figure A4. Contributions to Potential Growth



Source: IMF staff calculations.

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