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GDP Growth in Russia: Different Capital Stock Series and the Terms of Trade

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Abstract

There are different academic assessments as to what lies behind Russia's GDP growth: total factor productivity or fixed capital investments. Studies that reconstruct capital stocks for Russia using gross fixed capital formation and the perpetual inventory method tend to lean towards the former answer, while capital services datasets that have recently been made available lean towards the latter. We reconstruct a capital stock series for Russia for 1995–2013, and compare the results to two capital services time series using the Solow growth model. We also take into account terms of trade developments that have lent strong support to the economy. Finally, we use these tools to construct four possible scenarios for Russia's economic growth up until 2030.

Tiivistelmä

Taloustieteellisessä kirjallisuudessa on erilaisia arvioita siitä, onko Venäjän bkt:n kasvun taustalla kokonaistuottavuuden vai kiinteiden investointien kehitys. Tutkimukset, joissa rakennetaan pääomakanta käyttämällä kiinteiden bruttoinvestointien aikasarjoja ja PIM-menetelmää, päätyvät edelliseen selitykseen, kun taas viime aikoina valmistuneet pääomakannan palveluvirtatarkastelut päätyvät jälkimmäiseen selitykseen. Tässä tutkimuksessa rakennetaan Venäjälle pääomakantasarja vuosille 1995–2013 ja verrataan tuloksia kahteen palveluvirtatarkasteluun käyttäen Solowin kasvumallia. Otamme myös huomioon vaihtosuhteen, joka on selvästi tukenut talouskehitystä. Lopuksi laadimme näillä työkaluilla Venäjälle neljä mahdollista tulevaisuuden kasvuskenaariota vuoteen 2030 asti.

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1 Introduction

The driving factors behind economic development in Russia differ from those in other former transition countries in Central and Eastern Europe or China. In Europe, institutional and market-oriented reforms pushed forward by these countries' EU membership have increased competition and gross fixed capital formation, and induced an influx of foreign direct investment, that have transformed the economies. In China, market liberalisation has led to a huge increase in gross fixed capital formation, both domestic and foreign, as well as large internal labour movements from the countryside to cities thus resulting in over a quarter of a century of rapid growth.

Meanwhile in Russia, the massive windfall created by the exceptional rise in the world market prices of energy commodities has been a huge capital injection into the economy. On the other hand, economic reforms are lagging behind the development in the new EU countries. According to EBRD (2013), Russia's economic institutions are under-developed in international comparison relative to its GDP per capita level. OECD (2014) suggests improving the business climate to boost Russia's economic growth. Recommended means include, among other things, reducing corruption and barriers to trade and investment, as well as improving the rule of law, and investing in transport infrastructure.

We analyse the structure of Russia's growth from the 1990s to the present and make an assessment of potential future developments. There are considerable factors that burden the prospects: still relatively slow progress in reforms, an increasingly authoritarian political regime that views foreign relations with hostility, dismal population projections, continuing low investment relative to GDP, resource-intensiveness of the economy, and uncertainty over future export price developments that have so favoured Russia in the past. We will not discuss the repercussions of the crisis in Ukraine that started in 2014 for Russia's economic development. However, a long-lasting weakening of economic relations with the outside world would have a further negative impact on the prospects.

We start by reviewing relevant literature. Then we calculate a time series for Russia's capital stock in Section 3 and compare it with two freely available time series based on capital services. In Section 4 we discuss how the development in the terms of trade has affected GDP and welfare measured by real gross domestic income, or 'command GDP'. In Section 5 we analyse the historical development of Russia's GDP using the three capital stock series, and in Section 6 we make GDP projections up to 2030. Section 7 concludes.

Russia's GDP growth was very robust for a decade after 1998. Growth was supported by a low GDP-per-capita starting level, market-oriented reforms that took place largely in the 1990s (see EBRD 2013), initially low capacity utilisation rates, an increase in gross fixed capital formation, and very favourable export price developments. The windfall gains from the terms of trade improvement led to a surge in investment and consumer spending as well as supported public finances thus allowing for a low tax rate, among other things.

Terms-of-trade developments have had a strong influence on gross fixed capital formation which has then supported GDP growth. We estimate that GDP growth depended more on TFP growth and less on capital developments in 1995–2003 and vice versa in 2003–2013. There was more room for catching up in the first period, while the surge in the terms of trade induced robust investment activity in the latter period.

Unless economic reforms are introduced we expect Russia's GDP developments to continue to depend on its volatile terms of trade. However, the commodity boom is unlikely to continue the way it supported Russia between 1998 and 2008. With less room for catching up and other negative factors referred to above, our lowest scenario of average GDP growth over 2013–2030 while holding oil prices at their 2013 level is 1.7 per cent. If oil prices do not recover from their collapse in the

latter half of 2014, ceteris paribus, the scenarios are overly optimistic. Furthermore, reforms can also be negative, which would also lower the growth outlook.

2 Research questions and literature

TFP or Capital Deepening?

Different studies reach very different conclusions concerning the origins of Russia's GDP growth. The question is to what extent growth is due to total factor productivity (TFP) advances relative to capital deepening. Data on the labour input also vary, but the differences and importance of this are smaller than those of capital and TFP.

There are major problems with Russia when estimating its initial capital stock. The quality of price data (e.g. prices on investments), among other data issues, is low especially during the early transition period (see e.g. Voskoboynikov 2012). According to the World Development Indicators by the World Bank, GDP collapsed by 40 per cent between 1990 and 1996. Meanwhile, the volume of gross fixed capital formation plummeted by 80 per cent.

When Russia's capital stock has been recreated using the perpetual inventory method (PIM), the estimated importance of capital in long-term GDP growth has become very small, even negative. As a mirror image in the results, TFP has surfaced as the main factor behind growth. For example, Rapacki and Próchniak (2009) and Brock (2010) estimate that the contribution of TFP to GDP growth just exceeded 100 per cent before 2003. Michaelides and Milios (2009) reach even more radical results with average capital growth rate –12.5 per cent and TFP growth rate 15.0 per cent over 1994–2006. See Table 1 for a short review of recent literature.

There have been attempts to take into account the special circumstances in Russia after transition started and led to the dramatic decline in output. Adjusting the capital stock to capacity utilisation is used in a number of studies. As capacity utilisation has risen after the 1990s, the (utilised) capital stock has increased more than mere gross fixed capital formation would indicate.

Some of the GDP growth can undoubtedly be attributed to initially low levels of capacity utilisation, both of capital and labour. The industrial capital capacity utilisation rate was 54 per cent in 1996 and 80 per cent in 2012.[1] Meanwhile, the employment rate increased from a low of 58 per cent in 1998 to 71 per cent in 2013. Higher input utilisation rates have supported GDP growth. Consequently, future catching up will require more fixed investments than it used to earlier when idle capacity was available.

In the studies by Kuboniwa (2011) and Gray *et al.* (2012), the contribution of TFP to GDP growth declines to less than 70 per cent after they adjust the capital stock to capacity utilisation. The rise in the capacity utilisation rates is partly due to redeployment of spare capacity and partly due to scrapping of old capacity from the recorded capital stock.

However, Gray *et al.* (2012) argue that the TFP contribution is thus still very high. They argue that several possibilities may contribute to an overestimation of TFP growth: 1) there could be measurement problems in estimating capital stock and investment, 2) the capacity utilisation data may not reflect the actual trend of more intense use of capital accurately, and 3) an explicit consideration of resource reallocation and increasing returns to scale would reduce the TFP contribution further.

Another way has been used by Izyumov and Vahaly (2008) who adjust the early-1990s capital stock down. The reason for this is that a sizeable proportion of the Soviet capital stock was not of market-quality level. They divided Russia's capital stock into 'old', market-worthy Soviet capital,

[1] Data from Kuboniwa (2011) for 1995–2009 and from World Bank (2013) for 2010–2012.

and 'new', post-reform capital. They argue that 30 per cent of the capital stock in the beginning of economic transition was obsolete. However, their result still shows that TFP was by far the main driver of GDP growth in 1995–2005.

Table 1 A review of studies and databases on Russia's economic growth

	Years	Capital growth rate	TFP growth rate	TFP contribution to GDP growth	Notes
Studies					
Izyumov and Vahaly (2008)	1995–2005	–1.1%	4.1%	..	Market-quality capital stock
Michaelides and Milios (2009)	1994–2006	–12.5%	15.0%	..	Capacity utilisation; capital stock
Rapacki and Próchniak (2009)	1993–2003	..	0.6%	103%	Capital stock
Brock (2010)	1995–2003	–1.5%	11.0%	104%	Capital stock
Kuboniwa (2011)	1995–2010	4.0%	..	69%	Capacity utilisation; capital stock
Gray et al. (2012)	2001–2011	..	..	68%	Capacity utilisation; capital stock
Berlemann and Wesselhöft (2012)	1991–2010	Almost –1%	..	..	Capital stock
Timmer and Voskoboynikov (2014)	1995–2008	2.9%	2.6%	..	Capital services
Databases					
Penn World Tables 8.0 (2013)	1995–2011	0.3%	3.2%	..	Capital stock
World KLEMS Basic Tables, July 2013	1995–2009	3.6%	1.6%	..	Capital services
Conference Board Total Economy Database (TED) (2014)	1995–2012	0.5%	2.9%	..	Capital services

Note: See Izyumov and Vahaly (2008) for earlier research.

Are the official gross investment statistics and calculations based upon them giving us the right picture of capital stock developments and therefore of TFP growth in Russia? We refer to two recent TFP estimates that are based on capital services rather than capital stocks. These datasets are the Conference Board Total Economy Database (TED)[2] and World KLEMS Basic Tables, the July 2013 release. Especially the latter offers a very different picture, one that shows quite robust capital services developments and therefore much more moderate TFP growth.

According to Timmer and Voskoboynikov (2013), the input of capital services – especially of ICT services – has been underestimated even if the rise in capacity utilisation is taken into account[3] and, therefore, TFP growth has been much slower than what most research indicates. According to Voskoboynikov and Solanko (2014), who use the KLEMS database, there were two drivers of economic growth in Russia in 1995–2008: the extended oil and gas sector, and high-skill-intensive services (and high-skill-intensive goods to a lesser extent). Growth in the energy sector was due to a rise in capital inputs, i.e. factor movements as Easterly *et al.* (1993) proposed. Meanwhile growth in high-skill-intensive services was due to a rapid rise in TFP. This latter may be thanks to a very low initial TFP level in a transition economy and the influx of financial wealth following the large current account surpluses.

[2] Growth Accounting and Total Factor Productivity Country Details, 1990-2014.

[3] According to Timmer and Voskoboynikov (2013), 'The old industrial classification […] had been introduced in the period of the planned economy and was not consistent with any international classification schemes. It was supplanted by a new classification in 2003, but Rosstat did not revise pre−2002 industry-level series in the new NAS classification scheme.'

Help from Terms of Trade Developments

After the late 1990s, the world market prices of energy commodities have risen spectacularly. Since these are Russia's principal exports, the country's terms of trade developments have been very favourable. However, the terms of trade are a price development and as such do not directly affect real GDP. Do they matter then?

According to Diewert and Morrison (1986), a rise in the terms of trade is similar to a rise in TFP because it makes it possible for a country to increase net output for a given volume of domestic inputs. For a given level of export volume, imports can be raised without deterioration in international competitiveness. Consequently, a rise in the terms of trade increases welfare (Kohli 2004; Basu, Pascali and Schiantarelli 2013).

Fox and Kohli (1998) argue that it is not appropriate to measure technological progress with Solow residuals in the case of an open economy that faces terms-of-trade shocks. They use labour, capital, terms of trade, technology and domestic prices to explain developments in Australia's *nominal* GDP. According to their results, the terms of trade have affected GDP growth.

Barro (2001) analyses the growth rate of real per capita GDP in around one hundred countries with the terms of trade as an independent variable. He concludes that a rise in the terms of trade enhances economic growth. According to Bleaney and Greenaway (2001), growth and investment have been higher in Sub-Saharan Africa when the terms of trade have been favourable. MacDonald (2010) analyses real domestic income in OECD countries. Among other things he estimates the impact from trading gains (terms of trade and real exchange rate developments) on consumption and investment, and finds that the effects are positive.

Meanwhile, Miller and Upadhyay (2002) estimate TFP with, among other things, the terms of trade. In a group of 83 countries its coefficient is statistically insignificant, except for middle-income countries for which it is positive and statistically very significant. Russia was not included in the analysis. The study covers the years 1960–1989 and does not include the then socialist countries.

Wong (2010) analyses economic growth and the terms of trade in Japan and South Korea[4] using a production function augmented with the terms of trade and financial development. He uses the Johansen co-integration method to examine the long-run relationship between the two variables. According to his results, an increase in the terms of trade leads to an increase in economic growth. Wong also finds that an increase in terms of trade volatility leads to a decrease in economic growth. Terms of trade shocks have also been found to increase GDP volatility, see e.g. Easterly *et al.* (1993), Becker and Mauro (2006), and Kehoe and Ruhl (2008).

Feenstra, Mandel, Reinsdorf and Slaughter (2013) build on the GDP function approach of Diewert and Morrison (1986) to analyse US productivity growth after 1995. They conclude that approximately 20 per cent of the speed-up in productivity growth consisted of gains in the terms of trade and tariff reductions.

We argue that the improvement in the terms of trade has been a major factor behind investment activity in Russia not just in the sectors directly involved in the exports of primary products but also in services sectors following a rise in incomes, investment and consumption. Increasing purchasing power has supported retail trade and other private services, residential and business construction and business services, as well as public consumption and investment.

[4] The impact of the terms of trade on GDP growth in South Korea is also analysed by Kohli and Werner (1998).

3 Calculating the Capital Stock

Real GDP growth can be decomposed into growth in the volume of inputs, i.e. labour and capital. Growth thus unaccounted for is the change in TFP. Accordingly, we start with the basic constant-returns-to-scale Cobb-Douglas production function

$$Y = AK^{\alpha}L^{1-\alpha}, \tag{1}$$

where Y is GDP, A is total factor productivity, K is the capital stock, L is labour input given by total employment, and $0 < \alpha < 1$ is the elasticity of output with respect to capital. Taking logs and differentiating we get

$$\Delta y = \Delta a + \alpha \Delta k + (1-\alpha)\Delta l, \tag{2}$$

where y is the natural logarithm of GDP and $\Delta y = \ln(y_t) - \ln(y_{t-1})$, and accordingly for the other variables. We set $\alpha = 0.4$.[5]

We start by reconstructing a capital stock series for Russia. Following OECD (2009, p. 222), we estimate the initial capital stock K_0 using

$$K_0 = \frac{I_0}{\delta + \theta}, \tag{3}$$

where I_0 is gross fixed capital formation in the first year, δ is the depreciation rate of capital set at 0.05,[6] and θ is the long-run growth rate of GDP (or of investment). We will use the average GDP growth rate in 1993–2013 – instead of investment growth – to determine θ.[7] Capital stock series is reconstructed using PIM:

$$K_{t+1} = (1-\delta)K_t + I_t. \tag{4}$$

But what year should the 'initial' year be? If we set the initial year very early in the 1990s we get a very large initial capital stock. Setting the initial year to 1991 will result in a capital stock that is 19 per cent lower than if we use 1990 as the initial year. Year 1992 will further lower the initial capital stock by 48 per cent and year 1993 by another 31 per cent. We stop here and have chosen 1993 as the initial year on the basis of the resulting capital stock, its ensuing development based on PIM and in comparison with other estimates in the literature.

We do not take into account the rising capacity utilisation rate as has been done in a number of other studies (see the discussion above), nor will we take into account a correction to outdated Soviet-era capital as Izyumov and Vahaly (2008) have done. Our initial capital stock has been pushed down to the extent that the latter has been taken into account implicitly. Still, Izyumov and Vahaly's estimate of Russia's capital-to-GDP ratio is actually lower than ours.

Our estimate of the development of Russia's capital ratio (K/Y) is shown as a line in Figure 1 in fixed prices along with other estimates found in the literature. Our estimate is on the lower side compared with other capital stock estimates, albeit variation is considerable. Other estimates are shown in the graph with numbered dots and the sources are listed below in the 'Note'.

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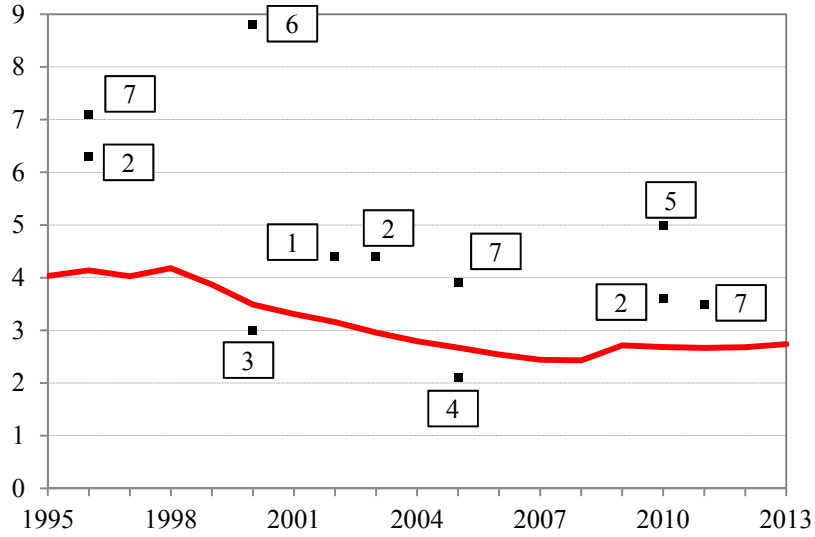
[5] Values used for α in other studies on Russia include: 0.35 in IMF (2002); 0.39 in Michaelides and Milios (2009); 0.4 in Izyumov and Vahaly (2008) and Brock (2010); and 0.5 in Gray *et al.* (2012) and Oomes and Dynnikova (2006). In the Penn World Table, Version 8.0, the share is on average 0.41 in 1995–2011. Voskoboynikov (2012) calculates that in 1995–2009 average α was 0.425 including shadow wages and corrected for the self-employed. In the KLEMS database, average α is 0.45 declining from 0.49 in 1995 to 0.36 in 2009.

[6] Values used for δ in other studies on Russia include: 0.018 in Kuboniwa (2011); 0.033 in Feenstra, Inklaar and Timmer (2013) and the Penn World Tables (Ver. 8.0); 0.04 in IMF (2002); and 0.05 in World Bank (2006), Izyumov and Vahaly (2008), and Gray *et al.* (2012).

[7] This does not make a big difference. The average growth rate of GDP over 1993–2013 was 2.3 per cent and that of gross fixed capital formation was 1.9 per cent.

Next we will compare our capital stock series with the TED and KLEMS data that use capital services. The KLEMS data for 1995–2009 have readily-available time series for TFP, capital services and total hours worked in Russia. The database does not show the elasticity of output with respect to capital explicitly, but we calculate from labour and capital compensation that it was on average 0.45. In fact, it declines from 0.49 in 1995 to a rather low 0.36 in 2009. The Conference Board Total Economy Database (TED) gives us an estimated TFP growth rate and total hours worked.[8] The elasticity of output with respect to capital is 0.5. Using these data and known changes in the GDP we can calculate the underlying changes in the stocks of total capital services in both databases.

Figure 1 Estimated capital ratio (*K*/*Y*) in this study and other sources in the literature



Note: (1) Kuboniwa (2011); (2) Feenstra, Inklaar and Timmer (2013), and the Penn World Tables, Version 8.0 (2013); (3) IMF (2002); (4) Izyumov and Vahaly (2008); (5) Berlemann and Wesselhöft (2012); (6) World Bank (2006); (7) Federal Reserve Bank of St. Louis (http://research.stlouisfed.org/fred2/graph/?g=sGO#).
Sources: World Bank; own estimations; (1) – (7) as listed in 'Note'.

Table 2 shows average growth rates in different time periods. We have used 2003 as a dividing line because of more rapid terms of trade developments after this year. In the text, we will discuss only the 1995–2009 period, shown in the last column, because here we have data from all three sources.

The average TFP growth rate in 1995–2009 in TED is 2.8 per cent, while our own estimate is 3.0. The KLEMS database figure is just 1.6 per cent. On the other hand, the average rise in capital stock calculated as a residual from the KLEMS dataset is very fast at 4.8 per cent annually, and much lower than this in TED, just 0.6 per cent. Our own estimate of the growth rate of the capital stock is 0.8 per cent, i.e. very close to the TED result. The differences to KLEMS are thus quite large.

Figure 2 shows how the three time series of capital stocks and TFP have developed after 1995. The data are presented in natural logarithms with 1995 = ln(100) so that we can visually detect any larger changes in growth rates. Note that we do not infer that the underlying capital stocks would have been the same in 1995. Comparing our capital stock series and the TED time series for capital services we find that the latter declines more but then grows very rapidly between 2004 and 2009 before levelling off completely.

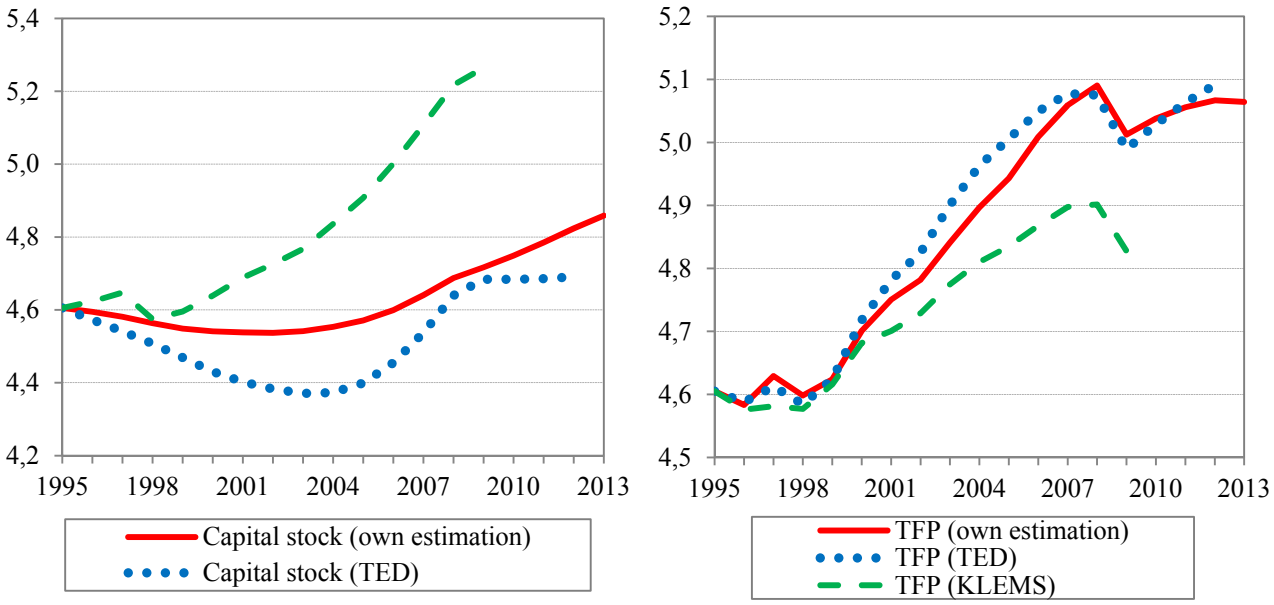
[8] According to TED, total hours worked in Russia was 136.8 billion in 2009, while the figure in KLEMS is 145.4 billion. Furthermore, the TED time series rises by 18.4 per cent between 1995 and 2009, while the KLEMS hours-worked data only rises by 0.5 per cent. The total employment data that we use in our own calculation grew by 9.7 per cent.

Table 2 Average annual growth rates, %

	1995-2003	2003-2012	1995-2012	1995-2009
GDP growth	3.1	4.3	3.8	3.7
TFP (own estimation)	3.0	2.3	2.8	3.0
TFP (TED)	3.8	2.1	2.9	2.8
TFP (KLEMS)	2.1	..	..	1.6
K (own estimation)	–0.8	3.2	1.3	0.8
K (TED)	–2.9	3.6	0.5	0.6
K (KLEMS)	2.1	..	..	4.8
Employment	0.8	0.8	0.8	0.7
Hours worked (TED)	1.7	0.7	1.2	1.2
Hours worked (KLEMS)	0.1	..	..	0.0
Terms of trade	1.9	7.0	4.5	2.7

Sources: The Conference Board Total Economy Database™; Russia World KLEMS - Basic Tables, July 2013; World Bank; own calculations (see text).

Figure 2 Capital stock (left) and TFP (right), natural logarithms with 1995=ln(100)



Sources: Own calculations (see text); The Conference Board Total Economy Database™; Russia World KLEMS - Basic Tables, July 2013.

Meanwhile the KLEMS data start to grow already in 1998, and end up at a completely different level from the other two time series relative to their respective starting levels. Note that in 2004–2009 the TED and KLEMS time series developed in a similar way. After 2009, the TED time series are flat, but unfortunately there are no data available in KLEMS for the recent past.

Despite some differences in labour input statistics as well as the elasticity of output with respect to capital, the TFP time series are more or less mirror images of the capital series. Growth in TFP is the slowest in the KLEMS data. The other two time series are mutually quite similar. They indicate that TFP in 2013 was about the same as it was in 2008 before the economic collapse of 2009.

Given the KLEMS message that emphasises capital developments, also the development in capital services after 2009 is very important. As both TED and KLEMS are calculated on the basis of capital services, we may tentatively assume that their development has been more or less flat after 2009 as TED reveals. On the other hand, gross fixed capital formation did grow rather robustly in 2010–2012 as can be seen in the next section and from our own capital stock estimate.

4 Terms of Trade and Economic Development

Russia's dependence on the exports of raw materials, especially energy commodities, is well known. According to data provided by UNCTAD, two-thirds of the value of Russia's goods exports consisted of fuels in 2013, up from 39 per cent in 1998. As a whole, 78 per cent of exports were primary commodities in 2013, while 20 per cent of the total was manufactured goods. The share of the latter has increased considerably after 2011. In exports to 'developed economies', as classified by UNCTAD, 87 per cent were primary commodities, of which 79 percentage points were fuels, while only 11 per cent of the total was manufactured goods. The growth in the exports of manufactured products has gone to other markets.

The rise in the share of fuels and other commodities in the value of Russia's exports is mainly a price phenomenon. With the commodity price boom that started in the late 1990s, Russia's terms of trade – the ratio of export prices to import prices – have improved considerably.[9] According to UNCTAD statistics, Russia's terms of trade improvement was the third-strongest in the world in 2000–2013. The improvement is largely due to the rise in the world market prices of commodities, especially crude oil. It is enough to consider crude oil prices because they are closely correlated with the prices of oil products and natural gas that are also important in Russia's exports.

Table 3 shows the correlation coefficients between the annual log-changes of the price of Urals grade crude oil, Russia's terms of trade, gross fixed capital formation and GDP in 1995–2013. The correlation coefficient between the log-changes in the price of Urals-grade crude oil and Russia's terms of trade was 0.81. Between the low in 1998 and 2013, the USD price of crude oil increased over seven-fold, and Russia's terms of trade improved on average by 5.5 per cent per year. The changes in the terms of trade also correlate nicely with changes in Russia's real effective exchange rate. Mironov ja Petronevich (2015) find that a 1 per cent increase in export revenues resulted in a 0.2 per cent appreciation of the real effective exchange rate of the rouble in 2002–2013.

Table 3 Correlation coefficients between the log-changes of the price of Urals grade crude oil, Russia's terms of trade, gross fixed capital formation and GDP 1995–2013

	Crude oil	Terms of trade	Fixed investment	GDP
Crude oil	1			
Terms of trade	0.809	1		
Fixed investment	0.566	0.618	1	
GDP	0.723	0.724	0.930	1

Sources: UNCTAD, World Bank (World Development Indicators), Bloomberg; own calculations.

The rise in the terms of trade and the ensuing influx of export revenues has of course had an impact on Russia's economic development. Ito (2012) analysed the impact of oil price volatility on Russia's economy between 1995 and 2009 using a VAR model and quarterly data. He found that a 1 per cent increase in real oil prices raised real GDP by 0.44 per cent in the long run.[10]

We argue that the improvement in the terms of trade has supported investment activity on the supply side (and consumption on the demand side), perhaps also TFP developments. The correlation coefficient between the changes in the terms of trade and gross fixed capital formation over

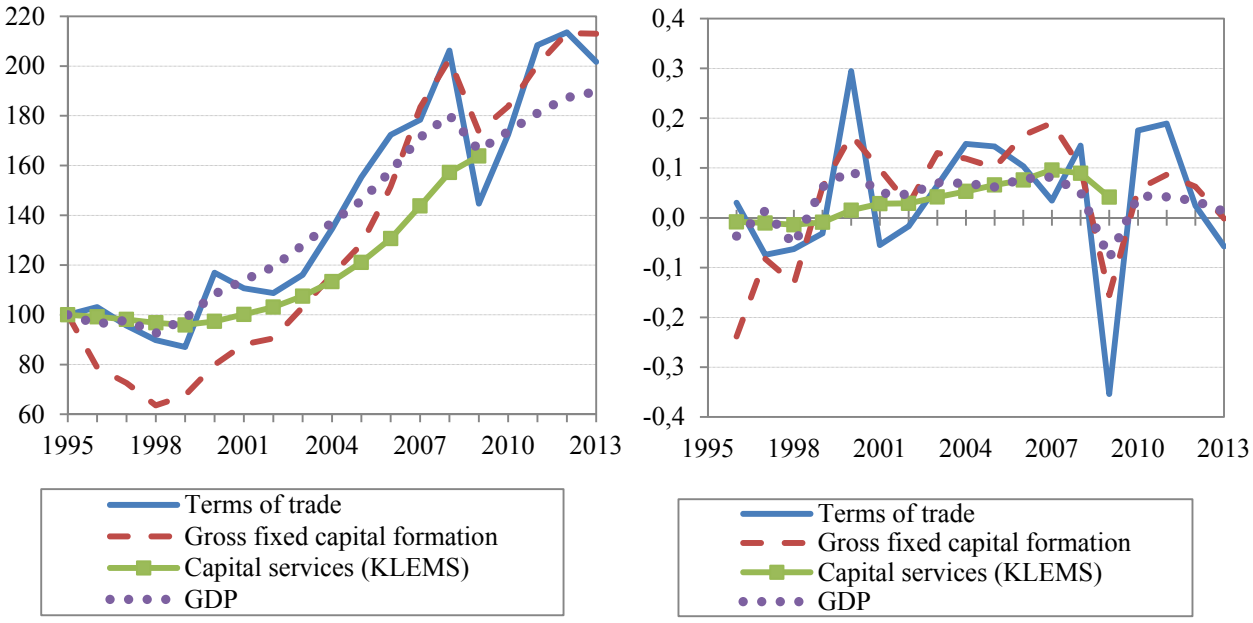
[9] We calculate Russia's terms of trade by using data on the exports and imports of goods and services in current and constant prices (base year 2000) in local currency terms as provided by the World Bank World Development Indicators database. It should be noted that different sources give somewhat different time series for the terms of trade.

[10] Kuboniwa (2012) argues that about 65 per cent of GDP growth can be explained by the oil price impact, albeit there is also a large negative statistical error and therefore about 65 per cent can also be explained by the underlying growth trend.

1995–2013 is 0.62. Finally the correlation coefficient between the changes in gross fixed capital formation and GDP is 0.93.

Figure 3 shows how the development in the terms of trade goes hand in hand with both the time series of gross fixed capital formation as well as the capital services data from KLEMS. It actually seems that gross fixed capital formation performs better in this respect. This is also indicated by correlation coefficients using the historical log-changes that are 0.63 between gross fixed capital formation and the terms of trade but only 0.28 between capital services (KLEMS) and the terms of trade. This does not necessarily mean that the former is a better indicator of capital developments.

Figure 3 GDP, terms of trade and investment activity, index (1995 = 100) on left and log-changes on right



Sources: World Bank (World Development Indicators); Russia World KLEMS - Basic Tables, July 2013; own calculations.

The OLS regression shown in Table 4 reveals how changes in the terms of trade work alone as independent variable in explaining the change in gross fixed capital formation. We find that a one-per-cent rise in the terms of trade has corresponded to a half-a-per-cent rise in gross fixed capital formation. The relation was stronger after 2003 than before. We also tried including lagged terms of trade but it was not statistically significant.

Table 4 OLS regression of log-change in gross fixed capital formation on log-change in the terms of trade

	1995–2003	2003–2013	1995–2013
Constant	-0.006 (0.048)	0.051** (0.020)	0.022 (0.024)
Terms of trade	0.548 (0.420)	0.473*** (0.124)	0.518*** (0.164)
R^2 **DW stat**	0.221 1.032	0.616 1.171	0.382 1.002

Note: The Durbin-Watson statistics are a bit low, but the Breusch-Godfrey Serial Correlation LM Tests came out clean. Standard errors in parentheses. ** = statistically significant at the 5 per cent level; *** = statistically significant at the 1 per cent level.

Also Russia's TFP growth and the development in its terms of trade are highly correlated. The correlation coefficient in 1995–2009 between these two is 0.77 with our own TFP calculation,[11] 0.72 with TFP (TED) and 0.77 with TFP (KLEMS). Table 5 shows regressions of log-change in the TFP series on the log-change in the terms of trade. The coefficient is on average about 0.20, though smaller than this with KLEMS data, and statistically significant. Consequently, a one per cent rise in the terms of trade has corresponded up to a 0.2 per cent rise in TFP.

Table 5 OLS regression of log-change in TFP series on log-change in the terms of trade

	TFP	TFP	TFP (TED)	TFP (KLEMS)
Years	**1995–2013**	**1995–2009**	**1995–2012**	**1995–2009**
Constant	0.018**	0.023**	0.019**	0.011*
	(0.007)	(0.008)	(0.008)	(0.006)
Terms of trade	0.190***	0.220***	0.205***	0.178***
	(0.048)	(0.053)	(0.054)	(0.042)
R^2	0.492	0.588	0.490	0.594
DW stat	1.732	2.368	1.310	1.371

Note: Standard errors in parentheses. * = statistically significant at the 10 per cent level; ** = statistically significant at the 5 per cent level; *** = statistically significant at the 1 per cent level.

According to our own calculations, TFP growth was faster in 1995–2003 than in 2003–2013. In the first period the terms of trade improved on average by 1.9 per cent annually, but by 5.7 per cent in 2003–2013. Growth in gross fixed capital formation and the capital stock was much slower in the first period than in the latter period. Consequently, it would seem that capital investments have become more important, and one factor behind their development is the more favourable development in the terms of trade.

An OLS analysis of the impact of the terms of trade changes on GDP growth up to 2013 is shown in Table 6. The coefficient on the log-change of the terms of trade is about the same in both sub-periods and the whole 1995–2013 period. A one per cent improvement in the terms of trade has corresponded to a 0.24 per cent increase in GDP. Between 1995 and 2013, GDP grew by an average annual rate of 3.6 per cent, while the terms of trade improved on average by 4.0 per cent.

Table 6 OLS regression of log-change in GDP in constant prices on log-change in the terms of trade

Time period	**1995-2003**	**2003-2013**	**1995-2013**
Constant	0.027	0.028***	0.026***
	(0.017)	(0.008)	(0.008)
Log-change in terms of trade	0.232	0.252***	0.245***
	(0.150)	(0.052)	(0.058)
R-squared	0.286	0.723	0.525
Adjusted R-squared	0.167	0.692	0.495
S.E. of regression	0.048	0.025	0.034
Log likelihood	0.014	0.006	0.019
F-statistic	14.079	25.862	36.146
Prob. (F-statistic)	2.398	23.501	17.669
Prob. (Wald F-statistic)	0.172	0.001	0.001
Durbin-Watson stat	1.859	1.086	1.725

Note: The Durbin-Watson statistics are a bit low for 2003–2013, but the Breusch-Godfrey Serial Correlation LM Tests came out clean. Standard errors are shown in parentheses. *** = statistically significant at the 1 per cent level.

[11] 0.70 in 1995–2013.

But while the coefficient is about the same in both sub-periods, the adjusted R^2 values are quite different: 0.29 in 1995–2003 and 0.72 in 2003–2013. Note also that in the first period the coefficient is not statistically significant. Consequently, the terms of trade have gained in explicatory value in determining the economy's growth. This is partly due to the already relatively high capacity utilisation rate.

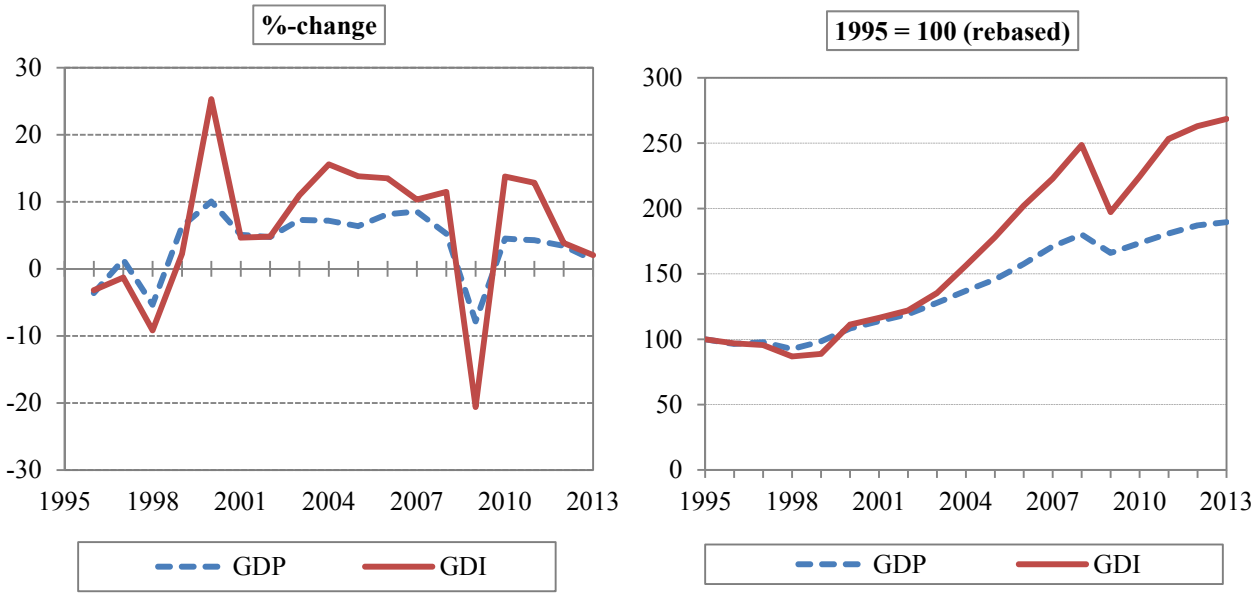
GDP measures value added, but it may differ from the level of consumers' welfare. Real gross domestic income (GDI) shows the purchasing power of a country's output.[12] It reflects gains and losses in real income resulting from trading gains that originate from changes in the terms of trade. Given the rise in its terms of trade, this analysis is pertinent for Russia. Real GDI is measured as:

$$GDI = D + ToT * X^{Vol} - M^{Vol} = GDP + (ToT - 1) X^{Vol}, \quad (5)$$

where D is real domestic demand, ToT is terms of trade, X^{Vol} is the volume of exports, and M^{Vol} is the volume of imports (see e.g. Gianella 2007).

Figure 4 shows the annual growth rates of real GDP and real GDI in Russia. After 1995, real GDP had increased by a total of 90 per cent by 2013, while real GDI had increased by 169 per cent. The terms of trade had raised GDI 38 per cent above GDP in 2013. The impact is positive during most years. The cumulative gain is 237 per cent of 2013 GDP. Thus between 1995 and 2013, Russia gained an extra 2.37 years of incomes on top of robust GDP developments thanks to the windfall gains accrued from the rise in the terms of trade. These revenues have supported private and public consumption and investment.

Figure 4 Real GDP and real GDI



Note: Real GDP and GDI have 2008 as the base year. The base year of the terms of trade time series is 1995.
Sources: OECD National Accounts Statistics; World Bank; own calculations.

[12] "Real gross domestic income" in the United Nations System of National Accounts (SNA 2008) is also known as "command-basis GDP" used by the US Bureau of Economic Analysis. Real GDI and real GDP are the same in a closed economy. There are several ways to calculate real GDI. (Kehoe and Ruhl 2008.) GDI and the terms of trade are discussed thoroughly by Reinsdorf (2010).

5 Estimation of Russia's historical GDP

Next we will estimate Russia's GDP growth using OLS. We use all three capital measurements, our own calculation of K, and the changes in K^{TED} and K^{KLEMS} reconstructed using the time series available from TED and KLEMS. We further complement the analysis with the development in the terms of trade.

Estimations (1) and (2) in Table 7 show the results using the capital stock we have constructed in this study for 1995–2009 and 1995–2013 respectively. The sum of the labour and capital coefficients is quite high, but nevertheless lower than in estimations (3) and (4) which show the results using the TED and KLEMS data respectively.

The only capital measure that is at all statistically significant is the KLEMS series at the 10 per cent level. Note that the coefficient for labour is much higher in (4) than in the other three estimations. Otherwise the labour series are statistically very significant in all four estimations. Note further that the R^2 value in the KLEMS-estimation (4) is very high.

Table 7 OLS-estimation results for annual log-change in GDP

	(1)	(2)	(3)	(4)
Years	**1995–2009**	**1995–2013**	**1995–2012**	**1995–2009**
Source	**own estimation**	**own estimation**	**TED**	**KLEMS**
Constant	0.024*	0.022*	0.018*	0.024***
	(0.012)	(0.011)	(0.010)	(0.007)
K	0.489	0.270	..	..
	(0.535)	(0.401)		
K^{TED}	..	..	0.339	..
			(0.211)	
K^{KLEMS}	..	..	..	0.246*
				(0.123)
Employment	1.288***	1.281***	..	..
	(0.391)	(0.344)		
Hours worked (TED)	..	..	1.454***	..
			(0.361)	
Hours worked (KLEMS)	..	..	..	2.407***
				(0.286)
R-squared	0.517	0.493	0.546	0.925
Adjusted R^2	0.429	0.425	0.481	0.911
S.E. of regression	0.042	0.037	0.036	0.016
Sum squared resid	0.019	0.020	0.018	0.003
Log likelihood	26.351	35.564	34.162	39.346
F-statistic	5.882	7.294	8.426	67.352
Prob. (F-statistic)	0.018	0.006	0.004	0.000
D-W stat	1.749	2.013	1.444	2.780

Note: All variables are in log changes. Standard errors are shown in parentheses. *** = statistically significant at the 1 per cent level; ** = at the 5 per cent level, * = at the 10 per cent level.

Table 8 is otherwise the same but includes the terms of trade as an independent variable. We find that the terms of trade are always statistically very significant. In the first three estimations its coefficient is about 0.17, but in the estimation based on KLEMS data significantly lower at 0.10. Introducing the terms of trade into the estimations raises the statistical significance of capital in estimation (4), again the only estimation with statistically significant capital. The sum of the coefficient for capital and labour input is very high with the KLEMS data, as it was without the terms of trade, but is much more reasonable in the other three estimations. The R^2 value is again very high in estimation (4).

We tested for autoregression using the Breusch-Godfrey Serial Correlation LM Test with two lags. These tests came out clean in all cases. Also the Breusch-Pagan-Godfrey heteroskedasticity test shows that there are no problems when the terms of trade are not included. However, when they are included in Table 8, the test shows heteroskedasticity at the 5% level in estimations (1) and (2) that use our own capital stock series. Estimations (3) and (4) with the capital services series do not suffer from heteroskedasticity.

Table 8 OLS-estimation results for annual log-change in GDP with the terms of trade

	(1)	(2)	(3)	(4)
Years	**1995–2009**	**1995–2013**	**1995–2012**	**1995–2009**
Source	**own esti-mation**	**own esti-mation**	**TED**	**KLEMS**
Constant	0.022**	0.020**	0.016*	0.024***
	(0.009)	(0.008)	(0.008)	(0.005)
K	0.415	0.147	..	..
	(0.398)	(0.320)		
K^{TED}	..	..	0.272	..
			(0.165)	
K^{KLEMS}	..	..	..	0.207**
				(0.081)
Employment	0.844**	0.870**	..	..
	(0.322)	(0.301)		
Hours worked (TED)	..	..	1.025***	..
			(0.311)	
Hours worked (KLEMS)	..	..	..	1.993***
				(0.215)
Terms of trade	0.199**	0.174***	0.169***	0.098***
	(0.063)	(0.055)	(0.053)	(0.025)
R-squared	0.758	0.704	0.746	0.970
Adjusted R^2	0.685	0.641	0.687	0.961
S.E. of regression	0.031	0.029	0.028	0.011
Sum squared resid	0.010	0.012	0.010	0.001
Log likelihood	31.191	40.421	39.092	45.882
F-statistic	10.439	11.124	12.721	109.001
Prob. (F-statistic)	0.002	0.001	0.000	0.000
D-W stat	2.424	1.938	1.328	2.210

Note: All variables are in log changes. Standard errors are shown in parentheses. *** = statistically significant at the 1 per cent level; ** = at the 5 per cent level, * = at the 10 per cent level.

Furthermore, we tested the variables for unit roots using the augmented Dickey-Fuller test and the Schwartz info criterion.[13] The results are shown in Table 9 and indicate that all three capital stock series suffer from a unit root.

[13] Note that the number of observations is a bit too low for the ADF test.

Table 9 Augmented Dickey-Fuller tests of unit roots in the log-changes of the variables

Variable	none	with intercept	with trend & intercept
Real GDP	H1**	H1**	H0 (10.6%)
K	H0	H0	H0
K^{TED}	H1*	H0	H0
K^{KLEMS}	H0	H0	H0
Employment	H1***	H1**	H1**
Hours worked (TED)	H1***	H1**	H0 (10.5%)
Hours worked (KLEMS)	H1***	H1*	H0
Terms of trade	H1***	H1**	H1***

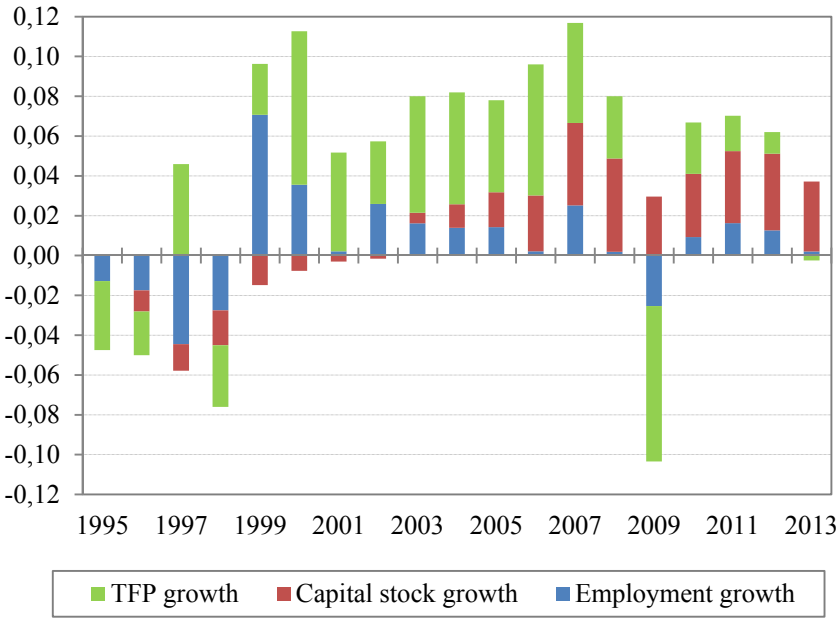
Note: With H1 there is no unit root. We used 3 lags and the Schwartz information criterion. All variables are in log changes. Standard errors are shown in parentheses. *** = statistically significant at the 1 per cent level; ** = at the 5 per cent level, * = at the 10 per cent level.

6 Growth Scenarios into 2030

In order to project Russia's economic development into the future, we need to make a number of assumptions. We will use the capital stock series calculated in this study as the benchmark in our scenarios. Labour input estimate is more straightforward to make, but the big question is, does GDP growth come more from capital or TFP developments.

Figure 5 shows the development of the unweighted sum of the annual log-changes of employment and our estimated TFP and capital stock. We see that TFP growth has slowed down and it has been overtaken by capital deepening as a driver of economic growth. The same overall trend can be found from the KLEMS data. This trend explains some of our exogenous choices in projecting future growth.

Figure 5 The un-weighted sum of the annual log-changes of employment and our estimated TFP and capital stock



Note: The sum is not equal to GDP growth.
Sources: World Bank (World Development Indicators); own calculations.

Employment

Russia's total population declined by over 4 per cent between 1990 and 2009, but has since started to grow a little. Despite the decline in total population, employment has tended to support growth in the past. Employment increased by 25 per cent between the trough in 1998 and 2013. There has also occurred a structural shift as employment in industry declined in the 1990s and employment in agriculture has declined continuously after 1990, while service sector employment has risen all the time.[14] According to de Vries et al. (2012), reallocation of labour across sectors has contributed positively to aggregate productivity growth in Russia. According to their results, the effect was one percentage point out of their estimated average productivity growth rate of 4.4 per cent in 1995–2008, or about 23 per cent of the total.

Crude birth rate has risen from the low of 8.3 per 1,000 women in 1999 to 12.6 in 2011. The total fertility rate, i.e. births per woman, rose accordingly from 1.17 to 1.54. This is still much below the 2.1 births needed to stabilise population in the long run but nevertheless comparable to general European figures. Regardless, the number of 0-14 year olds was 34 million in 1990, but only 22 million in 2012. When these smaller age cohorts come to child-bearing age, the number of births is likely to decline again. Net migration has supported population developments continuously, albeit more in the 1990s than during the 21st century (see MPC 2013).

According to World Bank HNP Stats Population Projection Tables, Russia's population aged 15–64 will decline by an average annual rate of 0.93 per cent in 2015–2020, by 0.78 per cent in 2020–2025 and by 0.60 per cent in 2025–2030. We will use slightly smaller figures reflecting the fact that Russia's population developments have recently been less negative than previously estimated. We assume that population aged 15–64 will decline annually by 0.70 per cent, 0.60 per cent and 0.50 per cent in 2015–2020, 2020–2025 and 2025–2030, respectively. Furthermore, we use implicitly the current labour force participation rate of 75 per cent which is quite high, and the current unemployment rate of 5.5 per cent which is quite low. The assumptions are thus favourable for Russia. As for international net migration, we use implicitly the assumptions made by the World Bank in their population projection.

TFP and capital stock

Capacity utilisation (in industry) increased from 60 per cent in 1995 to 72 per cent in 2003 and further to 80 per cent in 2012. We assume implicitly that it will henceforth remain unchanged at this relatively high level. According to Gray *et al.* (2012), Russia's TFP growth will slow down[15] and capacity utilisation cannot rise much anymore. Consequently, Gray *et al.* call for structural reforms to improve the investment climate and labour participation.

Kuboniwa (2012) termed Russia's experience of rising oil prices and high GDP growth a 'Russian disease'. He argues that it differs from 'Dutch disease' in that Russia has experienced a rise in manufacturing output regardless of the export-price-rise-induced increase in its real effective exchange rate. Indeed, this has more or less been the case so far, but we expect this to end because labour productivity growth (real GDP per employment) has been much slower than the rise in real compensation per employee since 2005, and imports have been rising rapidly. Also according to the KLEMS database, the share of capital compensation in total income (α) declined from 49 per cent in 1995 to 36 per cent in 2009 with a steeper decline after 2005. Consequently, Russia does catch

[14] Another factor – one that we will not discuss further due to lack of data – is the change in the quality of education and the skills of the labour force.

[15] Also Voskoboynikov and Solanko (2014) argue that the constant deceleration in MFP growth as Russian service companies approach the technology frontier implies an overall slowing in productivity growth rates for the economy.

the Dutch disease.[16] This will further constrain the economy's growth prospects without structural reforms.

In 1995–2003, the average annual TFP growth rate was 3.0 per cent, growth in gross fixed capital formation was 0.4 per cent and the terms of trade improvement was 1.9 per cent. In 2003–2013, these figures were 2.3 per cent, 7.5 per cent and 5.7 per cent. GDP growth picked up in 2003–2013, and TFP growth also slightly, according to our measurement.[17] On the other hand, the terms-of-trade improvement was considerable and probably an important factor behind the significant rise in gross fixed capital formation. In 2003–2013, it thus took a much larger increase in the terms of trade and investment to boost GDP growth. We assume that this will be the case in the future too.

In 2003–2013 a 10 per cent rise in nominal USD oil prices improved Russia's terms of trade by an average of 6 per cent. Consequently, the 2 per cent rise in the terms of trade assumed in Scenarios 3 and 4 below corresponds to an approximately 4 per cent annual rise in the price of oil in nominal USD terms, ceteris paribus. This would raise the barrel price of crude oil from USD 111 in 2013 to USD 178 in 2025, while the World Bank commodities price forecast from July 2014 for crude oil in 2025 is USD 108, or four dollars higher than in 2013.[18] A 2 per cent average rise in the terms of trade is of course much slower than the 5.7 per cent experienced in 2003–2013. However, as crude oil prices had risen by a factor of seven by 2013, who would expect this development to continue into 2030? Note that we assume that average oil prices will not decline in the long run from their 2013 level. However this cannot be ruled out for our period of analysis. This would have a negative impact on growth, ceteris paribus.

Above we regressed the log-change in gross fixed capital formation on the log-change in the terms of trade. On the basis of these results, we assume that a 4 per cent rise in nominal USD crude oil price raises the terms of trade by 2 per cent and, further, gross fixed capital formation by 1 per cent.

We also estimated above that a one per cent rise in the terms of trade has had a 0.2 per cent favourable impact on TFP growth. Consequently, we will add 0.5 percentage points to TFP growth from our 2-per-cent terms of trade improvement. Implicitly we thus assume that the export revenues are not wasted in the society, at least not more or less than has been the case historically, which is of course also possible.

Table 10 Historical growth rates, assumptions and the resulting GDP growth rates in Scenarios A–D, %

		A		K	L	Result
	Terms of trade*	**TFP***	**Gross fixed capital formation***	**Capital stock**	**Employ-ployment***	**GDP growth**
1995–2003	1.9	3.0	0.4	–0.8	0.8	3.1
2003–2013	5.7	2.3	7.5	3.2	0.7	4.0
Scenarios 2013–2030						
- A: No reforms, flat terms of trade	0.0	1.0	1.5	2.6	–0.6	1.7
- B: Reforms, flat terms of trade	0.0	2.5	3.5	3.5	–0.6	3.5
- C: No reforms, higher terms of trade	2.0	1.5	2.5	3.0	–0.6	2.3
- D: Reforms, higher terms of trade	2.0	3.0	4.5	4.0	–0.6	4.2

Note: * = assumption.

[16] Mironov and Petronevich (2015) find symptoms of Dutch disease but they argue that structural changes related to economic transition, Soviet disease as they call it, disturbs the analysis.
[17] According to TED, TFP growth slowed down.
[18] In their January 2014 forecast the World Bank put the nominal price of crude oil in 2025 at USD 97.

Scenarios A–D

Scenario A combines the weak prospects of no economic reforms and no changes in the terms of trade from their level in 2013. We assume that the annual trend increase in total factor productivity is just 1 per cent. Less room for structural changes (see de Vries *et al.* 2012) and less catching up opportunities together with weaker FDI inflows due to stagnant reforms support setting this low figure. EBRD (2013) argues that without structural reforms labour productivity (GDP per worker) in Russia relative to the EU will not change in the future. This is rather close to our Scenario A.

We further assume that the annual increase in investment is only 1.5 per cent. This scenario will nevertheless lead to an annual capital stock increase of 2.6 per cent because gross fixed capital formation is 8.3 per cent of our estimated capital stock in 2013. This may indicate that the capital stock has been pushed too low in our calculations.[19] We will leave the investment growth projections relatively low so that the capital stock does not grow too rapidly. However, the decline in the work force is a factor that will tend to lower the investment rate. Also, if productivity catching up slows down or even comes to a halt this too will lower the natural investment rate.

Scenario B still leaves the terms of trade flat, but as extensive economic reforms are introduced, investment activity picks up and grows by 3.5 per cent annually. Following higher investments (domestic and FDI) and the liberalisation of the economy, total factor productivity growth is assumed to reach 2.5 per cent.

Scenario C is our 'business as usual' setup in the sense that there are no economic reforms, but the terms of trade developments will continue to support the Russian economy. The positive impact from the terms of trade shock (+2%) on gross fixed capital formation (+1 %-p) and TFP (+0.5 %-p) are based on past developments as estimated above. Because the impact from rising terms of trade has declined over time, we will assume that the reform-oriented Scenario B will lead to faster investment and TFP growth than Scenario C.

Scenario D combines reforms and improving terms of trade developments. There we assume that TFP growth rises to 3.0 per cent and gross fixed capital formation increases by 4.5 per cent annually.

Economic development in the four scenarios

Figure 6 shows the historical development as we have estimated them and our assumptions for TFP and capital developments in the four scenarios. In Scenarios A and C, the growth rate of gross fixed capital formation slows down considerably. Consequently, the growth rate of the capital stock also slows down. The investment rate in constant prices rises slightly in Scenarios C and D. On the other hand, the capital ratio grows the most in Scenarios A and C due to the assumption of weaker TFP growth and therefore weaker GDP growth

As a result of our assumptions Russia's average annual GDP growth rate until 2030 is 1.7 per cent in Scenario A, 3.5 per cent in Scenario B, 2.3 per cent in Scenario C, and 4.2 per cent in Scenario D. Scenarios A, B and C mean that growth will slow down from historical development in 2003–2013.

Given the past poor record in reforms and the suppression of political and other liberties, we deem the reform scenarios unlikely. Consequently, economic development is likely to continue to depend on the world market prices of energy commodities.

[19] See above for a comparison of our estimated capital stocks and those estimated in other studies.

Figure 6 TFP and investment growth assumptions in Scenarios A–D

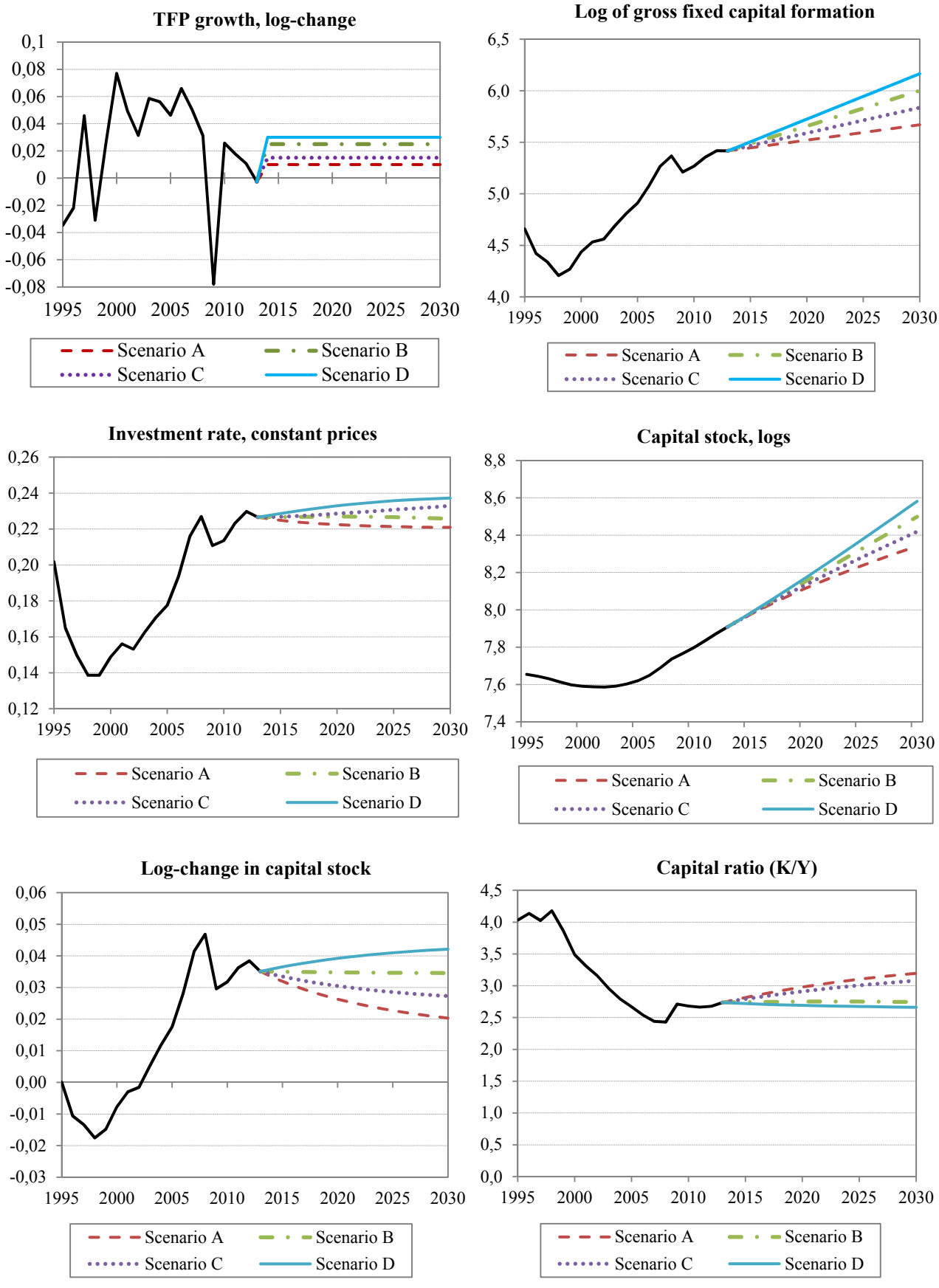
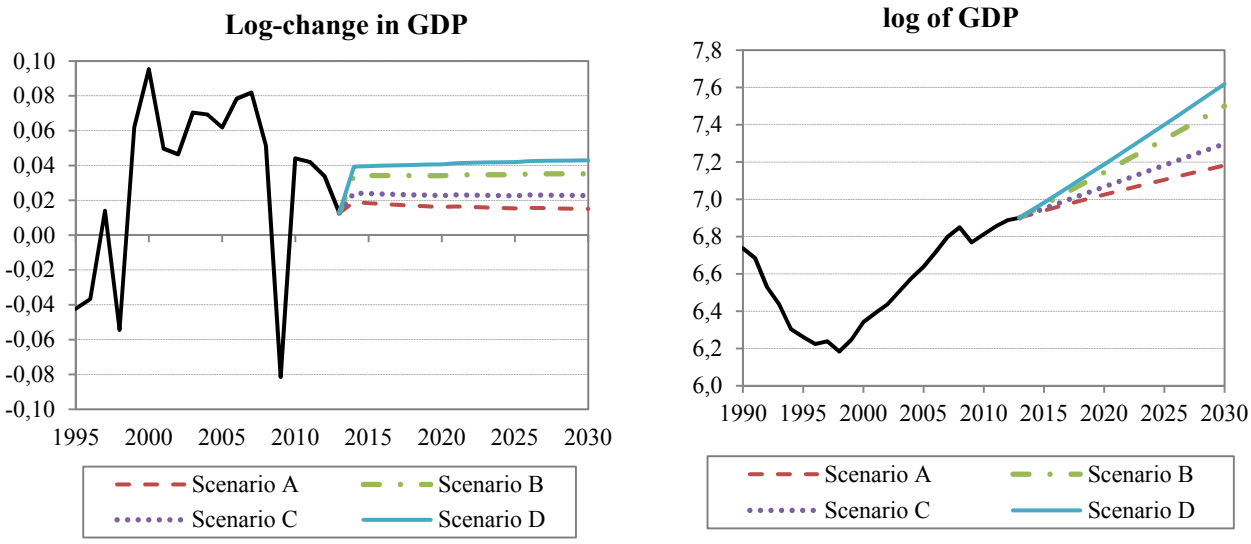
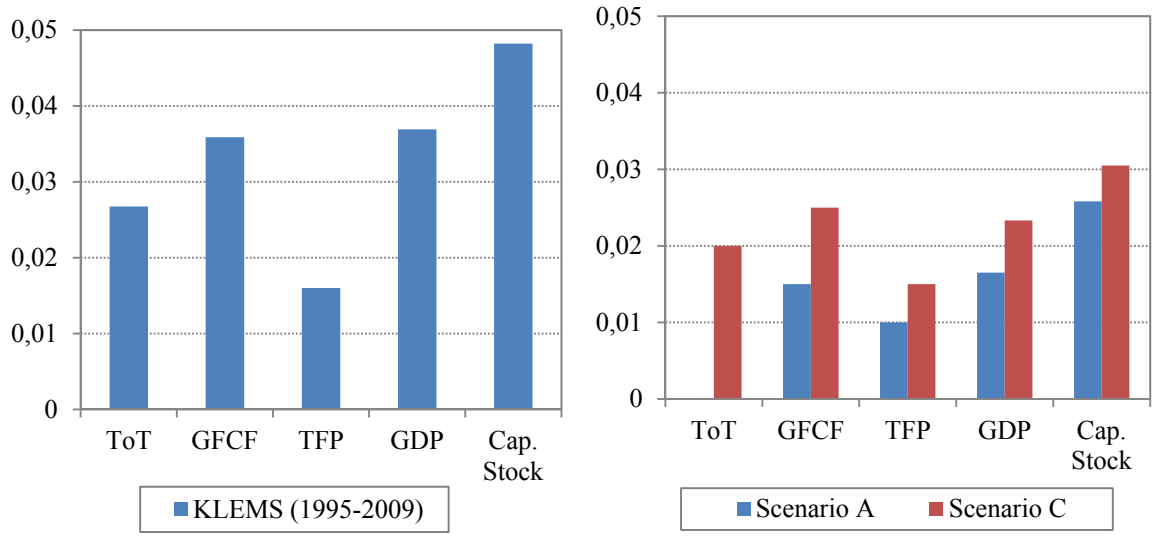


Figure 7 Projected GDP growth in Scenarios A–D



The structure of growth factors that we observe on the basis of KLEMS data corresponds to the one we get in our scenarios. Figure 8 shows the KLEMS growth profile and the profile in Scenarios A and C where no economic reforms are expected. TFP growth is the weaker component when capital growth drives economic growth.

Figure 8 Terms of trade, gross fixed capital formation, TFP, GDP and the capital stock growth rates in KLEMS (1995–2009) and Scenarios A and C (2013–2030), %



Sources: Russia World KLEMS - Basic Tables, July 2013; own calculations.

Sensitivity Analysis

Let us check how our assumptions concerning the depreciation rate of capital and the elasticity of output with respect to capital affect how we perceive historical developments and our Scenario A. We have used $\delta = 0.05$ and $\alpha = 0.4$ in our analysis. Table 11 shows how the capital stock growth rate in 1995–2013 and in 2013–2030 changes if we use $\delta = 0.10$ and/or $\alpha = 0.5$ as well as how this changes the scenarios for future GDP growth.

Changing α has no impact on past capital stock because it is not used in its calculation. However, raising the depreciation rate to 0.10 would raise the average growth rate of the capital stock in 1995–2013 by 0.2 percentage points. Consequently, the growth rate of TFP would decline by 0.1 percentage points (not shown in the table).

In Scenario A raising the depreciation rate to 0.10 will lower the growth rate of the capital stock and consequently also that of GDP, both by 0.1 percentage points. Remember that TFP is exogenously fixed. Raising the elasticity of output with respect to capital to 0.5 will not affect the capital stock but it will boost the GDP growth rate by 0.3 percentage points.

Table 11 Capital stock growth rate in 1995–2013, and GDP and capital stock growth rates in 2013–2030 in Scenario A with different assumptions, %

	1995–2013		2013–2030: Scenario A			
	Capital stock		Capital stock		GDP	
	$\delta = 0.05$	$\delta = 0.10$	$\delta = 0.05$	$\delta = 0.10$	$\delta = 0.05$	$\delta = 0.10$
$\alpha = 0.4$	1.4	1.6	2.6	2.5	1.7	1.6
$\alpha = 0.5$	1.4	1.6	2.6	2.5	2.0	1.9

Note: Our assumptions – results encircled in bold in the table – are $\delta = 0.05$ and $\alpha = 0.4$.

7 Conclusions

Russia's GDP growth was very robust for a decade after 1998. Growth was supported by a low GDP-per-capita starting level, market-oriented reforms that took place largely in the 1990s, initially low capacity utilisation rates, an increase in gross fixed capital formation, and very favourable export price developments. Strong growth coincided with a seven-fold increase in the nominal USD price of Russia's main export product, crude oil. Thanks to the global commodity boom, Russia's terms of trade improved by an average annual rate of 10.1 per cent between 1999 and 2008, and by 4.0 per cent over 1995–2013.

Terms of trade developments do not directly affect GDP calculations. However, the price developments led a surge in investment and consumer spending thus boosting GDP growth. Calculating gross domestic income, a.k.a. 'Command GDP' shows that between 1995 and 2013 Russia gained an extra 2.37 years of incomes from the windfall gains of terms of trade.

Different studies reach very different conclusions as to the origins of Russia's GDP growth. Studies that use data on gross fixed capital formation and the perpetual inventory method (PIM) to reconstruct the capital stock find that TFP growth has been the main or even the sole source of GDP growth. Meanwhile, according to capital services datasets (especially World KLEMS) that have recently been made available, capital deepening has been the main source of GDP growth.

We reconstructed a capital stock series for Russia using PIM and compared its performance with the Conference Board Total Economy Database (TED) and the World KLEMS Basic Tables, the July 2013 release. The latter two construct capital services time series. Our own growth reconstruction comes relatively close to the TED data in terms of capital and TFP developments. KLEMS however emphasises capital developments much more and consequently TFP much less.

We found that terms-of-trade developments have had a strong influence on gross fixed capital formation which has then supported GDP growth. We estimate that GDP growth depended more on TFP growth and less on capital developments in 1995–2003 and vice versa in 2003–2013. There was more room for catching up in the first period, while the surge in the terms of trade induced robust investment activity in the latter period.

We compared the performance of the three capital stock series using a Cobb-Douglas production function, and also included the terms of trade in the analysis. In our estimations the sum of the la-

bour and capital coefficients is quite high, especially when using the KLEMS data. The labour (and, when included, the terms of trade) are always statistically significant, but out of the capital measures only the KLEMS time series is statistically significant. The R^2 value rises suspiciously high when using the KLEMS data, however. All three capital stock series suffer from a unit root.

We produce four scenarios of future GDP growth with flat/improving terms of trade as one dimension and no-reforms/reforms as the other dimension. Baseline TFP growth is set at 1.0 per cent due to weaker catching up opportunities. Reforms are expected to raise this by 1.5 percentage points. A 2 per cent annual increase in the terms of trade from their level in 2013 – corresponding to a 4 per cent annual increase in nominal USD crude oil prices – is expected to bump up TFP growth by 0.5 percentage points. These higher terms of trade will raise gross fixed capital formation growth by 1 percentage point. These assumptions are based on past developments.

Our baseline scenario which excludes reforms and keeps the terms of trade flat at their level in 2013 results in an average GDP growth rate of 1.7 per cent over 2013–2030. Introducing both reforms and an annual 2-per-cent rise in the terms of trade would raise the average GDP growth rate to 4.2 per cent. Given the past poor record in reforms and the suppression of political and other liberties, we deem the reform scenarios unlikely. Consequently, Russia's economic development is likely to continue to be shaped by the volatile world market prices of energy commodities well into the future.

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