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Intermediate inputs, human capital, intangible assets and economic growth in Russia

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Abstract

. Recent developments of the Russia KLEMS initiative shed light on the nature of economic growth in Russia in the comparative perspective since 1995, especially in 2011-2016. Important aspects of modern growth as the role of intermediate inputs, human capital and intangible assets have been not covered properly because of the data insufficiency or limitations. The present paper aims to fill this gap, developing official benchmark supply and use tables on the basis of official supply and use tables in 2011-2016 and backcast imputations since 2003.

The paper updates the story of Russian growth in comparison with (Timmer, Voskoboynikov 2014; 2016) and related literature, taking into account the role of intermediate inputs. It highlights the link of productivity decline in Russian oil and gas and aggregate stagnation. Finally, it reports for the first time changes in labor composition at the detailed industry level and its contribution to Russian growth.

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1. Introduction

Recent developments of the Russia KLEMS project (Voskoboynikov, Burnell, and Nguyen 2019) shed light on the nature of economic growth and stagnation in Russia in the comparative perspective, as well as the link between global productivity slowdown and Russian stagnation (Voskoboynikov 2017). Similar to many developed economies, TFP slowdown started in Russia well in advance of the global financial crisis of 2008 (Demmou and Wörgötter 2015; Okawa and Sanghi 2018). In 1995-2014 aggregate GDP growth is driven as much by capital input as TFP growth. Mining and retailing industries were growing fast, but had poor TFP performance. In contrast, TFP growth was high in goods-producing industries but their share in GDP declined. TFP growth was highest in those industries that were particularly underdeveloped in the Russian economy in the 1990s (Timmer and Voskoboynikov 2016).

However, such important aspects of modern growth as the role of intermediate inputs, human capital and intangible assets have been not covered properly because of the data insufficiency or limitations. The present paper aims to fill this gap, developing official benchmark supply and use tables, which have been published in 2017 for the first time since 1995, as well as newly available GFCF series and data on labour force structure. It also elaborates recent revisions of the Russian system of National Accounts, which adapt new supply and use tables of 2011-2013, and also adjusts the output series in line with standards of SNA 2008.

Also the present paper sheds new light on the role of gas and oil sector in Russian economic stagnation since 2008.[2] It is TFP fall in oil and gas, that contributes the most to this stagnation. Indeed, negative TFP growth in mining is not something, which highlights Russia in comparison with other economies. For example, TFP fall in the Netherlands in the same years (2009-2016) is twice as much in absolute value as Russian. What marks Russia out is the share of oil and gas in GDP, and, correspondingly, the contribution of oil and gas sector to the stagnation.

The paper aims to present the growth accounting decomposition of the Russian economy at the level of industries on the basis of three main data frameworks, gross output growth accounting on the basis of official supply and use tables in 2011-2016 and backcast imputations since 2003, and value-added-based growth accounting decomposition for the Russian economy in 1995-2017 on the basis of the upcoming release of Russia KLEMS 2020. The dataset will be accompanied with the extended series of labour composition.

[2] Some results on this have been published in Russian only (Воскобойников et al. 2021).

The paper answers two main question: (1) update the story of Russian growth in comparison with (Timmer, Voskoboynikov 2014; 2016) and related literature, taking into account the role of intermediate inputs; (2) match the story with evidences on the basis of the three alternative datasets; shows that the lion's share of Russian stagnation comes from the negative contribution of TFP of oil and gas.

What are sources of stagnation of the Russian economy in recent decade? To what extend this stagnation can be attributed to the global productivity slowdown? The paper aims to present the growth accounting decomposition of the Russian economy at the level of industries on the basis of three main data frameworks, gross output growth accounting on the basis of official supply and use tables in 2011-2016 and backcast imputations since 2003, and value-added-based growth accounting decomposition for the Russian economy in 1995-2016 on the basis of the upcoming release of Russia KLEMS 2019 and preliminary data of Russia KLEMS 2020.

The second section of this paper overviews shortly standard growth accounting methodology. The third section discusses results at the aggregate level (subsection 3.1), shows the role of structural change and reallocation (3.2), considers the contribution of different sectors and types of assets to aggregate capital intensity growth, including ICT and intangibles (3.3), as well as labor composition (3.4); sectoral contributions to aggregate TFP growth (3.5) and, finally, discusses the role of intermediate inputs in case of chemical industry (3.6). Section 4 summarizes results and concludes.

2. Data and approach

Two datasets represent the empirical basis for this study. At the aggregate level this is the Conference Board Total Economy Database™ (TED).[3] TED includes the series of gross domestic Product (GDP), population, employment, hours, labour quality, capital services, labour productivity, and total factor productivity for 123 countries in the world, including Russia, at the total economy level. For most countries the series start from 1950. For Russia they are available from 1961 for GDP per worker and from 1992 for GDP per hour worked. TED provides data for the representation of labour productivity growth $\Delta \ln z$, where labour productivity defined as the ratio of real value added and hours worked $(z = Z/H)$, as the sum of countributions of capital intensity (the flow of capital services per

[3] The dataset is available at https://www.conference-board.org/data/economydatabase/index.cfm?id=27762 . Detailed methodology description is provided by de Vries and Erumban (2016).

hour worked, $k = K/H$), labour composition effect (LQ) and TFP growth rate ($\Delta \ln A$) (Vries and Erumban 2016, 16–18):

$$(1) \qquad \Delta \ln z = \bar{s}_K \Delta \ln k + \bar{s}_L \Delta \ln LQ + \Delta \ln A,$$

where $\bar{s}$ are yearly averaged shares of capital (K) and labour (L) compensation in value added.

The TED is based on national accounts from the official sources, such international sources as OECD or UN, and in some cases on alternative estimations in academic publications. For example, in case of China two sets of the series are presents, the official and the alternative one. This reflects debates in the literature on the reliability of the official statistics for China.[4] In case of Russia starting from 1990 TED uses official GDP series. For comparisons of GDP levels across countries purchasing power parities (PPP) are used in the TED. Unless otherwise stated, I use the GDP series in constant 1990 US dollars converted at Geary Khamis PPPs from TED release of June 2015.

The second source is the Russia KLEMS dataset (2017). It includes the dynamic series of value added, hours worked, labour and capital shares, as well as capital services for 34 industries in the industrial classicisation NACE 1 starting from 1995. The dataset is nearly consistent with the official Russian National Accounts at the aggregate level for the whole period, and at the level of industries starting from 2005. It is also harmonized with similar datasets for other countries within the World KLEMS framework, which makes possible cross-countries comparisons at the level of industries. A more detailed description of the dataset and its construction can be found in (Voskoboynikov 2012). GO-based growth accounting decomposition is based on the preliminary series of Russia 2020 KLEMS dataset.[5]

The TED and Russia KLEMS are partially consistent. They use the same Solow-Jorgenson growth accounting framework (Jorgenson, Ho, and Stiroh 2005). Moreover, starting from 2016 the TED uses Russia KLEMS as one of the sources of its Russian segment (Vries and Erumban 2016, 21). At the same time, regarding employment and hours worked in Russia, TED uses the data on organizations only, which leads to the upward bias in labour productivity levels and underestimation of labour contributions. Russia KLEMS data uses employment series, which cover the whole economy within the SNA production frontier.

$$(2) \qquad \Delta \ln z = \sum_j \bar{v}_{Z,j}^{GDP} \cdot \Delta \ln z_j + \left(\sum_j \bar{v}_{Z,j}^{GDP} \cdot \Delta \ln H_j - \Delta \ln H \right) =$$

$$= \sum_j \bar{v}_{Z,j}^{GDP} \cdot \Delta \ln z_j + R =$$

[4] Unless otherwise stated, the alternative set for China is used in this paper.

[5] This release is expected by the end of 2021. See more on this project at https://www.hse.ru/en/russiaklems/ .

$$= \sum_j \bar{v}_{Z,j}^{GDP} \cdot \bar{v}_{K,j}^{Z} \Delta \ln k_j + \sum_j \bar{v}_{Z,j}^{GDP} \cdot \Delta \ln A_j + R,$$

where $\bar{v}_{Z,j}^{GDP}$ – the yearly average share of industry *j* in total value added and $\bar{v}_{K,j}^{Z}$ is the yearly average capital share in value added of industry *j*. The reallocation term R captures changes in labour productivity growth, caused by the difference of the share of an industry in value added and hours worked. It is positive if industries with the above average share of value added show positive growth of employment shares.

Until now, Russia KLEMS dataset does not provide the full GO-based growth accounting decomposition, because the official statistics stopped developing SUTs in 2003, based on the benchmark SUTs of 1995. Output series include GO, intermediate inputs and value added both in current and comparable prices. Data construction process and sources of Russia KLEMS releases of 2013 and 2017 can be found in (Voskoboynikov 2012). The series are based on the official SNA data with minor adjustments for differences in SNA releases and backcast estimations of industry-level series in 1995-2003 to bridge the old Soviet industrial classification OKONKh and NACE 1. These series correspond to concepts of output in SNA 93, which was adapted in Russia in early 1990s. The industry level series, based on SNA 93, cover years until 2014.

Until recently the lack of official SUTs in NACE 1 was a major obstacle for the development of GO based growth accounting for Russia. In March 2017 Rosstat released the first set of benchmark SUTs in NACE 1 for 2011, which covers 178 industries and 248 products. Its projections of SUTs for2012-2015 are less detailed, but enough for the purposes of Russia KLEMS. The next benchmark SUTs for 2016 are expected in 2019. Taking into account the importance of long run series, we work on the backcast extension of the SUTs series back to 2003, which is the first year after transition of the official statistics to NACE 1. This extension is based on SNA series of GO, intermediate inputs and value added in 2003-2010, adjusted for the recent version of SNA, and the RAS projection.[6]

One of the adjustments in the official statistics with the transition to SNA 2008 is the further elaboration of input shares, taking into account informal activities. Proper backcast adjustments in Russia KLEMS series seem to be substantial, and have not been implemented yet.

3. Results and Discussion.

[6] This is the joint effort of Eduard Baranov, Dmitri Piontkovski and Elena Staritsyna. Detailed description of this methodology of this approach will be published separately a joint paper, which is in progress now.

3.1. Aggregate view

Comparing with the world economy Russian growth since 1990 is volatile (figure 1). In 1990-s and early 2000-s world economy accelerated from 2,1 % per year (1990-1995) to 5% (2002-2007) Russia fall in deep transformational recession with negative annual growth rates -9% per year (1990-1995) and impressive rebound by 7,5% (2002-2007). After 2008 Russia went into stagnation, growing just about by 1,5% annually. Figure 1 highlights periods of more or less homogeneous development for specific country groups, useful for comparisons. Figure 1 shows acceleration of emerging economies since 2002 in comparison with OECD. In 2002-2007 emerging economies grew by 4 pp faster than the OECD zone, with Russia being an outstanding outlier. The Russian economy grew these years by 7,5% per year or by 0,5 pp more than other emerging economies. Another break falls at 2011, when all major economies recovered after the shock of the 2008 crisis. After 2011 Russia grew slower not only in comparison with the world, but also with OECD.

Figure 1. Economic growth in global economy and Russia since 1990

In years of soaring growth 2002-2007 Russia narrowed the gap in labor productivity with developed economies, as can be seen in Figure 2. Unfortunately, this convergence terminated after 2008.

Figure 2. Labor productivity level in Russia relative to Germany and US

The link between the level of oil prices and economic growth in Russia, widely discussed in the literature (Bradshaw and Connolly 2016), can be seen in Figure 3 as the correlation between capital intensity and yearly average oil prices in 1995-2016. Indeed, soaring oil prices generated the inflow of export revenues, which transformed into investments and, consequently, accelerated growth. On the other extreme, years of low oil prices (e.g. 1997 or 1999) correspond to low capital intensity and output growth.

Figure 3. Capital intensity oil prices

More detailed picture of technology convergence and the link between oil prices, capital intensity and growth can be found in growth accounting decomposition (2), represented in table 1. Labor productivity growth (line 3 of the table) can be represented as the sum of contributions of

proximate sources of intra-industry growth and labor reallocation. The former includes capital intensity, labor composition and total factor productivity, while the latter – labor reallocation between industries.

As can be seen from table 1, labor productivity growth accelerates from moderate 2,9% in 1995-2002 to high 6,5% in 2002-2007, and fall to 0,9% in 2011-2016. In 2002-2007 TFP contributed the most, providing more than 3,5 pp. In the following stagnation its role also diminished, while labor productivity growth kept growing because of capital intensity for a while. The effect of investments slowdown after 2008 hit capital services was lagged. Many infrastructural projects, started before 2008, put in operation later. So, taking into account the increasing role of capital intensity of 2008 one may concludes that the post-crisis growth of 2011-2016 was more extensive than growth in years of soaring oil prices, 2002-2007.

Other factors also contributed to growth, although their role was more modest. The impact of labor composition was close to nil, varying between zero in 2002-2007 to 0,3 pp after 2011. Labor contribution, being substantial in early transition and recovery growth in 1995-2002, fall to 0,2 pp in years of the crisis 2008-2011. However, it started accelerating in the following years.

Table 1. Growth accounting decomposition of the Russian economy in 1995-2016

A. Total economy (pp)

	1995-2002	**2002-2007**	**2007-2011**	**2011-2016**	**1995-2016**
1. Real value added (2+3)	2,77	7,37	1,35	0,80	3,01
2. Hours worked	-0,09	0,90	-0,12	-0,05	0,15
3. Labor productivity (4+5+11+12)	2,85	6,47	1,47	0,85	2,86
4. Labor reallocation	1,29	0,63	0,16	0,52	0,65
5. Intra-industry growth (6+7+8+9+10)	1,56	5,84	1,31	0,33	2,22
6. Capital intensity	-0,17	2,26	2,74	1,59	1,39
7. ICT-capital	0,19	0,21	0,09	0,01	0,08
8. Machinery and equipment	0,11	1,11	0,96	0,48	0,53
9. Buildings and Constructions	-0,38	0,49	1,31	0,99	0,60
10. Other assets	-0,10	0,44	0,38	0,12	0,18
11. Total Factor Productivity	1,53	3,54	-1,60	-1,58	0,65
12. Labor Composition	0,21	0,04	0,18	0,31	0,18

Source: Own calculations on the basis of Russia KLEMS 2019.

B. Market economy (pp)

	1995-2002	2002-2007	2007-2011	2011-2016	1995-2016
1. Real value added (2+3)	2,62	8,08	1,10	0,72	3,11
2. Hours worked	-0,34	0,96	-0,17	-0,05	0,07
3. Labor productivity (4+5+11+12)	2,95	7,12	1,27	0,77	3,04
4. Labor reallocation	1,34	0,74	0,04	0,57	0,63
5. Intra-industry growth	1,61	6,38	1,23	0,20	2,41
(6+7+8+9+10)	-0,20	2,19	3,10	1,87	1,49
6. Capital intensity	0,22	0,18	0,12	0,02	0,10
7. ICT-capital	0,12	1,21	1,05	0,58	0,57
8. Machinery and equipment	-0,35	0,55	1,51	1,14	0,69
9. Buildings and Constructions	-0,19	0,25	0,42	0,13	0,14
10. Other assets	1,61	4,16	-2,03	-1,91	0,75
11. Total Factor Productivity	0,20	0,03	0,17	0,25	0,16

Source: Own calculations on the basis of Russia KLEMS 2019.

Note: Market economy includes all activities excluding real estate, public administration, education and healthcare (see Appendix P1).

3.2. Growth and structural change

Aggregate labor productivity growth includes not only growth within industries (capital intensity, TFP and labor composition) but also because of labor reallocation between industries, which differ by productivity levels. This section overviews structural change in the Russian economy, considering sectors.

Table 2. Sectoral shares in value added and hours worked in 1995-2016

A. Shares of hours worked (%)

Sector	**1995**	**2002**	**2007**	**2011**	**2016**
Total economy	100,0	100,0	100,0	100,0	100,0
Market economy	80,9	79,5	79,7	79,5	79,5
Agriculture	27,9	24,2	21,8	21,4	20,0
Extended gas and oil	3,5	4,5	4,8	4,5	4,7
Manufacturing	18,8	17,1	16,2	15,2	14,4
Retail, Construction, Telecom	19,7	23,6	26,2	27,1	28,3
Financial and Business Services	5,2	4,7	5,1	5,6	6,1
Transport	5,7	5,4	5,7	5,7	6,0
Non-market economy	19,1	20,5	20,3	20,5	20,5

Source: Russia KLEMS 2019.

Note: See Appendix A1 for sectoral composition

B. Shares of value added (%)

Sector	1995	2002	2007	2011	2016
Total economy	100,0	100,0	100,0	100,0	100,0
Market economy	85,9	84,2	84,7	81,0	80,9
Agriculture	7,6	6,6	4,4	4,2	5,1
Extended gas and oil	20,0	23,3	24,9	24,8	22,5
Manufacturing	22,5	19,2	17,4	14,6	15,8
Retail, Construction, Telecom	19,1	18,7	19,6	20,3	17,5
Financial and Business Services	5,0	8,3	11,1	10,7	13,0
Transport	11,7	8,1	7,2	6,3	7,0
Non-market economy	14,1	15,8	15,3	19,0	19,1

Source: Russia KLEMS 2019.

Note: See Appendix A1 for sectoral composition

We group industries by aggregated sectors. It is convenient using six sectors within the market economy, and one non-market economy sector. In turn, the market economy includes agriculture, extended gas and oil[7], manufacturing, financial and business services, transport and other services – retail, construction and telecommunications. Detailed information on industrial composition of sectors can be found in Appendix A1.

Table 2A shows sectoral shares in the total amount of hours worked in 1995-2016. Major trend in these two decades was the shift of economic activities from goods to services. Agriculture was a major donor of working hours. In 1995 its share exceeded one quarter, which seems too much for a post-industrialized economy. However, in case of Russia this reflects the role of non-market households, which produce for own consumption (Kapelyushnikov, Kuznetsov, and Kuznetsova 2012). Such households produced the substantial share of agricultural products and smoothed shocks of transformational recession in labor market, absorbing excessive labor force. When transition was passed, the share of hours worked in this sector shrank from 19% in 1995 to 14,5% in 2016. In turn, major recipient of working force were industries from market services, especially form the construction, retail and telecom sector. Its share expanded by 9 pp in 1995-2016.

Substantial structural change can be found, if one looks at shares of value added, represented in table 2B. Sectors of goods are also shrunk. In comparison with hours worked it is less sound in agriculture (only by 2,5 pp), and more substantial in manufacturing (7 pp). The fall of transport is also remarkable. On the other hand, finance and business services expanded by 8 pp, non-market services – by 5 pp, and extended gas and oil – by 2,5 pp.

3.3. Capital: ICT and intangibles

Capital intensity growth includes contributions of ICT capital, machinery, buildings and constructions, and other assets. It is represented both in table 1 and figure 4. First, the role of ICT capital is modest and diminishes in time, which captures the diminishing effect of ICT around the world. At the same time, it remains positive. Second, machinery and dominated in growth before stagnation. In years of high growth, 2002-2007,they dominated.[8] Finally, infrastructure moves into first place in stagnation.

[7] The true size of mining in the Russian economy and its contribution to economic growth were widely discussed in the literature (see, e.g., (Gurvich 2004)). An extended oil and gas sector includes organizations, which are involved in the process of extraction, transportation and wholesale trade of oil and gas. Some of them have establishments in different industries, such as mining, wholesale trade, fuel and pipeline transport. Because of strong vertical integration and transfer pricing its share in total value added exceeds mining. Following Timmer and Voskoboynikov (2016) the present study assumes that all this extended mining sector includes mining, wholesale trade and fuel. At the same time, I recognize limitations of this split. On the one hand, many firms in wholesale trade are not related with energy exports. On the other hand, some pipeline transportation organizations fall within transport in sector "market services".

[8] Interestingly, this is a unique period in Russian post-war economic history, when capital quality provided positive contribution (Voskoboynikov 2021).

Figure 4. Sectoral contributions to aggregate capital intensity growth

3.4. Labor and labor composition

As it follows from table 1, the contribution of labor composition is positive and relatively small. Figure 5 provides additional details. Two main trends change labor composition, which are aging and the growing share of workers, who hold a university degree.

Figure 5. Labor composition by age and education

3.5. Aggregate total factor productivity growth

Sustainable growth assumes high contribution of TFP. Before 2008 the role of TFP was substantial. Since 2007 aggregate TFP growth reverses to negative. As can be seen from Figure 6, in 2011-2016 this happens mostly because of extended gas and oil. Its negative contribution of -1,46 pp dominated, being amplified by other services. This effect is substantial at the aggregate level, shedding the fact that agriculture and finance and business services recovered after 2011 and stayed in positive zone.

Figure 6. Sectoral contribution to total factor productivity growth

To what extent the negative contribution of mining can cause stagnation in the comparative perspective? Figure 7A represents TFP growth of mining in OECD economies. As can be seen, negative TFP growth in Russia is not unusual. Denmark and Netherlands demonstrate higher fall, being leaders among other countries in the share of mining in value added of market services (7B). Moreover, negative TFP in mining can be caused by unfavorable extraction conditions (Baumol 1986). At the same time, the share of mining in Russia seems huge. So, the negative impact of TFP fall in the Netherlands, for example, is insignificant at the aggregate level, for Russia it causes stagnation.

Figure 7. Oil and Gas MFP growth. Russia in the comparative perspective

3.6. Intermediate inputs. Case of chemicals industry

The new benchmark tables for 2011 with the following projections to 2012-2015 have been published recently. SUTs unveil two opportunities for Russia KLEMS. First, real value added series can be revised, taking into account double deflation. In Russian official statistics, as well as in Russia KLEMS 2017, double deflation has not been adapted. Second, GO-based growth accounting can be implemented. In both cases, the question of interest is to what extent the story of Russian growth, presented above, will survive. In addition, the issue of new data quality is important.

Table 5. Value added-based growth accounting for Chemicals and chemical products in 2003-2014

(pp)

	2003-2007	2007-2014	2003-2014
Real Value Added	3.69	4.03	3.91
Hours worked	-2.82	-2.57	-2.66
Labor productivity	6.52	6.60	6.57
Labor composition	0.13	0.37	0.30
Capital intensity	3.16	3.41	3.04
Multifactor productivity	3.22	2.82	3.24
Real Value Added (double deflated)	6.34	-0.39	1.81
Multifactor productivity, based on double deflated real value added	5.87	-1.60	1.14
Labor share (%)	59.5	51.6	58.7

Source: (Voskoboynikov, Burnell, and Nguyen 2019).

Table 5 represents the GVA-based growth accounting decomposition for industry Chemicals and Chemical Products" with both the official and double deflated real value added. If the volume growth

rate of value added is calculated with single deflation or derived by the direct observation of volume output series, it will be sensitive to changes in relative prices of GO and intermediate inputs. In case of Russia, the corresponding bias could be substantial. For example, output prices of export-oriented sectors, such as chemicals, mainly on international markets, whereas intermediate inputs prices (e.g. prices on energy) are formed in the domestic market. These domestic prices might be heavily distorted due to explicit and implicit subsidies. As can be seen from the table, the difference between the single-deflated and the double deflated real value added growth rates are substantial. In 2003-2007 they are almost twice as much as the official ones, while in 2007-2014 both have an opposite direction. At the same time, both the single-deflated and double deflated versions of growth accounting demonstrate that the contribution of TFP becomes smaller.

Generalization of these observations can be derived from Table 5, which demonstrates, that the discrepancy between the single and double deflated real value added growth rates for some industries are substantial, being double deflated valued in most cases smaller and negative. Although these findings have to be considered as preliminary and only indicative of the potential importance of this issue given that they rely on preliminary backcast projections for the most years of the period and the sensitivity to measurement errors (Hill 1971), we can assume, that the official/Russia KLEMS 2017 numbers of real value added overestimate economic growth.

4. Conclusions

The paper aims to present the growth accounting decomposition of the Russian economy at the level of industries on the basis of three main data frameworks, gross output growth accounting on the basis of official supply and use tables in 2011-2016 and backcast imputations since 2003, and value-added-based growth accounting decomposition for the Russian economy in 1995-2017 on the basis of the upcoming release of Russia KLEMS 2020.

The paper updates the story of Russian growth in comparison with (Timmer, Voskoboynikov 2014; 2016) and related literature, taking into account the role of intermediate inputs. It highlights the link of productivity decline in Russian oil and gas and aggregate stagnation. Finally, it reports for the first time changes in labor composition at the detailed industry level and its contribution to Russian growth.

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Appendix

A1. List of industries and composition of aggregated sectors

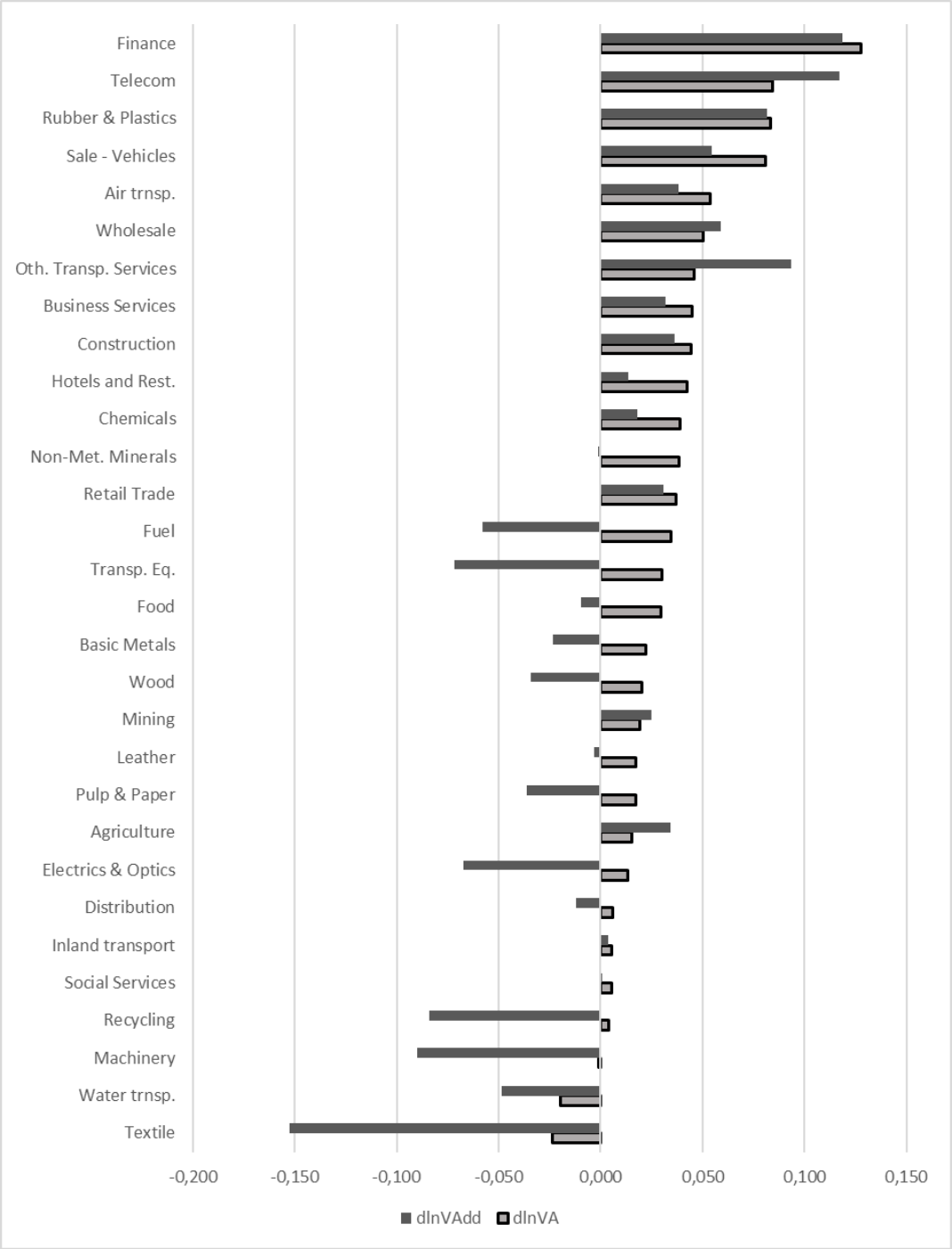
#	Code	Industry	Sector	Aggregated Sector
1	AtB	Agriculture, hunting, forestry and fishing	Agriculture	Market economy
2	23	Coke, refined petroleum products and nuclear fuel	Extended gas and oil	Market economy
3	C	Mining and quarrying	Extended gas and oil	Market economy
4	51	Wholesale trade and commission trade, except of motor vehicles and motorcycles	Extended gas and oil	Market economy
5	15t16	Food products, beverages and tobacco	Manufacturing	Market economy
6	17t18	Textiles, textile products	Manufacturing	Market economy
7	19	Leather and footwear	Manufacturing	Market economy
8	20	Wood and products of wood and cork	Manufacturing	Market economy
9	21t22	Pulp, paper, paper products, printing and publishing	Manufacturing	Market economy
10	24	Chemicals and chemical products	Manufacturing	Market economy
11	25	Rubber and plastics products	Manufacturing	Market economy
12	26	Other non-metallic mineral products	Manufacturing	Market economy
13	27t28	Basic metals and fabricated metal products	Manufacturing	Market economy
14	29	Machinery, n.e.c.*	Manufacturing	Market economy
15	30t33	Electrical and optical equipment	Manufacturing	Market economy
16	34t35	Transport equipment	Manufacturing	Market economy
17	36t37	Manufacturing, n.e.c. and Recycling*	Manufacturing	Market economy
18	E	Electricity, Gas and Water supply	Manufacturing	Market economy
19	F	Construction	Retail, Construction, Telecom	Market economy

20	50	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel	Retail, Construction, Telecom	Market economy
21	52	Retail trade, except of motor vehicles and motorcycles; repair of household goods	Retail, Construction, Telecom	Market economy
22	H	Hotels and Restaurants	Retail, Construction, Telecom	Market economy
23	64	Post and Telecommunications	Retail, Construction, Telecom	Market economy
24	O	Other Community, Social and Personal Services	Retail, Construction, Telecom	Market economy
25	J	Financial intermediation	Fin. & Business Services	Market economy
26	71t74	Renting of machinery and equipment and other business activities	Fin. & Business Services	Market economy
27	60	Inland transport	Transport	Market economy
28	61	Water Transport	Transport	Market economy
29	62	Air Transport	Transport	Market economy
30	63	Supporting and auxiliary transport activities; activities of travel agencies	Transport	Market economy
31	70	Real Estate Activities	Non-market services	Non-market economy
32	L	Public admin and defense; compulsory social security	Non-market services	Non-market economy
33	M	Education	Non-market services	Non-market economy
34	N	Health and Social Work	Non-market services	Non-market economy

* n.e.c. = not elsewhere classified

A2. Yearly growth rates of single- and double-deflated real value added in 30 industries of the market economy, 2003-2014

(Annual compound growth rates)



Source: (Voskoboynikov, Burnell, and Nguyen 2019)

Note: Annual compound growth rates of value added volumes by industry. Single deflation-based volumes (light) and double-deflation based volumes (dark)

A3. Labor composition in chemicals and chemical products, 2003-2014

	2003	**2014**	**Average**	**Hours worked growth**	**Contribution**	**Lab. comp. per hour worked**
	Share of value added (%)			Annual gr. rates	Percentage points	Percentage points
Total	100.0	100.00	100.00	-2.16	-2.16	0.51
Low skills	3.3	1.4	2.4	-11.10	-0.26	-0.20
Medium skills	66.9	55.3	61.1	-3.41	-2.08	-0.46
High skills	29.8	43.3	36.5	0.52	0.19	1.16
Male	64.1	64.3	64.2	-1.57	-1.01	0.70
Female	35.9	35.7	35.8	-3.21	-1.15	-0.19
Age 15-29	20.2	18.6	19.4	-2.72	-0.53	-0.01
Age 30-49	58.2	52.9	55.6	-3.15	-1.75	-0.27
Age 50+	21.7	28.5	25.1	0.48	0.12	0.79
Low skills, 15-29, male	0.60	0.22	0.41	-13.14	-0.05	-0.04
Medium skills, 15-29, male	10.35	7.91	9.13	-3.68	-0.34	-0.09
High skills, 15-29, male	3.73	4.79	4.26	1.11	0.05	0.16
Low skills, 30-49, male	0.86	0.52	0.69	-7.42	-0.05	-0.03
Medium skills, 30-49, male	24.65	18.86	21.76	-3.81	-0.83	-0.25
High skills, 30-49, male	10.25	14.09	12.17	1.02	0.12	0.45
Low skills, 50+, male	0.80	0.30	0.55	-9.37	-0.05	-0.04
Medium skills, 50+, male	9.12	11.04	10.08	0.57	0.06	0.33
High skills, 50+, male	3.78	6.54	5.16	1.63	0.08	0.22
Low skills, 15-29, female	0.21	0.08	0.14	-13.08	-0.02	-0.02
Medium skills, 15-29, female	2.95	1.95	2.45	-6.63	-0.16	-0.10
High skills, 15-29, female	2.33	3.60	2.97	-0.09	0.00	0.08

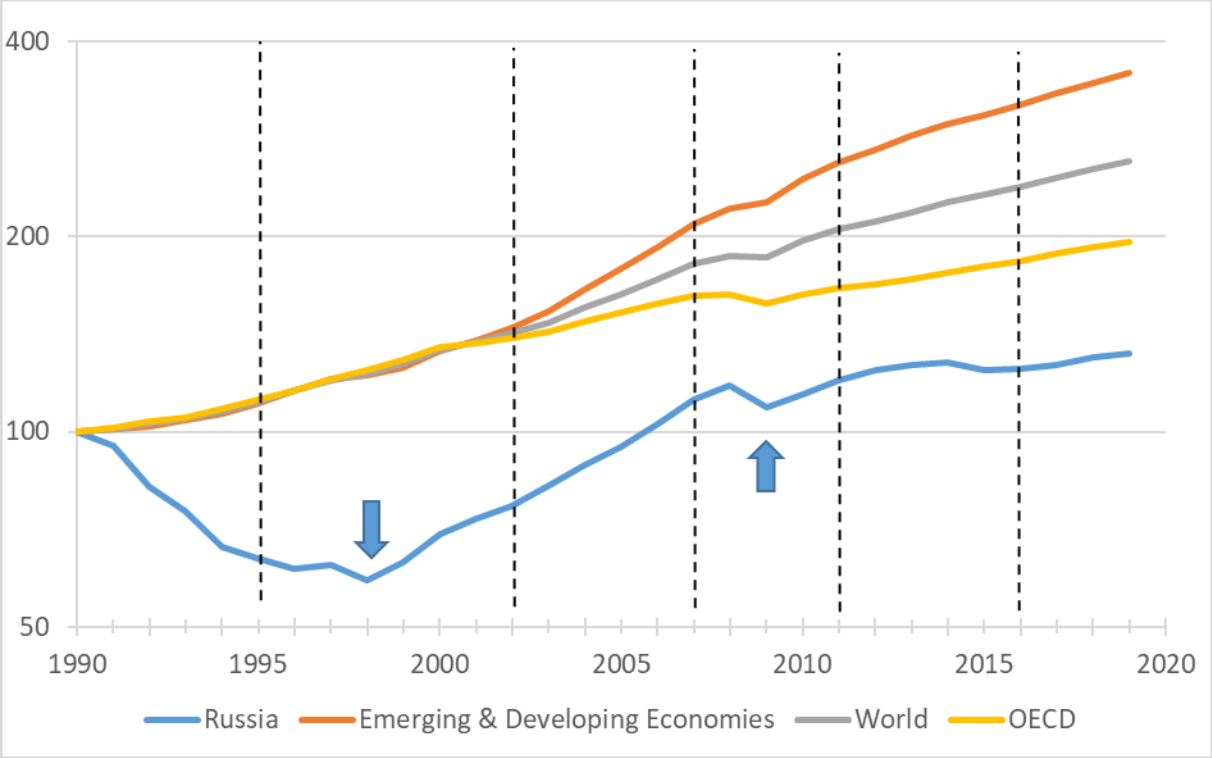
Low skills, 30-49, female	0.58	0.14	0.36	-17.58	-0.06	-0.05
Medium skills, 30-49, female	14.76	9.34	12.05	-6.93	-0.84	-0.51
High skills, 30-49, female	7.08	9.97	8.53	-1.12	-0.10	0.13
Low skills, 50+, female	0.29	0.13	0.21	-11.30	-0.02	-0.02
Medium skills, 50+, female	5.04	6.24	5.64	0.35	0.02	0.17
High skills, 50+, female	2.62	4.28	3.45	0.97	0.03	0.13

Source: (Voskoboynikov, Burnell, and Nguyen 2019)

Figures

Figure 1. Economic growth in global economy and Russia since 1990

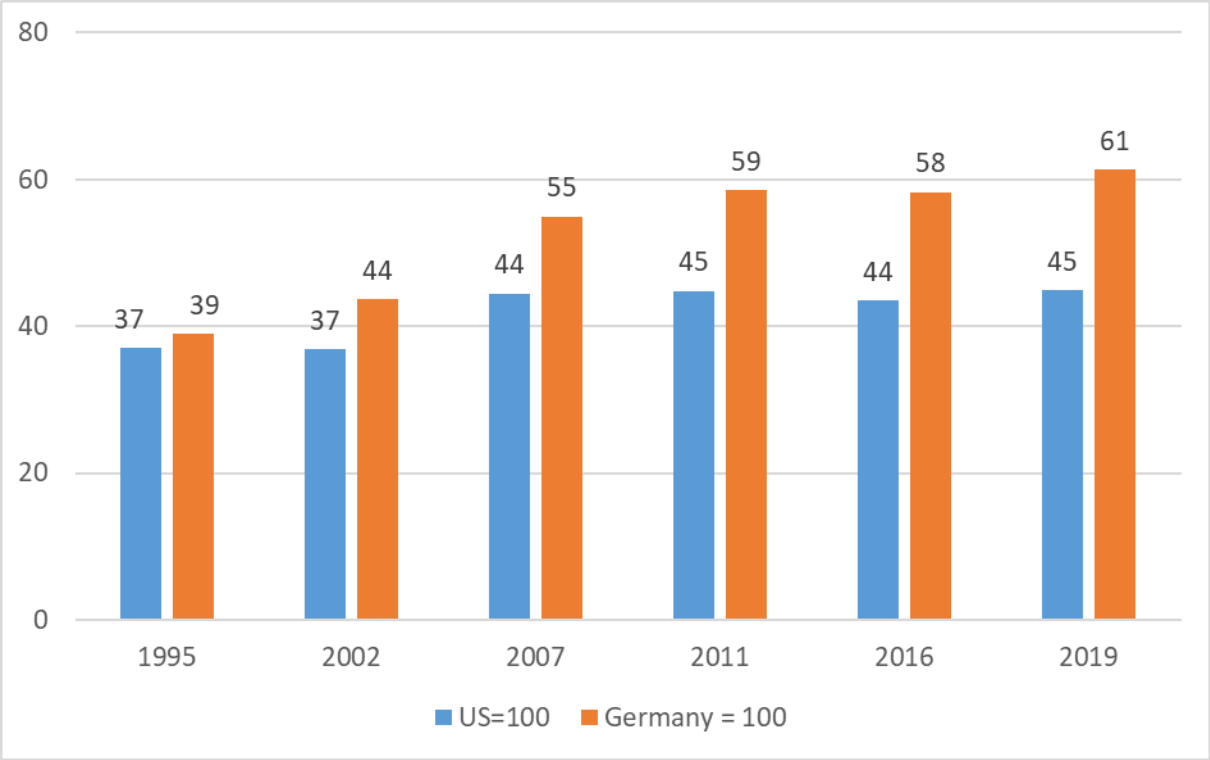
1990 = 100



Source: The Conference Board Total Economy Database™ (Adjusted version), April 2019

Notes: World includes all 122 countries, represented in Total Economy Database™. The group of Emerging and developing economies includes China, India, developing economies of Asia, Latin America, the Middle East, Sub-Saharan Africa, Russia, Central Asia, South and Eastern Europe

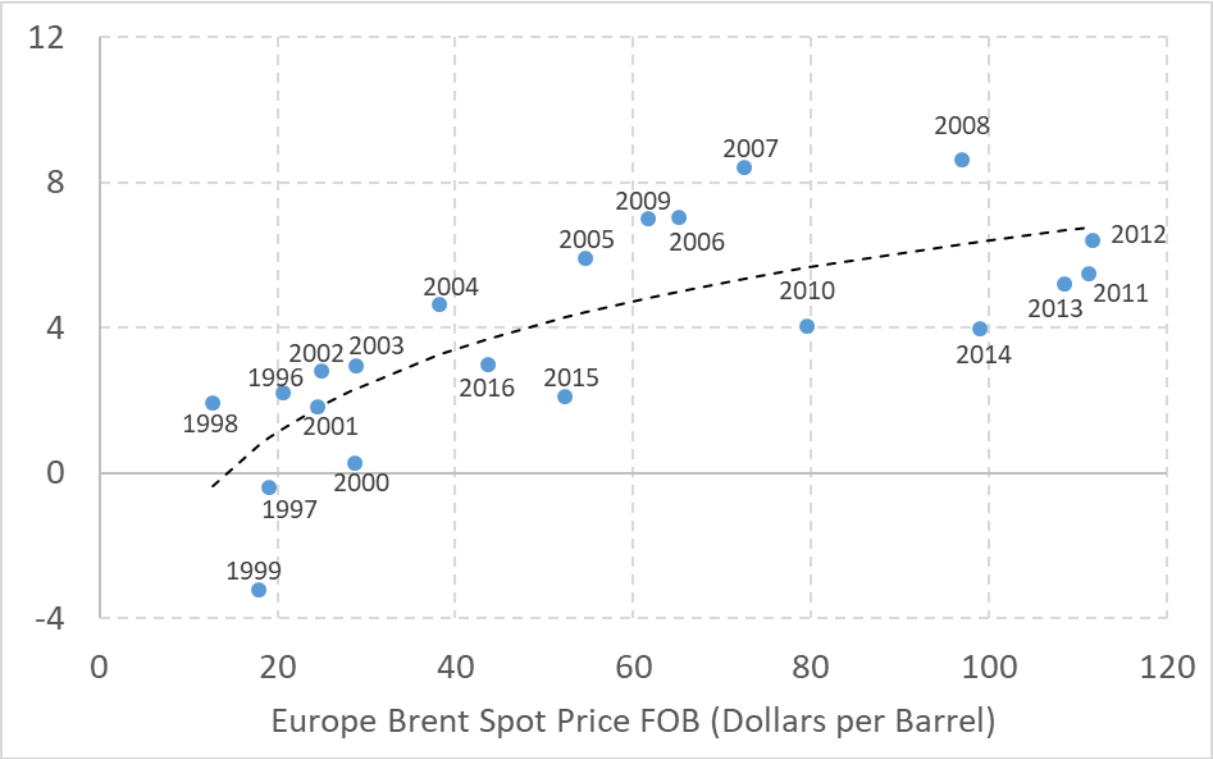
Figure 2. Labor productivity level in Russia relative to Germany and US in 1995-2019 (%)



Source: The Conference Board Total Economy Database™ (Adjusted version), April 2019

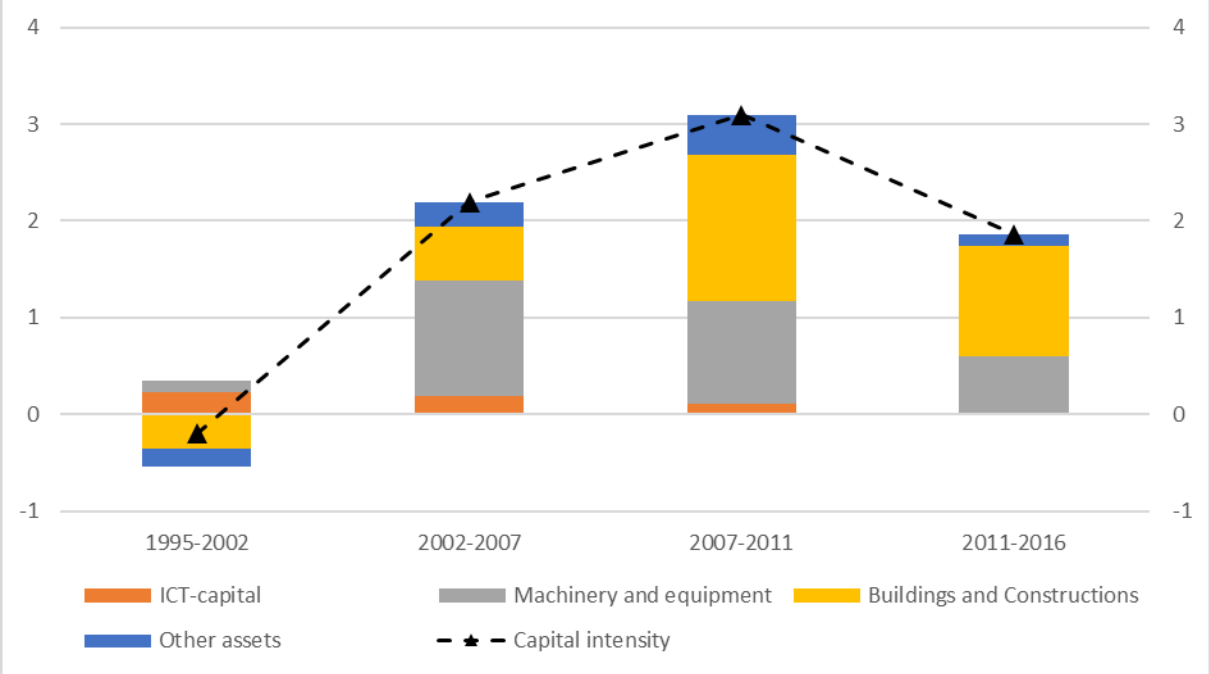
Notes: Labor productivity is defined as GDP per worker in constant PPP USD 2018.

Figure 3. Capital intensity growth rates and oil prices



Sources: Russia KLEMS 2019 and IEA

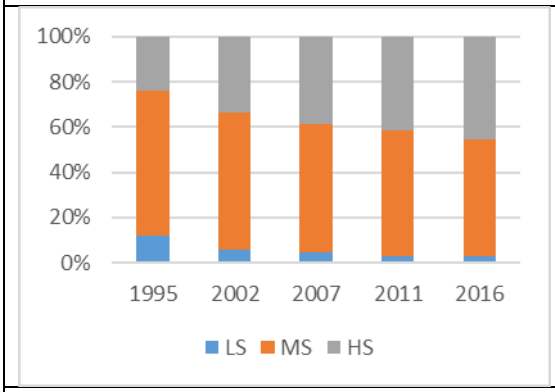
Figure 4. Sectoral contributions to aggregate capital intensity growth



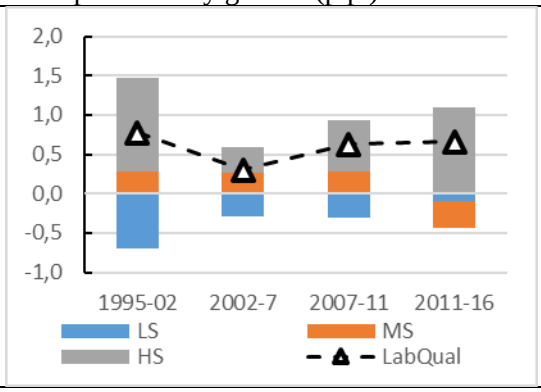
Source: Russia KLEMS 2019; Table 1

Figure 5. Labor composition by age and education

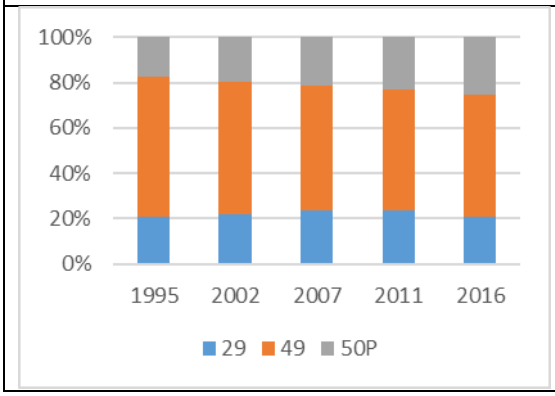
A. Shares of hours worked by workers with different levels of education



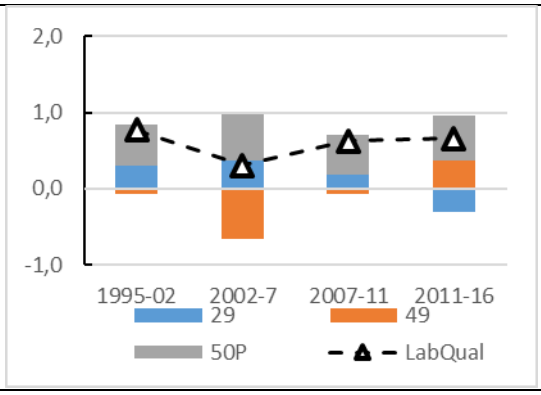
B. The contribution of labor composition to labor productivity growth (p.p.)



C. Shares of hours worked by workers of different age groups

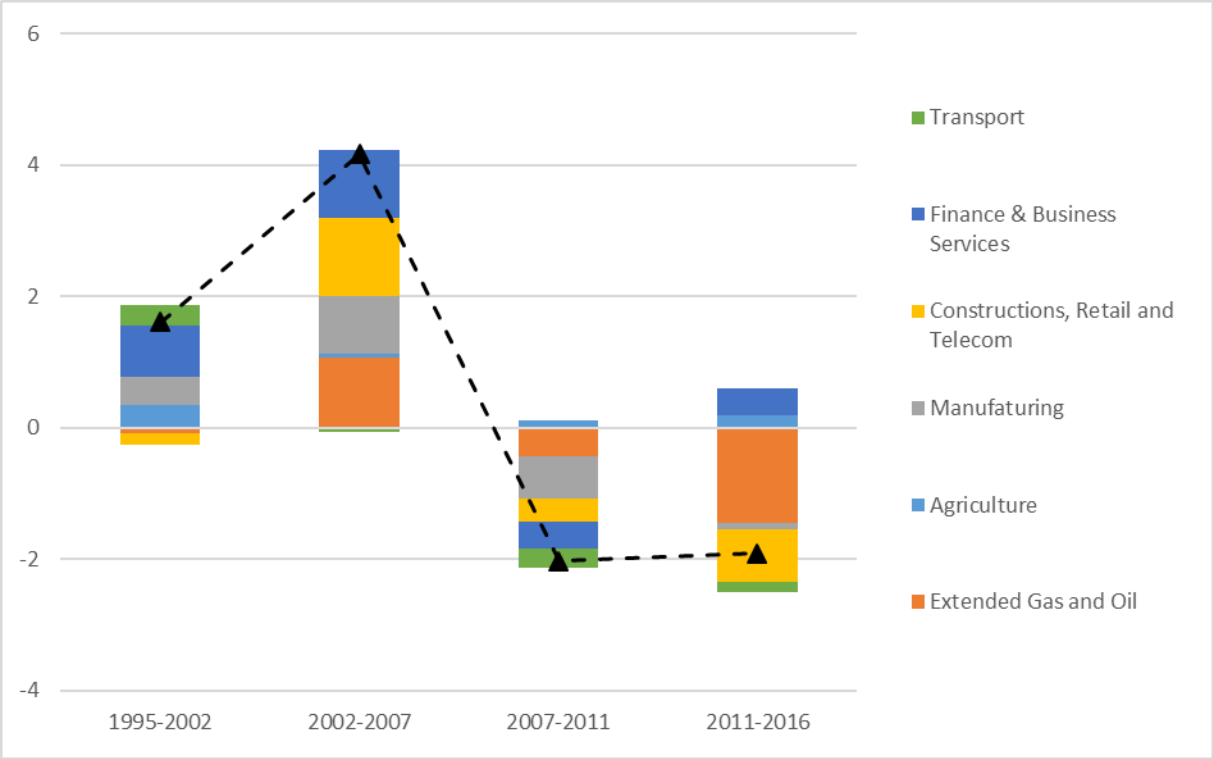


D. The contribution of labor composition to labor productivity growth (p.p.)



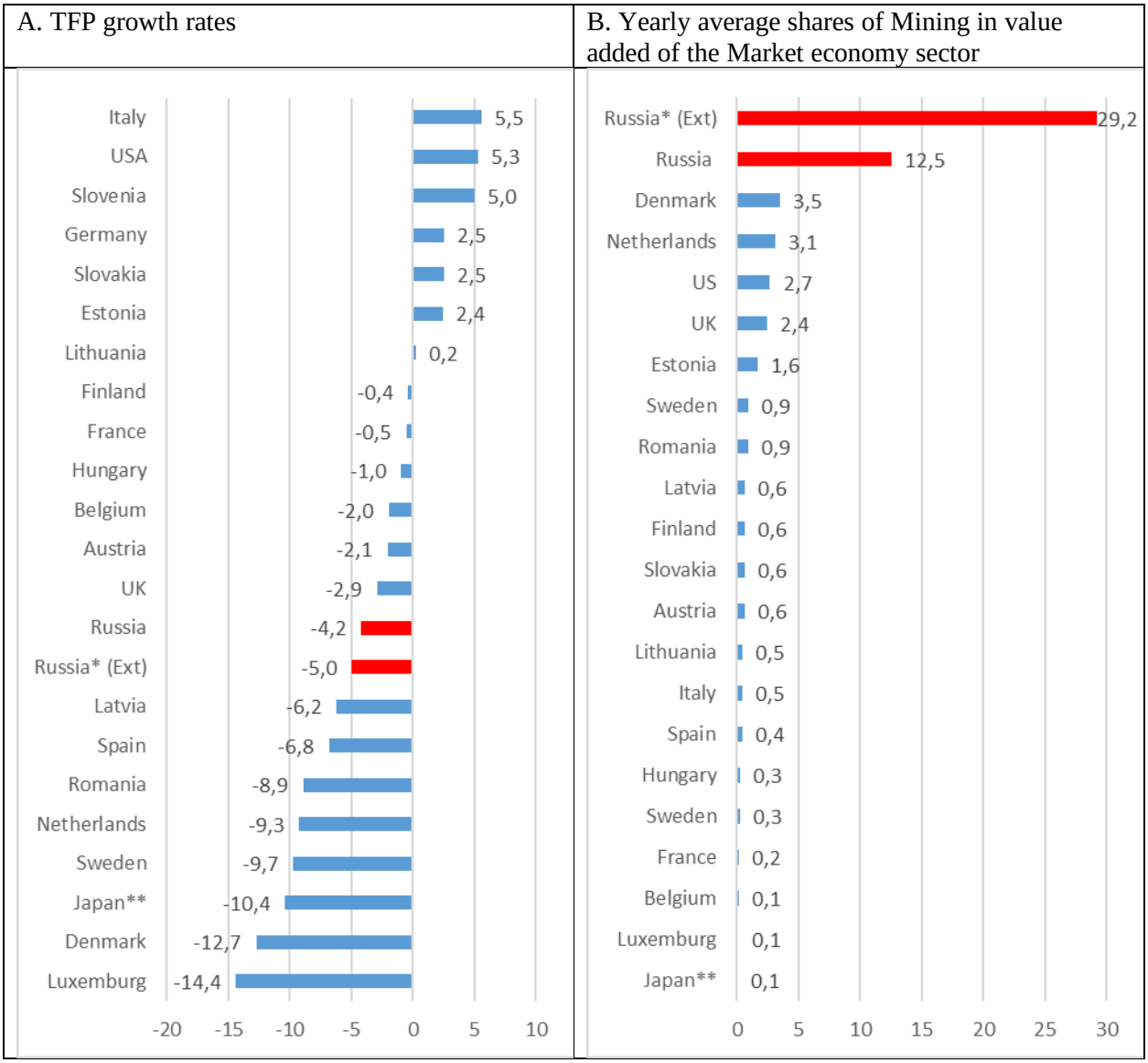
Source: Russia KLEMS 2019

Figure 6. Sectoral contribution to total factor productivity growth



Source: Russia KLEMS 2019

Figure 7. TFP growth of Mining in Russia and the OECD economies



Source: EU KLEMS 2019 and Russia KLEMS 2019

Notes: * Extended Oil & Gas. See Appendix A1; ** 2011-2015