

Russian manufacturing production capacity: Primary trends and structural characteristics[☆]

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Abstract

This paper estimates the capacity utilization rate for Russian manufacturing. We also propose a way to build continuous production capacity time series and indicators to describe the basic characteristics of production capacity. The data come from form 1-natura-BM of the Russian Federal State Statistics Service. Our findings on the trends and structural characteristics of production capacity are shown to be significant for economic policy since we found that in recent years capacities utilization rate in Russian manufacturing industry has been not extremely high and that there is a strong correlation not only between capacities utilization rate and inflation rate but between capacities utilization rate and capacities commissioning intensity as well.

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1. Introduction

This paper investigates the opportunities and industry structure for non-capital-intensive industrial production growth in Russia and the utilization and structural characteristics of production capacities (PC) in the manufacturing industry. We

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will formulate proposals for monetary policy and industry priorities for stimulating structural policy and for improving the industry statistics.

This paper's relevance follows from a lack of detailed post-Soviet estimates of manufacturing industry modernization by the expert community and public agencies, the fragmented nature of the basic concepts for measuring production potential, and insufficient investigation into the real utilization of PC. At the same time, the level of capacity utilization is directly or indirectly referred to (through the output gap estimates) by those discussing the optimal parameters for monetary policy.

2. International experience

In reviewing global practice, detailed analyses of PC trends and characteristics are usually made for individual products as part of specific industrial sector research. Meanwhile, there is a lack of cross-sectoral industrial capacities analysis. The main reason for the current state of affairs is apparently the lack of comparable data gathered across a wide range of sectors using a single methodology.¹ At the same time, direct and indirect estimates of production capacity utilization rates have been widely used for many years as a significant business cycle indicator.

Three main approaches to measuring PC² utilization are typically used according to global practice.

The first approach is based on *surveying* managers who estimate company's capacity utilization as a percentage of a given level. This is a common approach used by many countries and international organizations for promptly monitoring the economic "health" of the manufacturing sector. For example, in surveys by the U.S. Census Bureau, the respondent must measure a company's production output by fully utilizing the PC but without changing the working mode (Federal Reserve, 2016). In European Commission surveys (European Commission, 2016, p. 28), respondents specified PC utilization as a percentage of the maximum level. In the OECD surveys (OECD, 2003), the PC utilization rate is measured as a percentage of "normal" utilization rate.

The second approach is focused on measuring PC utilization for specific products as ratio of actual and maximum levels where maximum level is determined by characteristics of the equipment used ("engineering" approach). For example, the U.S. Federal Reserve uses both the Census Bureau surveys and PC utilization data in physical terms (for individual industries), gathered by industry associations and institutions. Similar production capacity estimates are also used in Japan (METI, 2015) and India (Reserve Bank of India, 2011).

¹ An additional recent factor has apparently been the relocation of production facilities from developed to developing countries, which had an additional negative impact on the availability of standardized data and deviated researches in developed countries from the issues of industrial development.

² Two main approaches to estimating maximum output produced with certain PC should be mentioned: the "engineering" approach interprets it as the maximum output achieved at a fixed capital supply and at no limitations on variable factors (labor, etc.); the "economic" approach—as the optimal and economically justified output where, over a short term, a firm cannot improve its position (in any sense) by increasing the intensity of capital utilization.

The third approach uses an indirect measurement of capacity utilization rates based on certain models and assumptions. The simplest methodologies for this approach include linear interpolation of values between local maximums and interpretation of those values as a potential output, the Wharton Business School Index (Klein and Summers, 1966), a comparison between current output and the output calculated as a ratio of capital and minimum capital-output ratio within a local neighborhood,³ and a comparison between the average and maximum hours worked and capital used (Taubman and Gottschalk, 1971; Beaulieu and Matthey, 1998). In the framework of this approach, more complex methodologies should be mentioned: the optimal utilization level would occur if either short-term costs are minimized (Klein, 1960; Friedman, 1963; Hickman, 1964; Morrison, 1985; Prior and Filimon, 2002; Ray, 2015), short-term output is maximized (Johansen, 1968; Fare et al., 1989; Ray et al., 2006), or profit is maximized (Coelli et al., 2002). Recently, the structural and cyclical components of economic trends have been isolated using filters or structural vector autoregression methods (Andrle, 2013; Havik et al., 2014; Apokin et al., 2014; Bank of Russia, 2014; Sinelnikov-Murylev et al., 2014; IMF, 2014), along with econometric analyses of the correlation between changes in the core inflation rate and capacity utilization rates (McElhattan, 1978; Oomes and Dynnikova, 2006; Mironov and Kanofiev, 2014). Finally, a number of papers estimate capacity utilization rates using indirect indicators that describe the consumption of electricity and other basic resources (Foss, 1963; Jorgenson and Griliches, 1967; Anxo and Sterner, 1994).

3. Data sources on capacity utilization rates in Russia

There are four data sources for capacity utilization rates in Russia today (Table 1). Despite the variety of data sources, it's very difficult to get the reliable estimates for capacity utilization rates (and certainly for other capacity characteristics).

Rosstat estimates are compiled based on the results of surveys among executives at large and medium-sized companies; the aggregated capacity utili-

Table 1
Basic characteristics of data sources.

	Rosstat (Business Activity of Organizations in Russia)	Russian Economic Barometer (REB)	Gaidar Institute for Economic Policy	Rosstat (Form 1-natura-BM)
Type of data	Surveys	Surveys	Surveys	Statements
Level	Sectors	Overall industry	Overall industry	Products
Frequency	Month	Month / quarter	Month	Year
Beginning of publications	Jan 2006 (OKVED) 1995 (OKONH, Russia Classification of Economic Sectors)	Dec 1991	Jan 1993	1992

Source: Compiled by the authors.

³ We were not able to identify the author of the method (it is commonly used; see, e.g., Gajanan and Malhotra, 2007).

zation ratio for the manufacturing industry is published in *Business Activity of Organizations in Russia* (as a percentage of the maximum⁴). Estimates by sectors are available as well.⁵ However, there are two major flaws in Rosstat's estimates. First, we identified a stable shift in estimates, they are understated because Rosstat assumes that non-responding companies had a zero capacity utilization rate. Second, Rosstat receives aggregated estimates across activities, without taking into account the size of the companies and sectors.

REB data on capacity utilization rates are compiled based on managers surveys. It should be stressed that, unlike the Rosstat capacity utilization ratio (percentage of the maximum possible utilization), the REB indicator measures utilization against the “normal” level, determined independently by respondents (it may exceed 100%), which is why these ratios cannot be directly compared. Speaking about drawbacks of the indicator, we should note that it is calculated on a monthly basis, but the bulletin is published quarterly, reducing the opportunity to promptly use the estimates. Moreover, the results are only presented for the industry as a whole and look distorted, while the calculation does not account for the size of companies and sectors (indicator for the industry is calculated as simple arithmetic mean).

IEP (Institute for Economic Policy) data (Monitoring of Russia's Economic Outlook monthly bulletin) are compiled from industrial company directors in response to the following question: “What is the current level of production capacity utilization in your company (%)?” However, they are not published regularly and are available publicly only as separate values for different periods, which is insufficient for a regular analysis. Combined with the limited openness of the methodology this does not qualify as an indicator for use in this paper.

Rosstat's statistical form *1-natura-BM “Information about the Production, Shipments, and Production Capacity Balance”*,⁶ represents the most complete source of information about capacities. The form cannot be used for real-time monitoring, as it is published annually, and only six months after the end of the reporting year. However, it offers highly detailed data about capacities for several hundred products disaggregated by the regions of the Russian Federation.

The PC of a company in the form are determined according to an “engineering” approach as the maximum possible output of product per unit of time at full utilization of the industrial equipment. The PC balance contains approximately 20 items (Table 2).

We directed our main efforts at compiling PC balance data based on Rosstat's highly disaggregated form 1-natura-BM: we gathered data on 388 product items for the 2010–2015 period (OKPD classifier, All-Russian Classification of Products by Economic Activities) and 411 product items for the 1995–2009 period (OKP classifier), with a breakdown by Russian regions for the 2000–2014 period. There are approximately 2.5 million primary data points.

⁴ The company specifies the decile of its own capacity utilization rate.

⁵ However, data by sectors can hardly be called easily accessible, as they are stored in Rosstat's database (Central Statistical Database), which lacks user-friendly interface. Gathering data by sectors could take a few hours.

⁶ Rosstat Order No. 320 dated July 15, 2015 “On the Approval of Statistical Tools for Organizing Federal Statistical Observation of Business Activities” (version dated 12.03.2015).

Table 2
Production capacity balance indicators.

No.	Line description
1	PC at the beginning of the year
2	PC increase, including:
3	Creation and expansion of facilities
4	Reconstruction of facilities (improving the technical and economic level of production through expanding or reconstructing existing production areas in a company)
5	Technical upgrades for facilities (improving the technical and economic level of production without expanding or reconstructing existing production areas in a company)
6	Leased equipment
7	Changes in the composition of products manufactured (conversion, decreasing labor intensity)
8	Other factors
9	PC reduction, including:
10	Changes in the composition of products manufactured (conversion, increasing labor intensity)
11	De-commissioning (due to the old age of equipment, transition to new types of raw materials, calamities, etc.)
12	Equipment lease-out
13	Other factors (sale, bankruptcy, or liquidation of companies, etc.)
14	PC at the end of the year
15	Annual average capacity during the reporting year
16	Product output during the reporting year
17	Utilization of annual average capacity during the reporting year (%)
18	Product output using non-core facilities
19	Product output during non-working hours

Source: Compiled by the authors based on Rosstat Order No. 320 dated July 15, 2015.

4. Methodology used for building continuous time series of PC

It is advisable to use time series to analyze the structural characteristics of PC. However, none have been built, until recently, for the Russian economy. We decided to fill the gap.

The key issue in building PC time series is interpreting the annual deviations between statements (between the year-end data of year t statements and the year-beginning data of year $t + 1$). To verify the approach, we studied a considerable number of actual deviations of this type and their representation in statistical reports and can confidently state that—at least in the case of Russian economy—it would be most correct to interpret these deviations not as sample shifts but as real movements of capacities (opening or closing down a factory, or fully converting it). Regrettably, the limitations of the article do not allow us to include a detailed rationale behind the approach used by citing the full range of these types of cases⁷.

⁷ Some representative examples are the following. In 2012, a fish-processing factory in Murmansk region was upgraded and was included in the sample in the region's PC balance. A similar situation was observed when a brewery in Kursk was closed down in 2012: statements were available for the end of 2012, but “disappeared” from 2013 onward (however, the factory was actually closed down in the middle of 2012). Another fact favors the selected approach: the average weighted value of positive deviations in the data for adjacent years (the cases when the values for the beginning of the year exceed the values for the end of the previous year) was 6.5%, while the same indicator for negative deviations was only 1.8%. This supports the interpretation of this deviation as changes in PC (in case of the sample shifts, negative deviations should be close to positive). An alternative explanation might be the relentless expansion of the sample of companies surveyed, but it contradicts two additional observations. First, subject to the median difference of 8 p.p. between positive and negative deviations, this would mean that the sample had expanded by three times during the period that is doubtful (Rosstat did not purposefully look to expand the sample when collecting data according to statistical form 1-natura-BM). Second, the median value of negative and positive deviations was close, while the weighted average was persistently positive, which also supports our hypothesis (all other things being equal, smaller companies are represented in the data less regularly).

In building the PC time series, we accounted for the change in the product type classifiers (the transition from OKP to OKPD at the beginning of 2010). To this end, we improved the existing OKP-OKPD transition key (it lacked a number of product items for PC balances). Changing the classifier did not allow us to interpret the deviations between the end of 2009 and beginning of 2010 as a real change in capacity.⁸

In the new series, we corrected for the gaps in the statements, which is especially important for regional data.⁹ Upon identifying a regional and national gap, we interpolated all data; upon identifying only a regional gap, we interpolated just the regional data and added the regional PC estimate obtained to the national value.¹⁰ Missing data on PC at the end of the year were treated as equal to the data on PC at the beginning of the next year (equivalent corrections were made for missing data on PC at the beginning of the year). The difference between PC at the end and the beginning of neighboring years was interpreted as the increase or reduction of capacities. This decision is based on studying a large set of particular cases of changes in capacity reported in the statistical form 1-natura-BM.

5. Methodology for calculating indicators to measure the main PC characteristics

The widespread approach is to review the PC increase, reduction, renovation, and liquidation ratios. For Russian industry, capacities estimates were calculated recently (Zamaraev and Marshova, 2015).

The PC increase ratio kv and PC reduction ratio kw are calculated as follows:

$$kw_t = \frac{c(9)_t}{c(1)_t}, \quad kv_t = \frac{c(2)_t}{c(14)_t}, \quad (1)$$

where $c(i)_t$ is the i -th indicator (i -th PC balance line in Table 2) per year t .

The renovation ratio kr and liquidation ratio kl are calculated from the following PC balance lines:¹¹

$$kr_t = \frac{c(3)_t + c(4)_t + c(5)_t}{c(1)_t}, \quad kl_t = \frac{c(11)_t}{c(14)_t}. \quad (2)$$

Certain doubts arise regarding this approach, as the renovation and, particularly, the liquidation ratios are quite small even in sectors with well-known high

⁸ Due to the mismatch of the varieties within product groups according to different classifiers, or due to a lower quality of statistics during the first year of using a new classifier (not all companies detect their product codes correctly). To remove the deviation, all data for a particular product and region for 2000–2009 were multiplied by a ratio of capacity values at the beginning of 2010 and at the end of 2009.

⁹ For many products, the regional data on capacities consists of the data provided by one or two companies. This confidentiality issue results in the fact that the data was not provided by Rosstat in 3,970 cases (for the sample of 240 major products by Russian regions for 2000–2014).

¹⁰ Thus, the deviation between the values for the end of the year and the beginning of the previous year at the national level was partly removed, while the impact of the sample shift on the deviation was reduced. This fact also favors our approach to eliminating deviations between adjacent years.

¹¹ The renovation ratio reflects the new PC commissioning, while the difference between PC increase and renovation ratios reflects other factors (which are not always differentiated) related primarily to the “production reorganization”. The real de-commissioning of facilities is characterized by the liquidation ratio, while the difference between PC reduction and liquidation ratios is related to the companies’ search for the ways to sell their products in changing economic conditions and demand (Zamaraev and Marshova, 2015).

investment intensity (e.g., in food production). At the same time, the PC increase and reduction ratios are extremely high, so much that Zamaraev and Marshova (2015) noted their “degenerated” nature (authors noted that such indicators fail to reflect the real changes in PC).

Relying on sufficiently detailed data on changes in PC at the regional level, media publications and company press releases, we analyzed a significant number of cases of real movements of PC by individual products. As a result, we confirmed that:

- a change of ownership is inversely reflected in increase and reduction of PC and is reported as the change in PC due to “other factors”;
- a company’s bankruptcy is reported as the reduction of PC due to “other factors”;
- PC leases between companies (usually within a given region, between adjacent regions or within a single company) are reflected in PC balances as “inverted” increase and reduction of PC.

We also discovered a number of new phenomena that are not in line with the classic methodology. We found that the emergence of a new factory is often reported as the increase of PC due to “other factors”¹² or as a discrepancy between data at the beginning and at the end of adjacent years. Shut-down of a factory is often reflected in the reduction of PC due to “other factors” or as a discrepancy between data at the beginning and the end of adjacent years. Moreover, real growth in the PC is often reflected in the increase of PC due to “other factors.” Finally, a top-down conversion of PC accompanied by modernization may be reflected as a “change in composition” (accounts 7 and 10 of the balance).

The numerous findings prove that *traditional liquidation and renovation ratios understate the real volume of new equipment de-commissioning and commissioning*. Therefore, we suggest modifying formula (2), considering the actual specifics outlined above:

$$kl_corr_t = kl_t + \frac{\max\{0, c(12)_t - c(6)_t\} + \max\{0, c(13)_t - c(8)_t\}}{c(1)_t} + \frac{\max\{0, c(10)_t - c(7)_t\} + \max\{0, c(14)_t - c(1)_{t+1}\}}{c(1)_t}, \quad (3)$$

where kl_t is the original liquidation ratio per year t .

Accordingly, the renovation ratio should be calculated as

$$kr_corr_t = kr_t + \frac{\max\{0, c(6)_t - c(12)_t\} + \max\{0, c(8)_t - c(13)_t\}}{c(14)_t} + \frac{\max\{0, c(1)_{t+1} - c(14)_t\}}{c(14)_t}, \quad (4)$$

where kr_t is the original renovation ratio per year t .

¹² For example, the opening of the LG Electronics RUS TV and appliances assembling factory in the Ruza District (Moscow Region) in 2006 was reported as the increase of PC due to “other factors”. A similar situation occurred during the opening of the Ford Sollers factory in Naberezhniye Chelny in 2014. An inverted situation is the shut-downs of the SUN InBev (2010) and Efes Rus (2013) breweries, which were reported as a decrease in PC due to “other factors”.

In addition, we introduce the net commissioning ratio and de-commissioning ratio of old facilities:

$$kr_old_t = \frac{\max\{0, c(7)_t - c(10)_t\}}{c(14)_t}, \quad (5)$$

$$kl_old_t = \frac{\max\{0, c(10)_t - c(7)_t\}}{c(14)_t}. \quad (6)$$

The suggested modification makes a considerable correction to the understanding of the actual PC renovation processes in the Russian economy. For example, according to the standard approach, only one-third of manufacturing facilities were less than 10 years old in 2015, while, according to the adjusted methodology, such facilities accounted approximately for one-half of all facilities.

Other specific features of the methodology used in the paper include the following.

PC at the industry level were obtained by aggregating the measurements by product type, using annual average prices of 2012.¹³ All estimates are provided only for civil products (dual-purpose or military products are excluded from the analysis). Mining and quarrying was evaluated without oil and gas production. Vehicle production accounts mainly for automobiles and railway rolling stock, as data on airplane and helicopter production has only been published since 2010.

We also calculated some additional indicators. First, we broke down output growth by factors (the commissioning of new PC and additional utilization of existing PC), separately by products and regions, based on the hypothesis that new PC are utilized first. We assumed that new PC, commissioned in a given year, can be utilized additionally during the next three years. Second, we calculated the capacity utilization ratio of newly commissioned capacities (the level of capacity utilization ratio which stimulates companies to increase their PC) as an average weighted ratio for products and regions in year $t-1$, with weights corresponding to the PC values in year $t-1$ and commissioning in year t across all regions where new capacities were commissioned.

6. Estimates of major structural characteristics of PC

A comparison of PC utilization estimates from different sources (Fig. 1) shows that, despite slight differences between them, the estimates appear to be very highly correlated in time. This fact supports the reliability of the PC utilization estimates obtained.

Since 2000, the capacity utilization ratio grew steadily, peaking in 2007 (at 72%). After the fall during the 2008–2009 crisis and the subsequent rebound, the ratio hovered at approximately 70% in 2011 and 2012, followed by a gradual decline to 66% in 2015.¹⁴

¹³ For most products, we directly used data on annual average prices from Rosstat's statistical form 1 producer prices. For the remaining 34 products, we used annual average producer prices for the closest equivalents. In particular, we addressed the issue of mismatched measurement units for products from different statistical reporting forms. The expert estimates were obtained in various ways—for example, using data from electronic trading platforms.

¹⁴ In the manufacturing industry (excluding oil refining), the capital utilization ratio dropped even sharper: the ratio decreased to the level of 62% in 2015, compared to 69% in 2007.

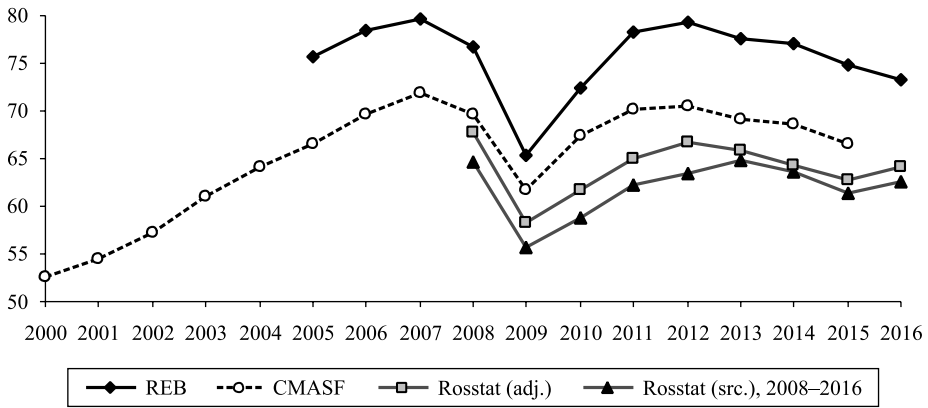


Fig. 1. PC utilization level in manufacturing companies (as a percentage of maximum level).

Source: Hereinafter in figures, Rosstat data and estimates by the Center for Macroeconomic Analysis and Short-term Forecasting (CMA SF).

These first results alone show that there were evidently some excess PC, at least from the beginning of 2013: in this year, the ratio decreased not just below the maximum of 2007 but below the level of the two preceding years. Moreover, in 2014, the capacity utilization ratio continued to decline, so that some excess PC definitely existed. Based on this tentative and extremely simplified estimate (an “upward estimate”, as shown below), excess PC account for at least 3–5 p.p. of PC, which corresponds to a possible increase in output for 4.5–7.5% in case of fully utilizing these PC.¹⁵

During the first phase of the post-crisis¹⁶ development (2001–2005), the PC level hardly increased until 2006 (Fig. 2), while the intensity of both PC de-commissioning and PC renovation rates did not exceed 3–4% (Fig. 3); on the whole industry level one can conclude that the output increased through additional utiliza-

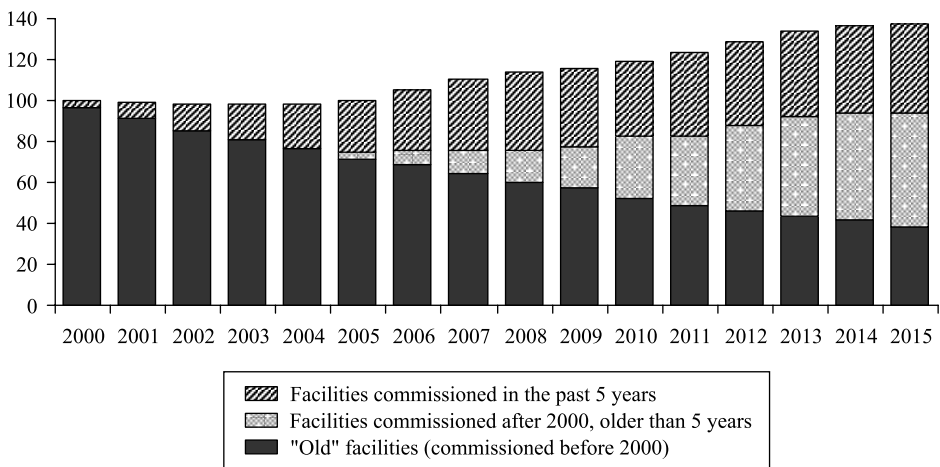


Fig. 2. PC volume and age structure (2000 = 100).

¹⁵ They were increasingly referred to as non-existent during this period.

¹⁶ i.e., the 1998 crisis.

tion of existing PC (as we found, the process was more complicated: new PC were commissioned and launched while existing PC were utilized more and old PC were utilized less, see below). During the second half of the 2000s, the situation changed considerably: the intensity of commissioning increased sharply while the intensity of de-commissioning remained the same, which gave rise to a new trend, i.e., PC growth until 2015. At the same time, the 2008–2009 and 2014–2015 crises only slowed but did not stop the intensity of PC growth. The deceleration was caused by less commissioning; the intensity of de-commissioning hardly changed since 2005.

Our approach allows obtaining the decomposition of output growth into the two components: growth due to commissioning of new PC and growth due to additional utilization of existing PC.¹⁷ It is usually considered by Russian experts that during the first half of the 2000s, output increased mainly due to additional utilization of existing PC. The estimates we obtained demonstrate that this factor has been overestimated for the period of early 2000s: according to our calculations, it accounted for slightly less than a half of the output growth, while PC commissioning accounted for the remainder (Fig. 4). At the same time, the role of additional utilization was underestimated in recent years (it is usually held that the additional utilization was no more important during the second half of the 2000s). Our research shows quite the contrary: in 2012–2014, around one-third of output growth was caused by additional utilization (this figure was only 1.5 times higher in 2001–2004).

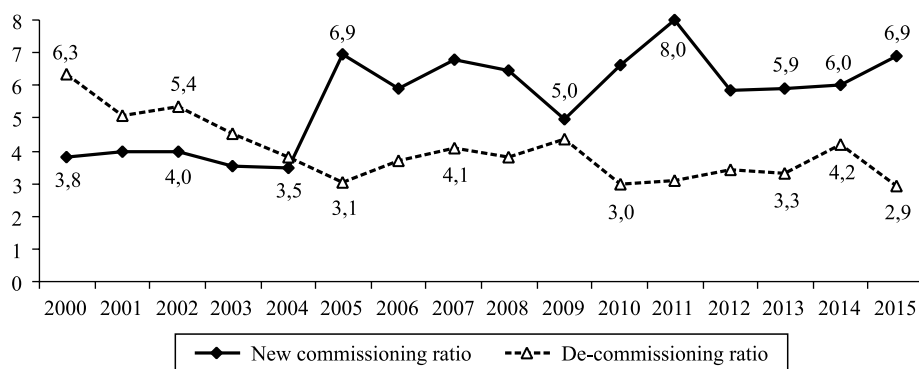


Fig. 3. PC renovation and liquidation ratios (%).

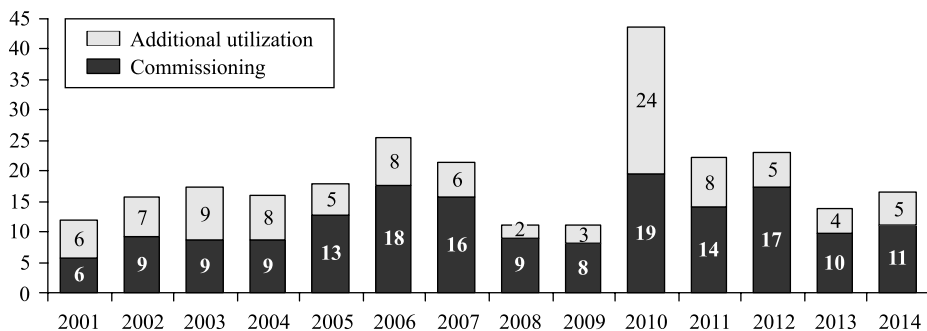


Fig. 4. Decomposition of output growth by factor (RUB trillion, 2012).

¹⁷ On the products/regions level we assumed that increase in production is based on new capacities if these new capacities were commissioned during last 3 years before production increase.

PC changes in physical terms are highly differentiated by economic activities (Fig. 5). Four groups should be identified.

Group A. Superleaders—PC more than doubled in 15 years. This group includes manufacture of rubber and plastic products, as well as manufacture of electrical equipment and consumer electronics. However, PC in the latter economic activity grew mainly due to the new assembling lines used to produce home appliances.¹⁸

Group B. Leaders—PC growth by 1.5–1.7 times. The group includes three sectors: coal mining and processing, manufacture of food products, and manufacture of motor vehicles and other transport equipment.¹⁹

Group C. Followers—PC growth by no more than one-third. The group includes almost all raw materials production, as well as non-fuel mineral extraction. The limited PC growth in this segment was caused by reduced incentives: as shown by the analysis, the age of PC in these sectors is not crucial factor to use them (as a rule, the old PC utilization ratio differs nonsignificantly from the new PC utilization ratio in these sectors).

Group D. Outsiders—PC reduction. The group includes mostly manufacture of machinery and equipment (without the military-industrial complex), as well as manufacture of textiles and wearing apparel.

This paper estimates the average age of PC. It is differentiated considerably by sectors and reflects the intensity of PC renovation. On the whole, there is a logical pattern: older PC (older than 15 years²⁰) are concentrated in raw materials production, while newer PC (younger than 10 years)—in end-use production (Fig. 6). Significant progress should be noted in the PC renovation—in manufacture of food products, manufacture of plastic products, and wood processing. On the other hand, PC renovation is not intensive in the majority of mechanical engineering sectors (in manufacture of electrical equipment and consumer electronics, new PC

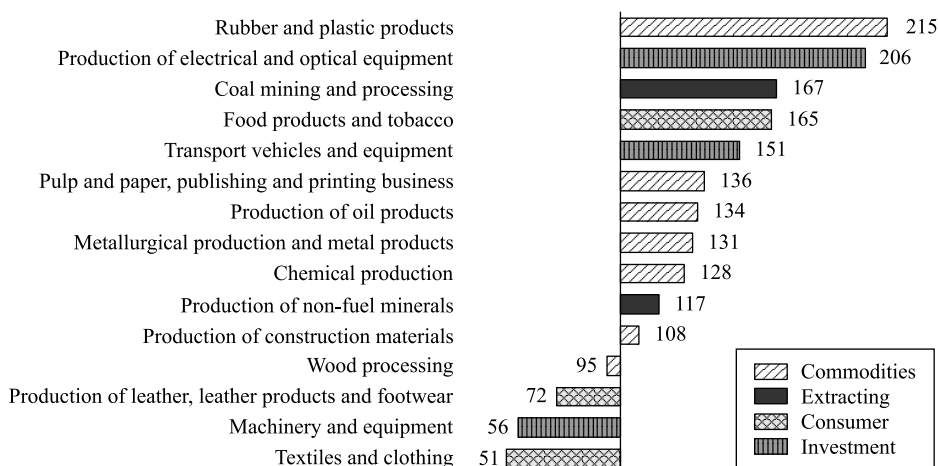


Fig. 5. Changes in annual average PC volume, 2015 compared with 2000 (%).

¹⁸ For basic electrical equipment, the PC increase was not large (+16%). Other products demonstrated considerable PC reductions.

¹⁹ In this sector, the data on PC is presented only for automobiles and railway rolling stock.

²⁰ The average age of PC commissioned before 2000 was assumed to be 25 years in 2015 (as a result we have some sort of an upward estimate).

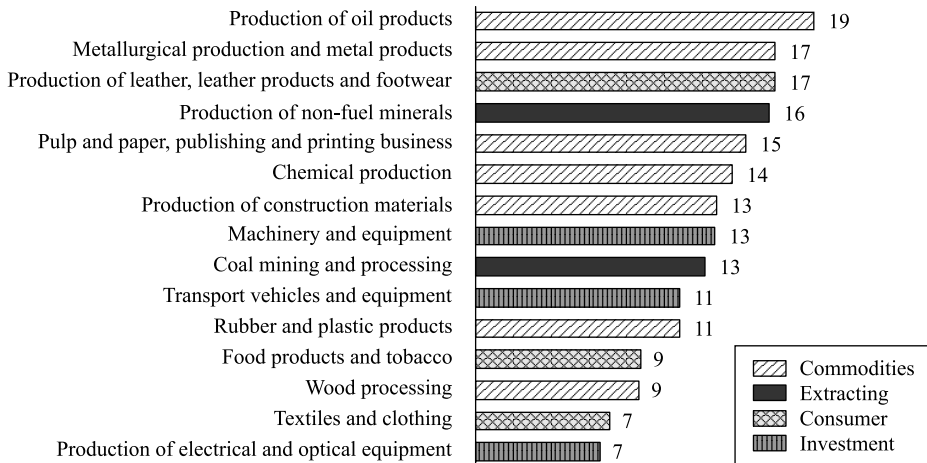


Fig. 6. Average PC age by sector in 2015 (years).

are largely assembly lines). In manufacture of textile and wearing apparel a significant portion of the new PC was commissioned for a narrow group of products in conditions of output stagnation and absence of de-commissioning of old PC.

We have estimated the share of noncompetitive PC (we define such PC as PC older than 10 years and not utilized for at least the past five years).²¹ Note that it can be reserved PC in a number of industries.²² Our estimate shows that the weighted average share of noncompetitive PC in the manufacturing industry (excluding oil refining) is 13–14% (Fig. 7). It is especially high in the investment segment: from 17% in manufacture of motor vehicles and other transport equipment to 26% in manufacture of machinery and equipment. A large share of these capacities is allocated in the dynamically developing chemical production (a number of old PC have not been de-commissioned and are not utilized across a wide range of both raw materials and the final products). In the other industries, the share of noncompetitive capacities is low, no more than 10–11% (in the manufacture of food products, estimation of their share is 14%; however, those are mainly reserved PC).

The capacity utilization ratio as of 2015 is highly differentiated by sectors (Fig. 8). On the one hand, we identified a group of products with capacity utilization ratios exceeding 80%, for which the prospects for non-capital-intensive growth are very limited (most raw materials products). On the other hand, sectors dependent on investment demand (almost all mechanical engineering productions) and focused on durable products (which is natural in a crisis) demonstrated extremely low performance on this ratio. If noncompetitive capacities are considered in the calculation, the PC utilization ratio estimate will increase for the majority of sectors: the excess competitive PC in raw materials production are very small,²³ but there is no deficit of PC in most domestically focused sectors.

²¹ Calculations of this kind are made at the products /regions level, allowing for a highly accurate estimate.

²² For example the key products for ensuring the country's food security in case of emergency are bread, oats, flour, pasta, and butter.

²³ This does not mean that there will be no vacant PC in the near future: the contribution of additional utilization is material.

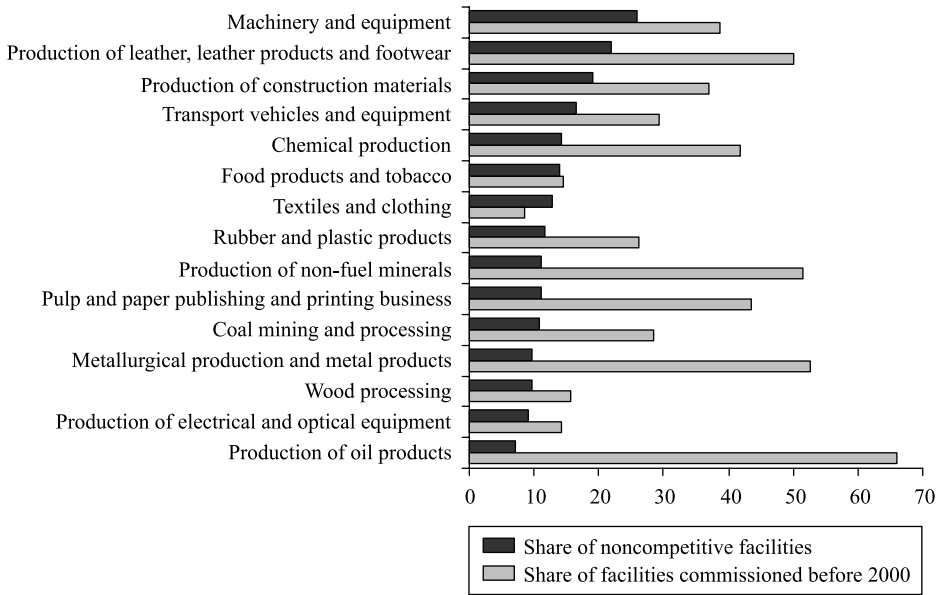


Fig. 7. Share of noncompetitive and old PC in 2015 by sector (%).

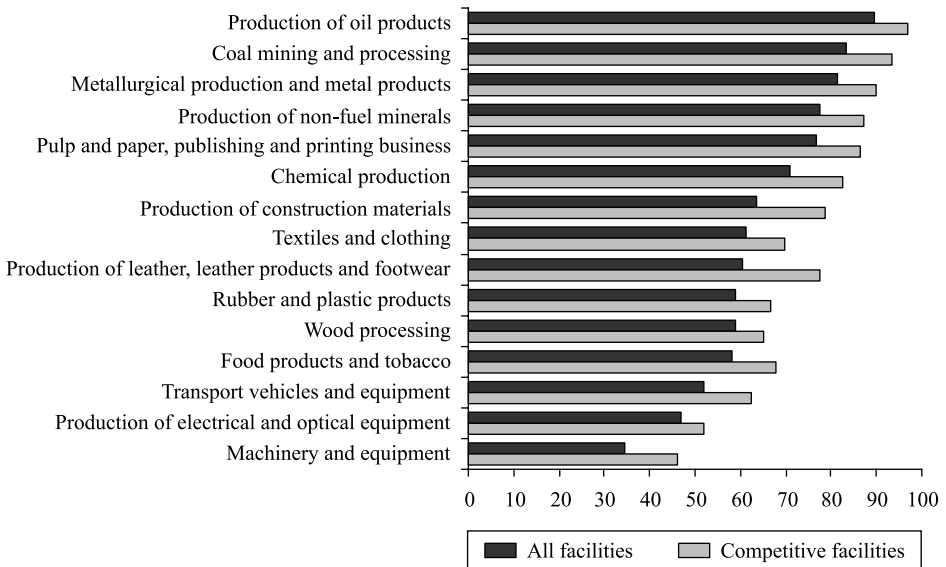


Fig. 8. Capacity utilization ratio in 2015 by sector (%).

To estimate the capacity utilization ratio growth potential, we conducted a sectoral analysis relying on information about the top decile of the capacity utilization ratio, the “new commissioning ratio,” capacity limitations at the detailed level, etc. We found that for the majority of sectors the level of PC utilization in recent years has been at least 5 to 10 p.p. below the maximum capacity utilization ratio (Table 3).

The literature (Oomes and Dynnikova, 2006; Mironov and Kanofiev, 2014) demonstrates that before the 2008–2009 crisis, Russia’s industry operated close to a capacity utilization ratio that accelerated inflation. As our study shows,

achieving a sufficiently high capacity utilization ratio at the same time stimulates investment activity. We found that an increase in the capacity utilization ratio by 5% results in 8% to 10% more commissioning if capacity utilization ratio is below 90%, whereas this figure jumps by 1.5 times if capacity utilization ratio is above this threshold (Fig. 9).²⁴

Table 3
Capacity utilization ratio growth potential: estimates for sectors.

Sector	Growth potential against 2015, p.p.	Capacity utilization ratio in 2015, %	Optimal ratio, %	For reference: capacity utilization ratio in 2013, %
Manufacture of food products	5–10	≈ 60	65–70	≈ 60
Manufacture of textiles and wearing apparel	≥ 10	≈ 67	75–85	70
Manufacture of leather and related products	< 10	51	75–80	≈ 60
Manufacture of wood and of products of wood and cork	≥ 10	≈ 60	70–75	≈ 60
Manufacture of paper and paper products	< 5	82	85–90	74
Manufacture of chemicals and chemical products	5–10	74	80–85	72
Manufacture of rubber and plastic products	15–20	56	75–80	56
Manufacture of other non-metallic mineral products	≈ 15	57	70–75	64
Manufacture of ferrous metals and fabricated metal products	≈ 10	78	85–90	78
Manufacture of machinery and equipment	25–30	35	65–70	39
Manufacture of electrical equipment and consumer electronics	≈ 20	34	65–80	47
Manufacture of motor vehicles and other transport equipment	> 30	38	75–85	60

Source: Compiled by the authors.

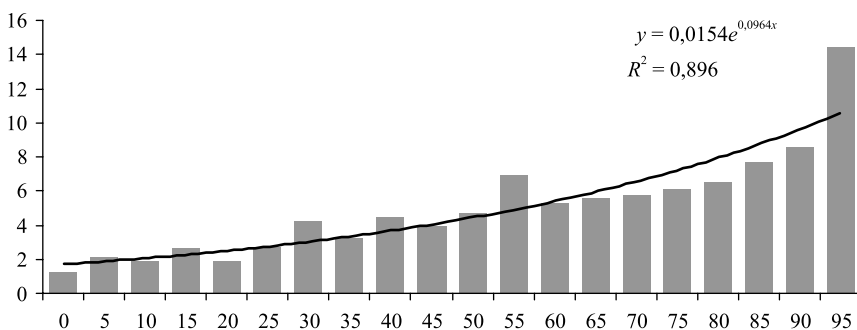


Fig. 9. Distribution of new commissioning based on the capacity utilization ratio (in previous year) in the manufacturing industry (aggregated results for 15 years, 200 products and 70 regions) (%).

²⁴ To obtain this result, one may conduct a product and regional level analysis. No correlation can be found on a country-product basis due to the mismatch of the spatial distribution of commissioning and capacity utilization ratios.

7. Main results by sector

7.1. *Manufacture of food products, beverages and tobacco products*

The development of food production sector was rather successful. In 2015, physical volume of capacity was estimated at 165% of the 2000 level (physical terms); PC in fruit and vegetables, oils and fats, and nonalcoholic beverages production grew explosively by more than threefold. Old capacities (commissioned before 2000) accounted for 12% of total capacities in 2015, while the share of new capacities commissioned over the past five years was nearly 40%. The average age of facilities was slightly more than 9 years by 2015 (compared with 12 in the manufacturing industry on average), whereas the share of noncompetitive capacities is less than 10%.

In 2000, the capacity utilization ratio was only 39%; by the mid-2000s, it stabilized at an optimal range for the sector (57–59%). The main driver behind the increasing output was the commissioning of new capacities; additional utilization of capacities accounted for approximately 25% of the growth on average (or approximately 2 p.p. of the output growth, while this share was stable throughout the entire period under review). Despite the 2014–2015 economic crisis in Russia, the commissioning of new capacities accelerated, primarily due to trade barriers implementation.

In recent years, the capacity utilization ratio for the sector has been approximately 60%, while the threshold for the maximum capacity utilization ratio for the sector is estimated at 65% to 70%,²⁵ i.e., the output growth potential through additional utilization is 5 to 10 p.p.

7.2. *Manufacture of textiles and wearing apparel*

The textile industry performed rather poor in terms of capacity renovation and utilization. During 15 years, physical capacity decreased almost by half, with a three- to tenfold reduction for most small-scale products. The share of new capacities commissioned during the past five years was equal to half of the existing ones in 2015; however, the bulk of capacities commissioned were concentrated in non-woven materials²⁶ (56% of the industry output in 2015).

The sector developed in two stages: until the mid-2000s, despite a slow decline in output, capacities were de-commissioned very quickly (the commissioning was non-intensive); beginning in 2009, the capacity reduction stopped, and output started to climb, while capacities began to be renovated more intensively such that old capacities were almost entirely liquidated by 2015.

To the end of the period, the situation improved: the average age of facilities reached 7 years (compared with an average of 12 for the overall manufacturing industry), while the share of noncompetitive capacities amounted to 13%. However, it was achieved due to the de-commissioning of capacities for nearly all products (low market demand), without a massive launch of the new produc-

²⁵ The optimal capacity utilization ratio is low in the food industry: for certain products, capacities are intentionally reserved (for flour, bread, cereals, butter, etc., in case of unforeseen events) or are utilized unevenly (for products with a clearly seasonal demand).

²⁶ With the launch of a factory producing this product in 2009, the capacity reduction stopped.

tion. We identify three types of capacity changes: a considerable decline in production without renovation of the capacities (wool, cotton, linen yarn production, finished wool and linen fabrics); the shut-down of a large number of factories operating old capacities, with the simultaneous launch of smaller capacities using upgraded equipment (knitted fabrics, carpets, linen, finished silk fabrics, coarse wool, linen, and cotton fabrics); and a full-scale renovation of industrial equipment and several-fold growth in capacity (nonwoven materials).

The commissioning of new and more competitive capacities was the main driver behind the increased output; additional utilization of capacities accounted for approximately 30% of the growth on average (or approximately 2.4 p.p. of output growth). In recent years, the capacity utilization ratio in the sector has been approximately 60%, while the threshold for the maximum ratio for the sector is estimated at 75% to 85%, i.e., the output growth potential through additional utilization is at least 15 p.p.

7.3. *Manufacture of leather and related products*

In this sector, the intensity of PC renovation was low. By 2015, total capacity decreased by 28% compared with 2000; the share of capacities less than five years old was only 7.5%, whereas almost half (48%) of the capacities were commissioned before 2000; the average age of facilities is nearly 17 years, while 22% are completely noncompetitive.

From 2000 to 2015, the sector developed in three stages. In the first five years, capacities declined almost twice (accompanied by a slight increase in output), but only a small portion of them ($1/5$) were replaced with new ones. During the next five years, the sector began to stagnate (no clear changes either in terms of capacities or output). After 2011, PC started to expand gradually, while output stagnated; the commissioning and utilization of new capacities²⁷ were not accompanied by the de-commissioning of old capacities.

At the product level, absolutely different processes occurred during the period. The production of yuft and hard leather products stopped almost entirely: the number of capacities decreased by 90% and 97%, respectively, in comparison with 2000. For chromed leather products and footwear production, the reduction of capacities was relatively moderate and reflected the de-commissioning of old capacities. Footwear production increased by 19% by 2015 (versus 2000) and chromed leather production rose by 129% (!). However, modernization was not sufficiently intensive even in these relatively successful segments: by the end of the period, capacities commissioned before 2000 accounted for 30% of PC in chrome leather production, and more than a half of PC in footwear production.

Beginning in 2012, the capacity utilization ratio for the sector declined permanently to 52% in 2015, although the maximum capacity utilization ratio for the sector is estimated between 75% and 80%. By 2015, the output matched the value of existing capacities commissioned after 2000, which means the absence of the excess capacity (for PC commissioned after 2000). Accounting for the increasing competition against imports the output growth potential through additional utilization appears to be less than 10%.

²⁷ The additional utilization factor was quite significant: on average, around 40% of the output growth happened due to better utilization of existing capacities.

7.4. *Manufacture of wood and of wood and cork products*

The development of this sector is successful in terms of investment and capacity utilization, and primarily in terms of the high intensity of capacity renovation. By 2015, old capacities (commissioned before 2000) accounted for slightly more than 10% of all capacities, while the share of new capacities commissioned over the past five years was nearly one-half. The average age of facilities was approximately 9 years (compared with 12 years on average for the manufacturing industry), while the share of noncompetitive capacities is estimated at 9%.

The lack of capacity growth should be viewed as a negative factor: in 2015, the physical volume was estimated at 95% of the 2000 level. However, the lack of capacity growth does not reflect the low competitiveness of Russian producers as much as increased competition with equivalent products made from other materials (mostly plastic). Accordingly, the stable capacity volume (across the industry as a whole) is accompanied by completely different trends for two production groups. On the one hand, there was a multiple (almost by an order of magnitude) decline in redundant capacities producing wooden crates, window frames (competition against plastic), and railway sleepers (competition against reinforced concrete). On the other hand, there was a many-fold increase in capacities producing the most widely used basic products (used in the production of furniture and other finished items), which found opportunity for growth both in foreign and domestic markets (through import substitution).

The commissioning of new capacities was the main driver behind the increased output; additional utilization of capacities accounted for approximately 30% of the growth on average (or approximately 4 p.p. of growth in output, while this share was stable throughout the entire period under review).

In recent years, the capacity utilization ratio for the industry has been approximately 60%, while the threshold for the maximum ratio for the sector is estimated at 70% to 75%, i.e., the potential output growth through additional utilization is at least 10%.

7.5. *Manufacture of paper and paper products*

The renovation of PC in the manufacture of paper and paper products can be characterized as fairly successful. By 2015, the majority of the most obsolete capacities, commissioned before 2000, were de-commissioned; however, the share of PC older than 10 years remains high (57% compared with the overall industry average of 41%)²⁸. The capacity trend almost fully matches the manufacturing industry average (136% of the 2000 level). At the beginning of 2015, the average age of facilities was 15 years (3 years older than the average for manufacturing industry), while the share of noncompetitive capacities was estimated only at 11%.

The situation in the sector is highly differentiated in products. The major products, such as pulp, paper and cardboard, had very high level of capacity utilization and small share of noncompetitive capacities, while experiencing growth of capacities. The PC for the final products (paper containers,²⁹ wallpaper, and copy-

²⁸ The data on capacities for the sector is fairly representative on the whole but is not sufficient for finished products. Sanitary and hygienic items and a considerable part of the writing paper segment are not represented in the data.

²⁹ Corrugated board container production developed actively.

books) reduced during the period, and the capacity utilization ratio for such products ranged between 33% and 67%. This situation reflects the structural problem in the sector: investment activity is concentrated in the low value-added production.

The age of facilities is not a significant factor of competitiveness for basic pulp and paper products since the production technology changes very slowly. As a result, the sector has almost no differentiation between the average age of utilized (15 years) and unutilized (16 years) facilities, and the capacity utilization ratio for capacities commissioned before 2000 is 75%, which is the highest ratio among all sectors. Naturally, the commissioning of new capacities was a key factor for ensuring output growth.

By 2015, the capacity utilization ratio in the sector reached a historical peak of 82%, mostly due to the active de-commissioning of capacities in 2014 and 2015 (while the threshold for the maximum ratio for the sector is between 85% and 90%). Thus, the output growth potential through additional utilization is less than 5%.

7.6. Manufacture of chemicals and chemical products

The development of the manufacture of chemicals and chemical products is quite successful, considering the renovation of PC. In recent years, this sector experienced a high level of investment activity, accompanied by fast and steady output growth. By 2015, approximately one-third of all capacities were not more than five years old. On the whole, over the 15-year period, capacities increased by 28% in physical volumes (a good result for such a capital-intensive sector), while the share of noncompetitive capacities is approximately 14%.

The output and investment growth in chemical production was driven mainly by basic polymers (the result of the high demand that was caused by active low initial consumption level and import substitution). For most other products, capacities renovation occur much less intensively. The age of facilities is not a limiting factor in basic chemical production segments, as the majority of old capacities producing basic goods (fertilizers, polymers, and rubbers) are being utilized to the same extent as the new ones.³⁰

By 2015, the capacity utilization ratio in the chemical industry reached a historical peak at 74%. While the threshold for the maximum ratio for the sector is between 80% and 85%, output growth potential through additional utilization is 5 to 10 p.p. On the whole, capacities may act as a limiting factor when markets grow rapidly, but companies successfully solve this problem through active investments.

7.7. Manufacture of rubber and plastic products

The development of the manufacture of rubber and plastic products with respect to PC can be described as rather intensive and productive. By 2015, nearly half of all PC were not older than 5 years, while share of old capacities (commissioned before 2000) were less than 25%. These capacities considerably outpaced the national trend during the period under review: the physical volume of capacities in 2015 was estimated at 215% to the level of 2000, with a significant portion of

³⁰ The exception is high-tech products (vitamins, detergents, paints and varnishes), but the output of those products accounts for a rather modest share of the sector's output.

capacities renovated during the short period between 2011 and 2013. The average facilities age was 11 years in 2015, while 12% of capacities were noncompetitive.

The situation from one sector to another is very different.³¹ Plastic products developed rapidly, with dynamic output growth and intensive capacity renovation. In contrast, rubber products stagnated in most cases (there was an especially depressing situation in the industrial products). The only successful exception for rubber products was passenger car tires, where the capacity utilization ratio exceeded 80% throughout almost the entire period, while output and capacity were actively growing.³²

From 2013 to 2015, the capacity utilization ratio for the sector was relatively low, at 56%–60%, compared with 74% (maximum) in 2007.³³ Thus, while the threshold for the maximum ratio for the sector is estimated at 75% to 80%, the output growth potential through increased utilization is more than 20%.

7.8. *Manufacture of other non-metallic mineral products*

The sector's development is characterized by a moderately high intensity of PC renovation. Over the past 15 years, around 70% of the capacities have been renovated, while the share of capacities commissioned within the past 5 years is almost 30% to the level of 2015. The average facility age was approximately 11 years (1 year younger than the average for manufacturing industry) in 2015, whereas the share of noncompetitive capacities is estimated at 15%.³⁴ Redundant capacities were actively de-commissioned so that the physical volume of facilities in 2015 was estimated at 108% to the level of 2000. The industry's capacity utilization ratio has been rather high during the past decade (at least 80% for more than a third of the products).

The relatively stable (on the whole industry level) capacity volume hides completely different trends in two production groups. On the one hand, at least a twofold reduction in noncompetitive capacities of obsolete materials (asbestos and cement pipes and couplings, shingles), as well as uncompetitive consumer products (crockery). On the other hand, there has been a fold increase in capacities producing the most popular basic products (tiles, flooring, wall blocks, and glass), which found opportunities to grow within a fast expanding domestic market (including the way of import substitution).

In the early 2000s, a rough balance was maintained between contribution of increasing PC utilization and commissioning. Since 2011 additional capacity utilization accounted for around $\frac{1}{3}$ of output growth. In recent years the industry's capacity utilization has been approximately 60%, the threshold for the maximum ratio for the sector is estimated at 70% to 75%, i.e., the output growth potential through increased utilization is at least 10%.

³¹ The relevance of capacity statistics for the sector is acceptable for rubber products and insufficient for plastic products. Most "new products" (packaging, plastic windows, and materials used in construction) are lacking. The pace of the sector's development is apparently underestimated.

³² The success is a result of a fast-growing market and the relative technical simplicity of production (unlike tires for freight vehicles and special-purpose vehicles).

³³ The reason is that output stabilized after 2012 despite companies' expectations (which actively invested in new capacities "for the future" in 2011 and 2012).

³⁴ The modernization process has continued until recently: for over half of the products, new capacities were commissioned even during the critical 2015, whereas 80% of them had reduced output. This is partly related to investment lags; by 2016, investment activity (the ratio of investments to added value) had dropped visibly within the sector (by half of the 2011 level).

7.9. *Manufacture of ferrous metals and fabricated metal products*

The results of modernization in the sector are rather controversial. On the one hand, it is a relatively successful industry that passed its investment peak during the second half of the 2000s when investments increased rapidly, accompanied by a powerful inflow of export revenues. On the whole, approximately one-half of the capacities were renovated between 2000 and 2015. Capacities increased by almost one-third in physical terms that is a good result for such a capital-intensive industry.

On the other hand, modernization was a prevailing trend only for mass-market products with low added value (bullions and billets, mass-produced rolled products) and a number of newly produced “medium-tech” products (cold rolled products, coated sheet, certain types of structures and pipes). At the same time, production of the most technologically advanced intermediate (special alloys), investment (boilers), and consumer (tubs, radiators) products experienced virtually no capacity renovation. Thus, the share of competitive capacities is lower for higher value-added products³⁵.

The threshold for the maximum capacity utilization ratio for the sector is estimated at approximately 85%. So, the output growth potential due to increased utilization in 2015 was estimated as 6–7%. However, capacities can hardly be considered a serious limiting factor since the sector is dominated by large companies possessing financial resources.

7.10. *Manufacture of machinery and equipment*

Machinery and equipment, that is *per se* one of the most technologically intensive sectors, clearly lacked investment during 2000–2015, which resulted in a low intensity of renovation and a rampant reduction in capacities. By 2015, capacities dropped twice in the physical terms, while old capacities commissioned during the 20th century accounted for 30% (an extremely high level for a high-tech sector). The average age of facilities was approximately 15 years in 2015 (compared with 12 years for the manufacturing industry average), whereas the average share of noncompetitive capacities is estimated at 22%. For half of the products, capacities were reduced by at least one-half; for products with low de-commissioning ratios, capacity is utilized very poorly (capacity utilization ratio is below 35%).³⁶

The situation is not homogenous across products. On the one hand, capacities for such products as machine tools, machinery for construction and agricultural machinery experienced a two- to threefold reduction. On the other hand, there was an explosive capacity growth for relatively simple products with a fairly large-scale domestic demand (feed threshers, vacuum pumps, refrigeration counters, elevators, and some household appliances).

In the early 2000s, two-thirds of output growth was covered by additional capacity utilization; from 2012 to 2014, the impact of this factor decreased slightly,

³⁵ As low-tech products dominate in the sector, the facility age factor becomes irrelevant: the capacity utilization ratio for PC older than 15 years is 74%.

³⁶ The fact that the output of mechanical engineering products has hardly changed in 15 years, although demand (investments in fixed capital) increased by 2.5 times, is a glaring evidence that modernization is absent. In this sector, one should expect that the new capacities would be utilized first; however, the differentiation of the average age of utilized and unutilized facilities is low, while the age of utilized facilities is significant (9 years, as compared to 12 years for unutilized capacities).

yet remained quite noticeable, accounting for approximately 35% of the growth on average (or approximately 3.5 p.p. of output growth). In recent years, the sector's capacity utilization ratio has decreased to below 40%, while the threshold for the maximum capacity utilization ratio for the sector is estimated at 65% to 70%, i.e., the potential output growth due to increased utilization is at least 25%.

7.11. *Manufacture of electrical equipment and consumer electronics*

During the period, the sector experienced virtually no modernization (note, however, that only a small fraction of the sector's capacities is reflected in the data³⁷). Capacities were commissioned only for a relatively narrow range of products. Capacity at the sector level doubled, but the new facilities are mainly represented by assembly lines with low value added.³⁸ Excluding TV set assembly, capacities in the sector remained unchanged from 2000, while old capacities (commissioned before 2000) accounted for over one-third. For a considerable number of products, noncompetitive capacities account for one-sixth to one-third of capacities.

Although the industry operated with a notably low capacity utilization ratio most of the time, increased utilization was not an important factor for output growth (especially in recent years), because the large share of capacities was found to be noncompetitive. The optimal utilization ratio for the sector is estimated at 65%–70%, whereas its current value is only 30%.

7.12. *Manufacture of motor vehicles and other transport equipment*

Manufacture of motor vehicles and other transport equipment³⁹ has experienced a relatively successful development due to production capacity renovation and significant capacity expansion. By 2015, capacities increased by 151% in 15 year; the rapid capacity expansion (by more than 1.5 times) occurred in locomotive and freight car⁴⁰ production. In 2015, 23% of capacities were commissioned before 2000, whereas nearly 30% were commissioned within the past five years. The average facility age slightly exceeded 11 years at the beginning of 2015 (compared with 12 years for the manufacturing industry average), whereas the share of noncompetitive capacities is estimated at 17%.

Two stages in the sector's development can be identified: until the mid-2000s no renovation was observed, the sector's utilization ratio increased mostly due to better utilization of existing capacities; in 2007, the sector started to experience an active modernization, while "old" capacities continued to be gradually de-commissioned (and the commissioning ratio considerably exceeded the de-commissioning ratio). New capacities were commissioned mostly for large-scale products with de-

³⁷ The data for the sector are not representative. Only basic electrical and certain consumer products are represented relatively well, unlike instruments, electronics and medical equipment.

³⁸ Partially, capacities were commissioned to satisfy the electricity producers' demand, who actively renovated their capacities during the late 2000s and the early 2010s; further prospects for utilizing these capacities are vague. An important exception is the production of automobile batteries, where the growth of capacity was accompanied by successful import substitution.

³⁹ The data on capacities cover automobiles and railway rolling stock and do not include the construction of vessels as well as aircraft and spacecraft. The data for the products covered are representative.

⁴⁰ Note that the sector was even "overinvested" a bit: a massive commissioning of capacities occurred before the crisis, following the expectations for further growth in demand.

veloped domestic market (passenger and freight vehicles, locomotives, and freight cars). The greatest increase in capacity occurred in passenger car production that accounts for about 58% of the sector's output, as the government stimulated foreign firms to open factories in Russia and supported consumer demand during crises. As a result, domestically assembled cars were pushing imports out of the market.

The manufacture of motor vehicles and other transport equipment is quite sensitive to worsening economic conditions. In 2009, the capacity utilization ratio for the sector was the lowest one across all sectors of the economy. In 2015, the capacity utilization ratio for the sector amounted to 38%, still among the lowest, while the threshold for the maximum capacity utilization ratio for this sector is estimated at 75% to 85%. Thus, the output growth potential from additional utilization exceeds 30 p.p.

8. Recommendations based on the research results

Our results clearly indicate that *there is some excess capacity in Russian economy*: currently, potential of output growth in the manufacturing industry by improving capacity utilization is estimated to be at least 6–8%. This fact should be recognized by policymakers.

We do not question the findings of other authors that the industry operated close to a capacity utilization ratio that accelerated inflation before the 2008–2009 crisis. However, we have shown that a high capacity utilization ratio also accelerates the intensity of investment activity. Hence, a careful policymaker should seek *a balance between accelerating inflation and accelerating capacity renovation*.

Statistical form 1-natura-BM is an important and unique source of data on production capacities. The economists would benefit much from the open access to this data (that should be ensured by publishing full data at the regional level).⁴¹ The quality of primary statistics should be improved by expanding the number of products represented in the form (to ensure that the data on capacities for individual sectors are representative). Finally, the methodology used by Rosstat should be corrected in order to eliminate the detected shift in capacity utilization estimates.

The further research may address a number of issues. First, it is interesting to study further the correlation between accelerating inflation and accelerating capacity renovation (the current level of capacity utilization ratio may influence both inflation and future investment intensity). Second, it's viable to obtain estimates of the costs of capacity commissioning by sectors and products. Finally, it is important to figure out are the data is representative for conducting a regional analysis.

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⁴¹ See amendments to 282-FZ dated November 29, 2007 on introducing a limitation period for confidential, but not secret data in statistical reporting.

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