

# TENDENCIES OF VARIATION OF THE PRODUCTION AND ECONOMIC PARAMETERS FOR THE RUSSIAN METALLURGICAL WORKS

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## Key words:

iron and steel industry, analysis,  
 production volume, apparent  
 consumption, cost, prices, profit-  
 ability, tendencies, exchange rate.

## ABSTRACT

The tendencies of variation of the production and economic parameters of manufactured products in the Russian iron and steel industry during 1990–2015 are presented, as well as analysis of increasing and decreasing factors of price forming, cost and profitability of products.

It was established on the base of analysis of these parameters, that the average technical level of domestic metallurgical enterprises elevated essentially during recent years. However, the parameters of usage of material and fuel-power resources, as well as working productivity in the Russian iron and steel industry, are still lower than abroad.

At present time the domestic iron and steel industry is on the stage of recovery growth. The volume of steel production in Russia made 71.4 mln. t, or about 99% from the 2007 level. Apparent consumption of rolled products in 2014 exceeds pre-crisis 2007 level by 10%.

In 2015 volume of steel production and apparent consumption of rolled products were lower by 1.3 and appr. 10% respectively compared with 2014.

The global financial crisis has a strong negative effect on the operating parameters of the Russian iron and steel enterprises. The average cost and price of rolled products at metallurgical works increased in 2014 by 66 and 39% respectively in comparison with 2007. It finalized in substantial lowering of production profitability.

In 2015 we observe outrunning growth of prices for metal products and rise of their profitability owing to continuing elevation of USD exchange rate.

Global steel production increased in 1990–2015 by 2.1 times in general (**table 1**). At the same time total production in the iron and steel industry in the Eastern Europe and CIS countries (including Russia) has cut approximately by 1.6 times. As a result, the part of these countries in global steel production volume decreased by more than 3 times. Recession of production in the Eastern Europe and CIS countries was compensated mainly by production growth in Asia and Latin America. The highest rates of steel production volume elevation were observed in P. R. China, as well as in BRICS group in general: they increased by 12.5 and 5.0 times respectively. Thereby the parts of P. R. China and BRICS group in the global steel production have risen by 5.8 and 2.4 times respectively. In 2015 BRICS countries manufactured about 63% of total volume of global steel.

Starting from 2010, India steadily occupies the 4<sup>th</sup> place in global steel production, moving Russia to the 5<sup>th</sup> place [5].

In general, since 1990 the Russian iron and steel industry is characterized by the cardinal variations in production scale (**table 2**), technical level and technical state of metallurgical production facilities.

The data about the volumes of production, foreign trade and consumption of finished rolled products during 1991–2015 are presented in the **table 3**.

During 1990-ies, all main operating parameters of the iron and steel industries substantially deteriorated. Small rise of the average technical level of production facilities has occurred at that time practically only based on their essential cutting and decrease of production volume of metal products due to putting the most physi-

cally worn and obsolete technological equipment out of the practice.

**Figure 1** displays variation of the technical level of the Russian steelmaking furnaces and shops and can illustrate the above-mentioned processes. Thus, during 1990–1999 the summarized specific weight of used basic oxygen converter and electric steel making technologies, as well as steel continuous casting technology in the total volume of steel production increases very seriously. However, the summarized production volume of steel manufactured via basic oxygen converter and electric steel making, decreases in the same period by 11%, while the volume of continuously cast steel enlarged only by a quarter.

Since 2000, the development tendencies of the Russian iron and steel industry have cardinally changed. The investments in this industry during 2000–2014 made appr. 1.8 trillion RUR.

The average ratio of fixed capital depreciation of the iron and steel industry was equal to about 42% in 2014, what can be considered as very good level.

The authors have analyzed the main tendencies of variation of production-technical and economic parameters of the Russian iron and steel industry, including eight largest Russian metallurgical works (Magnitogorsk, “Severstal”, Novolipetsk, EVRAZ United West Siberian, Nizhniy Tagil, Chelyabinsk, “Ural Steel” and Oskol) during the period 2000–2015 [6, 7]. Here are the brief results of this analysis.

The volume of rolled products during 2000–2014 has increased approximately by one third, and positive amount balance of foreign trade of rolled products decreased by 20%. At the same time the apparent consumption of rolled products elevated by more than 1.9 times.

	1990		1998		2000		2008		2014		2015	
	Pro-duction, mln. t	Part in global steel pro-duction, %	Pro-duction, mln. t	Part in global steel pro-duction, %	Pro-duction, mln. t	Part in global steel pro-duction, %	Pro-duction, mln. t	Part in global steel pro-duction, %	Pro-duction, mln. t	Part in global steel pro-duction, %	Pro-duction, mln. t	Part in global steel pro-duction, %
Europe (totally)**)	366.5	47.6	281.8	36.3	308.9	36.4	344.3	25.7	313.8	18.9	301.5	18.8
including:												
EC countries***)	148.4	19.3	159.9	20.6	163.4	19.2	198.2	14.8	169.3	10.2	166.2	10.4
CIS	153.9	20.0	74.0	9.5	98.5	11.6	114.3	8.6	106.1	6.4	101.3	6.3
i.e.												
Russia	89.6	11.6	43.8	5.6	59.2	7.0	68.7	5.2	71.4	4.3	70.8	4.4
Ukraine	52.6	6.8	24.4	3.1	31.8	3.7	37.3	2.8	27.2	1.6	22.9	1.4
Northern America (totally)****)	102.0	13.2	114.6	14.7	118.4	13.9	106.2	8.0	100.9	6.1	91.4	5.7
i.e.:												
USA	89.7	11.6	98.7	12.7	101.8	12.0	91.4	6.9	88.2	5.3	78.9	4.9
Oceania (totally)	7.4	1.0	9.7	1.3	7.8	0.9	8.4	0.6	5.5	0.3	5.7	0.4
Latin America (totally)	38.7	5.0	51.5	6.6	56.0	6.6	65.6	4.9	64.9	3.9	63.2	4.0
Africa (totally)	13.3	1.7	12.8	1.6	13.8	1.6	17.0	1.3	14.9	0.9	14.0	0.9
Middle East (totally)	4.1	0.5	9.1	1.2	10.8	1.3	16.6	1.2	28.3	1.7	27.4	1.7
Asia (totally)	238.5	31.0	297.9	38.3	333.1	39.2	783.0	58.4	1134.9	68.2	1096.3	68.5
including:												
Japan	110.3	14.3	93.5	12.0	106.4	12.5	118.7	8.9	110.7	6.7	105.2	6.6
P. R. China	66.3	8.6	114.6	14.8	128.5	15.1	512.3	37.6	822.7	49.5	803.8	50.3
Corea	23.1	3.0	39.9	5.1	43.1	5.1	53.6	4.0	71.5	4.3	69.7	4.4
India	15.0	1.9	23.5	3.0	26.9	3.2	57.8	4.3	86.5	5.2	89.6	5.6
Totally in the world	770.5	100.0	777.3	100.0	848.9	100.0	1341.2	100.0	1663.2	100.0	1599.5	100.0

\*) The table parameters are based on the data [1–4].  
 \*\*) Including CIS countries.  
 \*\*\*) In EC 15 countries have been taken into account for 1990–2000, 27 countries — for 2008 and 28 countries — for 2014–2015.  
 \*\*\*\*) USA and Canada.

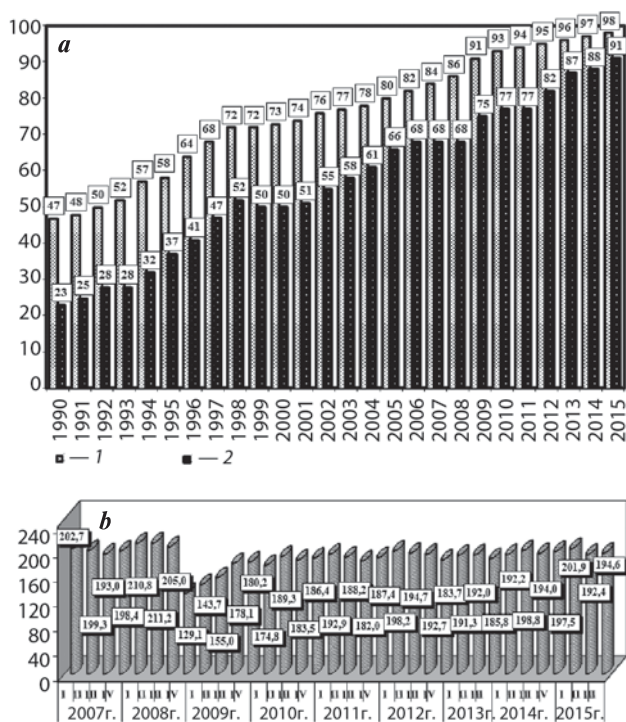
Kind of products	Years										
	1990	1998	2000	2005	2007	2010	2011	2012	2013	2014	2015
Hot metal	59.4	34.7	44.6	49.2	51.5	48.0	48.0	50.5	49.9	51.4	52.4
Steel	89.6	43.7	59.2	66.3	72.4	66.8	68.1	70.4	68.9	71.4	70.8
Rolled products	63.7	35.2	46.7	54.7	59.6	55.0	56.5	60.0	59.2	61.2	60.3
Steel tubes	11.9	2.8	5.0	6.7	8.7	9.2	10.0	9.7	10.1	11.2	11.4
Coke with humidity 6%	41.2	23.6	30.0	31.7	33.9	28.4	28.9	29.0	27.9	28.7	28.3
Iron ore	106.8	72.6	86.8	95.1	105.0	102.1	109.0	106.4	105.1	105.7	104.1

Parameters	Years										
	1991	1998	2000	2005	2007	2010	2011	2012	2013	2014	2015**)
Production, mln. t	55.1	35.2	46.7	54.7	59.6	55.0	56.5	60.0	59.2	61.9	46.5
Export, mln. t*)	12.4	21.8	27.0	29.9	28.0	29.3	24.8	26.9	24.8	25.4	20.1
Import, mln. t*)	14.0	1.6	1.8	4.0	6.4	5.2	6.4	6.0	6.0	5.3	2.8
Apparent consumption, mln. t	56.7	15.0	21.5	28.8	38.0	30.9	38.1	39.1	40.4	41.8	29.2
Export part in production, %	22.5	61.9	57.8	54.7	47.0	53.3	43.9	44.8	41.9	41.0	43.3
Import part in consumption, %	24.7	10.7	8.4	13.9	16.7	16.8	16.8	15.3	14.8	12.7	9.6

\*) Taking into account coated sheet metal and tinplate.  
 \*\*) During 9 months.

In 2015 the volume of manufacture of steel and rolled products has varied slightly compared with the corresponding 2014 period. However, apparent steel consumption has decreased by 10%.

Operating parameters of the blast furnaces have improved. The average specific productivity of the furnaces at the described works has increased more than by 19% during 2000–2014, while the average



**Fig. 1. Steel production parameters in Russia:**  
*a* — specific weight of used basic oxygen converter and electric steel making technologies, as well as steel continuous casting technology in the total volume of steel production, % (*1* — basic oxygen converters and electric steelmaking; *2* — continuous casting); *b* — dynamics of the average daily steel production in Russia, thousand t/day

specific coke consumption has decreased more than by 10%.

The volume and structure of steel production have varied during 2000–2015 in the following mode (see **table 4**): production of basic converter steel and electric steel has increased more than by one third and by 2.5 times respectively, while production of Siemens–Martin steel has decreased by 9.5 times. The volume of steel continuous casting has elevated by 2.2 times. Steel ladle furnace treatment has been actively put into practice — the volume of steel processed in ladle furnace units and the volume of vacuum treated steel has been risen cardinally [8].

Serious measures for renovation and modernization of the key assets have been undertaken and are realizing at present time in rolling production. The changes in the dimension range of manufactured rolled finished products during 2000–2015 are characterized in general by the data presented in the **table 5**. Those changes can be considered as increase of production volumes of rolled strip metal and cold-rolled sheet, as well as by rise of the specific weight of coated sheet metal almost by three times. These tendencies have been caused by realization of the large investing projects at Magnitogorsk, Cherepovets and Novolipetsk integrated iron and steel works, as well as at Vyksa steel works [9,10].

Since 2005, production of high-quality longitudinal-welded single-joint tubes of large diameter (up to 1420 mm) has been established in the Russian Federation. At present time manufacture of these tubes is conducted at the four works and is completely provided by large-size heavy plate fabricated at the domestic 5000 rolling mills (**table 6**).

In 2015 production volume at the 5000 rolling mills has increased substantially (at Cherepovets and Vyksa works it has made 13–25%).

The global financial crisis had the negative effect on development on the Russian iron and steel industry since the IV quarter 2008, when decrease of steel production volumes has been really a dramatic decline (see fig. 1).

It was described above that variation of production volumes of all kinds of products is stipulated by the joint effect of two factors: variation of domestic consumption and variation of the amount balance of foreign trade.

In 2014 the maximal pre-crisis level of the apparent consumption of finished rolled products (achieved in 2007) has been exceeded by 10.0%. At the same time the average daily manufacture of finished rolled products in 2014 corresponded to the level of 103.9% compared with 2007 parameters. Such relationship has been caused by decrease of the average daily

Parameters	Years			
	2000	2013	2014	2015
Steel production	59.2/100	68.9/100	71.4/100.0	70.8/100.0
including:				
Basic converter steel	34.3/57.9	46.0/66.7	46.7/65.3	47.0/66.4
Electric steel	8.7/14.7	20.4/29.6	22.9/32.0	22.1/31.2
Siemens–Martin steel	16.2/27.4	2.5/3.7	1.9/2.7	1.7/2.4
Continuous casting of steel	29.6/50.0	60.2/87.3	63.0/88.3	64.1/90.5

Parameters	Years			
	2000	2013	2014	2015
Rolling production	46.7/100.0	59.2/100.0	61.2/100.0	60.9/100.0
Part in the total volume of finished rolled products:				
— billets for re-rolling (export)	11.8/25.3	12.5/21.1	13.0/21.2	13.8/22.8
— section rolled products	14.5/31.0	19.8/33.4	20.3/33.1	18.6/30.8
— sheet rolled products	20.2/43.3	26.4/44.6	27.6/45.0	27.7/45.9
Part of cold-rolled sheet in the total volume of sheet rolled products	6.4/31.6	8.5/32.2	8.6/31.1	8.3/29.8
Part of coated sheet rolled products in the total volume of cold-rolled sheet metal	1.4/21.9	5.4/63.5	5.4/62.8	5.3/63.9

amount balance of foreign trade for finished rolled products by 7.0% during 2007–2014.

Profitability of manufactured products is among the most important integral economic parameters of production efficiency (see **fig. 2**). It has varied in very wide range for the Russian iron and steel industry during last 20 years: from 54% in 1992 (after transition to the market economic relations) to 3% in 1998 (before the default).

During the period 1999–2008 profitability of metallurgical products was rather high, and in the III quarter 2008 (before the beginning of the financial crisis) it achieved 32%. However, in 2009–2013 profitability of finished products decreased substantially.

In 2014 the average annual USD rate has risen more than by 20% compared with 2013, and in 2015 — by 57% compared with 2014.

The dynamics of the average quarterly USD rate in 2014–2015 is presented below (in relative parts):

2014 . . . . .	I quart.	II quart.	III quart.	IV quart.
	1.00	0.97	1.05	1.39
2015 . . . . .	I quart.	II quart.	III quart.	IV quart.
	1.75	1.50	1.79	1.90

Such essential variations of USD rate had substantial effect on the average domestic prices of metallurgical products and on their profitability; the details will be shown below.

It is concluded that the most important internal problem of metallurgy is a quick cost elevation for all kinds of products. The average cost of the unit of metallurgical commercial products has increased approximately by 5.2 times during 2000–2014.

It should be emphasized that essential cost elevation of metallurgical commercial products has occurred despite improvement of the average metallurgical parameters concerning usage of all kinds of resources consumed and used at the enterprises (in natural measurements). Thus, during the period 2000–2014, several important metallurgical parameters have decreased: specific coke consumption in blast furnace practice — from 462 to 422 kg/t, the ratio of steel consumption for rolling also — from 1148 to 1090 kg/t, the average specific consumption of electric power for manufacture of steel and finished rolled products — approximately by 25 and 15% respectively, the average specific fuel consumption for manufacture of finished rolled products — approximately by 40%. In the meantime the average working productivity has increased by 1.7 times and the average capacities utilization rate for steelmaking and rolling production has elevated from 72–77 to 81–86% [11].

Table 6. **Manufacture of finished rolled products at the 5000 heavy plate mills, thousand tons**

Enterprise	Production							Production facilities at the beginning of 2015
	2000	2005	2007	2009	2011	2013	2014	
Cherepovets iron and steel works	99	231	523	494	718	571	659	850
Magnitogorsk iron and steel works	—	—	—	199	1015	1032	1129	1500
Vyksa steel works	—	—	—	—	50 <sup>1)</sup>	627	708	1200

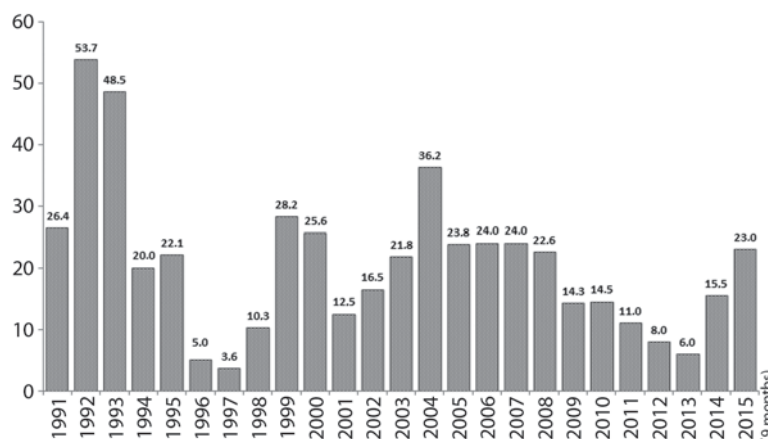


Fig. 2. Profitability of products of the Russian iron and steel industry, %

It should be noted that above-mentioned positive changes have occurred mainly owing to improvement of the production structure. E.g. in steelmaking and rolling production it is connected first of all with wide usage of continuous casting process. At the same time parameters of conventional metallurgical processes (i.e. steelmaking ones) has been changed very slightly or didn't change at all. Thus, the average specific consumption of metal charge materials in steelmaking has even increased a little during 1990–2014, while variation of its structure has led to steel cost rise (**tab. 7**).

Positive effect of the above-described changes of the average metallurgical parameters has been overlapped mainly due to making more expensive all used and consumed resources. The average prices for electric power, natural gas and coal consumed for coking by the iron and steel industry have risen during 2000–2015 (9 months) by 5.1, 19.8 and 4.2 times respectively, while railroad freight tariffs have elevated by 6.3 times. The average personnel salaries have increased more than by 11.5 times.

The cost of the assets of metallurgical works in current prices has enlarged approximately by 13 times (**tab. 8**).

The dynamics of the economic parameters of metallurgical enterprises is presented in the **tab. 9**. The analysis has shown that rise of the prices for metal products can be considered as the main factor of improvement and keeping of these parameters after 2000. Domestic prices for steelmaking iron, finished rolled products and steel tubes have increased by 5.5, 4.3 and 4.7 times respectively during the period since December 2000 to September 2015.

Metal charge materials	Years			
	1990	2000	2013	2014
Hot metal	672	753	800	804
Scrap	422	335	271	264
Metalized pellets	14	28	51	53
Ferroalloys and alloying elements	22	14	14	14
Charge billets	2	3	–	–
Totally	1132	1133	1136	1135

<sup>1)</sup> Presented data cover 8 largest metallurgical works.

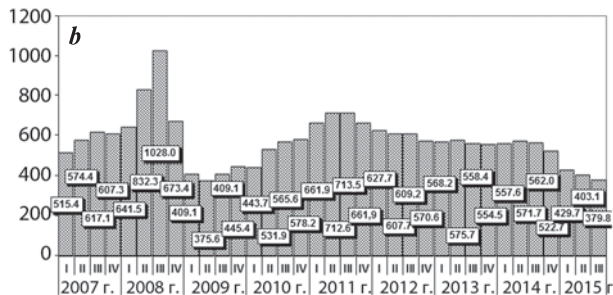
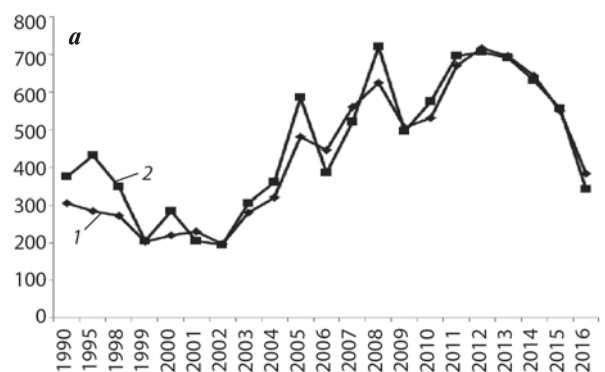
Parameters	Years		
	2000	2008	2015
Total facilities including:	1.0	7.0	13.0
Capital assets	1.0	9.3	17.1
Current assets	1.0	4.8	9.0

<sup>1)</sup> The data about dynamics of the cost of the assets of metallurgical works in current prices are presented at the year beginning for the 8 largest metallurgical works.

The detailed analysis of the effect of the financial crisis on production, technical and economic operating parameters of iron and steel works has been conducted on the example of the eight above-mentioned largest metallurgical enterprises.

The prices for metal products at the global steel market are characterized by rather high volatility (fig. 3). So, during 1990–1999 the average prices have decreased by 1.5–1.8 times. Afterwards, until 2008 the main tendency was elevation of prices: they have risen by more than 3 times. Then since 2013, the prices are lowering systematically. However, in general during 1990–2015 the average prices for rolled products at the EC market have increased approximately by 1.5–1.8 times.

Lowering of production volumes during the financial crisis is accompanied by simultaneous substantial



**Fig. 3. Dynamics of the average export prices:**  
*a* — dynamics of the average export prices for rolled products in EC countries<sup>1)</sup> (1 — steel reinforced bars; 2 — hot-rolled sheet metal);  
*b* — dynamics of the average export prices for rolled products in Russia, USD/t

<sup>1)</sup> Based on the materials of Metal Bulletin. The prices for January of the corresponding year for rolled products made of ordinary steel grades are presented for the export from EC countries in third countries (fob), including commission 2.5%, USD/t [12].

variation of the domestic prices for metal products. Market conditions of the global market can be also evaluated also based on the dynamics of export prices for domestic rolled products (see fig. 3).

The average dynamics of variation of prices in 2007–2015 has presented in the **table 10**. It is concluded from the

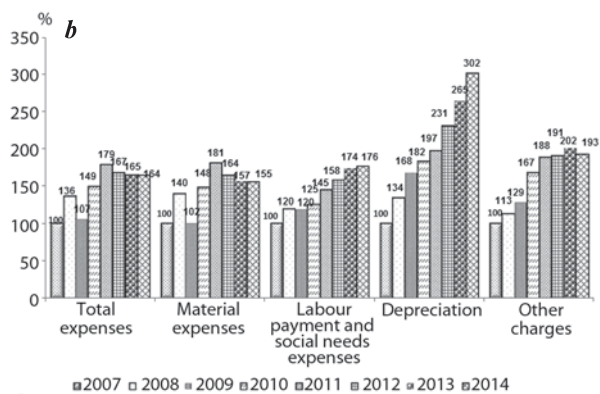
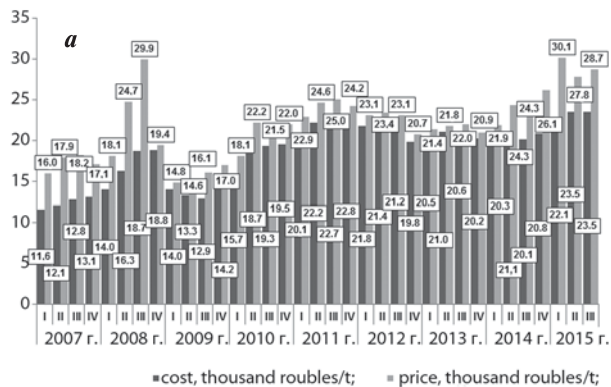
Parameters	Years									
	2000	2007	2008	2009	2010	2011	2012	2013	2014	2015 (9 mon.)
Indexes of prices and tariffs, units <sup>*1</sup>										
Electric power	1	2.71	3.22	3.65	4.19	4.24	4.46	4.66	4.95	5.05
Natural gas	1	3.93	4.84	4.65	5.32	6.75	12.44	13.21	16.55	19.83
Coal for coking	1	2.44	3.65	2.59	3.95	5.79	4.05	3.41	3.15	4.20
Railroad freight transportations	1	3.04	3.71	4.11	4.49	4.83	5.14	5.42	5.54	6.25
Index of the average domestic prices for steel products, units	1	3.64	4.90	3.51	4.53	5.39	5.03	4.77	5.05	6.18
Index of the average export prices for rolled products, units	1	2.92	4.03	2.06	2.63	3.47	3.06	2.86	2.81	2.06
Index of the working productivity, units <sup>*2</sup>	1	1.31	1.37	1.29	1.50 <sup>*3</sup>	1.56 <sup>*3</sup>	1.63 <sup>*3</sup>	1.59 <sup>*3</sup>	1.71 <sup>*3</sup>	1.70 <sup>*3</sup>
Monthly average salaries for production personnel, thousand roubles	3.5	15.3	17.0	17.2	20.0	23.0	32.0	33.7	36.0	38.5
Average profitability of products, %	25.6	24.0	22.6	14.3	14.5 <sup>3</sup>	11.0 <sup>*3</sup>	8.0 <sup>*3</sup>	6.0 <sup>*3</sup>	15.5 <sup>*3</sup>	23.0

<sup>\*1</sup> For the end of the period in general for the iron and steel industry.  
<sup>\*2</sup> Working productivity is calculated via steel melting per one employee.  
<sup>\*3</sup> Evaluated.

**Table 10. Dynamics of the average prices for rolled products and tubes**

Year	Level of prices, parts	
	Export prices	Domestic prices
2007	1.0	1.0
III quart. 2008	1.78	1.73
IV quart. 2008	1.17	1.12
2008	1.38	1.35
2009	0.71	0.91
2010	0.91	1.21
2011	1.19	1.41
2012	1.05	1.31
2013	0.98	1.24
2014	0.96	1.39
2015 (9 months)	0.71	1.67

above-mentioned data, that average export and average domestic prices for rolled products have decreased in 2014 more than by 1.8 and 1.2 times respectively, compared with their maximal level that has been observed in the 3<sup>rd</sup> quarter 2008. At the same time the average export prices for rolled products were in 2014 even lower than their pre-crisis level in 2007, while the average domestic prices were higher by 39% than this level.



**Fig. 4. Dynamics of expenses for manufacture of rolled products:**  
*a* — dynamics of the average parameters of cost and domestic prices for rolled products at the 8 integrated metallurgical works, thousand roubles/t; *b* — dynamics of the specific value of separate kinds of expenses for manufacture of rolled products at the 8 integrated metallurgical works, %

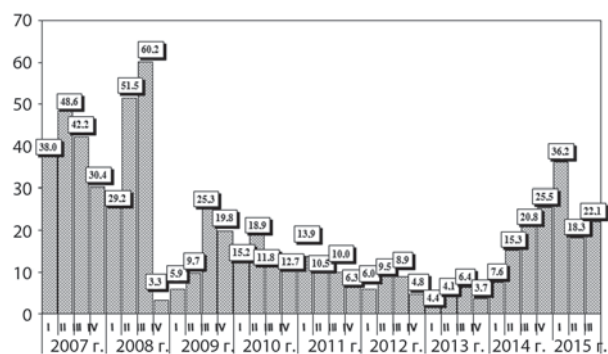
To an even greater degree these tendencies of variation of prices have been observed in 2015.

The level of average cost of rolled products in the III and IV quarters 2008 has been higher than the average cost level in 2007 by 1.5 times (fig. 4). In 2009 the level of average cost of rolled products has decreased substantially (by 1.2 times) in comparison with 2008, but in 2011–2011 it has increased again and, since the II quarter 2010 it has exceeded the parameters of the III and IV quarters 2008. The main causes of variation of the cost of rolled products can be illustrated using the data presented on the fig. 4. It is shown that several parameters have risen with the highest rate in 2007–2014 (compared with the 2007 level): specific depreciation charges by 3 times, other charges by 1.9 times, labour payment expenses by 1.8 times and material expenses more than 1.5 times.

In 2013, the average cost of rolled products has increased by 66% compared with 2007, while the price has elevated only by 24% (see table 10). In 2014 the situation in the Russian economics has changed seriously. Since July 2014 the USD rate exchange has started to rise, and it has become higher than in December of 2013 by 1.7 times. This process has been accompanied by growth of domestic rouble prices for metal products. As a result, the average cost of rolled products at metallurgical works has left on the level of 2013, while the average price of rolled products has increased by 12%. Essential rise of profitability of products has occurred. In the I quarter 2015 rise of the USD rate of exchange and average profitability has continued. In the II quarter 2015 we observed the opposite trend — lowering of the USD rate of exchange and the average profitability of rolled products. However, in the III quarter the rise of the USD rate of exchange and average profitability started again. In general, during 9 months of 2015, the average cost of rolled products has increased by 11.6%, the average cost of rolled products — by 19.9% and their average profitability — from 17.4 to 25.4% — in comparison with the average annual parameters of 2014 (fig. 5).

**Conclusions**

1. The average technical level of the domestic metallurgical works has increased essentially during recent



**Fig. 5. Dynamics of the average profitability of products at the 8 integrated metallurgical works, %**

years. However, the parameters of usage of material and fuel-power resources, as well as labour productivity are still lower in the Russian iron and steel industry than abroad.

2. At present time the Russian iron and steel industry seems to be at the stage of recovery growth. The steel production volume made 71.5 mln. t in 2014, otherwise appr. 99% from 2007 level. The apparent consumption of rolled products exceeded pre-crisis 2007 level by 10%. Steel production volume and apparent consumption of rolled products in 2015 was less by 1.3 and by 10% respectively (compared with 2014 level).

3. The global financial crisis had a strong negative effect on the operating parameters of the domestic iron and steel enterprises. In 2014 the average cost and average price of rolled products manufactured at the iron and steel works have increased by 66 and 39% respectively compared with 2007 level. It has led to substantial lowering of profitability of finished products. In 2015, the outrunning growth of prices for metal products and rise of their profitability can be observed based on continuing elevation of USD rate exchange.

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