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What Drives Labour Productivity Growth: A Case of Regional Economy

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Abstract. Labour productivity is a driver of national competitiveness, economic growth, and living standards. Labour productivity of the Russian economy is significantly lower than that of developed countries, and the gap is increasing. Labour productivity for most Russian regions tends to be lower than the average across the country. Those regions, where it is higher than the average, are resource-abundant. This article studies the drivers of regional labour productivity across a particular resource-abundant region and its sectors. We used regional statistical data from the Krasnoyarsk Territory (Krai) statistical service. We evaluated the contribution of labour productivity across industries to the regional average and studied the impact of human capital quality, capital-labour ratio, and multifactorial productivity. Our results showed the predominant contribution of the export-oriented and mining sector to regional labour productivity growth. Moreover, we found that a significant driver was physical capital. A notable result was the increasing impact of multifactor productivity for many sectors.

Keywords: labour productivity, level accounting, factor analysis, regional economy, resource-abundant region, sector of economy.

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Research area: economics.

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Факторы роста производительности труда: пример региональной экономики

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Аннотация. Производительность труда является движущей силой национальной конкурентоспособности, экономического роста и обеспечивает высокий уровень жизни населения. Производительность труда в российской экономике находится на значительно более низком уровне по отношению к развитым странам, и этот разрыв увеличивается. Большая часть регионов России характеризуется производительностью труда более низкой, чем средний национальный уровень. Те регионы, которые выступают драйверами роста национальной производительности, как правило, относятся к числу обеспеченных природными ресурсами. В данном исследовании изучаются факторы роста региональной производительности труда на примере отраслей экономики ресурсного региона. Для анализа использованы данные региональной статистики Красноярского края. В работе была проведена оценка вклада производительности труда каждой из отраслей региональной экономики в общий региональный уровень, а также рассчитано влияние таких факторов роста производительности, как качество человеческого капитала, капиталовооруженность труда и многофакторная производительность. Результаты исследования показали, что основной вклад в рост региональной производительности труда обеспечивается деятельностью добывающей промышленности и иных экспортоориентированных отраслей. Основным фактором роста региональной производительности труда выступает физический капитал. Значимым для региональной экономики является тот факт, что существенное и возрастающее влияние на рост производительности труда в ряде отраслей оказывает многофакторная производительность.

Ключевые слова: производительность труда, метод «level accounting», факторный анализ, региональная экономика, ресурсный регион, отрасль экономики.

Проект «Методология анализа факторов роста производительности труда в ресурсных регионах Российской Федерации в условиях перехода на новый путь технологического развития и реализации национального проекта «Производительность труда и поддержка занятости» (на примере Красноярского края)» проведен при поддержке Красноярского краевого фонда науки.

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Introduction

The comparative cross-country analysis of labour productivity growth is conducted based on economic growth theories and productivity theories. The studies of drivers for national productivity date back to the 1950s. The OECD, the World Bank, the US Bureau of Labour Statistics, the Kansai Centre of Productivity (Japan), the UK Office for National Statistics publish productivity reviews. Independent consulting and analytical agencies such as McKinsey, Market Watch regularly conduct national surveys of labour productivity.

The concept of productivity dates to the 17th – early 19th centuries (W. Petty 1997; R. Cantillon, 2010; A. Smith 1977; K. Marx, 2019). The concept reappeared in the mid-20th century (Solow, 1957) to support empirical studies of productivity drivers (Barro, 1991; Denison, 1985; Mankiw et al., 1992).

The national product does not depend only on the number of people in employment but also on the return of each employee. Smith argued that the wealth of nations is determined «…by the skill, dexterity, and judgment with which its labour is generally applied» (Smith, 1977). The idea that productivity is a source of economic growth promoted the development of different measurement methods that help calculate productivity and evaluate its growth.

Productivity can be estimated as the ratio of the output measured as a national or regional product to the factor inputs (1):

$$Labor\ productivity = \frac{Output}{Input} = \frac{Product}{Expenditures} \quad (1)$$

Gross value added (GVA), Gross domestic product (GDP), and Gross regional product (GRP) are used as the output measure for research at micro-, meso-, and macrolevels. Inputs are assessed as production costs such as labour costs (hours worked, hours paid, average number of employees), manufacturing overhead costs, capital costs (initial or residual value of fixed assets).

It is common to use (1) to calculate specific indicators of productivity reflecting the contribution of labour, capital, and other inputs to productivity. National labour productivity tends to be assessed as the ratio of annual GDP adjusted for purchasing power to yearly hours worked. Applied to regions, this indicator works as a ratio of GRP to hours worked. The regional indicator enables comparing regional productivity levels in different countries across time.

Specific productivity indicators are easy to calculate because little data are required. However, these indicators do not show how productivity is linked to particular inputs such as technological development and the marginal rates of substitution. Change in productivity reflects the combined effect of several inputs, including capital investments, technological development, management efficiency and employees' skill development (Cobet, Wilson, 2002).

Multifactor Productivity (MFP) accounts for the contribution of several inputs to the changes in output (2):

$$MFP = \frac{Q}{f(x_i)}, \quad (2)$$

where Q is output, x_i is the vector of inputs. Concerning time, (2) can be described as follows:

$$\frac{\Delta MFP}{MFP_0} = \frac{Q_1}{f(x_i)_1} : \frac{Q_0}{f(x_i)_0} - 1, \quad (3)$$

where 0 stands for the basic period and 1 – for the current period.

Further MFP studies became possible due to the appearance of the *Economic Growth Theory* in the 1940–1950s. This framework contributed to the MFP quantitative analysis. An influential approach was the Solow-Tinbergen model (Solow, 1957; Tinbergen, 1942). The Solow-Tinbergen model evolved into the *Growth Accounting Method* used to study productivity. This method looks at a combined effect of inputs that influence economic growth and aggregated performance. Mathematically, the Growth Accounting Method relied on the *Cobb-Douglas Production Function* (4) that studies the dependence of output (Q) on capital (K) and the amount of labour (L):

$$Q = A(t)f(K, L) \quad (4)$$

The *Solow-Tinbergen Model* establishes the relationship between output (Q) and main labour input (L), capital (K) capital and exogenous technological development ($A(t)$). At the next stage, we can study the dependence of productivity on several inputs. Dividing equation (4) by Q, we obtain the following model (5):

$$\frac{\dot{Q}}{Q} = \frac{\dot{A}}{A} + \left[w_k \frac{\dot{K}}{K} + w_L \frac{\dot{L}}{L}\right] \quad (5)$$

where $\frac{\dot{Q}}{Q}$ is the output growth rate; $\frac{\dot{K}}{K}$, $\frac{\dot{L}}{L}$ are the growth rates of capital and labour; w_k and w_L are the elasticity of output by capital and labour, with $w_K + w_L = 1$; $\frac{\dot{A}}{A}$ is the technological change rate. Thus, productivity growth depends on technological change and the weighted average growth of capital and labour.

Solow was the first to use the model for the United States over the period 1909–1949 (Solow, 1957). He demonstrated that 12.5 % of the productivity in the USA should be attributed to the capital-labour ratio. A major share of productivity (87.5 %) was attributed to technological change or MFP. Furthermore, a growing share of MFP reflected the importance of technological progress. Jorgenson demonstrated that productivity growth in the US over the years 1945–1965 depended on inputs (52.4 %) and MFP (47.6 %) (Jorgenson et al., 1967).

Denison highlighted a variety of drivers for the growth rates of the US economy over three periods: the Great Depression and World War II; the period of accelerating growth between 1948 and1973; the oil crisis period between 1973 and 1982 (Denison, 1985). He showed that the capital-labour ratio could explain almost 15 % of productivity, while the other 85 % was attributed to MFP. Later, aggregating productivity data by sectors was used to assess the contribution of inputs across different sectors more accurately (Jorgenson et al., 1987). Adjusting the influence of such inputs as labour, capital, and intermediate consumption, the authors confirmed a significant role of technological change (83 %) between 1948 and 1979.

Further research of how inputs are linked to productivity was conducted for the EU countries (Timmer et al., 2007), developing countries (Elias, 1978), and the OECD countries (Schreyer, 2001). The results showed a significant role of technology change for developed economies while capital growth was a more important driver for developing countries.

An *econometric approach* to productivity relied on the economic growth model and evolved along with the Growth Accounting Method. An influential streak in this field was initiated by Mankiw et al. (1992), who studied closed and steady-state economies and free transfer of technologies to explain cross-country differences in economic growth rates. Despite the significant advantages of econometric methods, they are limited by sample sizes, periods, and the necessity to average input elasticity.

The Level Accounting Method differs from the previous methods in that it compares inputs contributing to gaps in national productivity (Caselli, 2005). It was used to compare the productivity change of the US economy with that of the partners' economies (Canada, France, Germany, Italy, Korea, the Netherlands, and the United Kingdom). The analysis showed a decrease in relative productivity and inputs differentiation after World War II (Christensen et al., 1981). Jorgenson and Nishimizu were the first to apply the Level Accounting Method to compare the MFP levels of the USA and Japan (Jorgenson & Nishimizu, 1978). Hall and Jones decomposed the gap in productivity for several countries to study capital-labour ratio and MFP (Hall & Jones, 1999). They demonstrated that 40 % of the gap could be explained by the differences in human and physical capital; the other 60 % were found out to be caused by technological change.

The Level Accounting Method relates to between-countries comparison of productivity and the inputs for a benchmark country and a country from the sample. As a rule, the benchmark country is the country leading in productivity or any other country from the sample. The Level Accounting Method is based on Romer's Economic Growth Model (6):

$$Q = A \cdot K^{w_K} \cdot (hc \cdot H^{w_L}) \qquad (6)$$

where hc stands for Human Capital Index, H is the amount of labour.

Dividing equation (6) by H, we obtain the dependence of productivity on capital-labour ratio, human capital quality, and technological change (7):

$$p_i = A_i \cdot k_i^{w_K} \cdot hc_i^{w_L} \qquad (7)$$

where p – labour productivity, k – capital-labour ratio for i country.

At the next stage, we choose the benchmark country and compare the labour productivity of the i country with the BS benchmark country (8):

$$\frac{p_i}{p_{BS}} = \left(\frac{A_i}{A_{BS}}\right) \cdot \left(\frac{k_i}{k_{BS}}\right)^{\overline{w_{K_i}}} \cdot \left(\frac{hc_i}{hc_{BS}}\right)^{\overline{w_{L_i}}}. \quad (8)$$

Equation (8) is a basic model to study drivers of labour productivity using the Level Accounting Method.

This literature review shows that productivity has been studied at the macroeconomic level. Regions have never been the primary focus and could only be traced in the studies indirectly related to labour productivity. For example, Barro investigated the regional aspect in relation to the initial human capital and initial GDP per capita as drivers of economic growth for 98 countries between 1960 and 1985 (Barro, 1991). Holtz-Eakin tested the Solow and Romer's Economic Growth Models using the data received from the North American states (Holtz-Eakin, 1994).

Zaitsev was the first to use the Method of Economic Growth Factors known as the Level Accounting Method (LAM) to compare productivity in Russia and developed countries (Zaitsev, 2016). Voskoboynikov (2012) used a similar model to study the productivity of the sectors of the Russian economy (Voskoboynikov, 2012). However, few Russian studies applied economic growth models to analyse the drivers of labour productivity. Moreover, the models of economic growth are seldom adapted to investigate productivity growth at both regional and sectoral levels.

Labour productivity research at a regional level has several advantages. First, institutional conditions are the same for the country's regions. This helps to ignore institutional differences when we compare national economies. Second, subnational benefits of openness allow free technology movement as a major driver of economic growth models. Third, the results of comparing regions using national statistical data can be easily compared, while the results of cross-country comparisons require statistical alignment.

This study aims to adapt the Level Accounting Method for comparing labour productivity across sectors at a regional level. In this study, we use national and regional statistical data and show how such inputs as a capital-labour ratio, human capital, and multifactor productivity contribute to comparing labour productivity across sectors for the Krasnoyarsk Territory (Krai), a resource-abundant and important region in the Russian economy. This research is important because it shows how many sectors of the regional economy depend on different capital types, innovations and institutional environments. This paper also evaluates the contribution of the sectors to the labour productivity of the region.

Materials and methods

Equation (8) was used as a basic model to study drivers of labour productivity in the sector *i* in comparison with the regional economy level chosen as the benchmark (*BS*). The elasticity of output by labour ($\overline{w}_{Li}$) was determined as the average for individual elasticity of output by labour in the sector i (w_{Li}) and in the region (w_{LBS}):

$$\overline{w}_{Li} = \frac{1}{2} \cdot (w_{Li} + w_{LBS}). \quad (9)$$

The individual elasticity of output by labour was calculated as a ratio of labour costs of sector *i* to its gross value added (10):

$$w_{Li} = \frac{Sal_i + OLC_i}{GVA_i} \quad (10)$$

where Sal_i is a wage fund of sector *i*, OLC_i stands for other labour costs of the sector, including employers' social insurance payments, their costs for the advanced pieces of training and the health care of staff.

Capital-labour ratio was calculated (11) as the ratio of the average annual residual value of fixed assets ($\overline{FA_{res}}$) of the sector (*i*) or the region (*BS*) to the hours worked ($\overline{HW}$) by the employees of the sector (*i*) or the region (*BS*):

$$k_{i,BS} = \frac{\overline{FA_{res}}}{\overline{HW}} \quad (11)$$

The Human Capital Index ($hc_{i,BS}$) for the regional and sectoral levels of the study was modelled on UN Human Development Index (*HDI*), which was used to compare the living standards in more than 200 countries (United Nations, 2016). Some characteristics of HDI characterize the institutions of national development and could not be assessed for regions or sectors, which limits their use at this study level. Therefore, we retained the approach to calculation but omitted national level indicators used for HDI. To compare the human capital of the sectors, we excluded the indicators common for both the country and the region. The Human Capital Index of sector i (hc_i) was calculated as the geometric mean of the sector *Education Index* (EI_i) and the sector *Income Index* (II_i):

$$hc_i = \sqrt{EI_i \cdot II_i} \quad (12)$$

The *Education Index* reflects, to a degree, the quality of human capital and is calculated using the following equation (13):

$$IE_i = \frac{y_i - y_{min}}{y_{\max} - y_{\min}} \quad (13)$$

where y_i is the weighted average training years of the industry i employees, y_{min} is the minimum of training years possible for the industry i employees[1], y_{max} is the maximum of training years possible for the industry i employees[2].

Koritskiy (2010) calculates the weighted average training years as follows (14):

$$y_i = \sum_j ty_j \cdot w_{ij} \quad (14)$$

where ty_j is the years of training at a level of education (j)[3], w_{ij} is the share of employees with education level j in sector i.

The *Income Index* reflects the sufficiency of the funds paid by the sector to employees and their living standards. The logarithm typically used for calculations related to income or purchasing power indices allows us to consider the principle of diminishing income utility. Thus, the sector income index was calculated as follows (15):

$$II_i = \frac{\ln x_i - \ln x_{min}}{\ln x_{max} - \ln x_{min}} \quad (15)$$

where x_i is the average nominal monthly wage in the sector i, x_{min} is the minimum monthly wage in the region, x_{max} is the maximum of average monthly salary across sectors in the region.

The logarithms of the right- and the left-hand sides of equation (8) allow us to assess the contributions of capital-labour ratio, human capital, and MFP to sectoral labour productivity. In equation (16), the logarithm of labour productivity ratio includes technology, physical capital, and human capital:

$$\ln\left(\frac{p_i}{p_{BS}}\right) = \ln\left(\frac{A_i}{A_{BS}}\right) + \overline{w_{K_i}} * \\ * \ln\left(\frac{k_i}{k_{BS}}\right) + \overline{w_{L_i}} * \ln\left(\frac{hc_i}{hc_{BS}}\right). \quad (16)$$

The components in the right-hand side of equation (16) reflect cross-sectoral logarithmic differences in technology, capital-labour ratio, and human capital to the logarithm of labour productivity ratio (Zaitsev, 2016).

Dividing equation (16) by $\ln\left(\frac{p_i}{p_{BS}}\right)$, we assessed the influence of sectoral drivers of technological development ($\widetilde{A_\iota}$), capital-labour ratio ($\widetilde{k_\iota}$), human capital quality ($\widetilde{hc_\iota}$) on labour productivity ratio (17):

$$1 = \widetilde{A_\iota} + \widetilde{k_\iota} + \widetilde{hc_\iota} \quad (17)$$

Assuming the gap between labour productivity of the sector and the region expressed as $\ln\left(\frac{p_i}{p_{\text{per}}}\right)$ is taken as equal to 1, the terms on the right-hand side of equation (17) identify the contribution of each input.

To graphically display the contribution of each input to labour productivity differences on a non-logarithmic scale (as percentage points), we multiplied both sides of the equation (17) by (18):

$$(\frac{p_i}{p_{BS}} - 1) \cdot 100 \quad (18)$$

The Level Accounting Method applied to cross-sectoral analysis at a regional level was used to study the Krasnoyarsk Territory's productivity. We used the data from two years

[1] We used indicator «4» to assess the years of training attributed to employees without education. This approach differs from the HDI assessment method that used indicator «0». This was because the HDI was calculated for a nation with children with no years of education.

[2] We used indicator «16» for people with higher education.

[3] The number of years of education generally used in a variety of models are: 16 years for higher education, 14 years for incomplete higher education, 13 years for secondary special education, 12 years for primary vocational education, 11 years for complete secondary education, 9 years for incomplete secondary education, 4 years for primary education.

(2014 and 2019). The data from the pre-crisis year of 2014[4] showed the contribution of regional sectors and inputs to productivity. The data from 2019 showed how regional and sectoral economies and their inputs were changed by the crisis of 2014 and to identify sustainable sectors as a result of a comparison between two years.

Results

Labour productivity of the Krasnoyarsk Territory (Krai) for both years was higher than the Russian average but lower than the same indicator for developed countries. In 2014 regional productivity amounted to 9.59 in international dollars using Purchasing Power Parity (ID); in 2019, it amounted to 14.68 ID per hour worked. Productivity averaged for the OECD countries was triple (or greater) that of the Russian economy, which amounted to 8.56 ID and 10.28 ID per hour worked in 2014 and 2019.

As shown in Tables 1 and 2, four out of fifteen regional sectors demonstrated labour productivity exceeding the regional average in 2014. In 2019, the share of driving sectors was reduced to four out of nineteen. They were mining, manufacturing, electric power industry, and real estate. In 2014, labour productivity in mining exceeded the regional average of 7.88 times. In 2019, this gap increased to 11.65 times. In 2014, labour productivity in manufacturing was higher than the regional average by 150.3 %. In 2019, this figure changed to 181.02 %. The power sector's contribution to regional productivity was heterogeneous: in 2014, it exceeded the regional average by 34.34 %, in 2019 by 16.85 %. It can be partly explained by the transition to a detailed classification of economic activities (OKVED).

Discussion

Decrease in the rates of sectors contributing to productivity growth shows that the dependence of the regional economy on the resource-based type of production was growing steadily from 2014 to 2019. Mining remained the only sector determining the productivity of the regional economy. We demonstrate elsewhere that the high productivity of manufacturing in the Krasnoyarsk Territory (Krai) relies on non-ferrous metallurgy and petrochemistry. Labour productivity for manufacturing is much lower than that in metallurgy and petrochemistry (Samusenko et al., 2018). Obviously, manufacturing is among the leaders of regional labour productivity. Further studies are needed to find out the causes behind productivity growth in this sector. The growing gap in labour productivity between industries allows us to characterise the economy of the Krasnoyarsk Territory (Krai) as resource-based and export-oriented and depending on raw materials. We can conclude that most of the regional economy sectors unfavourably affect the overall labour productivity.

Our results showed that the *regional economic growth is capital-dependent* for most sectors, especially mining, electric power, and real estate sectors. However, with time the dependence of productivity on physical capital decreases, while the dependence of productivity on human capital and multifactor productivity increases. This corresponds to previous findings of the weak dependence of labour productivity on human capital/MFP in developing economies and a stronger link between productivity and human capital/MFP in developed countries (Barro, 1991; Caselli, 2005). The contribution of MFP to labour productivity in the power sector was found to be negative, which could be explained by the deficient innovative performance of the industry. However, the dependence of labour productivity on MFP in the manufacturing industry was high; the reliance on the quality of human capital remained low; the dependence on the physical capital proved to be negative. These results could be partially explained by integrating the contributions of a variety of industries to the overall labour productivity in manufacturing. To some extent, our findings confirm the idea that the outcome of the manufacturing industry critically depends on innovations and up-to-date technologies.

Since MFP was calculated as a residual amount, its impact on sectoral labour productivity could be explained by

[4] The crisis caused by anti-Russian sanctions.

Table 1. Assessment of capital-labour ratio, human capital, and multifactor productivity contribution to regional labour productivity, economic sectors of the Krasnoyarsk Territory (Krai), 2014

Sector of the regional economy, OKVED2007[5]	Annual labour productivity, GVA per hour worked, in 2011 internat. $	Contribution of factors, logarithm			Contribution of the factors to the gap between sectoral and regional labour productivity, percentage			
		Capital-labour ratio	Human capital	MFP	Labour productivity	Capital-labour ratio	Human capital	MFP
Agriculture, hunting and forestry	1.66	0.63	0.12	0.26	-82.63	-51.98	-9.57	-21.08
Fishery, fish farming	0.97	0.41	0.13	0.46	-89.88	-37.27	-11.25	-41.36
Mining	85.14	0.82	0.03	0.15	788.00	646.88	23.53	117.59
Manufacturing	24.00	-0.03	0.07	0.96	150.31	-4.06	10.42	143.95
Electric power, gas and water generation and allocation	12.88	2.77	0.30	-2.07	34.34	95.11	10.29	-71.06
Construction	10.47	-9.33	-0.10	10.43	9.16	-85.52	-0.91	95.60
Wholesale and retail trade	5.45	1.71	0.25	-0.96	-43.20	-73.88	-10.89	41.57
Hotels and restaurants	4.86	0.51	0.29	0.21	-49.27	-24.97	-14.15	-10.15
Transport and communication	8.39	-1.66	-0.16	2.82	-12.52	20.79	2.04	-35.35
Financial activities	1.53	-0.08	-0.07	1.15	-84.08	6.36	6.13	-96.57
Real estate operations, rent and services	8.11	-2.35	-0.16	3.52	-15.45	36.38	2.53	-54.35
Public administration and security; social insurance	9.07	2.39	-1.83	0.45	-5.42	-12.94	9.94	-2.41
Education	5.23	0.50	0.07	0.43	-45.43	-22.77	-3.04	-19.61
Health care and social services	7.23	1.23	0.14	-0.37	-24.64	-30.21	-3.44	9.01
Utility, social and personal services	3.65	0.15	0.15	0.70	-61.93	-9.58	-9.16	-43.19

[5] OKVED – The Russian Classification of Economic Activities, amended in 2007 (OKVED2007) and 2017 (OKVED-2).

Table 2. Assessment of capital-labour ratio, human capital, multifactor productivity contribution to regional labour productivity, economic sectors of the Krasnoyarsk Territory (Krai), 2019

Sector of regional economy, OKVED-2	Annual labour productivity, GVA per hour worked, in 2011 internat. $	Contribution of factors, logarithm			Contribution of the factors to the gap between sectoral and regional labour productivity, percentage			
		Capital-labour ratio	Human capital	MFP	Labour productivity	Capital-labour ratio	Human capital	MFP
Agriculture, forestry, hunting, fishing, and fish farming	2.43	0.41	0.10	0.49	-83.42	-34.26	-8.69	-40.47
Mining	171.02	0.75	0.08	0.17	1064.99	800.20	86.52	178.27
Manufacturing	41.25	-0.19	0.04	1.15	181.02	-34.36	7.28	208.11
Electric power, gas, and steam generation; air conditioning	17.15	5.13	0.18	-4.31	16.85	86.48	3.00	-72.63
Water supply; water disposal, waste collection and disposal, elimination of pollution	7.24	-0.52	0.01	1.52	-50.66	26.54	-0.42	-76.78
Construction	6.29	0.96	0.03	0.01	-57.13	-54.82	-1.95	-0.35
Wholesale and retail trade	4.93	0.81	0.10	0.10	-66.44	-53.77	-6.33	-6.34
Transportation and storage	10.25	-0.72	-0.03	1.74	-30.20	21.64	0.86	-52.70
Hotels and catering	4.87	0.33	0.18	0.49	-66.79	-21.90	-12.15	-32.74
Information and communications	10.23	0.11	-0.14	1.04	-30.31	-3.27	4.38	-31.42
Financial and insurance activities	1.40	0.03	-0.03	1.00	-90.46	-2.44	2.35	-90.37
Real estate	33.43	1.80	-0.25	-0.55	127.71	230.36	-32.09	-70.56
Professional and technical activities, research activity	7.42	0.32	-0.10	0.78	-49.44	-15.92	5.01	-38.53
Administrative activities and other services	9.95	1.38	0.25	-0.63	-32.19	-44.33	-8.17	20.30
Public administration and security; social security	9.51	0.35	-0.10	0.75	-35.21	-12.20	3.36	-26.37
Education	4.60	0.41	0.04	0.55	-68.68	-28.15	-2.91	-37.62
Health care and social work activities	7.20	0.71	0.04	0.26	-50.96	-36.06	-1.90	-13.00
Activities in the field of culture, sports, leisure, and entertainment	5.44	0.13	0.01	0.86	-62.96	-8.08	-0.87	-54.01
Other services	3.26	1.21	0.11	-0.32	-77.79	-94.16	-8.73	25.10

the dependence of sectoral outcome on technological development and the low impact of human and physical capital. The MFP shows the difference in productivity across sectors which could not be explained by the discrepancies in capital-labour ratio and the quality of human capital. However, the MFP's impact should not be explained only by technological change and innovations. MPF as the indecomposable balance of productivity drivers may reflect poor governance, loss of working time, and other non-technological factors of inefficiency such as institutional imperfections and market failures. MPF also proved to drive productivity growth in such regional sectors as agriculture, manufacturing, transport, scientific and technical activities, information and communication sector, finance and insurance, public administration, and education. At the same time, the influence of MFP could be lower in healthcare, where physical capital is more important. It should be noted that MFP had a negative impact on labour productivity in electric power generation, the real estate sector, and administrative activities. This could be explained by a weak institutional environment rather than the low innovative performance of these sectors.

The contribution of human capital to productivity remains extremely low in most sectors of the regional economy. Paradoxically, human capital has a negative effect on productivity in public administration, as well as in scientific and technical activities. This fact could be explained by the high dependence of productivity on MFP: as these sectors can achieve high productivity with innovations and mediocre human capital. The same could be observed in traditionally intellectually intensive types of economic activity such as education, finance and insurance, information and communications. This could be explained by low salaries in these industries. This decreases the impact of human capital input measured by the income index. As of 2014, the construction, transport, and communication industry demonstrate the negative dependence of productivity on human capital. This is caused by a high amount of low skilled and easily replaceable workers. At the same time, the dependence of productivity on human capital is relatively high in agriculture, power generation, health care, wholesale and retail trade, hotels and restaurants activities, and administrative activities, as of 2014. It is essential to clarify the relation between productivity change and human capital in resource-based regions such as the Krasnoyarsk Territory (Krai) because they take peripheral positions and depend on large national corporations that administer production in the area, with their headquarters located in capital cities. With time, the division of labour between managing central regions and producing peripherical regions promoted the outflow of highly skilled professionals to the central areas of Russia, where financial capital is concentrated.

Conclusions

Studying productivity drivers is essential to understanding economic growth at national and international levels. As shown in several other studies, economic growth models demonstrate the impact of physical and human capital and technological change on productivity at a national and international level (Cobet & Wilson, 2002; Denison, 1985; Elias, 1978; Jorgenson et al., 1987; Timmer et al., 2007). Russian researchers show how the Level Accounting Method and the Growth Accounting Method could be used to study productivity across sectors in Russia comparing it with productivity in developed countries (Voskoboynikov, 2012; Zaitsev, 2016). Our paper modifies the Level Accounting Method to study productivity at a sectoral and regional level. We also analysed the effect of physical and human capital and multifactor productivity on the sectoral and regional productivity growth using data from the Krasnoyarsk Territory (Krai), a typical Russian resource-based region.

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