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LABOR PRODUCTIVITY IN THE AGRICULTURE, STRUCTURAL SHIFTS AND ECONOMIC GROWTH IN THE CENTRAL AND EASTERN EUROPEAN COUNTRIES

Purpose. *In our article, we assess the scope and directions of changes in agricultural labor productivity compared to other sectors of the economy.*

Methodology / approach. *For our survey we choose 15 countries: (i) EU countries – Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia, as well (ii) post-Soviet European countries – Ukraine, Moldova, Belarus, russia and also (iii) Albania for period 1996–2019. We use an empirical methodology designed to analyze structural decomposition of labor productivity into the growth effect within the sector and structural dynamic and static effects, often called 'shift-share analysis'. We analyze process of convergence of sectoral labor productivity and its impact on economic growth.*

Results. *Labor productivity grows in the agricultural sector of the economy at the fastest rate, on average by almost 12 % per year. The growth effects within the industry takes a dominant position in all sectors of the economy in the countries of Central and Eastern Europe and its share is on average 88.5 %, and the structural effects are as follows: the dynamic effect is almost 1%, the static effect is 10.4 %. We have confirmed that the agricultural sector is gaining weight in the economic growth of the countries of Central and Eastern Europe, the influence of the service sector is increasing, although together they do not exceed the influence of the growth of value added in industry.*

Originality / scientific novelty. *For the first time we have used the methodology of decomposition of labor productivity growth into three effects: growth, dynamic and static ones for the period before the financial crisis 2008 and after the crisis for 15 countries of Central and Eastern Europe. Using panel GLS estimator with fixed effects we estimate the impact of labor productivity on economic growth in different sectors for 1991–2020 period.*

Practical value / implications. *The main results of the study can be used for elaboration of effective economic policy in agriculture development in Central and Eastern European countries; for identification of structural shifts in labor productivity in different sectors of the economy before and after the financial crisis; for estimation of the level of convergence between different sectors of the economy; determining main factors of increasing value added in agriculture in Ukraine and other Central and Eastern European countries; implementation structural changes in economy in the period of crisis.*

Key words: *labor productivity, agriculture, structural changes, economic growth, Central and Eastern Europe.*

Introduction and review of literature. The concept of economic structure, structural changes has aroused considerable interest of economists, especially in the context of economic development of states, increasing its efficiency and optimization. The economic structure is related to the industry, production structure,

the use of factors of production. The well-known American economist Simon Kuznets expressed structure as a composition of a set, the components of which are interconnected and play a special role, but serve to achieve a certain set of common goals [1, p. 348]. I. Fischer initiated scientific research on the transformation of the industry structure based on the analysis of the employment structure in the second half of the 1930s [2]. For the first time, he applied the division of economic sectors into primary, secondary and tertiary. Thus, such a type of the structure of the economy is analyzed today.

In the Lewis model, structural transformation is analyzed on the basis of comparing the functioning of modern and traditional sectors, the flow of resources from the latter to the former contributes to the growth of profitability and, accordingly, savings rates as a basis for capital accumulation. The analysis of the economic structure based on the dualistic model concerned mainly underdeveloped countries, where there was a surplus of labor in agriculture, low mobility of factors of production, inelastic demand, weak development of market infrastructure [3]. The Lewis model of structural shifts focuses on successive changes in economic, industrial and institutional structures that lead to the replacement of traditional agriculture with the new industries, which are the essence of economic development.

An analysis of the economic literature shows that economists in the twentieth century considered structural transformation in the context of economic development and growth. Crisis phenomena in the world economy in the recent period have actualized the issue of food security. Following questions are of great interest: how the agrarian economy was transformed during the period of market reforms in the countries of Central and Eastern Europe (CEE); which models of agricultural production ensure the highest efficiency; how all this is reflected in the structural changes in the economy of post-socialist countries. The largest structural transformations were observed in the CEE countries as a result of the transition from a planned-administrative economy to the market one.

According to the estimation made by S. Fan and K. Otsuka, total growth rates of labor productivity in agriculture in the countries of Central and Eastern Europe for period 2000–2009 were 0.496 and 0.531 and for 2010–2014 – 0.192 and 0.377 respectively, which are the highest rates in the world for these periods [4, p. 17]. In our survey, we will try to analyze this phenomenon in detail.

Traditional theory of agricultural development has made substantial advances over the last half century. Growth in agricultural production was considered as an essential condition, or even a precondition, for growth in the rest of the economy. But the process by which agricultural growth was took place remained outside the attention for most economists [5, p. 66].

At the beginning of the 1970s, Y. Hayami and V. Ruttan [5] formulated a model of induced technical change in which the development and application of new technology is endogenous to the economic system. In this model, alternative agricultural technologies are developed to facilitate the substitution of relatively abundant (and therefore cheap) factors for relatively scarce (and therefore expensive)

factors. V. Ruttan describes two kinds of technology generally corresponding to this taxonomy. Mechanical technology is labor-saving, designed to substitute power and machinery for labor. Biological and chemical technology is land-saving, designed to substitute labor-intensive production practices and industrial inputs such as fertilizer and plant and animal protection [6, p. 67–68].

The historical path of structural transformation has been accompanied by falling food prices, leading to a world without agriculture: but continued financial instability, coupled with impact of climate change, could lead to a new and uncertain path of rising real costs for food and therefore such a path would lead to a reversal of structural transformation [7]. So, the role and impact of agricultural sector in period of financial crisis on the economic development is becoming stronger.

C. Timmer marked a shift in the theory of agricultural development towards structural transformation [7]. As labor productivity increases, the amount of food produced per worker increases, prices decline, pulling up real wages, absolute poverty reduces, and agricultural workers move towards more productive sectors, thus increasing aggregate productivity. Agricultural transformation refers here to the transition from a traditional subsistence-based agricultural economy to a commercial agriculture relying on the agribusiness sector [5].

The former socialist countries were also more agrarian than non-socialist countries with comparable levels of income per capita. In the pre-transition decade of 1980s, the mean share of agriculture in GDP for former socialist countries was 21 %, compared to 14 % for non-socialist countries with similar per-capita income [8]. However, socialist and market economies' agriculture differed primarily in the productivity of agricultural labor. For instance, labor productivity in the USSR was ten or more times lower compared to the US and Canada. This low productivity of agricultural labor is clearly a reflection of the very high labor use.

The policy of pricing raw materials, food, investment goods also has a significant impact on the sectoral proportions of the economy. Rapid industrialization can be carried out by lowering prices for agricultural products, creating price priorities for industrial production, especially this type of policy is applied by the countries focused on the domestic market. Industrialization in the Soviet Union was carried out in the same way.

The harsh collectivization in the territory of the former Soviet Union, especially in Ukraine, left a deep social trauma in society and, in fact, led to radical changes in the socio-economic landscape in rural areas, which were accompanied by the destruction of motivation for honest, productive work, causing complete mismanagement in the economic aspect, and human sacrifices in conditions of famine, which the world had not seen. Therefore, the moving away from these anti-human, animal-cruelty, coercive methods of concentration of agricultural production is of great importance for the restoration of initiative and motivation in agriculture, and careful attitude to the land. However, in the post-Soviet space, collectivization in the 1930s still affects the predominance of huge agricultural holdings in the agricultural sector, which, in our opinion, does not contribute to the growth of value

added in the economy of the post-Soviet republics, but rather serves the flow of oligarchization processes from industry to agriculture.

The Soviet model of socialist agriculture in the description of Z. Lehrman means that most land, regardless of its ownership, was cultivated collectively in large-scale farms that managed thousands of hectares and employed hundreds of member-workers; the commercial production from the collective sector (which included large production cooperatives and state farms) was supplemented by subsistence-oriented individual agriculture based on rural household plots of less than 1 ha; product markets and input supply channels were largely controlled by state organizations within an administrative command framework; budget constraints virtually did not exist [9].

Inefficiency of socialized agriculture was, of course, an inevitable result of the command economy, which insulated the farms from market signals, imposed central targets as a substitute for consumer preferences, and allowed farms to operate indefinitely under soft budget constraints without proper profit accountability [9]. Besides, efficiency was never an important objective in socialist agriculture; meeting production targets at any cost was the main priority as pointed out by M. Rizov [10].

C. Timmer points out that a market economy is the only institution with a successful track record of rising labor productivity, and hence living standards, over many generations. In such economy, markets play three key roles: an engineering role by moving inputs to farmers and food to consumers; price discovery role to determine worth of commodity or service in monetary terms and also scarcity of goods, the distribution of incomes, and who gets what; the third role consists in efficient allocations of resources to meet the virtually unlimited needs and desires of consumers, which is critical to raising economic output in a sustainable fashion, and thus to reducing poverty and hunger [7].

A very important element of the reform packages of transition to market economy was land reform. Privatization of land in CEE and CIS follows two fundamentally different procedures: restitution to former owners and distribution to workers. Restitution to former owners is the procedure adopted by most CEE countries (except Albania) and by the Baltic states among the former Soviet republics. In the CIS countries and Albania, land ownership is distributed among workers without any payment and is quite fair [11]. Restitution and the physical distribution of land, ended up with relatively strong and well-defined property rights. While it was expected that restitution of land would lead to a decrease in productivity because of the fragmentation of land ownership, in many countries restitution contributed to a greater consolidation of land use because many of the former owners were not interested in farming themselves, and rented the land to the privatized cooperative and corporate farms [12]. In the regions that implemented land reforms through the distribution of certificates, property rights were less clearly defined and, at least in the first decade of the reforms, this negatively affected production and productivity [11]. In most countries, land reform eliminated the monopoly of the state in land ownership and produced a dramatic reduction in the share of agricultural land

directly owned or managed by the state.

The purpose of the article. The aim of our research is to determine the extent of differences in the level of productivity of economic sectors in CEE countries after market reforms and to assess structural changes and their influence on economic growth. In our article, we will try to assess the scope and directions of these transformations with the greatest attention to changes in agricultural labor productivity in comparison with other sectors of the economy.

Results and discussion. Over the past 30 years, the countries of Central and Eastern Europe have gone through several stages in their economic development, which are associated with structural transformation, as well as institutional changes. We begin our analysis from 1996, when the first stage of painful market reforms related to the liberalization of commodity and financial markets, the breaking of economic ties between countries, and the implementation of monetary reforms was completed, and, as a result, macroeconomic stabilization was achieved.

In our research, we focus on examining the main economic trends during two time periods: the first one is from 1996 to 2008, when the world monetary and financial crisis took place, which, in our opinion, became a turning point in the economic development of the countries of Central and Eastern Europe. The second period from world financial crisis 2008 until now is considered as a period of some kind of depression, deceleration of economic growth, rise of external and internal debt of CEE countries.

We would like to note the significant differentiation in the processes of economic growth of these countries. There are star countries that have made a catch-up in their economic development and achieved significant growth rates of labor productivity and also lagging countries.

We choose for our survey 15 countries: EU countries – Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia, as well as post-Soviet European countries – Ukraine, Moldova, Belarus, russia, and also Albania. Such selection of countries was done for possibility for comparative analysis of countries with different institutional environment and level of the development of agricultural sector. We use World Development Indicators Database of the World Bank for this period [13]. We limit our research only for the three sectors of economy: agriculture, industry and services and for period 1996–2019.

At the beginning of our analysis, we will consider indicators of changes in employment, value added and labor productivity in the total economy of the CEE countries. Employment during the studied period grew at a very low rate of 0.22 % per year on average (see Table 1). For comparison, we took the most developed country in the world, the USA, and among European countries – France. These countries have a powerful agricultural sector as well. The analysis showed that in these countries the employment of the population grew 4 times faster.

The highest rates of employment growth were observed in the richest CEE countries: in Poland – 0.74 % per year, Hungary – 1.09 %, Slovakia – 0.70 %,

Slovenia – 0.52 %, Czech Republic – 0.35 %. Employment decreased the most in Romania, Ukraine, Moldova, Lithuania and Latvia. Countries that have a sufficiently high level of capital per worker [14, p. 230] attract more labor force, there is an opportunity to create new jobs.

Table 1

Changes in total employment, value-added and labor productivity in economy of CEE countries for different periods, annual, %

Country	Total employment, %			Total value-added, %			Labor productivity, %		
	1996–2019	1996–2008	2008–2019	1996–2019	1996–2008	2008–2019	1996–2019	1996–2008	2008–2019
Albania	0.43	-0.50	1.55	10.04	11.50	3.55	8.74	12.83	1.64
Belarus	1.35	2.50	0.09	9.09	12.25	2.27	5.91	7.58	2.09
Bulgaria	0.04	0.42	-0.36	2.70	2.50	2.27	2.65	2.00	2.73
Czech Republic	0.35	0.00	0.64	3.43	4.00	1.91	2.91	3.92	1.18
Estonia	0.35	0.50	0.18	6.91	9.08	2.18	6.13	8.17	1.91
Hungary	1.09	0.58	1.55	3.78	4.17	2.27	2.17	3.33	0.64
Latvia	-0.04	1.17	-1.18	6.26	10.33	0.82	6.35	8.08	2.27
Lithuania	-0.26	-0.25	-0.27	6.78	9.33	1.91	7.48	9.75	2.27
Moldova	-0.78	-0.50	-1.09	4.04	3.33	3.45	5.87	4.17	5.18
Poland	0.74	0.67	0.82	6.17	5.33	4.27	4.61	4.33	3.27
Romania	-0.96	-1.75	-0.18	4.91	4.50	3.45	7.52	7.92	3.64
russian federation	0.35	0.92	-0.27	4.91	7.08	1.36	4.22	5.50	1.64
Slovak Republic	0.70	0.75	0.64	5.74	7.00	2.36	4.35	5.83	1.64
Slovenia	0.52	1.08	-0.09	3.87	5.42	1.27	3.00	3.83	1.36
Ukraine	-0.74	-0.75	-0.82	2.09	5.08	-0.82	3.39	6.42	0.09
Average	0.22	0.33	0.09	5.39	6.75	2.18	5.00	6.25	2.09
USA	0.87	-	0.82	2.70	-	1.91	1.48	-	1.00
France	0.83	-	0.18	1.83	-	1.00	0.83	-	0.82

Source: author's estimation.

The growth rate of labor productivity for the period 1996–2019 is very high, averaging – 5 %, which is 3.3 times higher than in the USA and 6 times higher than in France, indicating a catch-up that the CEE countries have achieved in their economic development, increasing the level of added value per employee by 2.2 times on average over 23 years.

The first period, 1996–2008, was marked by EU membership, which stimulated economic and financial integration, led to rapid economic growth and large capital inflows. It also created a "halo effect", protecting some countries from paying more to borrow external funds in spite of growing vulnerabilities [15]. Membership in the EU became a major milestone in their transformation to a market economy. During this period, in fact, the employment almost did not change, and the gross value-added grew at a very high rate. In Albania, Belarus, Latvia, Lithuania, value-added increased more than twice. A more moderate growth (1.4–1.8 times) was observed in European Post-Soviet countries.

After the crisis, the same proportions in the growth of labor productivity between sectors were observed, although it should be noted that the financial crisis

had the most negative impact on the growth rate of labor productivity in industry. This was especially noticeable in Albania, Ukraine, Hungary, Romania and Slovenia.

It should be noted that in the first years of market reforms, a sharp increase in labor productivity was achieved due to a significant decrease in employment in the agricultural and industrial sectors of the economy. In general, employment in agricultural production decreased by half. In addition, a massive outflow of agricultural labor occurred early in transition, facilitated by a well-developed social safety net system and radical reforms, which stabilized the macroeconomic environment [11]. This outflow of labor caused a significant increase in labor productivity at the beginning of the transition period. The largest reduction in employment in the agricultural sector was observed in the Baltic States, the russian federation, Slovakia, and Bulgaria. The share of people employed in industry decreased, but very moderately. Among the countries where, in fact, industrialization took place, are Albania and Moldova. The share of employment in the service sector has increased by an average of 30 % points and reached from 43 % in Albania to 69 % in Latvia (see Table 2).

Table 2

Sectoral structure of employment in economies of CEE, 1996–2019

Country	Employment in agriculture (% of total employment)		Changes for period, times	Employment in industry (% of total employment		Changes for period, times	Employment in services (% of total employment)		Changes for period, times
	1996	2019		1996	2019		1996	2019	
Albania	55.94	36.42	0.65	11.73	20.15	1.72	32.34	43.43	1.34
Belarus	15.88	11.06	0.70	34.23	30.38	0.89	49.89	58.56	1.17
Bulgaria	15.60	6.62	0.42	37.01	30.02	0.81	47.39	63.36	1.34
Czech Republic	6.22	2.66	0.43	42.01	37.25	0.89	51.78	60.09	1.16
Estonia	9.72	3.17	0.33	33.65	28.70	0.85	56.63	68.13	1.20
Hungary	8.22	4.72	0.57	33.24	32.09	0.97	58.54	63.19	1.08
Latvia	17.28	7.29	0.42	27.25	23.72	0.87	55.47	68.99	1.24
Lithuania	21.7	6.44	0.30	28.11	25.70	0.91	50.19	67.86	1.35
Moldova	42.83	20.96	0.49	15.06	21.72	1.44	42.11	57.32	1.36
Poland	21.98	9.15	0.41	32.77	32.13	0.98	45.25	58.71	1.30
Romania	37.96	21.24	0.56	31.52	30.07	0.95	30.52	48.69	1.60
russian federation	15.27	5.83	0.38	32.55	26.79	0.82	52.18	67.38	1.29
Slovak Republic	8.90	2.79	0.31	39.54	36.09	0.91	51.57	61.12	1.19
Slovenia	10.23	4.28	0.42	41.96	34.10	0.81	47.8	61.61	1.29
Ukraine	26.80	13.82	0.52	26.08	24.96	0.96	47.12	61.22	1.30

Source: author's estimation.

According to H. Chenery hypothesis [16]: with the growth of real GDP per capita, the structure of production changes (the share of agriculture decreases, and the share of services increases). Since the socialist economic structure favored industry and suppressed services, the structure of production should be expected to change

rapidly in the first years of the transition period.

What sectors of the economy were dominant in this impressive increase in labor productivity in the economy? Labor productivity grew at the fastest rate in the agricultural sector of the economy, on average almost 12 % per year. The highest achievements were in Slovakia – 48.2 %, Estonia – 21.5 %, Latvia – 14.8 %, Lithuania – 11.6 %, Ukraine – 14.2 % (see Table 3).

Table 3

Sectoral labor productivity in CEE countries, 1996–2019

Country	Agriculture, value added per worker (constant 2010 USD)		Changes for period, annual	Industry, value added per worker (constant 2010 USD)		Changes for period, annual	Services, value added per worker (constant 2010 USD)		Changes for period, annual
	1996	2019	%	1996	2019	%	1996	2019	%
Albania	2350	5600	6.00	9356	13168	1.78	3415	13572	12.91
Belarus	5806	11339	4.13	4035	14891	11.70	5540	10512	3.91
Bulgaria	5247	10836	4.65	5620	14712	7.04	15984	18471	0.70
Czech Republic	11165	27974	6.57	21675	41749	4.04	32122	46137	1.91
Estonia	4968	29592	21.57	11575	36151	9.22	18610	36091	4.09
Hungary	13090	24197	3.70	17257	28591	2.87	25048	34641	1.65
Latvia	4176	17628	14.00	13111	28451	5.09	14181	31803	5.39
Lithuania	4091	15064	11.65	11653	40037	10.61	16556	33321	4.39
Moldova	1548	6268	13.26	9519	11598	0.96	4738	10088	4.91
Poland	4301	7099	2.83	16522	33675	4.52	21139	36439	3.13
Romania	2670	6450	6.17	11670	26442	5.52	15861	34269	5.04
russian federation	4270	16970	12.91	12817	29256	5.57	12750	20391	2.61
Slovak Republic	3617	43716	48.22	13140	38693	8.43	27674	39864	1.91
Slovenia	9812	27102	7.65	22214	46827	4.83	42297	55930	1.39
Ukraine	1336	5714	14.26	3913	5971	2.30	5030	7200	1.87
Average	5230	17037	11.83	12272	27348	5.61	17396	28582	3.74
USA	49465	93728	4.07	72757	108265	2.22	84422	109433	1.35
France	34325	63436	3.85	64704	85942	1.49	89726	100283	0.53

Source: author's estimation.

Labor productivity in industry grew at 2 times lower rates, and in the service sector at almost 3 times lower rates than in agricultural production. The highest levels of labor productivity in agriculture were in Slovakia, the Czech Republic, Estonia, Hungary, Slovenia, Latvia and Lithuania. The same countries are the most productive in industry and services.

Data in Table 3 show changes in sectoral labor productivity in the CEE countries. If we consider the average indicators of this group of countries, the largest increase in labor productivity occurred in agriculture by 3.72 times, followed by industry by 2.29 times, and the lowest rates of growth of labor productivity were in the service sector by 1.86 times for the period from 1996 to 2019.

If we compare the growth rate of labor productivity in agriculture in the CEE

countries with similar studies by Alston et al. [17, p. 52–53] for the period from 1990 to 2005, the annual growth rate of labor productivity in the agricultural sector for the world was 1.36 %, Latin America – 3.53 %, Asia – 2.72 %, China – 4.75 %, we can make conclusions about the significant achievements of the CEE countries, in which, according to our calculations, for the period 1996–2019, the average growth rate was 11.83%, which is 9 times higher than world average indicators, and 3–4 times higher than other regions of the world.

Analysis by country shows that agriculture is dominant in terms of growth rates of labor productivity in almost all countries, except Poland, Belarus, Bulgaria and Albania. Slovakia, Estonia and Ukraine showed particularly phenomenal results. In the USA and France, labor productivity in agriculture is growing twice as fast as in industry and services. Compared to the CEE countries, in the USA and France, the level of labor productivity in agriculture is 4–5 times higher than in the CEE countries, the same indicators for industry and the service sector.

We will analyze in more detail two different models of agriculture development in Slovakia and Poland and their different indicators of labor productivity in the agricultural sector: 43716 and 7099 (constant 2010 USD) respectively. Agriculture in Slovakia and Poland has significant differences in its structure: crop production occupies 61.6 % of the total production in Slovakia and 44.7 % in Poland, and the share of livestock production is 38.4 % and 55.3 %, respectively. This structure led to the situation in which small family farms prevail in Poland, which were private even in the Soviet period, whereas large enterprises began to prevail in Slovakia (statistics of the number of farms with a cultivated area of more than 100 ha show that share of such farms in Slovak Republic is 9.4 % and in Poland – 0.9 % respectively [18; 19]).

All this led to a difference in labor productivity of almost 6 times in favor of Slovakia. Although there is an interesting indicator, the share of added value in production: in Poland it is 36.8 %, which is 1.5 times higher than in Slovakia (23.0 %). Therefore, animal husbandry provides an opportunity to increase value added, as well as employment in the agricultural sector. This can serve as one of the explanations for a very low level of unemployment in Poland (3–4 %). The social component prevailed over efficiency in the agricultural sector of Poland.

One of the causes of fast growth of labor productivity in Slovak agriculture was privatization of large state farms and transformation of cooperatives. J. Pokrivčak pointed out that transformed cooperatives and private firms cannot rely on selective assistance from the government and have to adjust to market fluctuations by themselves and these harder conditions led to a better organization and management of farms that resulted in productivity increase. Hard budget constraints and deteriorating terms of trade reduce resources such as labor, capital, and fertilizers [20].

K. Smędzik-Ambrozy et al. emphasized that large farms dominate in Slovakia. The average area size of analyzed farms from this country, in 2004–2017, amounted to as much as 550 ha compared to 18 ha for farms from Poland. The average area size of Slovakian farms was also the highest among all EU countries. The Polish agricultural sector in the last decade (2007–2017) showed almost the lowest

productivity of resources in relation to other EU countries and its competitive advantages were mainly the result of price advantages rather than resource productivity [21].

J. Némethová and L. Rybanský described Slovak agriculture and its main features. After Slovakia's accession to the EU, the structures of crop production began to change in favor of cereals and some industrial crops, especially oil crops. Oil crops are primarily used for energy production, which is reflected in their relatively high share in the sowing structure of the cultivated crops. They occupy the second highest share, amounting to 16 %. The sown areas of oil crops in 2020 compared to 2004 increased by 55%. The cultivation of energy crops represents a new source of increased income for farmers, while the cultivation of traditional crops is unprofitable [22].

J. Swinnen and L. Vranken made some conclusions about the influence of farm size on productivity. If labor/land ratios are high, i.e. if agricultural production processes are relatively labor intensive, the benefits of shifting to family farms (from corporate farms) are larger. On the other hand, if labor/land ratios are low, i.e. if agricultural production is relatively land intensive, the benefits of shifting to family farms is lower, thus maintaining large-scale corporate farming and the increased labor productivity that results from the layoffs of corporate farm workers [23].

Analysis of agriculture productivity in new EU members by J. Zsarnóczai, Z. Zéman and Kijek et al. led to the conclusion that the increase of output value was a result of concentration of agricultural production in large farms, modernization and mechanization in the sector, increasing resource productivity and factor income per AWU (average working unit), better price income, better market conditions and increasing subsidies on production. Without a significant acceleration of structural changes in agriculture, understood in a broad sense, processes of labor productivity convergence between old and new member states will not accelerate. Therefore, it seems justified to focus the CAP (Common Agricultural Policy) more strongly on supporting structural transformations of the agricultural sector in Central and Eastern European Countries [24; 25].

J. Swinnen and L. Vranken elaborate mechanisms of increasing labor productivity in agriculture and structural transformation. The first mechanism is through the labor market. Labor opportunity costs increase either due to improved off-farm employment or with improved governments' fiscal situations leading to improved social benefits (unemployment benefits and pensions). If returns to labor outside agriculture relative to the returns to agricultural labor are higher (lower) for efficient than inefficient producers, the most efficient (inefficient) producers might be inclined to leave agriculture. The second factor is that other rural factor markets improve, because of a reduction in transaction costs or improvement in institutions (or both), which leads to a reduction in capital costs and improved access to credit, technology and quality inputs. As a result, more farmers are able to invest and to increase their efficiency level. The combination of both factors causes a reduction in the bulk of less efficient farms and an increase in the group of (rather) efficient

farmers [23].

M. Rizov proved that the shift to individual farming has had a positive impact on productivity growth in transition countries. Second, investment and the reduction in excess labor, which are associated with active and initial restructuring are found to be very important determinants of the productivity growth in transition agriculture [10, pp. 24–25].

S. Burkitbayeva et al. reveal that shift to small-scale farming has been the lowest in labor-extensive production systems and the strongest in labor-intensive production systems. Small farms have also served as a labor-absorbing institution during transition. Agricultural productivity growth has been strongly influenced by value chain investments, up- and downstream from the farms. These investments have been motivated by a combination of market imperfections (especially in capital, inputs, and technology markets) and the introduction of quality standards by modern food processing and retail companies [26, pp. 247, 252].

Labor productivity in industry grew at the fastest rates in Belarus and Poland. In the service sector, the best indicators were demonstrated by Albania, high indicators are in Latvia, Lithuania and Romania. In general, employment in this sector of the economy grew at the fastest rate. We calculated the contribution of each sector of the economy to the overall increase in labor productivity (Table 4).

Table 4

Sectoral decomposition of labor productivity growth of total economy in CEE countries, 1996–2019

Country	1996–2019				1996–2008				2008–2019			
	Total	Agric.	Indus.	Service	Total	Agric.	Indus.	Service	Total	Agric.	Indus.	Service
Albania	2.01	0.21	0.44	1.36	1.54	0.14	0.42	0.97	0.18	0.02	0.01	0.15
Belarus	1.36	0.07	0.62	0.67	0.91	0.03	0.48	0.40	0.23	0.02	0.07	0.14
Bulgaria	0.61	0.00	0.22	0.39	0.24	0.00	0.18	0.06	0.30	0.00	0.04	0.27
Czech Republic	0.67	0.00	0.24	0.42	0.47	0.00	0.20	0.27	0.13	0.00	0.03	0.10
Estonia	1.41	0.03	0.43	0.94	0.98	0.04	0.31	0.63	0.21	0.00	0.06	0.16
Hungary	0.50	0.00	0.16	0.34	0.40	0.02	0.17	0.21	0.07	0.00	0.00	0.09
Latvia	1.46	0.05	0.26	1.16	0.97	0.01	0.24	0.72	0.25	0.02	0.01	0.22
Lithuania	1.72	0.01	0.56	1.15	1.17	0.00	0.44	0.74	0.25	0.01	0.06	0.19
Moldova	1.35	0.16	0.27	0.93	0.50	0.03	0.06	0.40	0.57	0.08	0.14	0.35
Poland	1.06	0.00	0.34	0.74	0.52	0.00	0.14	0.40	0.36	0.00	0.13	0.23
Romania	1.73	0.04	0.45	1.24	0.95	0.01	0.44	0.50	0.40	0.01	0.01	0.38
russian federation	0.97	0.03	0.32	0.62	0.66	0.01	0.22	0.43	0.18	0.01	0.06	0.11
Slovak Republic	1.00	0.05	0.44	0.51	0.70	0.02	0.33	0.34	0.18	0.01	0.07	0.10
Slovenia	0.69	0.01	0.22	0.47	0.46	0.00	0.19	0.28	0.15	0.00	0.02	0.13
Ukraine	0.78	0.12	0.13	0.54	0.77	0.04	0.25	0.48	0.01	0.04	-0.07	0.03
USA	0.35	0.00	0.04	0.30	-	-	-	-	0.11	0.00	0.01	0.10
France	0.20	0.00	0.00	0.19	-	-	-	-	0.10	0.00	-0.01	0.10

Source: author's estimation.

It is important to understand the motivation for the flow of the workforce to the service sector. Labor productivity, and, accordingly, higher incomes of workers in the service sector, in our opinion, serve as the main motive for the inflow of labor into this branch of the economy. Thus, in 1996, labor productivity in the service sector exceeded labor productivity in the agricultural sector and industry by 2–3 times. In addition, the level of physical exertion in this area is also low, the working conditions are more comfortable. The effect of backwardness of the service sector in Soviet times formed the possible growth potential of this industry in market conditions.

In general, during the period from 1996 to 2019, the growth of labor productivity in the economy by almost 66 % was provided by the service sector, the contribution of industry is estimated to 30.4 %, and agriculture – 3.6 %, respectively. If we consider the period before and after the crisis, we will find certain differences in the sectoral structure of labor productivity growth. During the period of economic boom of 1996–2008, the contribution of the service sector was 59 %, industry – 38 %, and agriculture 2.3 % on average for the sample (see Table 4).

If we consider these indicators by country, then the highest impact of the service sector on overall labor productivity was in Poland, Moldova, Latvia, and Estonia. After the crisis of 2008, the contribution of the service sector has increased significantly, to almost 78 %, and industry has halved, to 18.8 %, and the contribution of agriculture has grown to 3.4 %, and in almost all countries except Estonia and Hungary. It can be stated that the growth of labor productivity in agriculture in the post-crisis period was the highest.

In Ukraine, after the crisis, in fact, there was no increase in labor productivity in the economy, because labor productivity in industry decreased sharply (-1.91 % per year), and agriculture grew at a significant rate – 12.55 % per year. We try to explain this phenomenon in detail. In general, Ukraine has always been a country with an extremely high share of agriculture in the economy. A significant share of those employed in agricultural production, which amounted to 18.2 % in 2019, exceeded similar indicators in industry (14.8 %). During the years of market reforms, employment in agricultural production decreased, albeit very slowly compared to other post-socialist countries, but in the last five years began to increase, and the number of workers in industry drastically decreased. Although there are certain differences between Ukrainian statistics and World Bank statistics.

Analysis of the development of agriculture and industry reveals that fixed assets in industry in 2019 exceeded the similar indicator in the agricultural sector by 8 times, and the gross value added only by 2.2 times, accordingly, the ratio of capital to gross added value in agriculture was 1.2, and in industry it was 4, which indicates sufficiently high efficiency of the agricultural sector of the Ukrainian economy.

Why has the efficiency of agriculture increased in recent years? Why did labor productivity increase 2.38 times between 2008 and 2019 [27]? In our opinion, such trends are explained by the structure of agricultural production. We observe a steady trend of growth in the share of crop production and decrease in livestock production, so in 2019 their shares in total production were 70.1 % and 20.9 %, respectively. It is

also necessary to note that the share of large-scale production enterprises in crop production is 66.1 %, and in livestock production the share of households is 48.1 % in 2019, although labor productivity in crop production has increased by 2.2 times, and in livestock production by almost 3 times.

It is interesting to determine how the resource base of agriculture has changed over the past 20 years. The technical support of agricultural production has decreased several times, which can be explained by the higher productivity of foreign machinery and its greater reliability. So, in particular, during the period from 2000 to 2019, the number of tractors decreased from 318.9 thsd pcs to 130.5 thsd pcs, grain combine harvesters from 65.2 to 26.5 thsd pcs, corn combine harvesters from 7.9 to 1.5 thsd pcs, but the biggest decrease occurred in beet harvesting equipment from 13.0 to 1.6 thsd pcs. This deep fall of technical resources is the cause of high efficiency of agriculture in comparison to industry.

If we take a deeper look at the structure of land resources, there have been extremely significant changes in the structure of cultivated areas. Over the past twenty years, we have observed an extremely high rate of growth of sown areas under technical crops, for example, the area under soybeans increased almost 25 times from 65 to 1603 thsd ha, the land area under rapeseed increased 59 times from 214 to 1282 thsd ha, the area under sunflower grew the least, only 1.8 times from 2843 to 5328 thsd ha [27]. In general, the share of the sown area under fodder crops decreased from 26.0 % to 6.2 % (from 7063 to 1725 thsd ha), and the share of the sown area under maize for grain increased from 10 % to 37.7 %, soya from 1.6 % to 17.5 %, rape from 5.8 % to 14.0 % respectively.

The basis of the increase in labor productivity in agriculture can be considered in the growth of the yields of the main agricultural crops, in particular, the productivity of grain and leguminous has increased 2.5 times over the past twenty years from 1.94 to 4.91 t per ha; sugar beets in 2.3 times from 17.67 to 46.20 t per ha, sunflower almost twice from 1.22 to 2.30 t per ha, the yield of vegetables increased 2 times, and fruit almost 3 times from 3.84 to 10.81 t per ha [27].

It should be noted that the grain yield in large farms is 1.5 times higher than in households. S. Burkitbayeva et al. explain the domination of large farms in extensive crop cultivation (including grains) in the russian federation, Ukraine, and Kazakhstan by high transaction costs and supply uncertainty that existed because of weak infrastructure (physical and institutional), capital constraints and commercial support services for market agriculture [26, p. 246]. But this case of large-scale farming is not special only for Ukraine. Well-known American economist D. Gollin in his survey of relationship between farm size and productivity revealed that variety in yield due to farm size is relatively small, but there are very large differences in labor productivity in relation to farm size: large farms generate higher average labor productivity than small farms [28].

We would like to note that the production of the agricultural sector grew from 2000 to 2019, mainly due to technical crops [27]: sunflower more than 4 times, soya almost 60 times, rape 32 times, which served as the basis for the growth of exports of

these crops. In general, the share of the export of plant products is 58.3 % of the total export of the agricultural sector, although the share of finished food products in the export decreased from 25.9 to 14.5 %. This situation is very similar to agricultural development in the Slovak Republic [19].

As we noted, high-performance and reliable imported machinery contributes to the growth of agricultural production, but, in our opinion, the use of mineral fertilizers is of the greatest importance in increasing the yield of agricultural crops. Over the past twenty years, the use of nitrogen fertilizers has increased almost 7 times from 225.8 to 1467.5 thsd t, phosphorus fertilizers from 38.0 to 367.5 thsd t, potassium fertilizers from 18.0 to 307.8 thsd t [27]. The share of land fertilized with inorganic fertilizers increased from 22 to 91 %. Organic fertilizers are used only in 4.3 % of all cultivated areas (772.5 thsd ha). This is a very dangerous trend and A. Kucher et al. warned about erosion of soils and the necessity of sustainable management of land resources [29; 30].

In animal husbandry, there has been a decrease in livestock since 1990: in particular, cattle from 24.6 to 3.09 mln heads, cows from 19.4 to 1.7 mln heads, sheep and goats from 8.7 to 5.4 mln heads, poultry from 246.1 to 220.4 mln heads [27]. The share of poultry meat in livestock production increased from 11.6 % to 53.9 %, cattle decreased from 47.9 % to 16.1 %. Productivity in animal livestock also increased, milk yield per cow more than doubled from 2.3 thsd liters to 4.9 thsd liters. At large enterprises, the productivity of cows increased from 1.5 thsd to 6.1 thsd liters, which indicates the effect of scale and new technologies. In households, milk yield increased only 1.6 times from 2966 to 4630 kg [27].

Our economic analysis of the functioning of agriculture in Ukraine showed the main factors that contributed to such a significant increase in labor productivity and overall efficiency of the agricultural sector. Remaining the dominant sector of the Ukrainian economy, agricultural production requires certain structural changes in terms of raising the weight of animal livestock, the share of finished goods in exports, a more careful attitude to soils, which will make it possible to significantly raise the level of gross added value per worker and catch up with more developed CEE countries.

What is the impact of differences across countries in patterns of specialization and structural change on productivity growth? In doing so we will make use of an empirical methodology designed to analyze such issues, often called ‘shift-share analysis’. Such kind of analysis was made by J. Fagerberg [31], M. McMillan et al. [32], M. Maris [33], A. Dieppe and H. Matsuoka [34], P. Dobrzanski and W. Grabowski [35], E. Dorinet et al. [36]. We determined the decomposition of structural effects in labor productivity changes in CEE using the following methodology. Labor productivity we define as (1), and decomposition of change of labor productivity as (2).

$$P_i = Q_i / N_i, \quad (1)$$

where P_i – labor productivity of industry i;

Q_i – value added of industry i;

N_i – employment in industry *i*.

$$\frac{\Delta P}{P_0} = \sum \left[\frac{P_{io}\,\Delta S_i}{P_0} + \frac{\Delta S_i \Delta P_i}{P_0} + \frac{S_{io}\,\Delta P_i}{P_0} \right], \quad (2)$$

where *Si* – share of workers of industry *i* in total employment;

Δ Pi – changes of labor productivity of industry *i* for period of research;

ΔSi – changes of the share of employment of industry *i* in total employment;

P_{io} – labor productivity of industry *i* in the first year of research;

S_{io} – share of employment of industry *i* in the first year of research;

P – labor productivity in total economy;

Δ P – changes of labor productivity for total economy;

P_o – labor productivity in total economy in the first year of research;

$\frac{S_{io}\,\Delta P_i}{P_0}$ – *growth effect* is the contribution from productivity growth within individual industries (weighted by the share of these industries in total employment);

M. McMillan et al. emphasize that productivity can grow within economic sectors through capital accumulation, technological change, or reduction of misallocation across plants. Second, labor can move across sectors, from low-productivity sectors to high-productivity sectors, increasing overall labor productivity in the economy [32].

$\frac{\Delta S_i \Delta P_i}{P_0}$ – *dynamic effect* measures the interaction between changes in productivity in individual industries and changes in the allocation of labor across industries. This effect will be positive if the fast-growing sectors in terms of productivity also increase their share of total employment; when changes in employment shares are positively correlated with productivity levels, this term will be positive, and structural change will increase economy-wide productivity growth [32];

$\frac{P_{io}\,\Delta S_i}{P_0}$ – *static effect* is the contribution to productivity growth from changes in the allocation of labor between industries. It will be positive if the share of high productivity industries in total employment increases at the expense of industries with low productivity. Thus, it reflects the ability of a country to move resources from low to high productivity activities [33].

The growth within the industry in all sectors of the economy in the CEE countries occupies a dominant position and its share is on average 88.5 %, and the structural effects are as follow: the dynamic effect is almost 1 %, the static effect is 10.4 % (Table 5). After the crisis, the dynamic effect has become negative, the static effect has increased to 14 %, in the pre-crisis period the dynamic structural effect was almost 2 %, and the static effect was 9.9 %. In most countries, the dynamic effect has negative values. This means that labor force flows to the sector with lower productivity. W. Baumol elaborated the model of economy with two sectors: one modern sector with increasing labor productivity and an unprogressive sector with lower labor productivity. In the unbalanced productivity model, if the outputs of the two sectors are held constant, more and more total labor force must be transferred to the non-progressive sector and the amount of labor in the other sector will tend to

approach zero. An attempt to achieve balanced growth in a world of unbalanced productivity must lead to a declining rate of growth relative to the rate of growth of the labor force. In particular, if productivity in one sector and the total labor force remain constant, the growth rate of the economy will asymptotically approach zero [37].

Table 5

Decomposition of labor productivity growth into "within" growth effect and structural shift effect in CEE countries in 1996–2019

Country	1996–2019			1996–2008			2008–2019		
	Within growth effect	Dynamic shift effect	Static shift effect	Within growth effect	Dynamic shift effect	Static shift effect	Within shift effect	Dynamic shift effect	Static shift effect
Albania	1.578	0.231	0.201	1.242	0.163	0.136	0.112	-0.008	0.080
Belarus	1.396	-0.050	0.009	0.928	-0.024	0.005	0.242	-0.002	-0.006
Bulgaria	0.517	-0.071	0.161	0.198	-0.050	0.089	0.276	0.001	0.022
Czech Republic	0.633	-0.015	0.047	0.444	0.000	0.030	0.124	-0.002	0.009
Estonia	1.378	-0.055	0.083	0.969	-0.032	0.046	0.213	-0.019	0.021
Hungary	0.479	-0.003	0.024	0.406	-0.032	0.025	0.073	-0.002	0.001
Latvia	1.339	0.041	0.085	0.857	0.036	0.075	0.241	-0.003	0.015
Lithuania	1.505	0.048	0.162	0.974	0.073	0.127	0.250	-0.012	0.011
Moldova	1.121	-0.020	0.248	0.344	0.006	0.146	0.503	-0.015	0.083
Poland	0.827	0.100	0.137	0.399	0.036	0.087	0.298	0.011	0.047
Romania	1.228	0.262	0.238	0.753	0.070	0.128	0.281	0.037	0.081
russian federation	0.982	-0.086	0.069	0.625	-0.014	0.050	0.188	-0.012	0.008
Slovak Republic	1.008	-0.110	0.099	0.654	-0.014	0.056	0.179	-0.016	0.016
Slovenia	0.609	-0.035	0.115	0.425	-0.023	0.063	0.124	-0.010	0.040
Ukraine	0.729	-0.076	0.131	0.693	0.026	0.054	-0.012	-0.045	0.063
Average	1.022	0.011	0.121	0.661	0.015	0.074	0.206	-0.006	0.033

Source: author's estimation.

If we look at the branches, the most interesting changes were observed in the service sector, where the share of structural shifts was more than 39 % (Table 6). After the crisis, the static structural effect has increased in all sectors. In the service sector, the share of growth within the sector is the lowest among the sectors of the economy. In particular, in Bulgaria, Romania, Slovenia and Ukraine, it is less than 50 %, and accordingly the structural shifts in the economies of these countries were the greatest.

Over the entire period of the study, the static structural effect prevailed over the dynamic one in almost all countries except Albania, Latvia, Moldova and Romania, and, on average, accounted for 21 % in the growth of labor productivity in the service sector. After the 2008 crisis, the share of static effects has increased significantly to 36 %, and the share of dynamic effects has fallen to 6.6 %. This shows that labor productivity growth remains very low in the service sector, although the level of value added per worker remains the highest compared to other sectors (Table 6).

Table 6

Decomposition of labor productivity growth of agriculture, industry and services in CEE countries in 1996–2019

Country	Agriculture				Industry				Service			
	Within growth effect	Dynamic shift effect	Static shift effect	Total growth	Within growth effect	Dynamic shift effect	Static shift effect	Total growth	Within growth effect	Dynamic shift effect	Static shift effect	Total growth
Albania	0.52	-0.18	-0.13	0.21	0.13	0.09	0.22	0.44	0.93	0.32	0.11	1.36
Belarus	0.17	-0.05	-0.06	0.07	0.73	-0.08	-0.03	0.62	0.49	0.09	0.09	0.67
Bulgaria	0.08	-0.05	-0.04	-0.01	0.32	-0.06	-0.04	0.22	0.11	0.04	0.24	0.39
Czech Republic	0.04	-0.02	-0.02	0.00	0.32	-0.04	-0.04	0.24	0.27	0.04	0.10	0.42
Estonia	0.16	-0.11	-0.02	0.03	0.55	-0.08	-0.04	0.43	0.66	0.13	0.14	0.94
Hungary	0.04	-0.02	-0.02	0.00	0.18	-0.01	-0.01	0.16	0.26	0.02	0.05	0.34
Latvia	0.19	-0.11	-0.03	0.05	0.34	-0.04	-0.04	0.26	0.80	0.20	0.16	1.16
Lithuania	0.19	-0.13	-0.05	0.01	0.64	-0.05	-0.02	0.56	0.67	0.24	0.23	1.15
Moldova	0.49	-0.25	-0.08	0.16	0.08	0.03	0.15	0.27	0.55	0.20	0.18	0.93
Poland	0.04	-0.02	-0.03	-0.02	0.35	-0.01	-0.01	0.34	0.43	0.13	0.18	0.74
Romania	0.15	-0.07	-0.05	0.04	0.49	-0.02	-0.02	0.45	0.59	0.35	0.30	1.24
russian federation	0.17	-0.10	-0.04	0.03	0.47	-0.08	-0.06	0.32	0.35	0.10	0.17	0.62
Slovak Republic	0.18	-0.12	-0.01	0.05	0.51	-0.04	-0.02	0.44	0.32	0.06	0.13	0.51
Slovenia	0.06	-0.03	-0.02	0.01	0.34	-0.06	-0.06	0.22	0.21	0.06	0.19	0.47
Ukraine	0.31	-0.15	-0.05	0.12	0.14	-0.01	-0.01	0.13	0.27	0.08	0.19	0.54
USA	0.01	0.00	0.00	0.00	0.11	-0.02	-0.05	0.04	0.23	0.02	0.06	0.30
France	0.02	-0.01	-0.01	0.00	0.07	-0.02	-0.05	0.00	0.09	0.01	0.09	0.19

Source: author's estimation.

Industry is dominated by growth within the sector, dynamic and static structural effects are negative in all countries, except Albania and Moldova, where industrialization has taken place in a certain way. After the crisis, although productivity growth rates in industry have decreased, especially negative indicators of growth are visible within industry, dynamic structural effects have increased and amounted to 0.068, exceeding the overall growth of labor productivity in the industry by 0.04 on average across countries. Consequently, labor productivity in industry is growing at a higher rate than in the service sector and an influx of labor has begun.

In agriculture, where employment has fallen the most, the structural effects are negative in all countries, but the increase in labor productivity within this sector significantly exceeds their negative impact. The agricultural sector is the most dynamic sector of the economy in terms of labor productivity in the countries of Central and Eastern Europe. The Baltic States, Ukraine, Moldova, Slovakia, and Albania are among the leaders in terms of labor productivity growth in agriculture. Among the lagging countries there are Bulgaria, the Czech Republic, Hungary and Poland.

Similar studies were conducted by A. Dieppe and H. Matsuoka and their database consists of sectoral and aggregate labor productivity statistics for 91 countries, and 8 sectors (agriculture, mining, manufacturing, utilities, construction, trade services, transport and financial services, and government and personal

services) covering the period from 1975 up to 2018.The results of the survey show that productivity growth in advanced economies had been almost entirely driven by within-sector productivity growth mainly in the manufacturing, transport and finance sectors. However, since the 2000s both within-sector and between-sector productivity growth have slowed. During the 2010s, the contribution of between-sectors slowed down due to small movement to higher productivity sectors such as manufacturing and trade [34]. Our results are very similar to surveys by M. McMillan et al. [32], and P. Dobrzanski and W. Grabowski [35].

The question of the convergence of labor productivity levels in various sectors of the economy is of serious interest among economists. As explained above, an increase in output per worker in the agricultural sector is key for structural transformation. Yet, agricultural productivity in developing countries tends to be significantly lower relative to the non-agricultural sectors. This fact is known as the agricultural productivity gap [38]. Implications for development are huge as reducing the gap may increase aggregate productivity and be growth-enhancing.

Considering the significant surge in labor productivity in agriculture, the convergence of this indicator with the economy average was expected. A. Dieppe and H. Matsuoka emphasize that agricultural productivity growth has been a significant contributor to aggregate convergence, whereas a catch-up in other sectors has only contributed a small amount to convergence [34]. The process of convergence of the level of productivity in the sectors of the economy means the equalization of the level of productivity in industry, the service sector and agriculture and converging with the average level of labor productivity in the economy as a whole. We analyzed this process using two indicators: 1) the ratio of labor productivity indicators in the agricultural sector to this indicator in the economy as a whole; 2) as well as σ-convergence, which is determined by the ratio of the standard deviation of labor productivity indicators in each industry to the average value. Regarding the last indicator: the lower it is, the higher the level of convergence.

The data in Table 7 show the rapid convergence of labor productivity indicators by industry in the Baltic countries, Slovakia and Ukraine. The lack of convergence is observed in Belarus, Poland and Romania. Consequently, significant labor flows from agriculture to other industries are possible in these countries. If we compare the processes of convergence and overcoming the gap between labor productivity in agriculture and other sectors of the economy of the CEE countries with developed economies, we can conclude that in the USA these processes are carried out at a very fast pace, the σ-convergence rate is especially rapidly decreasing, in France the convergence of productivity is somewhat slower. Estonia, Slovakia, and Ukraine have reached US convergence rates.

At the end of the study, we determined the strength of the impact of labor productivity in the sectors of the economy on the well-being of the population, which we measure through GDP per capita and also on the economic growth. We used the technique of panel regressions using GLS (generalized least square) estimator.

Models based on panel data include a number of observations of the same units

(firms, industries, countries) that are collected over a period of time. Panel data are typically collected at the microeconomic level, but it is becoming increasingly popular at the applied level to combine the time series of several countries or industries to analyze them simultaneously. Having a series of time-repeated observations of the same structural units allows economists to define specifications and calculate more complex and realistic models than cross-sectional or time series databases and models allow [39, pp. 310–320].

Table 7

Convergence of sectoral labor productivity in CEE countries, 1996–2019

Country	Ratio of agriculture productivity to total productivity of economy		σ-convergence of sectoral labor productivity	
	1996	2019	1996	2019
Albania	0.668	0.520	0.749	0.417
Belarus	1.146	0.926	0.186	0.190
Bulgaria	0.501	0.738	0.681	0.260
Czech Republic	0.422	0.724	0.484	0.245
Estonia	0.333	0.872	0.582	0.111
Hungary	0.610	0.830	0.329	0.180
Latvia	0.343	0.679	0.524	0.285
Lithuania	0.328	0.511	0.583	0.438
Moldova	0.378	0.673	0.762	0.295
Poland	0.270	0.276	0.622	0.629
Romania	0.280	0.288	0.669	0.641
russian federation	0.372	0.764	0.494	0.286
Slovak Republic	0.183	1.073	0.818	0.064
Slovenia	0.321	0.626	0.662	0.340
Ukraine	0.356	0.908	0.553	0.126
USA	0.612	0.860	0.258	0.084
France	0.426	0.658	0.441	0.223

Source: author's estimation.

An important advantage of panel data compared to time series or cross-sectional data sets is that they allow identifying certain parameters or questions, without the need to make restrictive assumptions. Panel data make it possible to analyze changes on the individual level. That is, panel data are not only suitable to model or explain why economic units behave differently, but also to model why a given unit behaves differently at different time periods.

We apply for all variables the index i for economic units (countries) $i = 1,\ldots, N$ and t for the time period ($t = 1,\ldots,T$). In general, the linear model has the form:

$$y_{it} = x_{it}\,\beta_{it} + \varepsilon_{it}, \quad (3)$$

where β_{it} measures the partial effects of x_{it} in period t for country i. The standard assumption used in many empirical studies is that β_{it} is a constant for all i and t. This can be written:

$$y_{it} = \alpha_i + x_{it}\beta + \varepsilon_{it}, \quad (4)$$

where x_{it} – is a vector of explanatory variables that does not include a constant.

This means that the effect of changes in x is the same for all economic units and periods. The value of α_i reflects the influence of these variables, which are unique to each unit i and is constant throughout the period. In the standard case, let's assume that ε_{it} is an error that is an independent quantity that is identically distributed among countries and time periods with zero mean and variance σ_ε^2. If we consider α_i as N fixed unknown parameters, model (2) refers to the standard model with fixed effects.

The computation of goodness-of-fit measures in panel data application is somewhat uncommon. One reason is the fact that one may attach different importance to explaining the within and between variation in the data.

The total variation in y_{it} can be written as the sum of the within variation and the between variation, that is:

$$\frac{1}{NT}\sum_{i,t}(y_{it}-\bar{y})^2=\frac{1}{NT}\sum_{i,t}y_{it}-\bar{y}_i)^2+\frac{1}{N}\sum_{i}(\bar{y}_i-\bar{y})^2, \quad (5)$$

where $\bar{y}$ – denotes the overall sample average.

For example, the fixed effects estimator is chosen to explain the within variation as well as possible, and thus maximizes the "within R^2" given by

$$R^2_{within}(\hat{\beta}_{FE})=corr^2\{\hat{y}^{FE}_{it}-\hat{y}^{FE}_{i},y_{it}-\bar{y}_i\}, \quad (6)$$

where $\hat{y}^{FE}_{it}-\hat{y}^{FE}_{i}=(x_{it}-\bar{x}_i)'\hat{\beta}_{FE}$ and $corr^2$ denotes the squared correlation coefficient.

The between estimator, being an OLS estimator in the model in terms of individual means, maximizes the "between R^2".

$$R^2_{between}(\hat{\beta}_B)=corr^2\{y^B_i,\bar{y}_i\}, \quad (7)$$

where $\hat{y}^B_i=\bar{x}_i'\hat{\beta}_B$. The OLS estimator maximizes the overall goodness-of-fit and thus the overall, which is defined as:

$$R^2_{overall}(\hat{\beta})=corr^2\{\hat{y}_{it},y_{it}\}, \quad (8)$$

where $\hat{y}_{it}=x_{it}'b$. Studies have shown that panel data estimates are more effective in most cases than when the same amount of data is available, and the data is generated by selecting different units in each time period. Models with panel data are more stable with respect to missed variables, measurement errors and the presence of endogenous variables among regressors.

For the analysis, we took several periods of time: the entire period from the beginning of the reforms to now 1991–2020, the period of rapid economic growth 2002–2008, as well as the broader period from macroeconomic stabilization to the world currency crisis of 1996–2008 and the period after the world crisis of 2009–2020 (Table 8). The study included the same 15 countries as before. We use the World Development Indicators Database of the World Bank for this period [13].

For estimation of this model we used panel GLS regression with fixed effects for all periods. Dependent variable is $GDPC_{ti}$ – Gross Domestic Product per capita in period t; independent variables: $agriproductiv_{ti}$ – labor productivity in agriculture in period t; $indproductiv_{ti}$ – labor productivity in industry in period t; $servproductiv_{ti}$ –

labor productivity in service in period *t*.

Table 8

Level of welfare and sectoral labor productivity in CEE countries, 1991–2020

Independent variables	Dependent variable $GDPC_{ti}$				
	For period 1991–2020	For period 2002–2008	For period 1996–2008	For period 2002–2020	For period 2008–2020
$agriproductiv_{ti}$	0.058 (6.01)	0.04 (2.13)	0.07 (4.47)	0.037 (2.86)	0.058 (3.35)
$indproductiv_{ti}$	0.25 (19.68)	0.16 (4.99)	0.23 (11.84)	0.22 (10.52)	0.25 (8.77)
$servproductiv_{ti}$	0.266 (15.84)	0.50 (11.07)	0.29 (10.76)	0.36 (13.2)	0.39 (11.85)
$Constant_{ti}$	-1710.7 (-7.57)	-5190.4 (-8.5)	-2157.9 (-6.8)	-3104.4 (-6.1)	-5227 (-6.87)
Within R^2	0.94	0.92	0.93	0.84	0.80
Between R^2	0.97	0.95	0.96	0.96	0.96
Overall R^2	0.96	0.95	0.96	0.95	0.96
F-test	2188.8	293.9	45.93	398	199.3
Number of observations	397	90	152	269	179

Note. In parenthesis *t-statistic*.
Source: author's estimation.

The results of the study showed that over the entire period, the impact of the level of labor productivity in the service sector is almost the same as the impact of labor productivity in industry: an increase of 1000 USD in labor productivity increases GDP per capita by 250–260 USD (Table 8). The impact of labor productivity in agriculture is five times lower. The statistical significance of the results is quite high. If we consider the period of economic growth (2002–2008), the impact of labor productivity in the service sector on GDP per capita increases by 2 times, and the impact of a similar indicator of industry falls significantly. In general, in the pre-crisis period of 1996–2008, the impact of sectoral labor productivity on general well-being is similar to the indicators for the entire period of survey. In the post-crisis period, the coefficient determining the impact of labor productivity in the service sector increased from 0.29 to 0.39.

We obtained slightly different results when studying the impact of the growth of value added in the economic sectors on the economic growth rates in the economy (Table 9). The periods during which the research was conducted were the same as in the previous case. Dependent variable is $GDPCG_{ti}$ – Gross Domestic Product growth in period *t*; independent variables: $agrigrowth_{ti}$ – growth of value added in agriculture in period *t*; $industrygrowth_{ti}$ – growth of value added in industry in period *t*; $servicegrowth_{ti}$ – growth of value added in service in period *t*.

During the entire period of post-socialist economic growth, the dominant factor was the growth of value added in industry with a coefficient of 0.52, which indicates that an increase of value added in industry by 1 percentage point will cause an increase of 0.5 percentage points in the rate of economic growth, an increase in value

added in the service sector affects it with a coefficient of 0.11, in the agricultural sector with a coefficient of 0.04.

We also analyzed the period before the accession of CEE countries to the European Union and after the accession to the present time and compared. Thus, the impact of the growth of value added in industry decreased from 0.54 to 0.41, and the growth of value added in the service sector increased from 0.06 to 0.41, and in the agricultural sector, the growth of value added changed from a negative and statistically insignificant impact before the accession of countries to the EU to a positive and statistically significant impact on economic growth with a coefficient of 0.065.

Table 9

Economic growth and growth of sectors of economy in CEE countries, 1991–2020

Independent variables	Dependent variable $GDPCG_{ti}$				
	For period 1991–2020	For period 1991–2003	For period 1996–2008	For period 2002–2020	For period 2008–2020
$agrigrowth_{ti}$	0.04 (4.34)	-0.001 (0.95)	0.027 (1.70)	0.065 (9.88)	0.066 (7.92)
$industrygrowth_{ti}$	0.52 (30.56)	0.54 (15.84)	0.44 (12.90)	0.41 (29.8)	0.42 (26.14)
$servicegrowth_{ti}$	0.11 (9.15)	0.06 (3.71)	0.07 (4.72)	0.41 (21.2)	0.33 (15.45)
$Constant_{ti}$	1.15 (8.83)	0.82 (3.01)	2.19 (7.72)	0.64 (6.33)	0.568 (5.47)
Within R^2	0.78	0.75	0.56	0.91	0.91
Between R^2	0.76	0.85	0.62	0.58	0.67
Overall R^2	0.78	0.78	0.57	0.89	0.89
F-test	474.7	113.4	203.11	882.14	545.1
Number of observations	397	128	152	269	179

Note. In parenthesis *t-statistic*.

Source: author's estimation.

The results of the study of the pre-crisis period from 1996 to 2008 and after the crisis period indicate an increasing impact of the growth of value added in the services sector (the coefficient increased by 4 times) and agriculture (the coefficient increased by 2 times). The impact of the increase in value added in industry is decreasing, but remains the highest on the economic growth of countries.

Therefore, we have confirmed that the agricultural sector is gaining weight in the economic growth of the CEE countries, the influence of the service sector is increasing, although together they do not exceed the influence of the growth of value added in industry. Such research results encourage the implementation of an effective industrial policy that would contribute to raising labor productivity in the agricultural sector and the service sector. Governments should stimulate the inflow of investment in agriculture to catch up with productivity in industry, as well as to preserve and increase the fertility of arable land in the long term, as well as to improve cropping patterns.

In general, structural changes in the economy are a rather painful process that affects the way of life of large groups of the population, changes in their place of residence and employment. S. Kuznets pointed out that government policy and institutional change must minimize costs and reduce resistance to the structural changes needed to achieve high economic growth [1]. M. McMillan et al. emphasized that the speed with which this structural transformation takes place is the key factor that differentiates successful countries from unsuccessful ones [32]. Structural changes are designed to reduce the level of imbalances in the economy, use resources more efficiently and allocate them in certain areas to accelerate technical change and achieve dynamic efficiency of society.

Conclusions. Our research made it possible to obtain significant results regarding the evolution of labor productivity and structural shifts in the countries of Central and Eastern Europe for the entire period from the beginning of market reforms in the 1990s. We paid special attention to the study of the structural transformation of agriculture and its impact on changes in labor productivity, identified the reasons for the initial decline of the agricultural sector, and then for its sharp rise. The research period covered the time of the economic boom – 2002–2008, as well as the post-crisis recession, which covered the whole world. The currency and financial crisis of 2008, as our research showed, was a turning point and the reason for the slowdown in economic growth and, accordingly, a decrease in labor productivity in the countries of Central and Eastern Europe. This global shock caused significant structural transformations in the sources of labor productivity growth in general in the economy. Labor productivity in agriculture grew in a number of countries at a significant pace and, in fact, agriculture became the dominant sector along with services in raising the productivity of the economies of Central and Eastern Europe.

Industry got the biggest hit, although the structural dynamic effect began to grow, and in certain branches of industrial production, there was an increase in labor productivity while the general process of decreasing employment was observed.

The growth rate of labor productivity for the period 1996–2019 was very high, on average – 5 %, which was 3.3 times higher than in the USA and 6 times higher than in France, which indicates a catch-up, which the CEE countries have achieved in their economic development, increasing the level of added value per employee by 2.2 times on average over 23 years. In the pre-crisis period of 1996–2008, the CEE countries demonstrated extremely high growth rates of labor productivity – 6.25 %, which sharply decreased in the post-crisis period by almost 3 times to 2.09 % per year. In the USA, the rate of labor productivity fell by only 1.5 times, and in France, such a phenomenon was not observed at all.

What sectors of the economy were dominant in this impressive increase in labor productivity in the economy? Labor productivity grew at the fastest rate in the agricultural sector of the economy, on average almost 12 % per year. The highest achievements were in Slovakia – 48.2 %, Estonia – 21.5 %, Latvia – 14.8 %, Lithuania – 11.6 %, Ukraine – 14.2 %. Analysis by country shows that agriculture is

dominant in terms of labor productivity growth rates in almost all countries, except for Poland, Belarus, Bulgaria and Albania. Slovakia, Estonia and Ukraine showed particularly phenomenal results.

In general, during the period from 1996 to 2019, the growth of labor productivity in the economy by almost 66 % was provided by the service sector, the contribution of industry is measured by 30.4 %, and agriculture – 3.6 %, respectively. If we consider the period before and after the crisis, we will find certain differences in the sectoral structure of labor productivity growth. During the period of economic boom of 1996–2008, the contribution of the service sector was 59 %, industry – 38 %, and agriculture 2.3 % on average for the sample. After the crisis of 2008, the contribution of the service sector increased significantly, to almost 78 %, and industry fell more than 2 times, to 18.8 %, and the contribution of agriculture grew to 3.4 %, and in almost all countries except Estonia and Hungary. It can be stated that the growth of labor productivity in agriculture in the post-crisis period was the highest. The growth within the industry in all sectors of the economy in the CEE countries occupies a dominant position and its share is on average 88.5 %, and the structural effects are as follows: the dynamic effect is almost 1 %, the static effect is 10.4 %.

After the crisis, the dynamic effect has become negative, the static effect has increased to 14 %, in the pre-crisis period the dynamic structural effect was almost 2 %, and the static effect was 9.9 %. In most countries, the dynamic effect has negative values. This means that labor force flows to the sector with lower productivity.

During the entire period of post-socialist economic growth, the dominant factor was the growth of value added in industry with a coefficient of 0.52, which indicates that an increase of value added in industry by 1 % point will cause an increase of 0.5 % points in the rate of economic growth, an increase in value added in the service sector it affects with a coefficient of 0.11, in the agricultural sector with a coefficient of 0.04.

We also analyzed the period before the accession of CEE countries to the European Union and after the accession to date and compared. Analysis showed that the impact of the growth of value added in industry decreased from 0.54 to 0.41, and the growth of value added in the service sector increased from 0.06 to 0.41, and in the agricultural sector, the growth of value added changed from a negative and statistically insignificant impact before the entry of countries the EU to a positive and statistically significant impact on economic growth with a coefficient of 0.065. The results of the study of the pre-crisis period from 1996 to 2008 and after the crisis period indicate an increasing impact of the growth of value added in the services sector (the coefficient increased by 4 times) and agriculture (the coefficient increased by 2 times). The impact of the increase in value added in industry is decreasing, but remains the highest on the economic growth of countries.

Especially interesting processes took place in the agriculture of Ukraine. We carried out a detailed analysis of Ukrainian agricultural development, starting from

2000. The increase in world prices for food products in 2008–2010 and maintaining its high level during the following years, as well as the growing demand for technical crops for the needs of the energy sector acted as the main factors of demand, in our opinion, caused the rise of the agricultural sector in Ukraine. In addition, agricultural production does not require significant investments in fixed capital, as well as access to new technologies of grain production, high-yield crop varieties, seed material, pesticides and mineral fertilizers. Besides, new imported agricultural machinery allowed increasing dramatically labor productivity in crop production. All the above-mentioned factors affected the supply of agricultural products and increased efficiency of their production. The change in the structure of cultivated areas in favor of industrial crops increased the export potential and profitability of agricultural production.

In almost all CEE countries, the contribution of agricultural production to total labor productivity has increased over the past 12 years, although the level of labor productivity still falls short of the level of other sectors. In further research, it will be valuable to determine spillovers of technology between industrial sector and agricultural sector, as well as the impact of innovative technologies on employment in agricultural production in the countries of Central and Eastern Europe, influence of global COVID-19 pandemic on agriculture development and also the prospects of structural changes in the agricultural sector of Ukraine in the post-war period.

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