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on the topic: "**WELFARE EFFECTS OF THE LIBERALIZE-AND-SUBSIDIZE POLICY IN UKRAINIAN AGRICULTURE INDUSTRY**"

на тему: «**ЕФЕКТИ ДОБРОБУТУ ВІД ПОЛІТИКИ ЛІБЕРАЛІЗАЦІЇ ТА СУБСИДУВАННЯ В СІЛЬСЬКОМУ ГОСПОДАРСТВІ УКРАЇНИ**»

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INTRODUCTION

Relevance of the topic. Governments in different countries implement policies aimed to improve the agriculture sector conditions and achieve desired levels of food security, export revenues, regional development and farmers' incomes. Ukraine has a great potential in agricultural productivity and, as an emerging market country, is highly dependent on the agriculture sector development. State support became a necessary part of the economy during globalization and trade liberalization to protect domestic manufacturers, facilitate transitions, enhance employment and incomes.

Positive and negative welfare effects of agricultural subsidies have been important topics for a vast amount of researchers during different periods of time. They were aimed at exploring the types of domestic policy measures (OECD 2015), environmental impacts of the agricultural subsidies (OECD 2005), quantity effects on the production (Vozarova, Kotulic 2016), transfer efficiency of farm support (Dewbre 2002), common agricultural policy in the European Union (Baldwin, Wyplosz 2019), support for small- and medium-sized enterprises (Ilchuk 2019), fiscal efficiency of agricultural subsidies (Nivievskyi, Deininger 2019), theoretical impact on macroeconomic development in Ukraine (Zorya 2004), application of Green Box measures in Ukraine (Demyanenko, Galushko 2004) [40, 38, 13, 18, 37, 64, 11]. Therefore, it is essential to investigate this topic with a complex approach to give a current overview on Ukrainian agriculture state support, as well as to supplement it with a regional research measuring the influence of subsidies on farmers and production in a regional context.

Purpose and objectives. The purpose of the research is quantitative analysis of the subsidies in Ukrainian agriculture sector to develop policy approaches. Subsequently, the following objectives were set:

- define the role of agriculture sector in Ukrainian economy and trade;

- determine the peculiarities of the production structure;
- identify features and development of agricultural market;
- explore the purposes of the subsidies implementation in agriculture;
- review the indicators representing the level of state support in Ukrainian agriculture, shape main tendencies and make international comparisons;
- define main economic and political ambiguities arising from the subsidies assignment;
- investigate regional agricultural production in Ukraine and identify key factors within subsidized directions;
- develop policy recommendations to increase production volumes through state support, and make conclusions.

Object of research is state support in the agriculture sector.

Subject of research is types of state support, its dynamics and effects, assignment problems and influence on agricultural production.

Research methods. While undertaking the research, theoretical approach is used to investigate the nature of subsidies. Statistical method is used to derive main features of agricultural market and dynamics of key state support indicators. Econometric methods are employed to explore the relationships between regional agricultural production in Ukraine and factors that influence it.

Information base for the research consists of statistical and analytical materials published by the Ministry for Development of Economy, Trade and Agriculture of Ukraine, the Cabinet of Ministers of Ukraine, the National Bank of Ukraine, the State Statistics Service of Ukraine, the State Customs Service of Ukraine, the State Treasury Service of Ukraine, scientific papers written by Ukrainian and foreign authors, the World Trade Organization reports, publications by the Organization for Economic Co-operation and Development accessed via the Internet.

Practical significance of the obtained results. Research results can be used to predict future production volumes of investigated agricultural commodities and to design policy approaches aimed at increasing the production levels through subsidizing desired factors.

Research results expand the investigated topic and provide a complex examination of the state support in Ukrainian agriculture. The econometric findings of foreign authors were supplemented with a case of Ukraine explored in the research. The method can be employed to investigate factors that differ from those chosen in this research, as well as to select other regions for comparison.

Structure and brief description. This thesis is composed of the introduction, three chapters, conclusions and references. The First Chapter provides a general overview on the conditions of the agriculture sector in Ukraine, illustrates the main indicators and development trends of the sector. The Second Chapter is devoted to a detailed investigation of subsidies, their assignment in Ukrainian agriculture and common effects. It is, in addition, supplemented with international comparisons, using statistical methods, and with investigation of the political side of the state support implementation, considering the case of Ukraine. The Third Chapter presents a detailed study of the regional agricultural production in Ukraine, applying econometric analysis to derive the influence of researched factors and to develop possible policy approaches in subsidizing those factors.

Key words: agriculture subsidies; state support; agriculture sector; regional production; effects of subsidies.

CHAPTER 1
GENERAL CONDITIONS OF AGRICULTURE SECTOR IN UKRAINE

1.1 Role in the Economy and Export

The agricultural sector plays a key role in the economies of emerging markets, and Ukraine conforms with these tendencies due to its market characteristics and extensive fertile farmlands. As of 2020 Ukraine has approximately 41 million hectares (ha) of agricultural land, 33 million ha of which is arable land.

Ukrainian agriculture, forestry and fishing industries contributed 358 billion UAH to the gross domestic product (GDP) in 2019 - about 9% of GDP. The agricultural sector provided workplaces for 3 million of employed population aged 15-75 years, which comprised 18% of the total employment (see Figure 1.1).

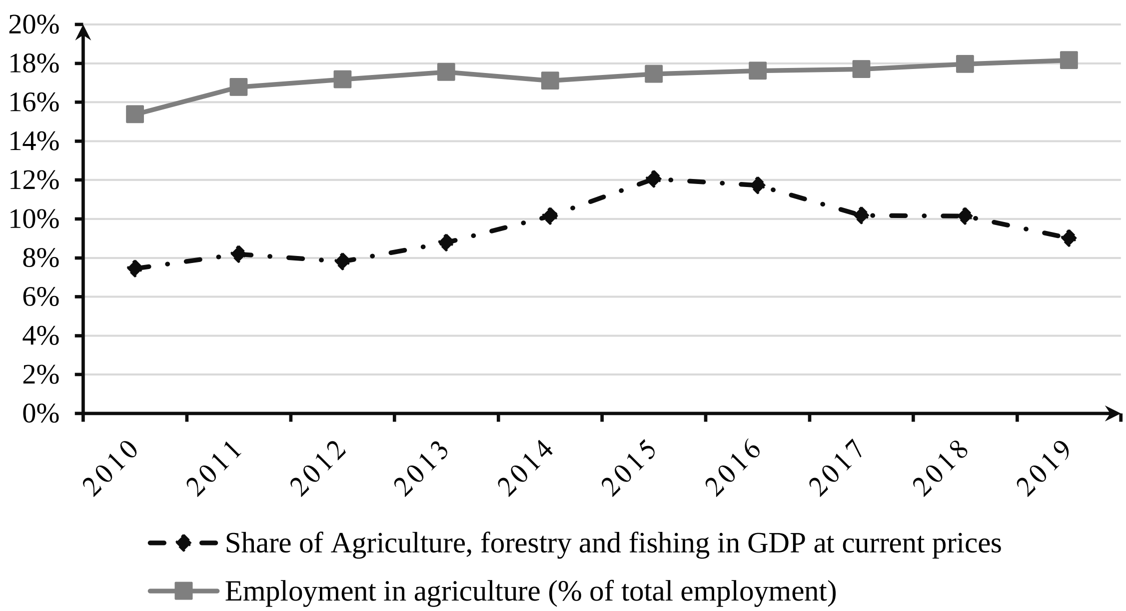


Figure 1.1 - Share of Agriculture, forestry and fishing in GDP and Total Employment (2010-2019)

Source: own calculations using the data [57].

Figure 1.1 demonstrates the tendencies of agriculture, forestry and fishing role in the main macroeconomic indicators. During the past decade, its share has been fluctuating within 15-18% of the total employment with a slightly increasing tendency, and within 7-12% in GDP with a trend of decreasing after 2015 as a result of losing agricultural land of temporarily occupied territories, reorientation of trade relations with Russia due to the military conflict and, in addition, general development of more modern economic activities.

The crucial moment in development of Ukrainian agriculture sector and economy in general was acceptance of Ukraine as a member of the World Trade Organization (WTO) on 16th of May 2008, hence, accession to the international trade market and global economy.

While the total agricultural production continues to increase it is important to define its structure and priorities. Traditionally, agriculture can be divided into cultivating plants and livestock. According to the State Statistics Service of Ukraine (SSSU), crop production comprises the following groups of products: grain crops (wheat, rue, barley, oats, maize, rice, buckwheat and millet), industrial crops (oil crops, raw tobacco, sugar beet), fodder crops, vegetables, potatoes, fruits and berries. Animal output is composed of breeding the livestock and poultry (cattle, pigs, horses, sheep and goats), animal products (milk, eggs, honey etc.) [53].

Agricultural commodities have a special place within Ukrainian export. According to the Ministry for Development of Economy, Trade and Agriculture of Ukraine (MDETA), the share of the agriculture sector in the total export revenues comprised 44.2% in 2019 [33]. Over the year of 2020, this trend continued and the share has accounted for 45.1%, which was approximately 22.2 billion USD, according to the State Customs Service data [56].

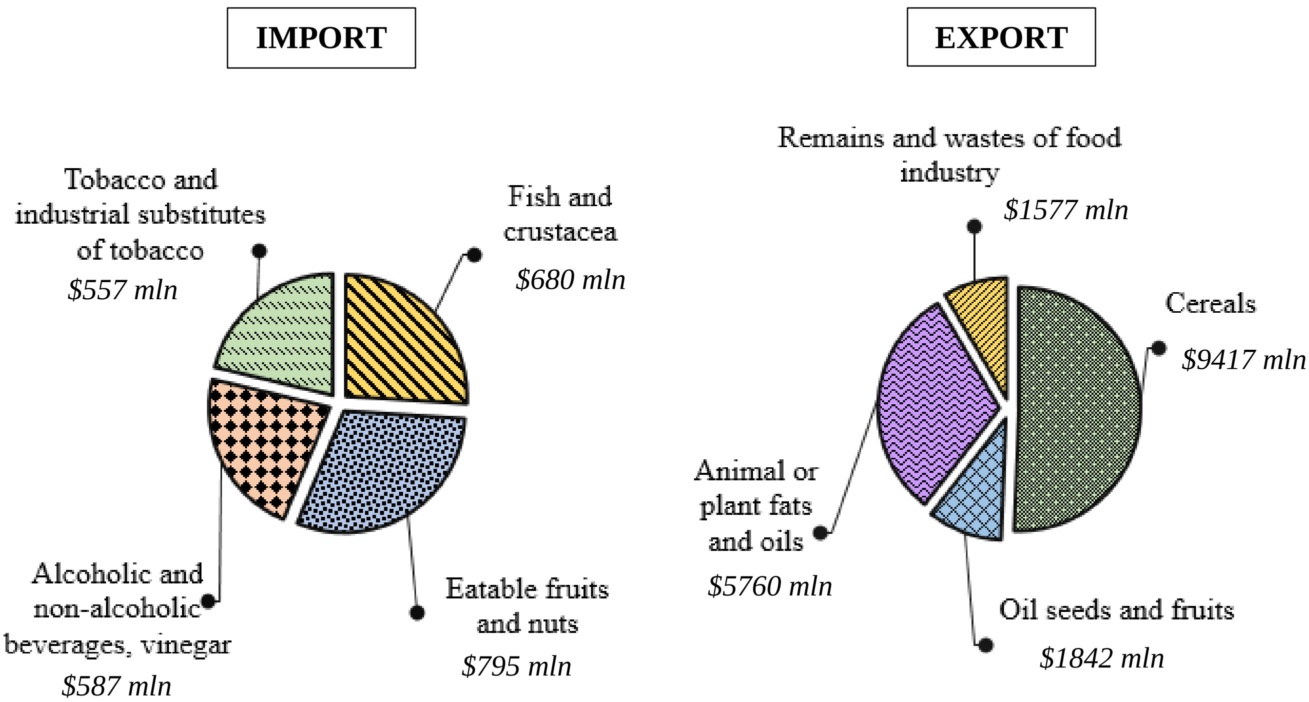


Figure 1.2 - Commodity Pattern of imports and exports of main agricultural and provisions production in 2020

Source: own calculations using the data [56].

Groups of *Cereals* and *Animal or plant fats and oils* remained the highest value exports (see Figure 1.2) with the shares of 42.4% and 25.95% in the total value of agricultural exports, respectively. Looking at the key commodity groups of agricultural imports, we observe that in 2020 these were *Eatable fruits and nuts, Fish and crustacea, Beverages and vinega*r and *Tobacco or substitutes*, with almost equal shares. Overall, agricultural imports accounted for 6.5 billion USD, which was 12% of the total country's imports [56].

Figure 1.2 also illustrates certain unevenness in Ukrainian commodity pattern of agricultural exports while the import pattern appears to be balanced within the major commodity groups. This irregularity in exports points out a possible dependence of Ukrainian agricultural export on the cereals production since it accounts for almost a half of the total revenues.

After defining the main groups of agricultural exports and imports, it is important to look closer at the constituents of those groups, as well as to determine the key trade counterparties. Figure 1.3 and Figure 1.4 present statistics on these phenomena in 2020. Fundamental components within the *Cereals* exports are Wheat, Barley and Corn, whereas *Animal or plant fats and oils* group predominantly consists of Sunflower, Safflower or Cotton seed oil (see Figure 1.3). Overall, the most exported commodities within the two considered agricultural groups were corn with China as a key importer with a value of 1382.5 million USD, and sunflower seed oil with India as a key importer with a value of 1436.9 million USD.

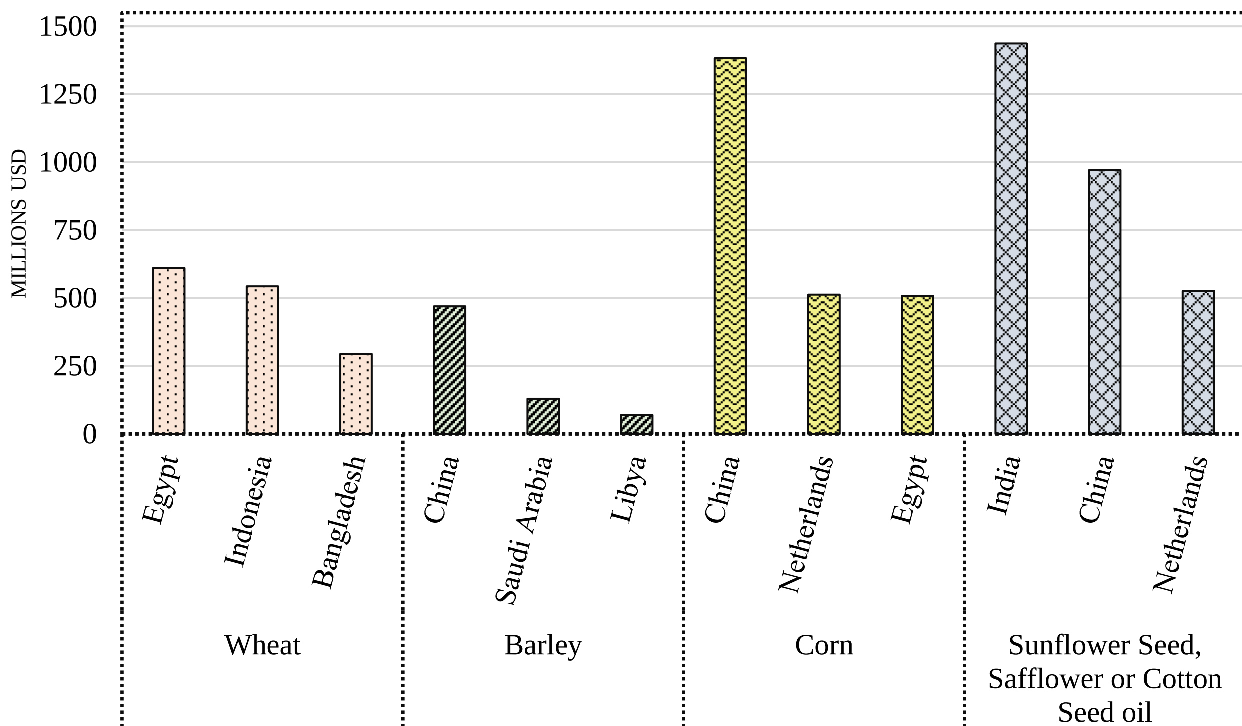


Figure 1.3 - Key counterparties in export of main agricultural commodities within Cereals group and Oils group in 2020

Source: State customs service data [56]

Since the import pattern appears to be relatively balanced within four main agricultural groups (see Figure 1.2) there is no need to consider separately each component of the imported group as it was previously done to the export structure to define the key trade counterparties in 2020 (see Figure 1.3).

The group *Eatable fruits and nuts* had a slightly larger share in the total value of imported commodities and accounted for 12.3% in 2020. Figure 1.4 demonstrates that Turkey played a key role in this trade with the value of almost 226 million USD and mostly exporting citrus fruits. *Fish and crustacea* commodities were imported predominantly from Norway with a value of 212 million USD, Iceland and the USA.

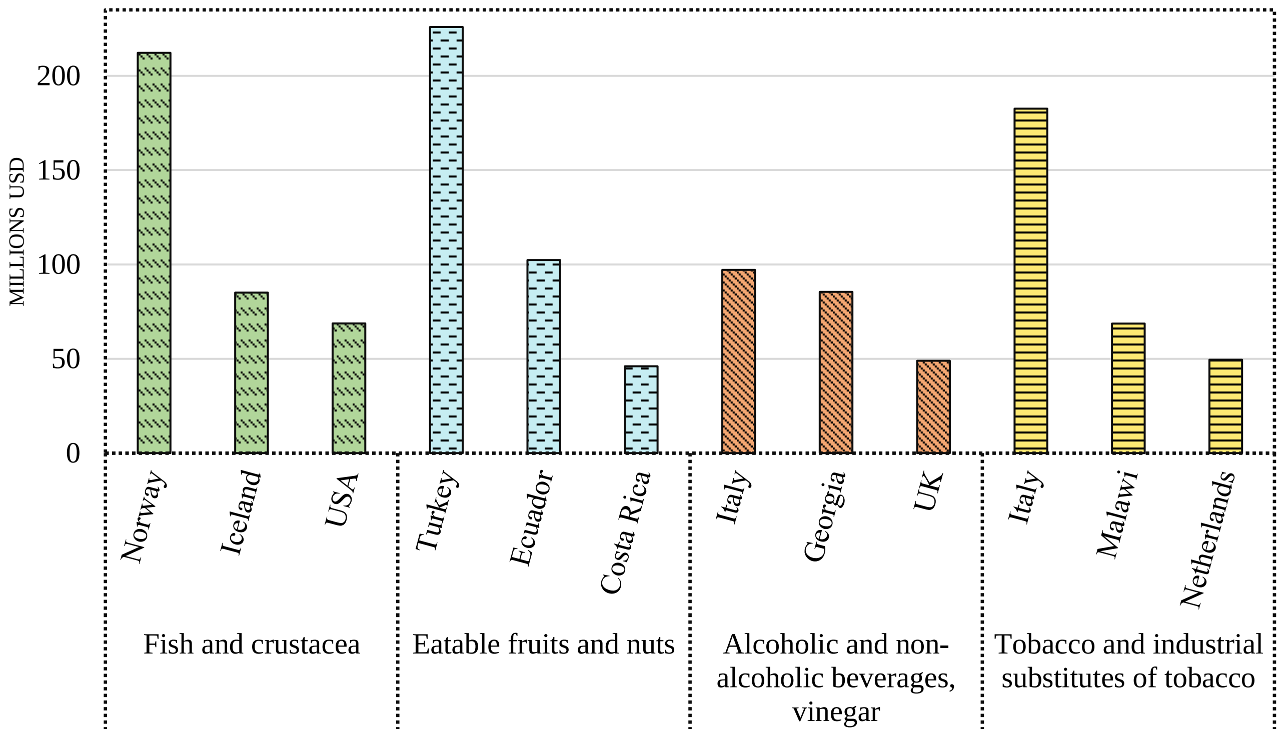


Figure 1.4 - Key counterparties in import of agricultural commodities within main groups in 2020

Source: State customs service data [56].

Mapping key trade partners discussed above, we observe that in 2020, Ukrainian agricultural export was oriented on southern and eastern countries such as Asia, Africa and Oceania. Simultaneously, the prevalent direction of import were mostly Western European and Nordic countries (see Figure 1.5).

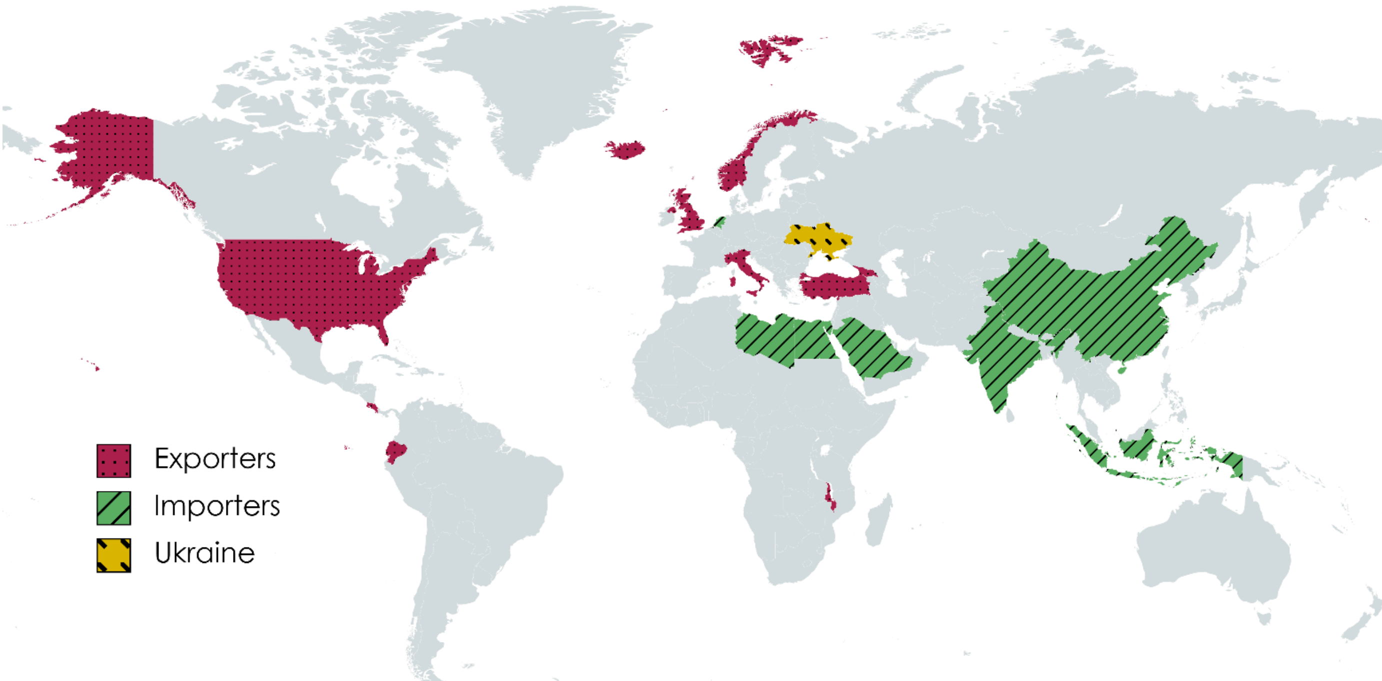


Figure 1.5 - Main trade partners of Ukraine in agricultural sector in 2020

Source: State customs service data [56].

Overall, Ukrainian agriculture sector holds a competitive position in the economy due to the fertile nature resources, as well as plays a crucial role in the export revenues generation, accounting for 45% of the total value. Import of agricultural commodities remains relatively small which points on the food security in the country. However, Ukrainian trade in agriculture strongly depends on the demand on cereals in the world, China in particular, since these crops take the greatest share in the export.

1.2 Production Structure

During the period of 2012-2019, the total number of holdings engaged in agricultural activity was fluctuating between 45379 and 49415 units with a decreasing tendency over 2019 [54]. Agricultural holdings in Ukraine can be classified into households and enterprises, including private farms, according to the SSSU methodology. The data reveals that the total production was highest in 2019 and accounted for approximately 681 billion

UAH at 2016 prices; the enterprises' production composed 66% and households' was 34% of the total, respectively.

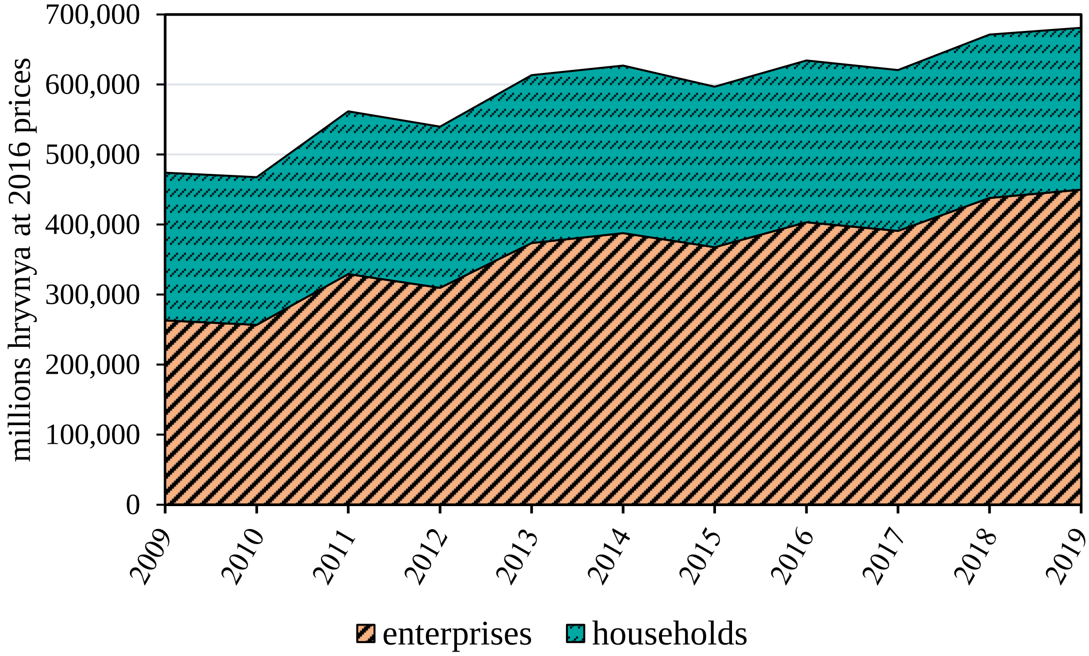


Figure 1.6 - Agricultural production by types of agricultural holdings in 2009-2019

Source: own calculations using the data [57].

We observe that on average there is an increasing trend in agricultural production for all types of holdings, but the total growth is predominantly provided by enterprises since for larger firms the average costs are lower and all production factors can change, while small households are functioning mostly in a short run and are not able to build that powerful production structure due to the high amount of fixed costs [58, p. 55].

In Ukraine, the crop production has a dominant position and in 2019 accounted for 79.1% of the total output while the animal production contribution was only 20.9%.

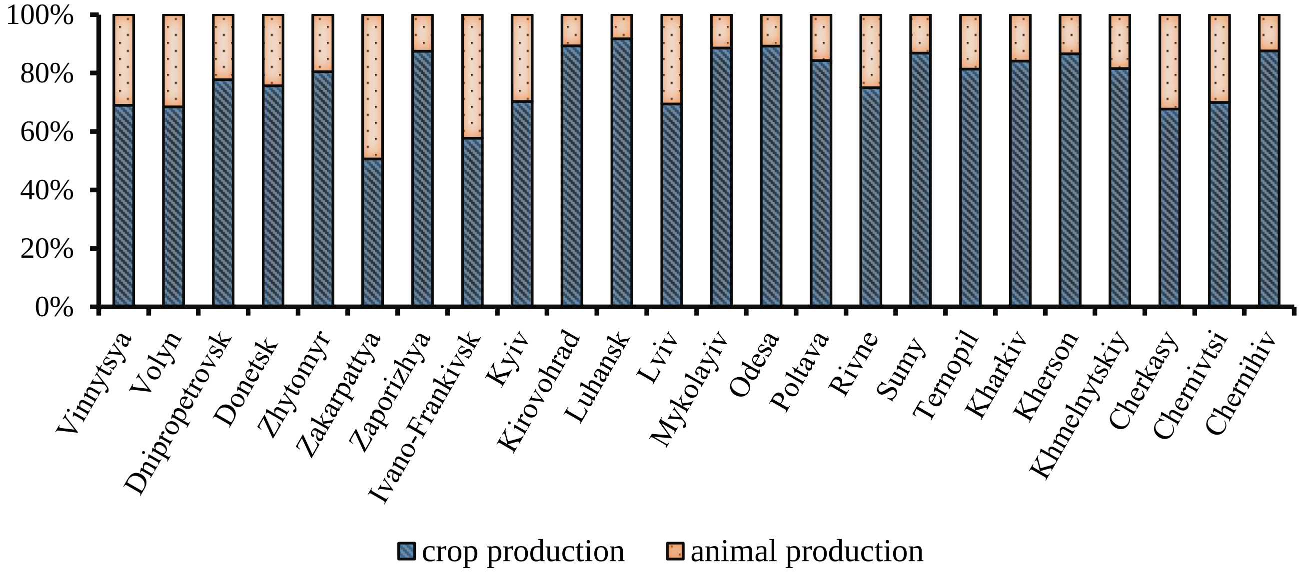


Figure 1.7 - Agricultural production in all agricultural holdings by regions in 2019

Source: the State Statistics Service of Ukraine data [57].

There is a little difference in the production structure among the regions of Ukraine, and crop production value still accounts for more than a half of the total amount (see Figure 1.7). But there is indeed an implicit regional pattern in agricultural production since the greater share of animal production can be observed in the west of Ukraine, Zakarpattya in particular - 49.4%.

The highest number of enterprises specialized in animal production is among those which own cattle - 2045 units as of January 1, 2020, followed by cows and pigs owners - 1894 and 1551 units, respectively (See Table 1.1).

Table 1.1 Groupings of enterprises by the number of agricultural animals as of January, 2020

Pigs	***Enterprises – total***	*of which, heads*	*no more than 100*	*100 – 199*	*200 – 499*	*500 – 999*	*1000 – 4999*	*5000 – 9999*	*more than 10000*
	1551		494	203	277	177	269	57	74
Cattle	***Enterprises – total***	*of which, heads*	*no more than 50*	*50 – 99*	*100 – 499*	*500 – 999*	*1000 – 1499*	*more than 1500*	
	2045		550	161	678	360	141	155	
Cows	***Enterprises – total***	*of which, heads*	*no more than 50*	*50 – 99*	*100 – 499*	*500 – 999*	*more than 1000*		
	1894		625	228	801	175	65		

Source: own calculations using State Statistics Service of Ukraine data [57].

After grouping the enterprises by the number of agricultural animals within these three categories, we observe that in total most enterprises are oriented on the smaller amount of pigs heads, small or average amount of cattle heads and small or average amount of cows heads. We conclude that there is no defined mass production among livestock agriculture in Ukraine. The most exported animal production in Ukraine is poultry, which demonstrated also an increasing trend in production by 8.8% and accounted for 128.8 million of heads in enterprises in 2019 [25].

Within the main crops, which are cereal and leguminous crop, sunflower seeds, fodder beet and rapeseed, most of the enterprises were specialized in producing cereal and leguminous crop - 34674 units in 2019.

Table 1.2 Grouping of enterprises by the size of the harvested area of the main crops in 2019

	Cereal and leguminous crop	**Sunflower seeds**
Enterprises - total	**34673**	**22251**
of them with an area, ha		
up to 100,00	21160	13602
100,01 – 200,00	3665	2821
200,01 – 500,00	4095	3313
500,01 – 1000,00	2766	1510
1000,01 – 2000,00	1917	736
2000,01 – 3000,00	562	175
more than 3000,00	508	94
	Fodder beet	**Rapeseed**
Enterprises - total	**586**	**5828**
of them with an area, ha		
up to 100,00	310	2917
100,01 – 200,00	97	1165
200,01 – 500,00	81	1137
500,01 – 1000,00	48	434
more than 3000,00	50	175

Source: own calculations using the State Statistics Service of Ukraine data [57].

Table 1.2 reveals that most of the agricultural enterprises specializing in plants cultivation had the harvested area up to 100 hectares, irrespective of their total number within the chosen group. Hence, we observe a certain diversity in the Ukrainian crop market since there is a considerable amount of small competitive enterprises. Notwithstanding, the biggest yields within the first two main groups are provided by big enterprises: 65.4 centers per hectare by those who produce cereal and leguminous crop and 30.1 centers per hectare by big sunflower seeds producers, which indicates the more efficient exploitation of agricultural land by large-sized enterprises.

Table 1.3 TOP Ukraine's largest agricultural landholders in 2019

Company	**Land area as of 2019 (thsd ha)**	**Profit (USD mln)**	**Main activity**	**Data on Profits**
Kernel	530	189	*production and export of sunflower oil and grain*	FY 2019
UkrLandFarming	500	62,6	*crops and seeds production, dairy farming, egg production and processing, sugar production, livestock farming, storage services, beef and leather production*	FY 2017
Agroprosperis (NCH)	396	17,7	*cultivation of wheat, rapeseed, corn, sunflower, soy*	FY 2019
MHP (Myronivsky Hliboprodukt)	380	215	*production and processing of poultry meat, grain and fodder production*	FY 2019
Astarta	235	2	*production of sugar and related products, cereals and oilseeds, milk and meat*	FY 2019

Source: companies' annual financial reports [61, 10, 8, 15, 7, 9].

As of 2019, the largest agricultural landholders were Kernel, UkrLandFarming, Agroprosperis (NCH), MHP (Myronivsky Hliboprodukt) and Astarta (See Table 1.3). The greatest profits were demonstrated by Kernel's and MHP's performances, according to the 2019 financial reports.

Kernel is a big producer and exporter of sunflower oil, it is famous for such trademarks as "Shchedryi Dar", "Chumak Sunflower Oil" etc [4]. UkrLandFarming is oriented on both crop and animal production, it controls several subsidiary companies and known for a big trademark "Kvochka" (egg production) [6]. Agroprosperis (NCH) is a large producer and exporter of crops, which also provides small and medium-sized Ukrainian farmers with a full range of services for growing, storing and selling grain [2]. Astarta is large soybean crusher, sugar and milk producer, its program called “Grain of ASTARTA” is aimed to build more grain storage facilities [1]. MHP is vertically integrated holding, which generated most of its income from poultry breeding and meat processing, it functionates under the following trademarks: “Nasha Ryaba”, “Qualiko”, “Baschinsky” [3]. Moreover, this holding might be classified as an industry monopolist since its share in the poultry market accounted for 45.16% in 2018. This also was a reason for Antimonopoly Committee of Ukraine to bring several lawsuits against this holding [25]. Overall, all of the above mentioned enterprises have several subsidiary companies, trademarks, shares of foreign investors and are actively engaged in the Ukrainian agricultural export.

Over the last decade, Ukrainian agriculture production had an increasing trend and was predominantly generated by enterprises. It is oriented on crop cultivation with a share of 79% among regions in 2019, and most of the enterprises maintain the land for harvesting up to 100 ha. However, there are several agricultural holdings which own large land area with a more efficient exploitation and have a noticeable share in Ukrainian agriculture export.

1.3 Investment Tendencies

The efficient use of foreign investment (FDI) provides the necessary scale and pace of structural adjustment of domestic agriculture. Moreover, the volume of FDI is one of the indicators of the country’s integration degree into the world economy, which is an important development factor in the current globalization. FDI encourages the country's exports, provides expansion of the sales networks and thus expansion of the range of goods sold in foreign markets [46].

Financial instruments are divided into functional categories to analyze the cross-border flows and stocks. Direct investment is one of those five categories of the external sector account of Ukraine, according to the National Bank of Ukraine (NBU) [35].

Direct investments can be classified into two categories: equity and investment fund shares and debt instruments. Share capital does not cause a debt increase. Conversely, debt capital is generated by borrowing when the borrowers assume the debt in exchange for the funds provided [62].

Since 2015, FDI in agriculture on average has been contributing 2.42% to the total value of respective investment in Ukrainian economy, which indicates a certain unattractiveness of this sector for investors. This could be explained by considerable investment risks, insufficient return on capital, low qualification of employees, inadequate quality of infrastructure (transporting, storage, energy and irrigation) and arduous bureaucratic investment procedures [12].

In 2019, the total amount of FDI in agriculture dropped by 22% to the value of 768.1 million USD, even though the total value of FDI in Ukrainian economy demonstrated a big increase. That was predominantly affected by a decrease of equity and investment fund shares, particularly in the animal production sector (49% decrease to 98.4 million USD in 2019), growing of non-perennial crops (22% decrease to 226.3 million USD in 2019). Overall, we observe that currently investment in agriculture plays a less important role in the total amount of invested funds in the Ukrainian economy.

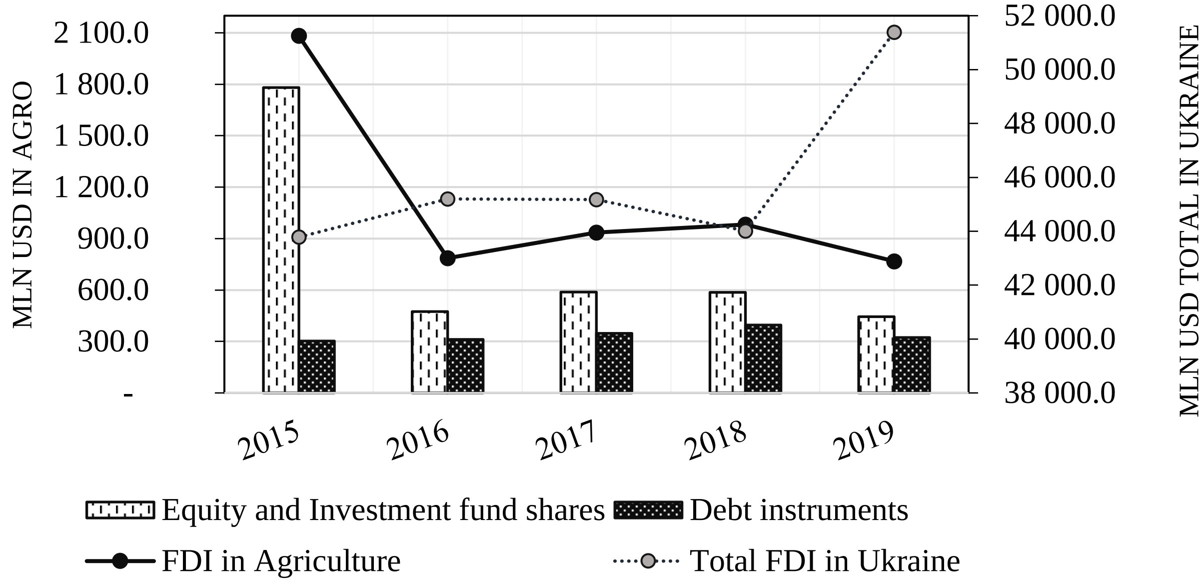


Figure 1.8 - Foreign Direct Investment Positions with main components in Ukrainian Agricultural sector (2015-2019)

Source: the National Bank of Ukraine data [47].

Over the period 2015-2019 countries-leaders, which invested the most in Ukrainian agriculture sector were: Cyprus - 44.3% on average, the Netherlands - 7.8%, Germany - 7.4%, the United Kingdom - 6.3%, Denmark - 5.4%, the USA - 3.4%, Poland - 3.3% and France - 3% (see Figure 1.9).

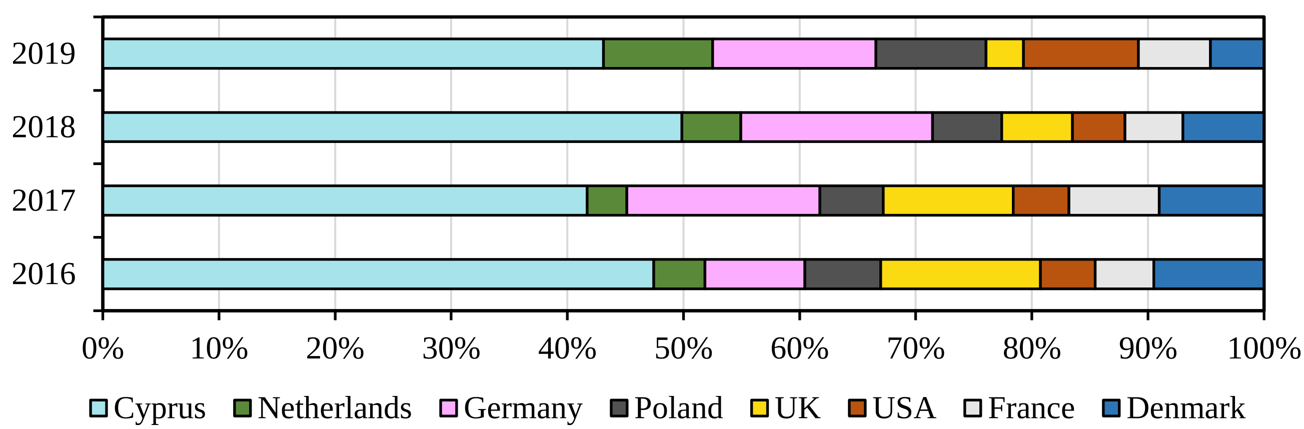


Figure 1.9 - Direct investment in Ukraine (Equity and investment fund shares): Positions by Countries over the period 2016-2019

Source: the National Bank of Ukraine data [47].

Figure 1.9 reveals that in 2019 the Netherlands, Poland and USA increased their shares in the total value of invested funds in Ukrainian agriculture to 34.2 million USD, 34.4 million USD and 36.1 million USD, respectively. Nevertheless, it should be noted that not all of these investments can be considered as funds from foreign investors, since there is a certain volume of round tripping transactions where the ultimate control investor is a resident. “Round tripping refers to the channeling abroad by residents of local funds and the subsequent return of these funds to the local economy in the form of direct investment”. Moreover, according to the estimations by the Statistics and Reporting Department of NBU in 2020, Cyprus was the key country through which the largest volumes of round tripping transactions were routed [36]. Thus, during the last four years Germany was the biggest foreign investor in Ukrainian agriculture, based on the existence of round tripping transactions.

Important improvement for the development of agriculture and increasing its investment volumes was a conclusion of the loan agreement - Program for Acceleration of Private Investment in Agriculture (Program) between Ukraine and the International Bank for Reconstruction and Development on 27th of August, 2019, which accounted for 200 million USD [48]. According to the Program, priority areas for development are: improving the efficiency and targeting of state support in the agricultural sector, improving the functioning of agricultural land markets, improving access of agricultural small and medium enterprises to export markets.

Since the first key Program area covers adoption of the Ministry of Agrarian Policy of medium-term strategic priorities of agricultural state support, these development benchmarks of the Program gradually lead us to the detailed investigation of the state support in agriculture, subsidies in particular, with defining the main directions of support and its consequences.

CHAPTER 2
DEFINING AGRICULTURAL STATE SUPPORT IN UKRAINE

2.1 The Essence of Subsidies and Impact on Trade

Definitions of subsidies are usually broad and depend on the country, given economic circumstances, sector and, sometimes, analysts for given sectors. They may constitute direct budgetary expenditures, public provision of goods at lower prices or regulatory interventions with no direct financial involvement [66, p.23]. Subsidies are proffered by the governments to protect domestic manufacturers within the sector, promote regional and research development, facilitate transitions, enhance employment and incomes. Such interventions are implemented to improve positions of domestic production during the times of trade liberalization and growth of the global nature of the economies. *“Within agriculture sector subsidies are paid to farmers and agribusiness operators to supplement their income in order to manage the offer of agricultural commodities or influence the cost and supply of these commodities in the international markets”* [28].

Since state aid is granted on a selective basis, it can distort the price and resource allocation decisions, shifting the amount of goods produced and consumed, as well as creating the artificial competitive advantage [38, p.15; 66, p.22]. Because of that, the WTO developed strict policies to prevent any possible trade distortion.

Generally, subsidies can be broken down into three main categories, according to the WTO legislation which limits the use of certain support measures due to their wastefulness and trade distortion effects. All subsidies are identified by, so called, “domestic support boxes”, which are labeled using the metaphor of a traffic light: green (permitted), amber (need to be reduced), and red (forbidden). However, in agriculture this classification is slightly adjusted, meaning the classification into amber, blue and green boxes. Amber Box includes highly trade distortive subsidies, which are policies to support prices, or subsidies directly oriented on production quantities. Currently there are thirty-two WTO members, Ukraine as well, who committed to reduce the amount of support given under the Amber Box umbrella. If the support can be classified as that from Amber Box, but also requires farmers to limit production, it is placed in the Blue Box. Finally, the Green Box constitutes subsidies that do not have trade distortive effects or cause a minimal distortion. These programs include governmental support that does not directly affect production levels or prices, that is these subsidies are "decoupled" from them. In addition, they comprise environmental protection and development programs. There are no limits for the support provided within this category [67].

Since the perfect market assumption cannot be met in the current world, various market failures may arise, causing inconsistency between costs and benefits. Policy interventions, such as subsidies, are introduced to improve welfare within an imperfect market framework. Positive and negative externalities, associated with output and consumption levels at socially optimal amounts, can be considered here as examples of market failures. Agriculture sector not only brings food to the society, but also provides external benefits and non-market goods which are difficult to put value on. Studies have shown that agriculture shapes the landscape, preserves biodiversity, contributes to the development of rural areas and employment, provides land conservation, controls soil erosion, animal welfare and food security [66, p.105; 24, p.11]. Thus, agriculture produces "non-commodities" which are publicly beneficial, and causes positive externalities.

2.2 Indexes of Support

It was mentioned before that there is no precise definition for determining subsidies, however, agriculture is relatively advanced in using widely accepted descriptions, particularly those which measure agricultural state support at a global level and comparable across countries and regions. They constitute several indicators, which are: the producer nominal protection coefficient (NPC), the total support estimate (TSE), the producer support estimate (PSE), the consumer support estimate (CSE) and the general services support estimate (GSSE). These indicators are uniform across the world and measured by one organization - The Organization for Economic Co-operation and Development (OECD) [41].

It is important to consider some of these indicators when measuring Ukrainian state support in agriculture, since their essence gives a possibility to perform comparisons, as well as to obtain a better understanding of Ukrainian support within international experience, the OECD member countries particularly. Firstly, we identify the level of agricultural producer protection in Ukraine and hereupon the rate of consumer support, simultaneously comparing these results with performance of the OECD countries.

According to the OECD definition, *“producer protection is defined as the ratio between the average price received by producers (measured at the farm gate), including net payments per unit of current output, and the border price (measured at the farm gate)”*. The coefficient reflects the ratio of farm price to border reference price [42].

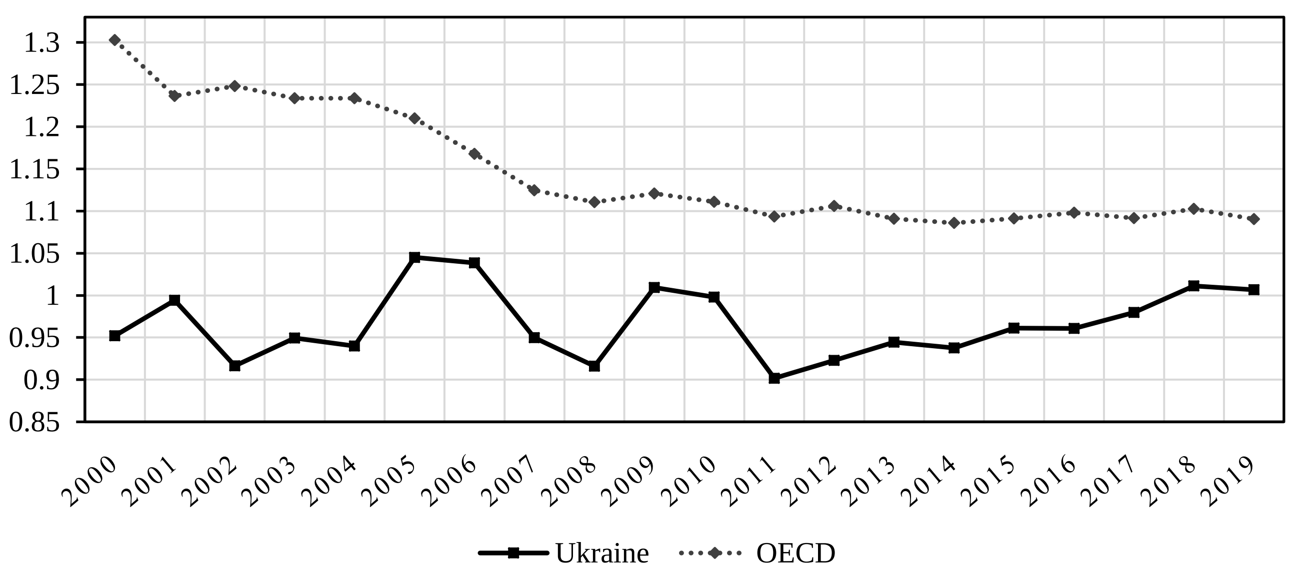


Figure 2.1 - Dynamics of the Producer Nominal Protection Coefficient in Ukraine and OECD

Source: the OECD Data [42].

Figure 2.1 reveals that NPC for Ukraine is lower than for the OECD and is characterized by pronounced variability over the last nineteen years, in comparison with smooth transition for OECD. NPC for Ukraine was fluctuating between 0.902 and 1.05, and for the OECD between 1.086 and 1.303, never falling below one. The average NPC for the OECD area was 1.094 for the period 2011-2019, and for Ukraine 0.958. This implies that in the OECD farmers received prices that were 9.4% above world market levels. In Ukraine, conversely, prices received by farmers were around 4.2% lower than international prices. Overall, the level of support to producers in Ukraine is relatively low in comparison to that provided in OECD member countries.

NPC dynamics is predominantly affected by the volumes of produces support, hence, we state that producer support provided is little and has great variability [41]. Moreover, according to the OECD estimates, Ukrainian agricultural support is more consumer oriented. Therefore, is it necessary to consider CSE rates measured as a percentage of agricultural consumption, which reflects the cost (or benefit) to consumers arising from market price support policies and food subsidies (see Figure 2.2).

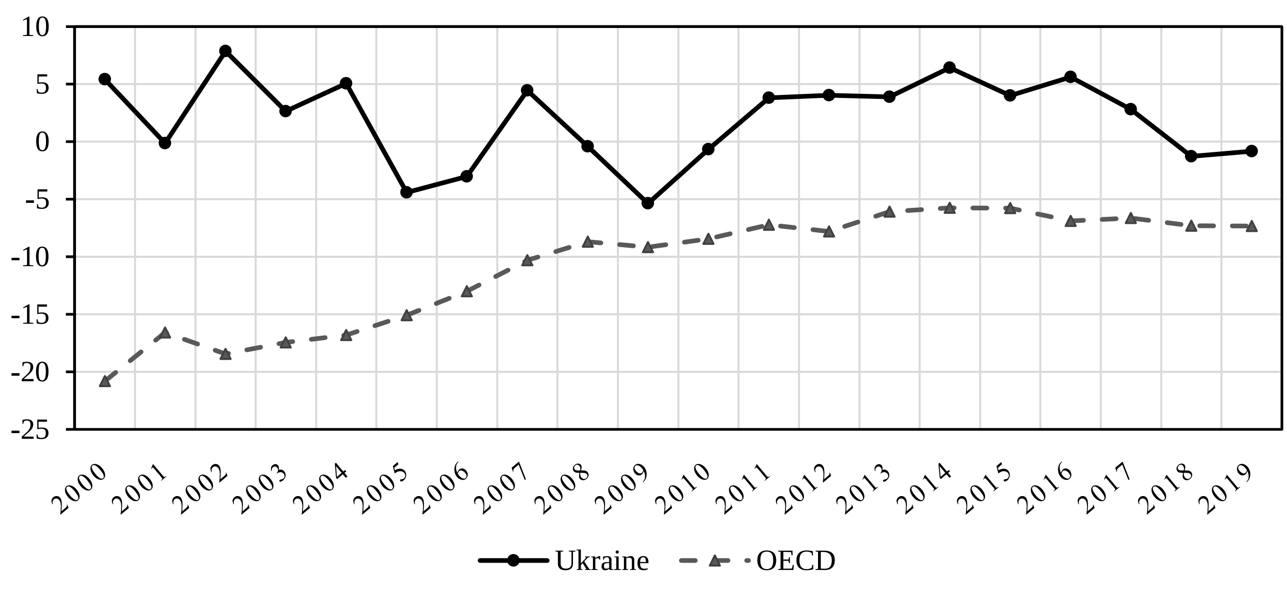


Figure 2.2 - Consumer support (CSE) in Ukraine and OECD, % of agricultural consumption

Source: the OECD Data [41].

From Figure 2.2 we observe a noticeable difference in CSE rates for Ukraine and the OECD, where the estimate for Ukraine was fluctuating between -5.4 and 7.9, while estimates for the OECD showed the lowest value of -20.8 and the highest of -5.8. This indicated that in Ukraine there is an implicit support, i.e. consumers pay domestic prices lower than the international prices. In the OECD, on the other hand, there is an implicit tax on consumers, that is consumers buy at prices higher than international market level. Negative CSE is more prevalent in the world, and only few countries feature positive values (USA, Argentina, India, Kazakhstan and Ukraine). Processors or wholesalers in Ukraine benefit from the lower prices of agricultural commodities, while in most OECD countries consumers are, conversely, taxed. During the last ten years, CSE for Ukraine, on average, accounted for 2.78%, which means that the first-stage consumers pay prices reduced by 2.78% because of public policies.

2.3 Overview of Agricultural Subsidies in Ukraine

After defining the indexes of support according to the OECD estimates and having the abstract summary of Ukrainian levels of support, it is possible to investigate these cases more precisely, looking at the absolute volumes and main channels of the state support.

Starting with the general understanding of governmental expenditure on agriculture, it is feasible to consider them within functional classification of the budget outlays.

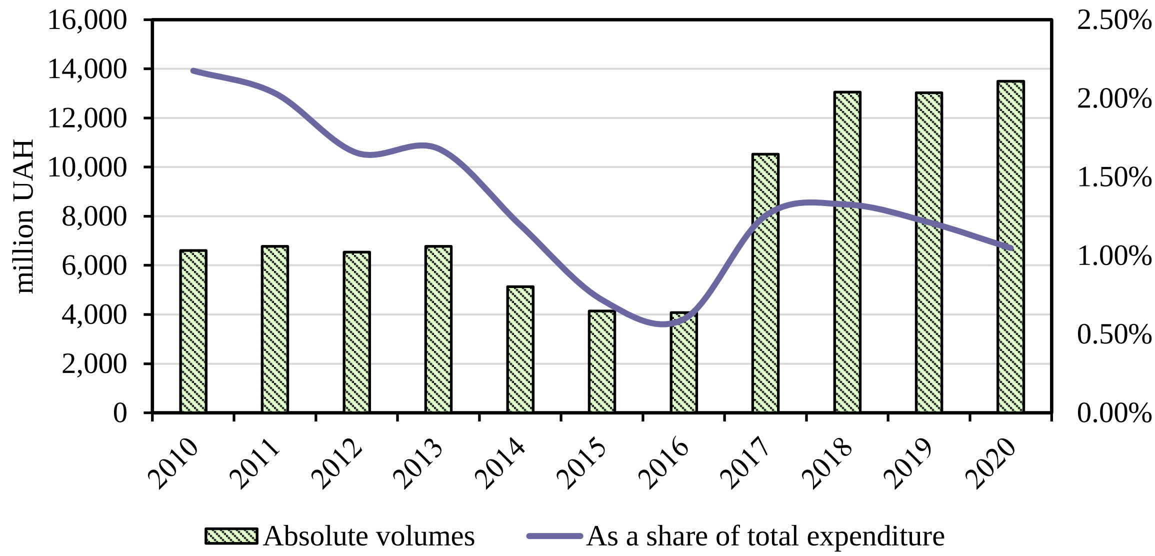


Figure 2.3 - Dynamics of government expenditure on agriculture in the total budget outlays

Source: own calculations using The State Treasury Service of Ukraine data [59].

Figure 2.3 demonstrates the volumes of agricultural state support over the last ten years. Absolute values appear to increase and even show a positive trend from 2016, accounting for 13496 million UAH in 2020. Data reveals that, in fact, expenditures on agriculture have a decreasing trend with a noticeable collapse started in 2014, when the share comprised only 1.19% of the total expenditures due to the armed conflict on the east of Ukraine and economic conditions, and afterwards a slight recovery in 2017. Overall, we admit that there is a weak monetary support given to the agriculture sector in Ukraine, and it never exceeded 2.2% of the total budget outlays during the last ten years.

Subsequent steps in measuring the volume of agricultural state aid require examination of its detailed directions, which are, in this case, specific budgetary programs. Over the period 2013 - 2019 there were different ministries in Ukraine responsible for the accounting and assignment of agricultural governmental support, according to the state budget reports [59]. Main executors were the National Academy of Agrarian Sciences of Ukraine (NAASU), responsible only for research activities; the Ministry of Agrarian Policy and Food of Ukraine (MAPF); the Ministry of Economic Development, Trade and

Agriculture of Ukraine (MDETA), which took over the authority from MAPF in 2019 due to its merger with the Ministry of Economic Development and Trade of Ukraine (MEDTU).

As discussed in subsection 2.1, subsidies can be placed in different "boxes", and the Green Box subsidies are considered as the most effective state support. It is possible to explore Ukrainian agricultural subsidies more closely starting with the kind of support that usually does not cause trade distortion at all - that is research and development activities (R&D).

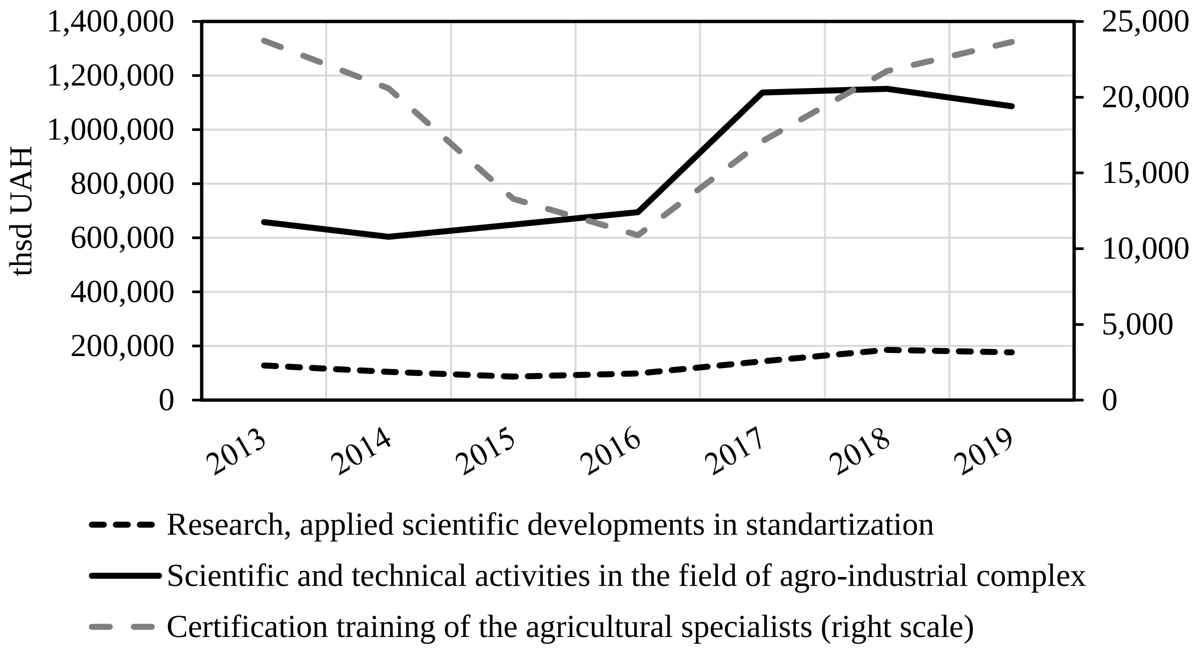


Figure 2.4 - Dynamics of expenditures in relation to programs that provide research services or benefits to agriculture

Source: own calculations using The State Treasury Service of Ukraine data [59].

In 2019, the total support of R&D activities in agriculture accounted for 1287 million UAH. It was composed of projects led by the MDETA: certification training of the agricultural specialists and research, applied scientific developments in standardization. The NAASU contributed 1086 million UAH in 2019 to the R&D activities spending on scientific and technical activities in the field of agro-industrial complex (see Figure 2.4). We observe an irregularity in subsidising these projects in agriculture over the 2013-2019 period.

Activities guided by the NAASU were dominating in the total amount of state support - 84.4% in 2019, which can be explained with a specific specialization of this authority.

Agricultural subsidies in Ukraine are mostly oriented on the inputs with prevalently subsidized items such as machinery and equipment, credit, animals and seeds. These types of subsidies to input use can potentially reduce variable and fixed costs [38, p.80]. In 2019, the key directions of agricultural subsidies were: support of the livestock industry, cheapening of loans, machinery and equipment cost compensation, support for private farms development and development of hop growing and young orchards [21].

There is a defined orientation on increasing the share of livestock industry in the total agricultural production in Ukraine, according to the prioritized directions of subsidies. It can be justified in monetary terms: higher added value compared to crop production and greater value of the commodities; as well as in landscape terms: livestock production requires less space (which leads to the reduced amount of rent costs) and causes smaller land depletion.

According to the OECD study completed in 2002, this reorientation from crop to livestock production can be resulted by farmers responding to policy-induced changes and shifting their resources towards the activities benefiting from support. Furthermore, farmers might extend production of subsidized commodities by intensifying purchased input use, which, as a result, will maximize the benefits from support [13, p.6].

According to the Passports of Budget Programs, the key directions of support are subsidies on dairy and beef cows, subsidy for cattle breeders, compensations of the value of pedigree animals purchased for further reproduction, partial reimbursement of the cost of construction of livestock farms.

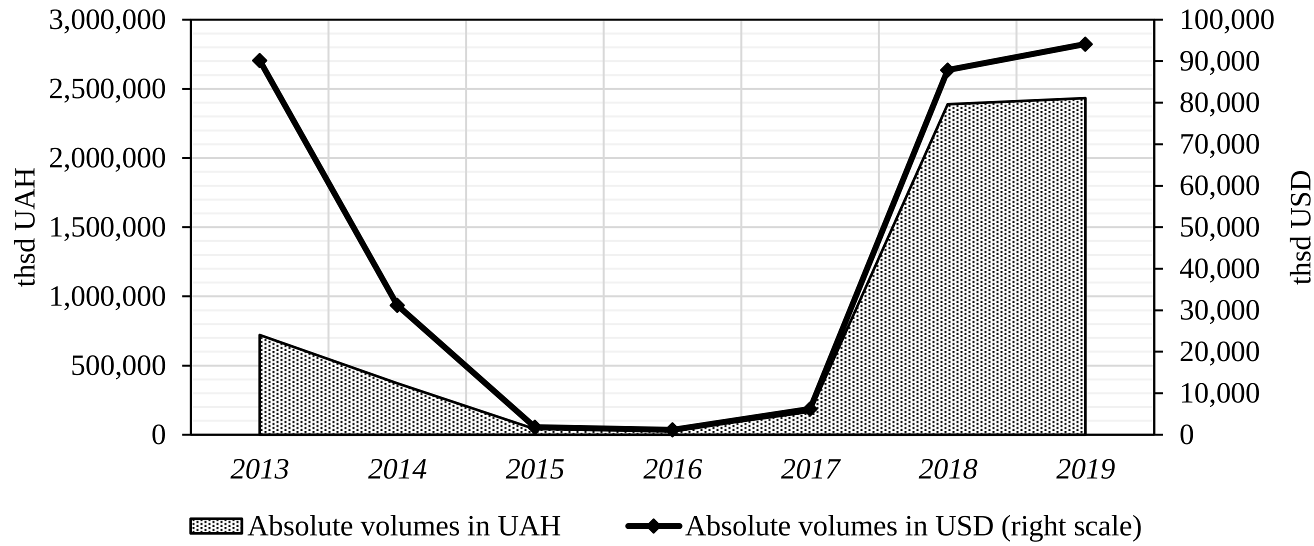


Figure 2.5 - Dynamics of state support of the livestock industry

Source: own calculations using The State Treasury Service of Ukraine and NBU data [59, 34].

Figure 2.5 demonstrates the fluctuations of the amounts of support granted to the livestock industry in Ukraine. The data reveals noticeable improvements in 2018 and 2019 both in hryvnia and US dollar, but it is important to specify that there is no defined tendency in increasing the livestock industry support, as since 2018, the amounts granted merely returned to the 2013 levels, according to the volumes adjusted on the annual average UAH/USD exchange rate.

However, together with possible economic benefits livestock industry might cause negative consequences for the environment, thus, its subsidizing should be limited in a long perspective. According to the report prepared by The Johns Hopkins Center for a Livable Future in 2015, livestock production contributes 14.5% of global greenhouse gas emissions, which is more than a transportation sector. The largest share of emissions (39%) is from ruminant animals enteric fermentation which produces methane. Other causes include manure (26%) and feed crop production (24%). Under the different scenarios meant to reduce the impact on climate by 2050, it is recommended to implement policy incentives to promote a shift toward reduced meat and dairy production. It is suggested to perform it by removing economic support for the livestock industry, subsidies in particular, and by increasing support for R&D of plant-based meat alternatives [27, p.2, p.5]. In 2019, the Intergovernmental Panel on Climate Change (IPCC) led by the United Nations described plant-based diets as an opportunity to adapt to climate change, as well as introduced a policy recommendation to reduce meat consumption [50]. Hence, if the meat consumption decreases by 2050, there will be less demand for livestock production, thus, Ukrainian commodities will not be preferable among European countries. Therefore, there is no need to stimulate a livestock industry in Ukraine with a purpose to expand agricultural exports. In the short term the livestock industry subsidizing can be justified with establishing a better national food security, however, turning this sector into export oriented will require too much costs and could be ineffective due to the climate change issues.

"Agricultural Policies in Emerging Economies" report conducted by the OECD in 2009 states that producer access to credit is vital for the development of agriculture in the emerging economies, thus government should establish a credit market, as well as expand private sources of credit, to small manufacturers in particular [39, p.19]. Since 2015, a separate program within agricultural subsidies was established, which is aimed at the partial compensation of the loans interest rate to economic entities of the agro-industrial complex.

The juridical foundation for the agribusiness and banks partnership is a Memorandum on the implementation of state support for agricultural producers (Memorandum). As of 2020, there are 36 banks (49% within the banking system) which signed the Memorandum with the MDETA [30].

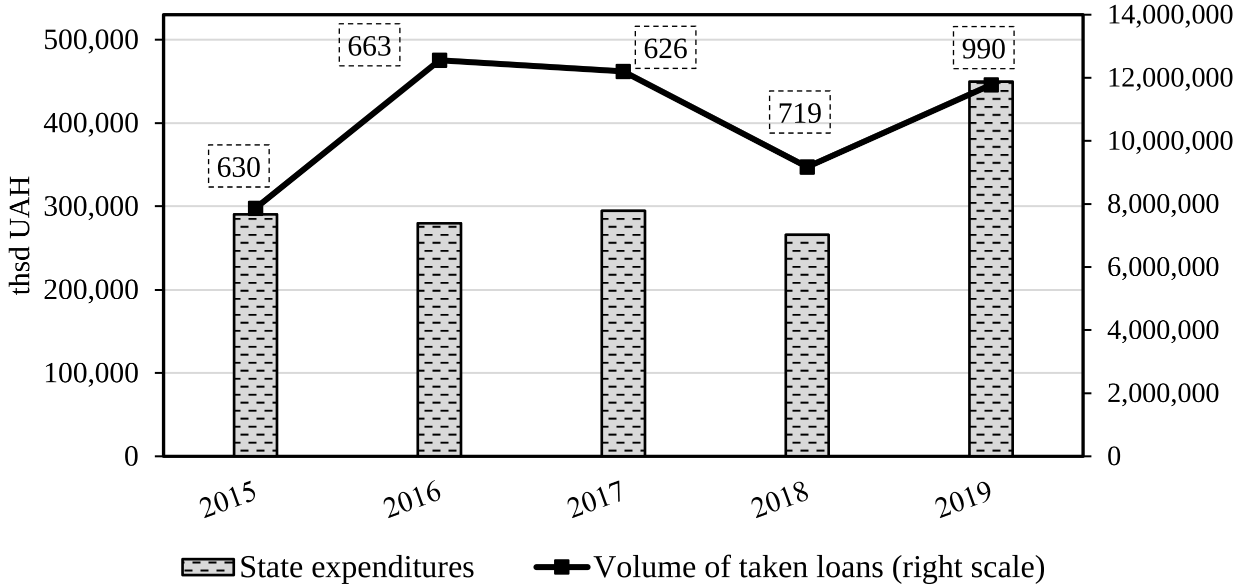


Figure 2.6 - Inputs and outputs of the state Cheapening of Loans Program with number of enterprises participated

Source: Passports of Budget Programs performance reports [45, 44].

Figure 2.6 reveals that the amounts granted for this program have been fluctuating between 266 and 450 million UAH with uneven tendency. We observe slight oscillations during 2015-2018 and a noticeable growth in 2019, which is also followed by an increase in the number of enterprises participated in the program and in the total volume of taken loans. According to the Passports of Budget Programs performance report in 2019, cheapening of loans program provided a possibility for 990 agricultural business entities to lower their credit costs and take out the loans with a total value accounted for 11781 million UAH. However, it is important to state that there were, predominantly, short-term loans up to one year (81.6%) among the taken loans. This might be a notice of enterprises being cautious in their credit relations, as well as indicate a low endeavor to invest in the long-term and costly development projects, such as construction of the new farm complex or modernization of agricultural equipment. Moreover, the amount of enterprises participated in the program was not exceeding 2% of the total number of enterprises engaged in agricultural activity.

Important part of the agriculture sector development is equipment and machinery acquisition and modernization. For this purpose, the governmental Machinery and Equipment Cost Compensation Program was established in Ukraine as one of the methods to subsidize inputs for the agriculture producers, as well as to support domestic manufacturers of the agriculture machinery. The list of machinery appropriate for compensation was approved and is reviewed on a regular basis by the MDETA [16]. This Program provides 25% compensation of the total value (excluding value added tax) of the machinery and equipment purchased from domestic manufacturers and / or their dealers.

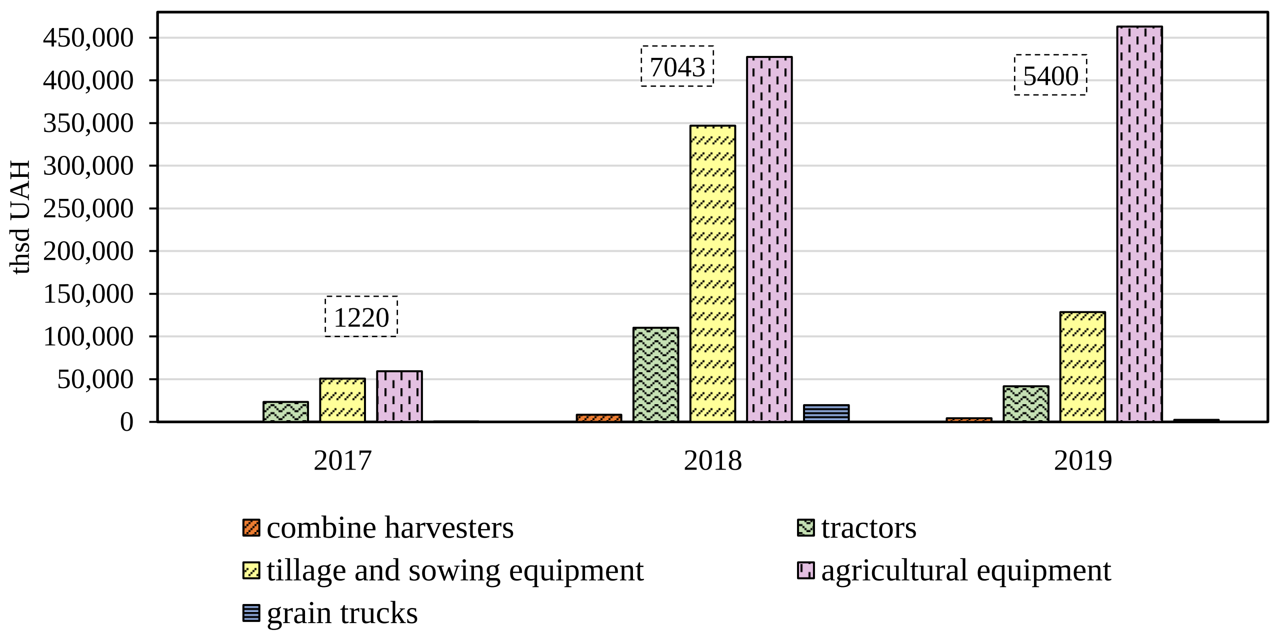


Figure 2.7 - Components of the Machinery and Equipment Cost Compensation Program with number of enterprises participated

Source: Passports of Budget Programs performance reports [45, 44].

The data reveals a noticeable increase in the total amount of the state support granted in 2018 up to 913 million UAH, which could be explained with farmers' improved awareness of the Program details. On average, the greatest expenditures were aimed on tractors (58.5 million UAH), agricultural (316.8 million UAH), tillage and sowing (175.4 million UAH) equipment compensation, while the lowest amounts compensated were among combine harvesters and grain trucks (4.2 and 7.5 million UAH). In 2019, 5400 agricultural enterprises received compensation benefits, and the total amount of the compensated machinery and equipment accounted for 10309 units. According to the Passports of Budget Programs performance reports, 2019 was characterized by a decrease both in the total number of enterprises participated (7043 entities in 2018) and units of machinery compensated (17182 units in 2018) due to the reduction of the approved support level by 200 million UAH.

Since the Cost Compensation Program is aimed to support manufacturers of different sectors, it is important to consider its effectiveness and results in macroeconomic terms. According to the National Research Center "Institute of Agrarian Economics", the total import of agricultural machinery decreased by 17% in 2019, however, Ukrainian producers still prefer to exploit the foreign machinery due to its level of service, comfort and productivity [20, 31]. Association “Ukrainian Agribusiness Club” (UCAB) conducted a research on the dynamics of agricultural machinery imports for the period 2015-2019, and we conclude that over the last years the total costs of the units imported indeed decreased for the combine harvesters, tractors, tillage equipment, seeders and fertilizer spreaders. Therefore, we state that the Cost Compensation Program had positive results, despite the decrease in the import expenditures was minor and Ukrainian farmers still favor foreign equipment [19].

Since 2018, the separate support direction was established - which is financial support for private farms development. It implies partial compensation of the cost of domestic seeds, financial support of agricultural service cooperatives, partial compensation of the cost of domestic machinery, cheapening of loans, budget subsidy per unit of arable land (1 ha) for newly created farms, budget subsidy per unit of arable land (1 ha) to other farms. In 2019, the amount of private farms which received the support benefits accounted for 9.4 thousand entities, which was 29% of the total number of operating farms.

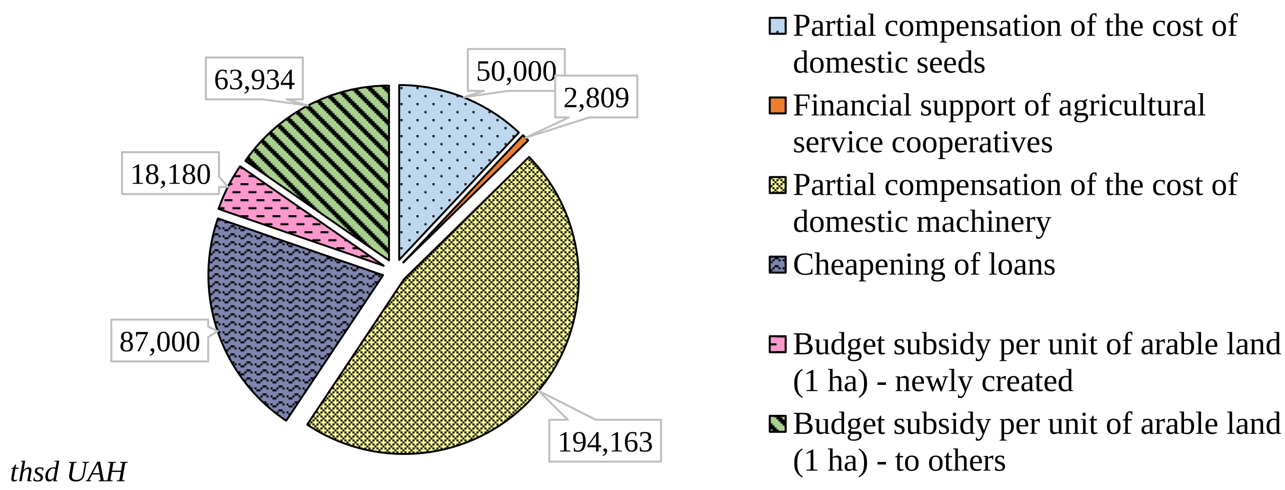


Figure 2.8 - Areas of financial support for private farms development

Source: Passports of Budget Programs performance reports [45, 44].

Figure 2.8 demonstrates the distribution of state support paid to private farms in 2019. We notice that the biggest share of financial resources (47%) was assigned to the compensation of the cost of domestic machinery for private farms (194 million UAH for 4141 business entities). Budget subsidies per unit of arable land were distributed unevenly with a greater share of support received by not newly created private farms (15.3% compared to 4.4%).

Overall, we observe unstable governance of the state support programs for Ukrainian agriculture due to the different ministries responsible for their financing and performance. Furthermore, the rearrangement of the programs components from year to year is confusing and might result in the low awareness of the agriculture manufacturers about the subsidies they are able to receive. However, according to the last MDETA statement in January 2021, it is planned to maintain state support on a stable level within the key areas - Cheapening of Loans, Cost Compensation of Machinery and Equipment, Private Farms Development and Support of the Livestock Industry. Moreover, it is planned to implement an online platform - the State Agrarian Register, which should provide farmers with simplified access to state support programs and publicity of their performance [22].

2.4 Are Subsidies a Political Action?

The ambiguity which arises from assigning the subsidies is closely connected not only with their economic impact, but, simultaneously, with the political process of their implementation. Elective officials' decisions do not always lead to the optimal use of subsidies and can be influenced by the beneficiaries (e.g., large agricultural enterprises) or by those who incur a cost (e.g., taxpayers). Politicians might manipulate trade and subsidy policies offering them for different purposes, such as to improve social welfare and stay appealing for the voters or to generate financial contributions from specific interest groups and retain office [66, p.63-64]. Moreover, even a subsidy with defined and justified purposes may not demonstrate the expected results due to the absence of a "one-to-one" relationship between taxpayers and farmers. Namely, the support might not reach the agricultural producers, going to the coverage of the costs of administering a program [13, p.6].

In 2019, different lock-in effects in agriculture were investigated by the International Panel of Experts on Sustainable Food Systems, and it was stated that one of the effects is "the enormous concentration of power in agribusiness". Specifically, large amounts of profit in the food systems are usually generated by a limited number of actors, which makes them more powerful to influence the governance. They might lobby policymakers to create an environment which benefits their business interests [17].

As discussed in subsection 1.2, Ukrainian agriculture market can be characterized with large landholders and producers acting in it. Hence, it is interesting to investigate some influence on the subsidies framework. In subsection 2.3 the Components of the Machinery and Equipment Cost Compensation Program were explored, and one of the subsidized groups was grain trucks. Typically, this kind of machinery is not used by small producers, who are the target beneficiaries of the implemented agricultural subsidies in particular. Large exporters are characterized by high revenues and usually do not need state support since it has a small share in their operating costs (e.g. the whole state support for Ukrainian agriculture constitutes only 13.8% of Kernel's costs in 2019) and is not aimed on the development, but on even higher profits [8]. However, especially large businesses won from the Machinery Cost Compensation in 2018 and inclusion of the grain trucks in the list of compensated machinery. Particularly, the largest landholder as of 2019 Kernel was a beneficiary of such a policy implementation, which gave a possibility to purchase 500 grain trucks for the cost of taxpayers after it was lobbied by the owner of Kernel - Deputy and member of the Verkhovna Rada Committee on Tax and Customs Policy Vitaly Khomutynnik [26].

During 2017-2019, a great share of agricultural subsidies did not reach their target recipients – small-sized enterprises, but went to the large holdings. The top-receivers of the governmental state support were MHP (2.6 billion UAH), UkrLandFarming (418 million UAH), APK-Invest (85.9 million UAH), Agro-Oven (85 million UAH) [55].

In October 2020, governmental actors introduced a bill which is aimed to establish a minimum purchase price for grain crops. It was justified by Andriy Bohdanets, Deputy of the Verkhovna Rada of Ukraine, with stregneting a competition and correction of the existing gaps between Ukrainian and international prices for grains [23]. This strong market intervention might not only cause negative consequences for the agriculture sector, but harm Ukraine’s reputation in the WTO, most members of which emphasize on reducing the price control measures. It was asserted that Green Box subsidies will bring more benefits, while market price support (MPS) tools (located in the Amber Box as was discussed in subsection 2.1) will distort production and trade. MPS will impair the relations between trading partners, result in trade disputes and might spill over to other economic sectors [64, p.18].

If a large proportion of agricultural subsidies ends up supporting input suppliers (e.g., domestic machinery manufacturers) and large producers, they also might displace smaller ones out of the market [32, p.16]. The same conclusions can be drawn from the state price support schemes which are currently considered by Ukrainian government (see Figure 2.9).

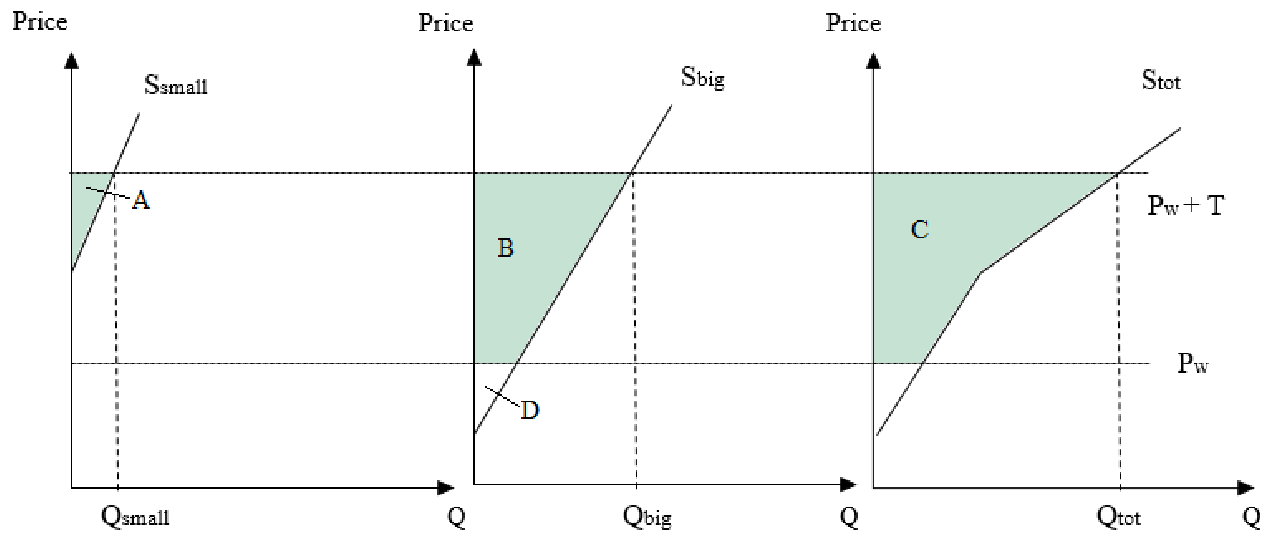


Figure 2.9 - Effects of price support schemes for small and large agricultural enterprises

Source: Economics of European Integration [11, p. 211].

Figure 2.9 illustrated supply curves for different agricultural enterprises: small-sized enterprise, large-sized and total. The world price is P_w, it is below the small farm supply curve to indicate a lower efficiency and higher marginal cost for output. After a price floor (P_w+T) is introduced, both small and large farms produce, their outputs are Q_{small} and Q_{big}, respectively, and Q_{tot} indicates a sum of the two. Since the minimum price supports manufacturers in proportion to the production, large-sized and industrial farm will earn more - the area B, while small-sized and less advanced farm earns only area A. Thus, large producers will benefit more from the policy, which will also reflect in the income generation (area A for small and B+D for large). Consequently, large enterprises tend to be richer than small ones and the benefits from the policy are biased in their favour. Hence, the proposed bill will not make Ukrainian agricultural manufacturers more competitive, but, conversely, will concentrate the production in even fewer businesses.

To sum up, subsidies, as a way to support producers and economic development, can be divided into three main groups ("boxes") depending on the effects they have on the economy and market. They stimulate domestic production and improve social welfare having positive externalities. We assert that levels of agricultural support in Ukraine differ from those established in OECD countries, since prices received by farmers in Ukraine are around 4.2% lower than international prices and there is an implicit support for consumers. Overall, the amount of state support to agriculture in Ukraine has a decreasing tendency as a share of the total governmental expenditures and constitutes only 2.2% of them. However, it increases in absolute volumes, particularly within the following input subsidies: support of the livestock industry, cheapening of loans and support for private farms development. R&D activities and machinery and equipment cost compensation programs demonstrate decreasing trends. The main problems which are observed in the agriculture subsidizing in Ukraine are: predominantly short-term loans taken out under governmental program for credit access, favour to imported machinery due to the higher quality compared with domestic ones, few number of private farms benefited from the support program, irregularities in assigning subsidies, low level of awareness among producers. Additionally, subsidies might be vulnerable to the political manipulations and lobbying of interests to generate higher incomes. Their effectiveness requires thorough governance and minimal trade distortion.

CHAPTER 3
LINEAR REGRESSION MODEL OF THE REGIONAL AGRICULTURAL PRODUCTION

3.1 Theory

Agricultural production plays an important role in the Ukrainian economy, generating large export revenues, providing jobs for 18% of the working aged population, developing rural areas and ensuring food security. Hence, it is necessary to explore factors which affect the production levels, and how these factors can be supported by the state to expand the output.

As it has been discussed in subsection 1.1, Ukrainian agriculture is predominantly oriented on crop cultivation. Moreover, cereals production constituted 42.4% of the total export revenues in 2020. Thus, it is more appropriate to investigate particularly this type of production. Subsequently, several hypotheses were developed to investigate the main drivers of agricultural *grain and leguminous crops production* in agricultural enterprises.

Primarily, it was decided to consider the four main factors of production. Firstly, the sown area (land and natural resources factor) is a central focus of virtually all agriculture, thus greater sown areas under grain and leguminous crops will enlarge their production due to increasing yields. Secondly, a *number of employees in agricultural enterprises* (labor) will also contribute to the production investing their physical and mental resources. Thirdly, a greater *number of enterprises engaged in agricultural activity* (entrepreneurship) will stimulate the production and contribute to the economic growth through starting a business. Finally, higher machinery exploitation (capital), *tractors*, in particular, will increase the productive capacity of the sector and expand the output [5]. This hypothesis was amplified by investigating not only the number of machinery exploited, but also its *energy capacity*, assuming the more advanced technology used in manufacturing.

Furthermore, there were considered additional factors that might influence the grain production in Ukraine. Financial capital helps to improve wealth and make the production possible, thus the hypothesis about connection between the production levels and *direct costs of agricultural crops production* was developed. It implies that direct costs spent by enterprises will affect the level of output with a time lag, because, according to the SSSU, direct costs of crops production comprise seeds and planting materials, inorganic fertilizers, oil products etc. [51]. Hence, a greater purchased amount of these items in the current period will indicate a better preparation for the next sowing season, as well as a higher production in the following period. This hypothesis was also supplemented with the assumption that expenditures on crops production will not demonstrate reliable results due to the high volatility of hryvnia, thus it will be necessary to adjust the absolute volumes to the official *hryvnia exchange rate* against foreign currencies, US dollar in particular.

The last hypothesis was related to the ability of agricultural enterprises to maintain a stable production cycle, particularly to distribute their production inputs and outputs without barriers. Namely, the *logistic performance index* was considered. Since large amounts of agricultural crop production are exported, the effective supply chain will depend on their fast delivery from the farm gates to elevators and ports. It was assumed that manufacturers will plan their production volumes in the next period according to the logistics experience acquired in the current period. Hence, a better performance index during the operating year will affect farmers' decisions and expectations in the subsequent year, increasing their willingness to produce more outputs due to the easy distribution.

3.2 Data Description

Agricultural production is unevenly distributed among regions in Ukraine due to the specific local orientation, nature resources and geographic location. Therefore, it is essential to test the hypotheses considering the regional context. The data chosen for the research represents annual indicators for selected variables for 24 regions of Ukraine from 2008 to 2019. Required information was collected from the World Bank, the NBU and from the SSSU official annual statistical yearbooks and publications on agriculture [60, 34, 52].

Dependent variable is reflected by the production of grain and leguminous crops **(PROD)** and is estimated in thousand tons.

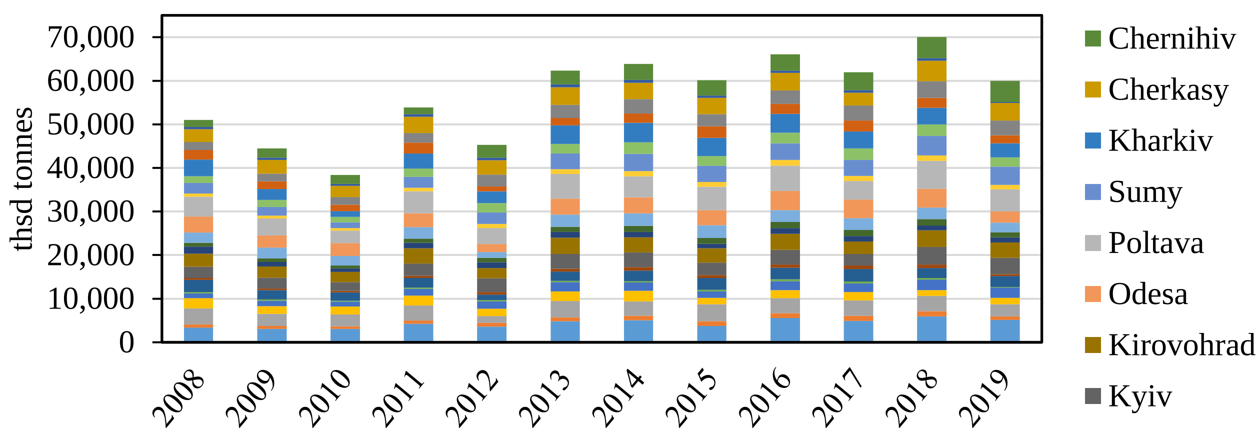


Figure 3.1 - Production of grain and leguminous crops among regions of Ukraine

Source: the State Statistics Service of Ukraine data [57].

Figure 3.1 reveals that production levels differ among regions, affecting annual cumulative amounts. On average, during 2008-2019, the main producers of grain and leguminous crops were located in Poltava (4.8 mln t), Vinnytsya (4.4 mln t), Cherkasy (3.6 mln t) and Kharkiv (3.5 mln t) regions.

Independent variables are represented by several indicators or their interactions. One of them is sown area under grain and leguminous crops **(SOWN)** which is estimated in thousand hectares (see Figure 3.2).

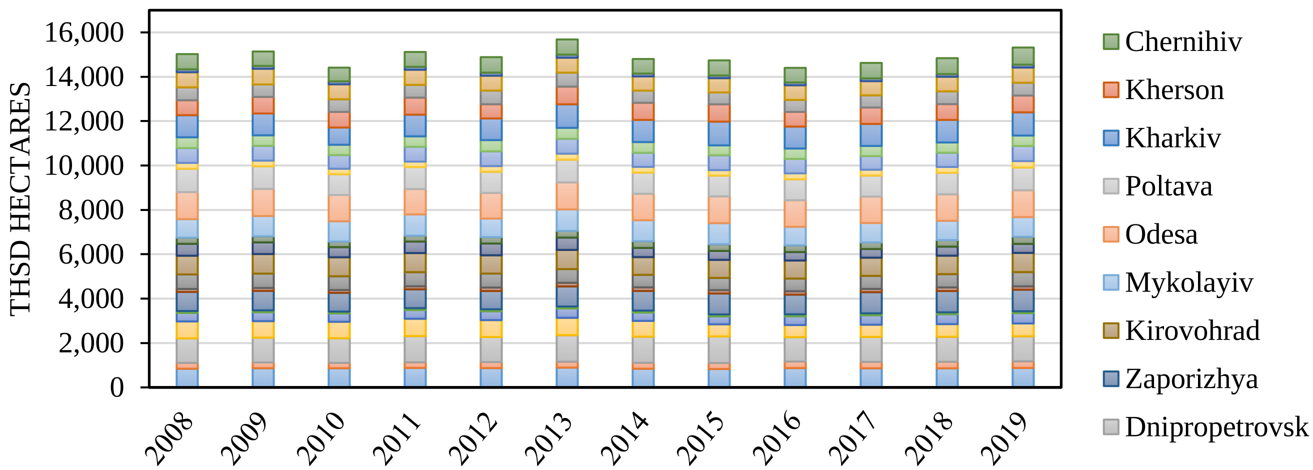


Figure 3.2 - Sown areas under grain and leguminous crops among regions of Ukraine

Source: State Statistics Service of Ukraine data [57].

From Figure 3.2, we observe slight fluctuations during the selected period. The leaders with greatest sown areas, on average, were Odesa (1195 thsd ha), Dnipropetrovsk (1140 thsd ha), Kharkiv (990 thsd ha) and Poltava (977 thsd ha) regions.

Subsequent indicators are average annual number of employees in agricultural enterprises **(EMPL)** estimated in thousand persons and number of enterprises engaged in agricultural activity **(ENTERP)** measured in the number of entities (see Figure 3.3).

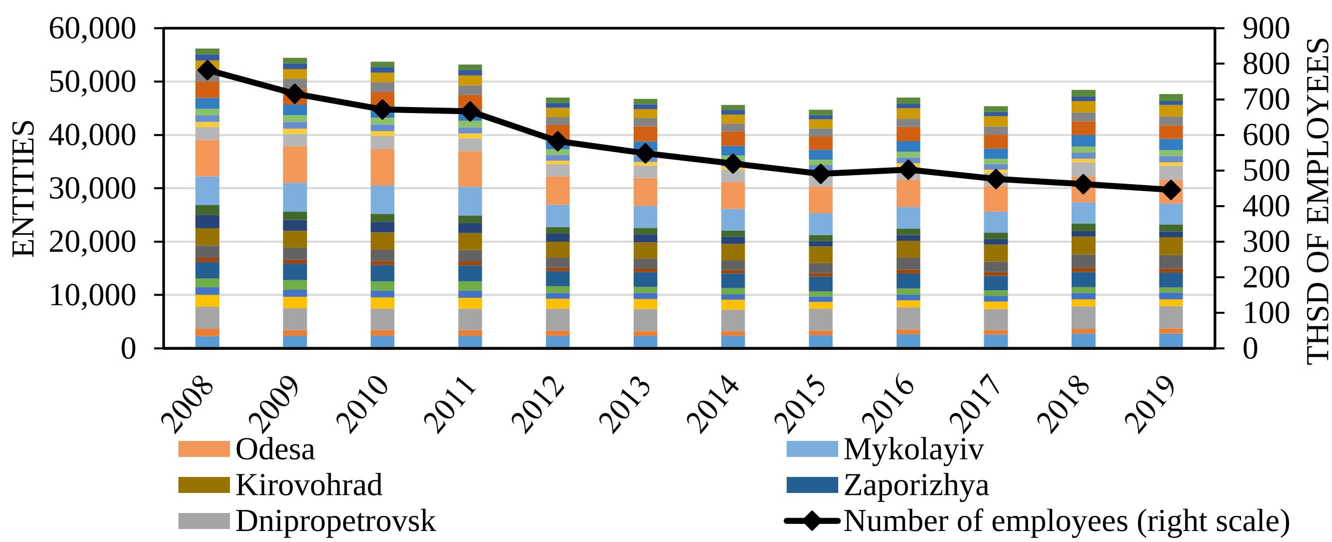


Figure 3.3 - Number of agricultural enterprises among the regions of Ukraine and dynamics of the number of employees

Source: State Statistics Service of Ukraine data [57].

During 2008-2019, most of the agricultural enterprises were located in Odesa (5587 entities), Mykolayiv (4468), Dnipropetrovsk (4099) and Kirovohrad (3191) regions. Preliminary descriptive statistics demonstrate that these variables have different trends, particularly the number of enterprises engaged in agricultural activity tendency is not that pronounced as the one depicting the number of employees. We observe general decreases, however, different intensity. Thus, it is interesting to investigate their impact on production on a regional scale to identify more detailed effects.

Independent variables which describe capital factor of production are represented by availability of tractors in agricultural enterprises **(TRACTORS)** estimated in pieces and total energy capacity of the tractor engines **(CAP_TOT)** measured in thousand kilowatts (see Figure 3.4).

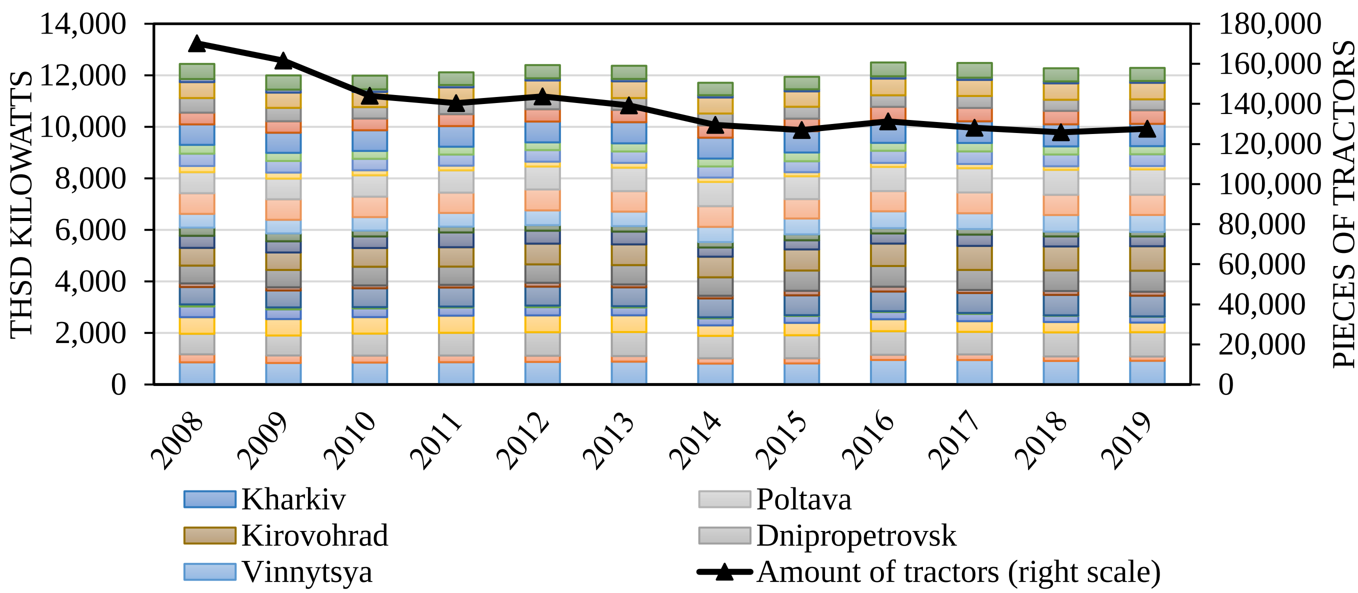


Figure 3.4 - Total energy capacity of the tractor engines among the regions of Ukraine and dynamics of tractors available in agricultural enterprises

Source: State Statistics Service of Ukraine data [57].

On average, regions characterized by the highest capacity of tractor engines were Kharkiv, Kirovohrad, Vinnytsya, Poltava and Dnipropetrovsk. We observe similar behavior as in case with number of enterprises and employees, i.e., preliminarily we notice that decrease in tractors availability does not necessarily cause decrease in total capacity of their engines, thus we assume that the capacity per one tractor increases which stimulates the production due to the technological advancement.

Interaction of direct costs of agricultural crops production **(DIR_COSTS)** measured in thousand hryvnia and official hryvnia exchange rate against foreign currencies - US dollar (period average) **(EX_RATE)** represents the next independent variable (see Figure 3.5).

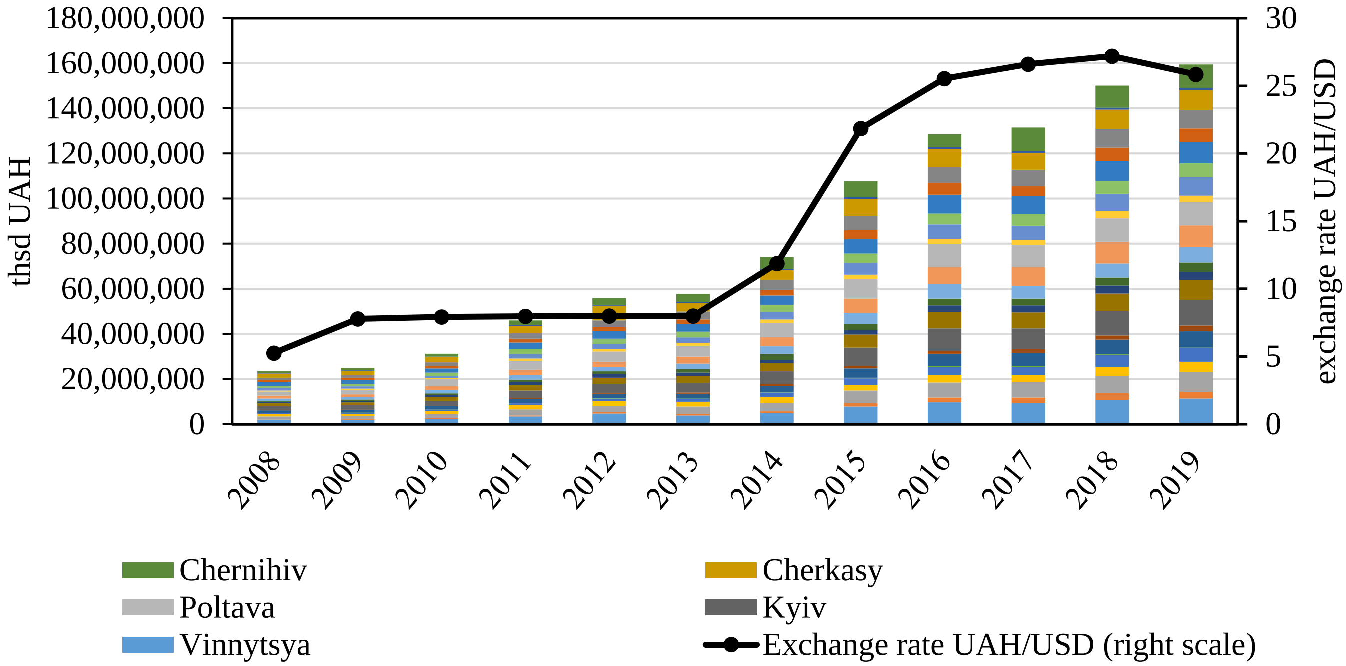


Figure 3.5 - Direct costs of agricultural crop production among regions of Ukraine and dynamic of hryvnia exchange rate

Source: the State Statistics Service of Ukraine and the NBU data [57, 34].

On average, the largest volumes spent by enterprises on crop production were in Chernihiv, Poltava, Vinnytsya, Cherkasy and Kyiv regions. As it was assumed in subsection 3.1, it is necessary to adjust absolute costs to the exchange rate since on Figure 3.5 we observe a rapid increase in the expenditures in line with the hryvnia devaluation in 2014.

Finally, Logistics Performance Index **(LPI)** represents the weighted average of six dimensions to estimate overall country's performance, specifically: efficiency of the clearance process at the border control, quality of infrastructure, ease of arranging international shipments, competence of logistic services, ability to track consignments, timeliness in reaching destinations within the scheduled delivery time. In 2018, LPI for Ukraine was estimated at the level of 2.83 and represented 66th rank among 160 countries. After 2007, however, Ukraine's positions have been improving from 73rd rank and 2.55 score [65].

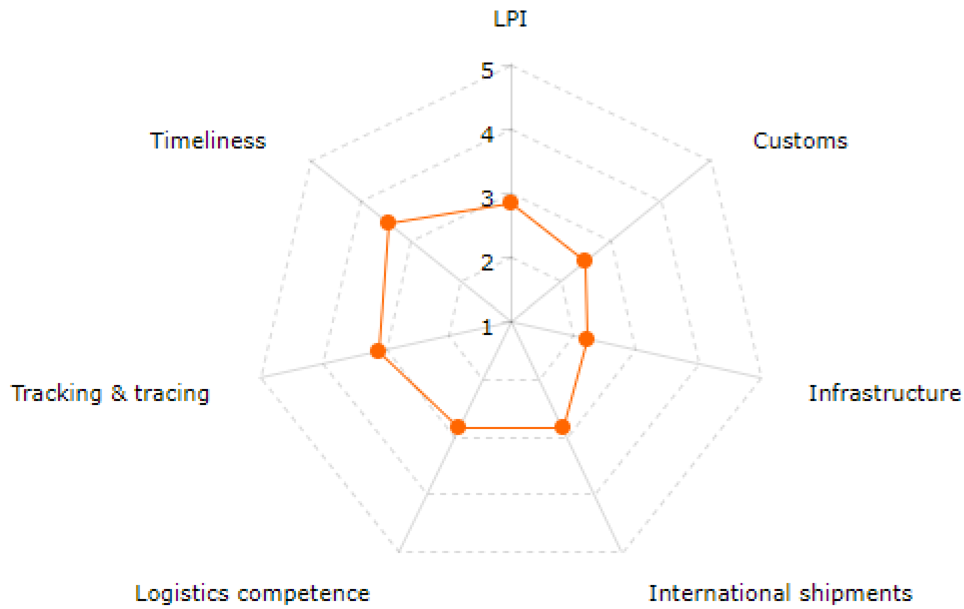


Figure 3.6 - Ukraine Score Card in 2018

Source: [65].

Figure 3.6 illustrates that the weakest score was observed in infrastructure quality (2.22 score), e.g., ports, railroads, roads, information technology. Additionally, clearance processes and customs by control agencies could be characterized by difficulties and low speed (2.49 score). The best performance was observed in timeliness (3.42 score).

Since an exchange rate is uniform for the whole country, it will not differ among the regions of Ukraine within the same year, thus the data should be duplicated for 24 regions. The same actions are required for LPI score due to the existence of a monopolist railway system for agriculture production transportation - "Ukrzaliznytsia".

3.3 Estimating Regressions

The least squares method was chosen to estimate regression parameters and demonstrate an approximated linear relationships between the dependent and independent variables. Regression analysis was conducted with the EViews8 software package using the data over the period from 2008-2019 for 24 regions of Ukraine. Since the data constituted both cross-sectional and time-series dimensions represented by regions of Ukraine and by period of time, it was decided to model the balanced panel data regression. There are observations available annually for 24 regions of Ukraine, hence, it is necessary to apply fixed effects on our panel data model for cross-sections to determine the permanence in the regions sample and to avoid omitted variable bias [62, p.19].

General equation has a form of cross-sectional multiple regression for 264 observations after introducing time lags for independent variables discussed in subsection 3.1:

$$Y_{it} = \beta_0 + \beta_1 * X_{1it} + \beta_2 * X_{2it} + \cdots + \beta_k * X_{kit} + u_{it};\ i = 1, 2, \dots, N;\ t = 1, 2, \dots, T, \quad (3.1)$$

where β_0 is the intercept;

$\beta_0 - \beta_k$ are the slope coefficients;

$X_{1it} - X_{kit}$ are the explanatory variables for dependent variable Y_{it};

u_{it} is the error term.

Model requires logarithmic specification due to the analysis of the quantitative data observed in the variables representing production, sown area, number of employees and enterprises, total tractor engines capacity, number of tractors available and direct costs. Therefore, the equation can be defined as:

$$LOG(PROD) = \beta_0 + \beta_1 * LOG(SOWN) + \beta_2 * LOG(EMPL) + \beta_3 * DLOG(ENTERP) + \beta_4 * LOG(CAP\_TOT) + \beta_5 * LOG(TRACTORS) + \beta_6 * LOG\left(\frac{DIR\_COSTS(-1)}{EX\_RATE(-1)}\right) + \beta_7 * LPI(-1) + u_{it}, \quad (3.2)$$

It is necessary to estimate multiple equations and adjust them to define the one which has complete explanatory characteristics. Preliminary coefficient analysis should include significance tests at 95% confidence level, particularly consideration of the p-value which relies on the t-statistics ratio. The first regression has the following results (see Figure 3.7).

Dependent Variable: LOG(PROD)
Method: Panel Least Squares
Date: 04/14/21 Time: 18:46
Sample (adjusted): 2009 2019
Periods included: 11
Cross-sections included: 24
Total panel (balanced) observations: 264

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.720993	1.291923	-0.558077	0.5773
LOG(SOWN)	1.313685	0.187725	6.997907	0.0000
LOG(EMPL)	-0.023214	0.076224	-0.304554	0.7610
DLOG(ENTERP)	0.877742	0.154795	5.670368	0.0000
LOG(CAP_TOT)	0.723007	0.110485	6.543932	0.0000
LOG(TRACTORS)	-0.789601	0.143584	-5.499225	0.0000
LOG(@LAG(DIR_COSTS/EX_RATE,1))	0.128027	0.062069	2.062647	0.0403
LPI(-1)	0.337945	0.140597	2.403638	0.0170

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.953216	Mean dependent var	7.550318
Adjusted R-squared	0.947192	S.D. dependent var	0.744219
S.E. of regression	0.171022	Akaike info criterion	-0.584115
Sum squared resid	6.814884	Schwarz criterion	-0.164211
Log likelihood	108.1031	Hannan-Quinn criter.	-0.415385
F-statistic	158.2428	Durbin-Watson stat	2.004185
Prob(F-statistic)	0.000000		

Figure 3.7 - First tentative regression results

Source: own calculations using EViews8.

From Figure 3.7 we observe that the variable representing the influence of the employees number on production is not significant for 5% significance level since it exceeds 0.05 threshold. Other coefficients, however, are statistically significant, thus are different from zero and demonstrate statistical relationships between independent and dependent variables. We observe logical signs of the coefficients, which confirms our hypotheses made in subsection 3.1. Particularly, the assumption made about the influence of availability of tractors in agricultural enterprises on the production is correct. Namely, the influence is indirect and occurs not through the actual number of machinery, but through the capacity of its engines, as we observe a negative linear relationship between the production and the number of tractors, but a positive relationship between the production and the total engines capacity. Nevertheless, these two variables might be interconnected and generate better regression results due to the multicollinearity inherent to them. Thus, it is necessary to build a correlation matrix before the subsequent model analysis to exclude the probability of artificially inflated t-statistics due to the multicollinearity (see Table 3.1):

Table 3.1 Correlation matrix for the first tentative regression

	LOG(PROD)	LOG(SOWN)	DLOG(ENTERP)	LOG(CAP_TOT)	LOG(TRACTORS)	LOG(@LAG(DIR_COSTS/ EX_RATE,1))	LPI(-1)
LOG(PROD)	1.000000	0.891055	0.295476	0.877081	0.848891	0.915983	0.176970
LOG(SOWN)	0.891055	1.000000	0.133736	0.955615	0.956759	0.880361	0.003546
DLOG(ENTERP)	0.295476	0.133736	1.000000	0.134338	0.104993	0.152576	0.127380
LOG(CAP_TOT)	0.877081	0.955615	0.134338	1.000000	0.986086	0.888549	-0.026140
LOG(TRACTORS)	0.848891	0.956759	0.104993	0.986086	1.000000	0.863673	-0.096524
LOG(@LAG(DIR_COSTS/ EX_RATE,1))	0.915983	0.880361	0.152576	0.888549	0.863673	1.000000	0.210964
LPI(-1)	0.176970	0.003546	0.127380	-0.026140	-0.096524	0.210964	1.000000

Source: own calculations using EViews8.

Indeed, Table 3.1**Error! Reference source not found.** reveals high correlation values for variables representing total capacity of tractor engines and number of tractors available. Moreover, we observe it not only between these two independent variables, but also there is an influence on sown area and adjusted direct costs. Hence, it is reasonable to estimate the new regression by adding a variable which represents simultaneously the total capacity and the number of tractors - that is a capacity per one machine (see Figure 3.8):

Dependent Variable: LOG(PROD)
Method: Panel Least Squares
Date: 04/14/21 Time: 18:38
Sample (adjusted): 2009 2019
Periods included: 11
Cross-sections included: 24
Total panel (balanced) observations: 264

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.069267	1.116681	-0.957540	0.3393
LOG(SOWN)	1.302014	0.186187	6.993045	0.0000
LOG(EMPL)	-0.051084	0.055874	-0.914272	0.3615
DLOG(ENTERP)	0.892590	0.152088	5.868912	0.0000
LOG(CAP_TOT/TRACTORS)	0.737995	0.106760	6.912682	0.0000
LOG(@LAG(DIR_COSTS/EX_RATE,1))	0.126776	0.061932	2.047027	0.0418
LPI(-1)	0.335666	0.140320	2.392146	0.0175

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.953157	Mean dependent var	7.550318
Adjusted R-squared	0.947352	S.D. dependent var	0.744219
S.E. of regression	0.170762	Akaike info criterion	-0.590447
Sum squared resid	6.823365	Schwarz criterion	-0.184089
Log likelihood	107.9389	Hannan-Quinn criter.	-0.427160
F-statistic	164.1877	Durbin-Watson stat	2.001462
Prob(F-statistic)	0.000000		

Figure 3.8 - Second tentative regression results

Source: own calculations using EViews8.

Results of the second adjusted regression illustrate that the new variable is significant, and the performed procedures eliminated the correlation. Nevertheless, from Figure 3.8 we still observe the insignificance of the employees variable in the regression (p-value = 0.36), which was not affected by the adjustment of the variables representing machinery. Hence, we finally decline the hypothesis implying the dependence of the grain and leguminous crops production on the number of employees in the agricultural enterprises. We might explain it with a high level of technical automatization, which stimulates the production, thus capital plays a more important role than labor.

Therefore, the final panel regression equation is following:

$$LOG(PROD) = \beta_0 + \beta_1 * LOG(SOWN) + \beta_2 * DLOG(ENTERP) + \beta_3 * LOG\left(\frac{CAP\_TOT}{TRACTORS}\right) + \beta_4 * LOG\left(\frac{DIR\_COSTS(-1)}{EX\_RATE(-1)}\right) + \beta_5 * LPI(-1) + u_{it}, \quad (3.3)$$

Plotting the selected regressors with the dependent variable, we obtain preliminary expectations for the results (see Figure 3.9).

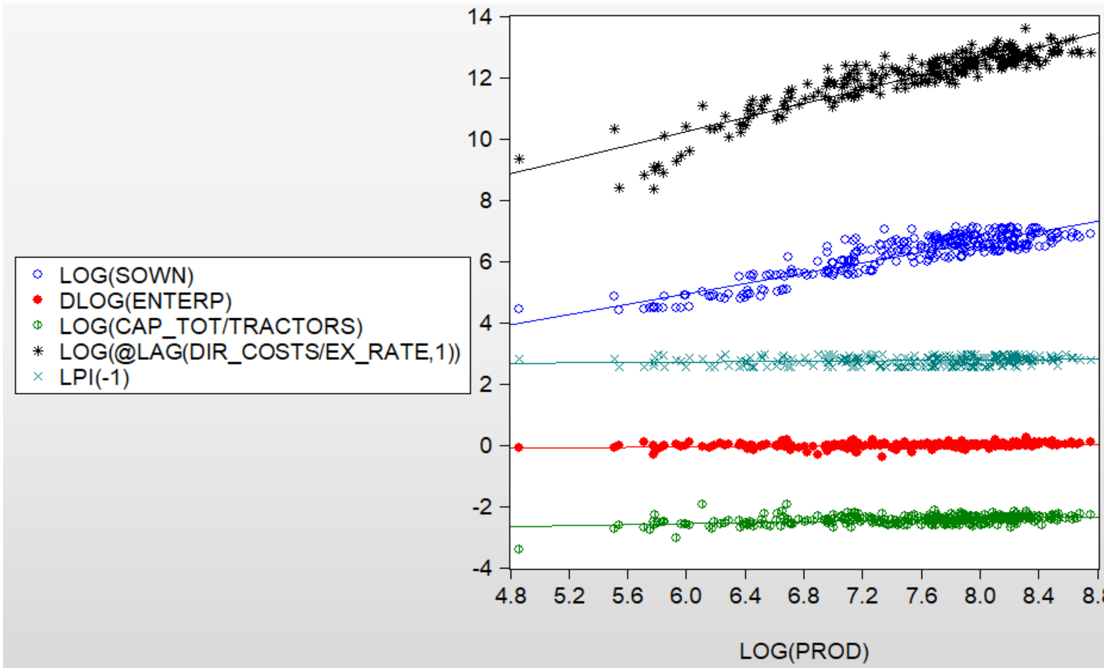


Figure 3.9 - Scatter plot with fitted regression lines for selected factors

Source: own calculations using EViews8.

We anticipate to derive positive coefficients for the explanatory variables since the graphical analysis indicates direct relationships with the dependent variable.

3.4 Interpretation and Prediction

Final estimated regression is composed of one dependent and five explanatory variables (see Figure 3.10). Interpreting coefficients implies hypotheses verification and deriving the effects of independent variables on the dependent.

Dependent Variable: LOG(PROD)
Method: Panel Least Squares
Date: 04/14/21 Time: 18:41
Sample (adjusted): 2009 2019
Periods included: 11
Cross-sections included: 24
Total panel (balanced) observations: 264

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.304820	1.086173	-1.201301	0.2308
LOG(SOWN)	1.291169	0.185744	6.951339	0.0000
DLOG(ENTERP)	0.896067	0.151987	5.895677	0.0000
LOG(CAP_TOT/TRACTORS)	0.746691	0.106298	7.024517	0.0000
LOG(@LAG(DIR_COSTS/EX_RATE,1))	0.128711	0.061874	2.080215	0.0386
LPI(-1)	0.390588	0.126767	3.081143	0.0023

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.952990	Mean dependent var	7.550318
Adjusted R-squared	0.947389	S.D. dependent var	0.744219
S.E. of regression	0.170702	Akaike info criterion	-0.594456
Sum squared resid	6.847739	Schwarz criterion	-0.201644
Log likelihood	107.4683	Hannan-Quinn criter.	-0.436612
F-statistic	170.1405	Durbin-Watson stat	2.014012
Prob(F-statistic)	0.000000		

Figure 3.10 - Final regression results

Source: own calculations using EViews8.

Considering the obtained results, the model is as follows:

$$LOG(PROD) = -1.3 + 1.291 * LOG(SOWN) + 0.896 * DLOG(ENTERP) + 0.747 * LOG\left(\frac{CAP\_TOT}{TRACTORS}\right) + 0.129 * LOG\left(\frac{DIR\_COSTS(-1)}{EX\_RATE(-1)}\right) + 0.391 * LPI(-1) + u_{it}, \quad (3.4)$$

From Figure 3.10 we observe a 5% significance level for all explanatory variables chosen for the analysis, thus the coefficients are statistically different from zero and demonstrate relationships with the dependent variable. We conclude that respective hypotheses made in subsection 3.1 can be confirmed. Particularly, for Ukraine there are positive relationships between the grain and leguminous crops production and sown area under these crops, number of agricultural enterprises, tractors capacity, direct costs of agricultural crops production adjusted on the exchange rate, Logistics Performance Index. A

1% increase in the sown area results in 1.291% increase in average production, all other variables held constant. A 1% increase in the number of agricultural enterprises causes an increase in production by 0.896%. An increase in the capacity of a single tractor engine by 1% results in an increase in production by 0.747%. A growth of the adjusted direct costs on crop production by 1% causes an expanding of production by 0.129%. To analyze the effect of the LPI on the production, it is necessary to take an exponent of the respective coefficient: exp(0.391)=1.478, meaning that an improvement in LPI score by 1 position stimulates the production by 1.478%.

Further diagnosis of the model significance relies on the F-statistic tests, implying the joint null hypothesis that all the coefficients in the model excluding the constant are zero. The p-value associated with F-statistic is the probability of observing an F-statistic that is much greater, and, according to our results, equals to zero (see Figure 3.10). Therefore, we reject the null hypothesis and conclude that the model as a whole is highly significant.

The R-squared (R^2) represents the coefficient of determination, demonstrating that our model explains about 95.3% of the variation in production of grain and leguminous crops, which indicates a strong relationship between the model and the dependent variable. The R-squared adjusted for the number of terms in the model equals to 94.7% and also indicates a high level of explanation.

Since the model is built with application of fixed effects for cross-sections, it is important to test the significance of including such effects by conducting a redundant fixed effects test (see Figure 3.11). The null hypothesis of the test is that the fixed effects are excessive (not significant). The p-value shows the probability of this null hypothesis, i.e., the probability that the fixed effects are not significant.

Redundant Fixed Effects Tests
Equation: MODEL
Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	11.460350	(23,235)	0.0000
Cross-section Chi-square	198.579398	23	0.0000

Cross-section fixed effects test equation:
Dependent Variable: LOG(PROD)
Method: Panel Least Squares
Date: 04/14/21 Time: 18:42
Sample (adjusted): 2009 2019
Periods included: 11
Cross-sections included: 24
Total panel (balanced) observations: 264

Figure 3.11 - Redundant fixed effects test

Source: own calculations using EViews8.

Figure 3.11 reveals that p-values for cross-section F and cross-section Chi-square are less than 0.05 (95% confidence level), thus, fixed effects should be included in the model.

To test the model for the autocorrelation we consider Durbin-Watson statistic and build a correlogram of residuals. The null hypothesis for Durbin-Watson test is that the residuals from the least-squares regression are not autocorrelated. Figure 3.10 illustrates a value of 2.014 for DW-criteria, which indicates a high probability of absence of the autocorrelation. Additionally, it should be proved by fitting the value within the bounds calculated for the respective numbers of observations and regressors in the model. Considering five regressors in our model, the bounds for determining autocorrelation are the following: lower bound (dL) is 1.718 and upper bound (dU) is 1.820, according to the Durbin-Watson Statistic with 5% significance [43, p.8].

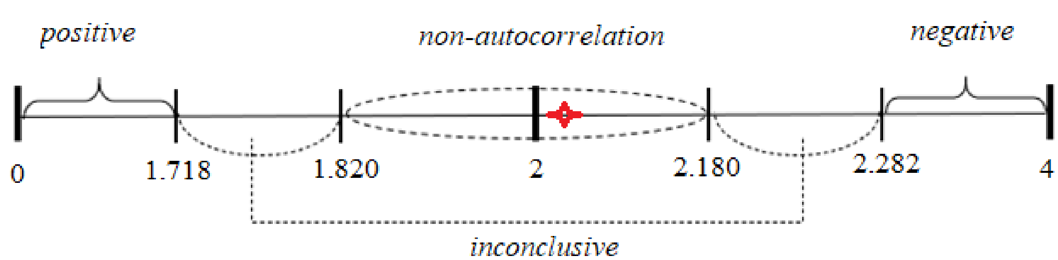
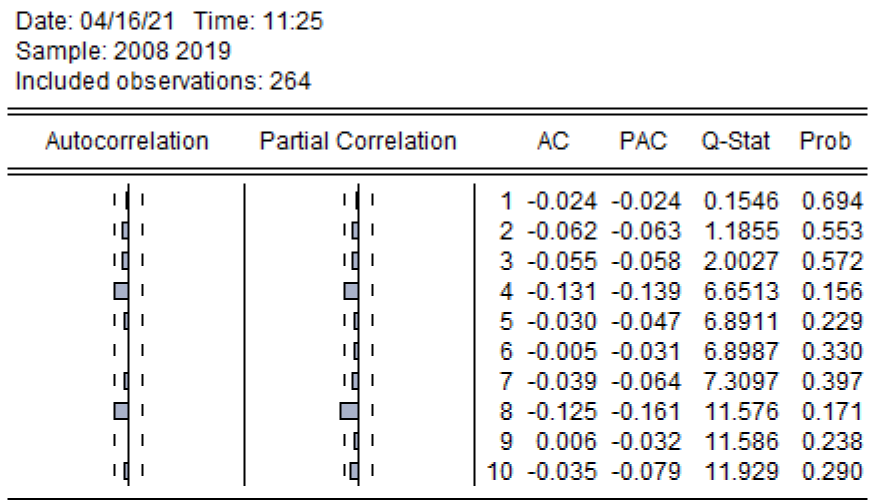


Figure 3.12 - Durbin-Watson significance test

Source: own calculations using the data [43].

From Figure 3.12 we observe that our value falls in the non-autocorrelation interval from 2 to 2.180, meaning the absence of first-order serial correlation.



Date: 04/16/21 Time: 11:25
Sample: 2008 2019
Included observations: 264

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.024	-0.024	0.1546	0.694
		2	-0.062	-0.063	1.1855	0.553
		3	-0.055	-0.058	2.0027	0.572
		4	-0.131	-0.139	6.6513	0.156
		5	-0.030	-0.047	6.8911	0.229
		6	-0.005	-0.031	6.8987	0.330
		7	-0.039	-0.064	7.3097	0.397
		8	-0.125	-0.161	11.576	0.171
		9	0.006	-0.032	11.586	0.238
		10	-0.035	-0.079	11.929	0.290

Figure 3.13 - Correlogram of residuals

Source: own calculations using EViews8.

From the correlogram of residuals and associated statistics we obtain information about autocorrelation between residuals at the different lags (see Figure 3.13). Values for autocorrelation and partial correlation are located within the two approximate error bounds. The Q-statistics are insignificant at all lags, indicating no significant serial correlation in the residuals. They can be depicted as white noise since the respective p-values indicate the insignificance. Hence, there is no evidence of unmodelled residual autocorrelation [64].

Further diagnosis of the model requires to reevaluate the correlation between the independent variables after the equation adjustment made in subsection 3.3.

Table 3.2 Correlation matrix for the final regression

	LOG(PROD)	LOG(SOWN)	DLOG(ENTERP)	LOG(CAP_TOT /TRACTORS)	LOG(@LAG(DIR_COSTS/ EX_RATE,1))	LPI(-1)
LOG(PROD)	1.000000	0.891055	0.295476	0.428726	0.915983	0.176970
LOG(SOWN)	0.891055	1.000000	0.133736	0.290462	0.880361	0.003546
DLOG(ENTERP)	0.295476	0.133736	1.000000	0.204440	0.152576	0.127380
LOG(CAP_TOT/TRACTORS)	0.428726	0.290462	0.204440	1.000000	0.413912	0.382160
LOG(@LAG(DIR_COSTS/EX_RATE,1))	0.915983	0.880361	0.152576	0.413912	1.000000	0.210964
LPI(-1)	0.176970	0.003546	0.127380	0.382160	0.210964	1.000000

Source: own calculations using EViews8.

Correlation matrix demonstrates that regressors do not have high linear correlation since their values do not exceed 0.7 (see Table 3.2). However, there is a considerable correlation observed between the sown area and adjusted direct costs on crop production. Thus, it is necessary to transform these values into determination coefficients by squaring them, and afterwards to compare individual estimates with the determination coefficient of the model.

Table 3.3 Squared correlation values

	LOG(PROD)	LOG(SOWN)	DLOG(ENTERP)	LOG(CAP_TOT /TRACTORS)	LOG(@LAG(DIR_COSTS/ EX_RATE,1))	LPI(-1)
LOG(PROD)	1	0.7939791	0.0873061	0.183806	0.8390249	0.0313184
LOG(SOWN)	0.7939791	1	0.0178854	0.0843682	0.7750355	0.0000126
DLOG(ENTERP)	0.0873061	0.0178854	1	0.0417958	0.0232795	0.0162257
LOG(CAP_TOT/TRACTORS)	0.183806	0.0843682	0.0417958	1	0.1713232	0.1460463
LOG(@LAG(DIR_COSTS/EX_RATE,1))	0.8390249	0.7750355	0.0232795	0.1713232	1	0.0445059
LPI(-1)	0.0313184	0.0000126	0.0162257	0.1460463	0.0445059	1

Source: own calculations using EViews8.

Table 3.3 illustrates that squared correlation values do not exceed the determination coefficient of the model (R^2=0.953), even for regressors which demonstrated a high linear correlation. Thus, we conclude that our model is adequate, and the results are not biased by the multicollinearity.

Furthermore, it is possible to test the residuals for the normality of distribution by conducting a Jarque-Bera test. The null hypothesis implies a normal distribution of the residuals and the p-value demonstrates a probability of this hypothesis.

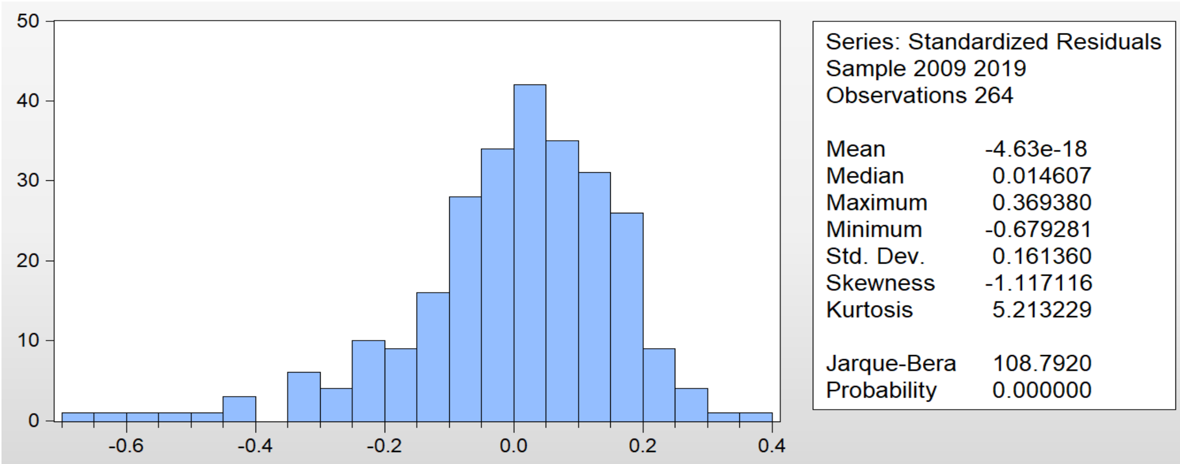


Figure 3.14 - Normality test

Source: own calculations using EViews8.

Visual representation illustrates a potentially normal distribution, however, the p-value states that we should reject the hypothesis (see Figure 3.14). We observe that a distribution is moderately skewed to the left. Nevertheless, it is still possible to rely on the model results since the normality assumption might be violated due to the small sample size.

Graphical analysis of the model behavior can be performed through accessing how accurately the model can reproduce actual values of the grain and leguminous crops production (see Figure 3.15):

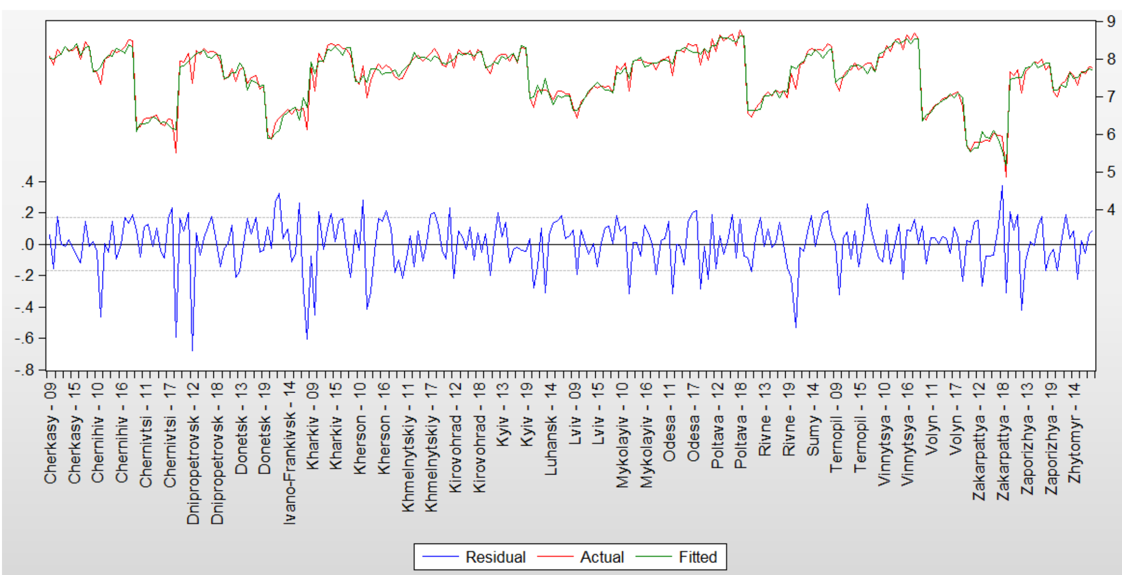


Figure 3.15 - Graphical diagnosis of the model

Source: own calculations using EViews8

From Figure 3.15 we observe that fitted values of the model can reproduce the actual data fluctuations with a high precision. The greatest variations were observed in 2012 for Dnipropetrovsk region and in 2019 for Chernivtsi and Ivano-Frankivsk regions due to the unexpected drops in production levels.

It was concluded that the model is adequate since it passed the performed tests, abnormal distribution detected during the testing was justified with the small number of observations and did not distort the model reliability. According to the obtained results, five of six hypotheses were confirmed, which allows to make predictions and suggest policy approaches.

Since a 1% increase in the sown area results in 1.291% increase in the production, it is important to maintain the sown areas at current or higher levels. For this purpose, agricultural subsidizing can be oriented at ensuring the farmers to sow more through implementing affordable agricultural insurances. This risk management tool will provide financial protection against production losses and stimulate farmers to be more risk tolerant to greater sown areas.

It was confirmed that the expansion of production is influenced by the greater number of agricultural enterprises, thus current state support of the newly created farms is necessary since their 1% increase will cause 0.896% growth in production.

The research has shown that production levels are not that dependent on the number of agricultural machinery, but on its energy capacity. Therefore, existing agricultural subsidy program for machinery cost compensation can be adjusted in this direction. Namely, the government might modify the list of compensated machinery by including there more energy-efficient tractors, which will stimulate the production by 0.747%. However, this might be potentially problematic due to the greater cost of such machinery.

Since the direct costs on crop production are mainly composed by seeds and planting materials purchase, it is important to maintain the existing state support for seeds compensation. Therefore, a successful performance of this subsidy will generate a 0.129%

production increase. Due to the low impact on the production, there is no need to expand this direction of support.

Great influence (1.478%) was also demonstrated by the Logistic Performance Index. Hence, it is important to improve the infrastructure for agricultural delivery. Currently "Ukrzaliznytsia" is a monopolist in the Ukrainian logistics market, therefore there are no appropriate competitive circumstances to upgrade the infrastructure. Nevertheless, Ukrainian railway system is too overarching (2nd place in Europe after Germany) and will require large financial investments [65]. A bill submitted in 2020 implies a privatization of "Ukrzaliznytsia", remaining the control stock for the government [66]. Consequently, with the possibility of privatization, a better infrastructure will depend on the presence of investors who desire to buy shares, which might be problematic due to the expensive modernization (carriage and railway system) and political instability in Ukraine (risk to lose the rail tracks because of the war). However, there is an additional solution how to improve Ukrainian logistics for agriculture - boosting the inland water transport, which will increase the volume of freight transportation via the Dnipro river. Currently only 10% of grain crops production is delivered to the ports via the river, which causes inefficiency and damages to the environment (one barge can potentially replace 200 grain trucks and reduce air pollution) [67]. Therefore, modernized inland transportation will shorten the delivery time of agricultural commodities, increase the efficiency, decrease rail congestion during the harvest season, lower the financial and environmental costs.

CONCLUSIONS

Agriculture sector has a significant influence on Ukrainian economy, contributing 18% to the total employment and 45% to the total export revenues as a source of foreign currency. Under the WTO regulations, agriculture enables large volumes of international trade of *Cereals and Animal or plant fats and oils* with China, India and the Netherlands. Ukrainian agriculture outputs are predominantly provided by enterprises (66%) and are oriented on crop production (79%). This sector is characterized by large and rich landholders who demonstrated monopolistic peculiarities and lobbied their interests during the policy making, which would not benefit the target subsidy recipients (small enterprises) and, moreover, might displace them from the market. Large enterprises have shares of foreign investors, however, total volumes of FDI in the agriculture sector are relatively low (2.42% in total, predominantly in growing non-perennial crops) due to the high risks and bureaucracy levels, insufficient infrastructure quality, low employees qualification and return on capital. Nevertheless, there are support programs for agriculture both from the international partners (IBRD development projects) and Ukrainian government (subsidies).

It was identified that while the subsidies are implemented to protect domestic producers, promote regional and research development, facilitate transitions, enhance employment and incomes, increase social welfare in case of positive externalities within the sector, they might also be harmful and distort trade, thus they are placed in different “boxes” according to their influence on the free market.

During the research, several comparisons were performed using international OECD classificators to determine the level of Ukrainian state support for agriculture. NPC value revealed that prices (measured at the farm gate) received by the OECD farmers were 9.4% above world market levels, and Ukrainian farmers, conversely, received prices around 4.2% lower than international prices. Additionally, CSE value demonstrated an implicit support for consumers who pay lower domestic prices, which was indicated by fluctuations of CSE for Ukraine between -5.4% and 7.9%, while CSE for the OECD countries was fluctuating between -20.8% and -5.8%. On average, over the last ten years consumers in Ukraine were paying prices reduced by 2.78% due to the public policies.

The key directions of agricultural subsidies were investigated, and we conclude that albeit supporting R&D activities is the most effective way, Ukrainian government provides low sponsorship of these projects and agriculture state support is predominantly oriented on the input subsidies. Peculiarly, the livestock industry support had an increasing trend over the last four years and by 2019, recovered to the 2013 levels. Additionally, it was justified why this industry should not be subsidized in the long run due to its high costs and influence on climate change (14.5% of global greenhouse gas emissions). Investigating other directions of agriculture support in Ukraine, it was ascertained that cheapening of loans program plays an important role in the development, however in 2019, it covered mostly short-term loans up to one year (81.6%) and provided only 2% of agricultural enterprises with partial compensation of the loan interest rate. Machinery cost compensation program granted benefits simultaneously for the agriculture sector (5400 enterprises purchased 10309 units of compensated machinery) and for domestic manufacturers of the agricultural machinery (import decreased by 17% in 2019). Financial support for private farms development is oriented on arable land and inputs subsidizing, and provided benefits for 29% of operating farms in 2019. It was identified that low awareness of the farmers about the subsidies results in their inefficiency, however, an implementation of the State Agrarian Register should simplify the access to state support.

The last stage of the research implied regional investigation of the most exported Ukrainian agriculture commodities - grain and leguminous crops production. It is indirectly affected by various kinds of agriculture state support, thus a linear regression model was used to investigate potential effects of different production factors, which are subsidized in the agriculture sector. Several cross-sectional panel regressions for 24 regions of Ukraine during the 2008-2019 period were estimated to test the following hypotheses: what are the relationships between the grain and leguminous crops production and sown area, number of employees, number of agricultural enterprises, amount of exploited tractors and their energy capacity, direct costs on crops production adjusted on the exchange rate and the Logistics Performance Index. Final version of the model explained 95.3% of the variation in production of grain and leguminous crops, and demonstrated a high level of adequacy, according to the performed diagnostic.

Overall, five of six hypotheses were confirmed, meaning that 1% increases in the sown area, number of agricultural enterprises, the capacity of a single tractor engine, adjusted direct costs on crop production, LPI score results in increases in average production by 1.291%, 0.896%, 0.747%, 0.129%, 1.478%, respectively. Finally, several policy approaches were suggested to influence these factors and to improve the production. They implied establishing affordable agricultural insurances, expanding the support for the newly created farms, subsidizing more energy-efficient tractors, upgrading the infrastructure by “Ukrzaliznytsia” modernization and improvement of the inland water transport.

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