THE ROLE OF AGRICULTURAL PRODUCTIVITY IN REDUCTION OF RURAL POVERTY AND INEQUALITY IN UKRAINE

by

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Abstract

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Poverty and inequality have been considered the key economic issues worldwide, gravitating towards developing countries in particular. Scientific literature on those show a majorly rural character of the outlined phenomena, including their developments in Ukraine. Given a great extent of the problems' non-urbanity, it is surprising that little attention is paid among national and foreign scholars to Ukrainian agriculture and its productivity as possible and potential contributors to eradication of rural poverty and the overall growth of well-being in the countryside.

In this work, we develop a framework described in the literature in order to analyze the role of agricultural productivity on rural poverty, inequality, employment and level of wages. Based on 50-sg agricultural firm-level data together with wage and population controls from SSSU, the analysis is conducted at the level of rayons for Ukraine. Referring to both total and partial measures of productivity, the authors investigate revenue-cost patterns of productivity effects and discuss what policy implications can be derived from them.

TABLE OF CONTENTS

LIST OF FIGURES

Number *Page*

LIST OF TABLES

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GLOSSARY

FE. Fixed Effects. Panel data estimation technique which allows one to control for time-invariant unobserved individual characteristics that can be correlated with the observed independent variables.

IDSS. Ptoukha Institute for Demography and Social Studies of the National Academy of Sciences of Ukraine

PPP. Purchasing power parity. Currency conversion rates that tend to equalize the purchasing power of world currencies, readjusting the different price levels between countries to the same scale.

SSSU. State Statistics Service of Ukraine.

TFP. Total factor productivity (TFP) can be defined as a ratio of aggregate output produced relative to aggregate input used. It measures the account for using a number of factor inputs in production and, therefore, is more suitable for performance measurement and comparisons across firms and for a given firm over time (Coelli, et al. 2005).

SE. Standard Error. Statistical category that measures the accuracy of sample distribution in representing population by using standard deviation.

RE. Random Effects. Panel data estimation technique in which parameters (effects) defining model's systematic components have some form of random variation.

VA. Value-added. Extra value created in extent of the original value of good/service.

Chapter 1

INTRODUCTION

The notion of poverty has been considered as one of the most argued economic phenomena: both reason and consequence of unsuccessful economic performance (Lopez and Servén 2009), poverty is listed as the Number 1 Sustainable Development Goal of the UN (The United Nations 2019). Discussing the context of the world poverty distribution, the World Bank estimates that around 79 per cent of those experiencing poverty live in rural areas (Suttie 2019). The majority of people living below the poverty line come from the developing countries, mainly in sub-Saharan Africa and South-East Asia. Nevertheless, a small fraction of them lives in the developing parts of Europe, including Ukraine.

According to the Ukrainian Institute for Demography and Social Studies, 1.8% of Ukrainians spent less than 5.05 USD PPP a day in 2018, which is recognized by the UN as the monetary poverty criterion (IDSS 2019). As for the structure of poverty, 31.5% of rural inhabitants earn less than the respective monthly subsistence level, comparing to 25.6% of urban citizens in 2018. Also, 31.6% of people in rural areas spend less than 75% of the median level of total personal expenditures, comparing to 20.3% of urban inhabitants, pointing out to the unequal wealth distribution. The above facts support the issue of relatively high level of poverty and income inequality in Ukraine, with its disproportional gravitation towards the rural areas. More pronounced poverty in rural areas in Ukraine has been largely out of academic and policy agenda for a while, thus it requires reconsideration and more empirical evidence on the major drivers that lead rural areas out of poverty in Ukraine.

In order to understand the nature of rural poverty in Ukraine, it would be reasonable to consider previous works related to the topic and available statistic data. Traditionally, the notion of rurality in the developing economies is associated with agricultural production (Chand, Srivastava and Jaspal 2017). In Ukraine, which is a transition economy, around 70% of legally employed rural population works in agriculture (SSSU 2019). It means that agriculture serves as a crucial source of income for those 31% of Ukrainians living in rural areas, as it provides the most jobs locally. While employing about 18% of national labor force, Ukrainian agriculture amounted to 10% of GDP in 2018 (SSSU 2019), though focusing increasingly more on relatively low value-added and less labor intensive activities (Gollin, Lagakos and Waugh 2011). In view of the above, the analysis of rural poverty and inequality should be conducted within the context of developments in agriculture and the respective changes in the well-being of rural citizens of Ukraine.

Referring to Ukrainian agriculture, it has become one of the strongest sectors within the economy, growing by 3% within the GDP structure over the last 8 years and mitigating the negative impact of military and economic crises in Ukraine in 2014. Starting from 2010, when Ukrainian agriculture was incentivized and supported by post-2008 high commodity prices, Ukrainian agricultural output increased by about 55%, while the share of total labor employed in the agriculture went up by only 2% (see Figure 1 below). At the same time, the capital investment in agriculture (another key factor input) fluctuated and had no feasible pattern of growth, as well as the cropped area decreased by approximately one million ha, which gives some room for consideration of productivity growth within the sector (SSSU 2019). The increased agricultural production contributed to about 40% of national exports (UCAB 2019) and was expected to bring higher returns to the inputs intensively used in agriculture, including labor (according to Heckscher-Ohlin Theorem) (Ohlin 1933).

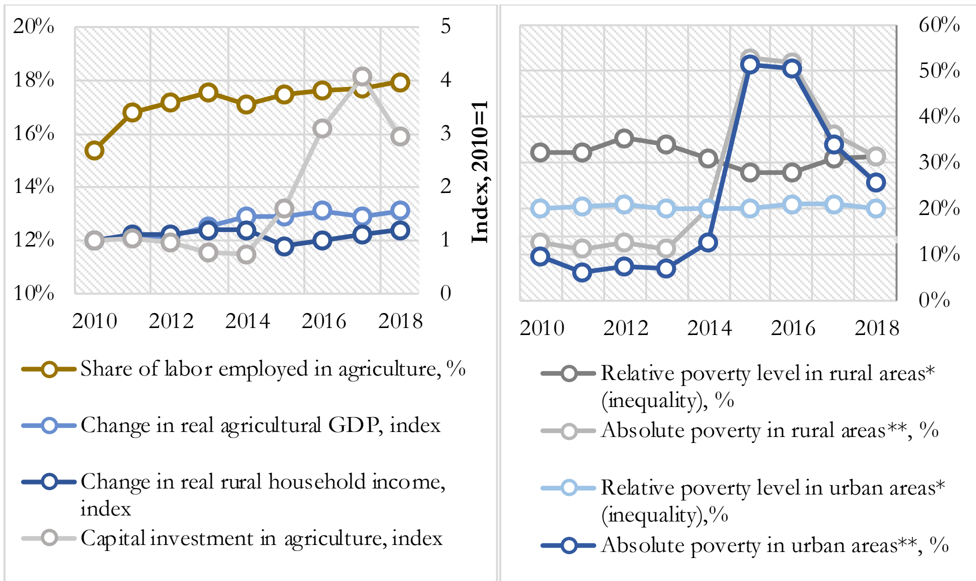

Figure 1. Developments in agriculture, poverty and inequality in Ukraine, 2010-2018

Note: *expend.-based, <75% of the median level of total personal expenditures; **total income less than the factual minimum subsistence level

Source: SSSU

Nevertheless, Figure 1 points at a certain mismatch in development of real agricultural GDP and real rural household income, creating the background for current research. In more detail, agricultural revenues grew at a significantly higher pace than incomes of rural labor, thus questioning the key role of agriculture being a backbone of rural areas and giving room for further detailed investigation of other drivers.

Another interesting fact is that the absolute poverty level in rural areas oscillated around the same level before 2014 and was exacerbated by the economic and security crises, slowly recovering in 2017-2018. At the same time, the relative poverty level in rural areas was following the inverse pattern, meaning that inequality was increasing in rural areas before the conflict and decreased during it, while recovering to higher levels in 2017-2018. This could be explained by the higher reliance on in-home production in rural areas during the crises, while the share of wages in total income depressed both in urban and rural areas, decreasing inequality between them (in line with Kuznets (1955) (see Appendix A). On the contrary, in the recovery period agricultural employment grew and increased the share of wages in total rural income, putting the upward pressure on inequality. It should be also mentioned that the absolute poverty level in urban areas went up more sharply, giving a precondition to assume that agricultural employment mitigated the poverty increase in rural areas (in historical crises cases as well) (Otiman 2008). Moreover, the effect of productivity on poverty is regarded to be lagging (Lin, et al. 2001), so the time factor has to be accounted for in order to understand the true effect of agricultural productivity on poverty and inequality.

The above observations provide some initial evidence to perceive agricultural growth as an essential contributor to the development of rural poverty and inequality, while a certain mismatch in their performance together with no consensus in economic literature (Ahluwalia, et al. 1974) regarding the relative effectiveness of agricultural growth in reducing poverty motivate investigation of how agricultural growth affects income inequality and poverty in Ukrainian rural areas.

Given that there has been only one work dedicated to the influence of productivity growth in Ukraine for the period 1999-2002 (Galushko and von Cramon-Taubadel 2004) this thesis contributes to investigation of the topic within the context of economic shock of 2015-2016, as well as the world economic crisis of 2008-2009. In view of this, a longer time period between 2000-2016 is considered (general upward trend in Ukrainian agriculture), as well as a more detailed geographic disaggregation for rayons rather than oblasts is accounted for in this work. Given that Galushko and von Cramon-Taubadel (2004) received close to zero effect of agricultural TFP growth on poverty reduction, the more disaggregated data and longer timespan of this thesis might allow the authors to research if agriculture turned into a strong poverty alleviating segment of national economy over the studied period.

The data used for the empirical findings include both firm-level and aggregated rayon-level statistics, covering the productivity, poverty, inequality, and other supporting measures between the years 2000 and 2016.

Accounting for both inequality and poverty effects, the thesis will contribute to the discussion of wealth distribution among the owners of factor inputs, as well as have policy implications on rural labor. The topic is strongly motivated by the UN Sustainable Development Goals and EuroAtlantic economic integration efforts of Ukraine, embedded in its the national strategy.

The thesis is organized as follows: Chapter 2 starts with a review on the relevant to agricultural growth and rural poverty and inequality literature. In Chapter 3 the authors develop a methodological framework used for investigating the relationship between agricultural productivity growth, rural poverty, inequality, and supplementary measures of rural well-being in Ukraine. Chapter 4 is dedicated to the description of data, required for the respective econometric models. Empirical results are discussed in Chapter 5 and tested for robustness in Chapter 6. Finalizing the thesis, Chapter 7 summarizes its findings and discusses policy instruments for alleviating poverty and contributing to well-being in rural areas of Ukraine.

Chapter 2

LITERATURE REVIEW

Economic growth has been studied within the context of poverty since the mid-twentieth century. In the studies conducted in the 1950s and 1960s, economists developed and sustained the hypothesis of a poverty-alleviating effect of economic growth ('trickledown effect'), which would provide greater employment opportunities and wages to labor (Locke Anderson 1964). At the same time, some early works argued the nature of economic growth, decreasing poverty but increasing inequality at the early development stages simultaneously, under the assumption of an inverted U-shape relationship between income inequality and economic growth (Kuznets 1955). In the following 1970s, the scientific focus was moved to investigating ambiguities, questioning the poverty-reducing effects of economic growth (Ahluwalia, et al. 1974). Given the continuous increase in technological development and productivity, the above argument on the role of economic growth in poverty alleviation was complemented with unemployment increasing externalities, widely investigated starting from the 1980-1990s (Gordon 1995). The above findings set a framework for succeeding in scientific research questions and papers, based on the analysis of 'trade-offs' between economic growth, poverty, inequality and unemployment.

As declared in Datt and Ravallion (1998), the interplay between mentioned above economic categories has a long history of investigation, resulting in a number of theoretical and empirical works. International organizations played an important role in discussion of the poverty decreasing effects of growth. The World Bank was among the first international actors to stress the importance of economic growth for generating employment and other income-earning opportunities for the poor, outlined in the numerous editions of World Development Report, started in 1990 (The World Bank 1990). Within its poverty-dedicated research, the World Bank developed a concept of "pro-poor growth" (Ravallion and Datt 1999), supported by the research of OECD (OECD 2008) and EU (European Commission 2016).

Alternatively to the "pro-poor" growth idea, many scholars argued about the growth-impeding role of poverty, showing a reverse effect. One such argument explains that the poor have fewer opportunities for investment, what negatively affects growth rates and eradicates poverty even more (Binswanger, Deininger and Feder 1995). This leads to a conclusion that the initial conditions of human resource and rural development significantly affect the long run differences between rural poverty reduction worldwide (Datt and Ravallion, Farm productivity and rural poverty in India 1998). Moreover, the elements of sectoral composition of growth were added into analysis, proving that poverty is more affected by rural economic growth rather than urban (Datt and Ravallion 1996), as well as positively related with inequality (Ravallion 1997).

The mentioned works raised academic interest to the mechanism of poverty reduction based on different patterns of growth (such as expansion of labor-intensive agriculture), which could have more impact on the poor comparing to others (e.g. support of the capital-intensive industries) (de Janvry and Sadoulet 2010). As a result, a number of empirical papers aimed at investigating relationship between agricultural growth, poverty, and inequality, creating a solid literature base for this thesis.

Given that poverty and a significant share of agriculture in economy are peculiar to developing economies, a particular attention to investigation of a practical link between them is paid in Africa- and Asia-related studies. Namely, there is an empirical proof that agriculture contributes significantly to GDP growth in Nigeria, but not vice versa, demonstrating the responsive nature, the buffer role and the resilient character of agriculture (Odetola and Etumnu 2013). For the developing countries like Nigeria, López (2007) established that agricultural growth is statistically much more effective in reducing poverty than either total growth or secondary sector growth considering the cases of India and Côte d'Ivoire. These findings are in line with Bresciani and Valdés (2007), who discuss the idea that agricultural growth alleviates poverty to a greater extent than growth in non-agricultural sectors. By the same logic, Montalvo and Ravallion (2009) show that the primary sector was the one driving China's successful fight against poverty, unlike the secondary (manufacturing) or tertiary sectors. Nevertheless, some scholars still question the leading role of agriculture in poverty reduction, such as Fane and Warr (2002) proving the services sector to contribute the most to alleviation of poverty in Indonesia, Thailand, Malaysia and the Philippines. Alternatively, some scholars think that there is little evidence to say that African countries can use a broad-based agricultural growth to start their successful economic transformations (Diao, Hazell and Thurlow 2010).

As outlined above, a poverty alleviating role of agriculture is widely accepted in literature, and it is mostly supposed to work through a productivity growth (both factor and total productivity). According to Dao (2007), the poverty in developing countries may be reduced with increasing labor productivity growth in agriculture, as transforming countries have higher agricultural growth than urbanized economies. Irz, et al. (2001) and Lin, et al. (2001) suggest that an increase of value added to land and value added to output ratios together with a land-labor ratio significantly reduce poverty, proving a strong poverty-alleviating effect of agricultural factor productivity growth. Cervantes-Godoy and Dewbre (2010) extend the discussion and witness the poverty alleviating effect of agricultural TFP growth. The same effect, though, has not been observed in the country case of

Indonesia, where an increased agricultural performance has not been able to reduce poverty (Susilastuti 2018).

Various empirical studies, considering agricultural growth and its effect on poverty, analyze the relationship within the context of inequality. Many of those works support both inequality increasing and poverty reducing effects of productivity growth. For example, Amare, et al. (2016) estimates the heterogeneous impact of agricultural productivity on both poor and non-poor households, proving that agricultural productivity has a positive, significant impact on consumption growth, which is higher for non-poor households in Nigeria. Nevertheless, the general effect of growth on inequality can also be indeterminate (Bruno and Ravallion 1998).

To the best of our knowledge, the most relevant to the thesis papers are Galushko and von Cramon-Taubadel (2004) and Thirtle, Lin and Piesse (2003). The latter investigates a relationship between poverty and agricultural productivity growth, inequality, and other controls, proving a significant poverty-alleviating and inequality-increasing effect of partial productivity measures (VA/land and VA/labor ratios) for selected countries of Africa, Asia, and Americas. By extension to the findings in foreign country cases, former shows that due to inequality enhancing and unskilled unemployment increasing effects of agricultural TFP growth, rural poverty decreases only by 0.06% per year (for every 1% increase in TFP) in the context of Ukrainian economy of 1999-2002. Given the close relation of the above papers to the topic of this thesis, they are used as a basis for the research, while the methodology, hypotheses and data coverage involved are extended in order to find answers to the hypotheses of this thesis.

Chapter 3

METHODOLOGY

Based on the above literature review and statistics on the relationship between agricultural productivity growth, inequality, and poverty, the authors outline two main hypotheses to be investigated for the country case of Ukraine.

First, we looked at if agricultural productivity growth has a positive and significant effect on the reduction of rural poverty in Ukraine. This hypothesis finds its scientific rationale in Datt and Ravallion (1996), proving poverty to be a markedly rural phenomenon, affected by rural economic growth rather than urban. Since Ukraine falls into the category of developing countries (The United Nations 2019) with a considerable share of agriculture in national product (SSSU 2019), López (2007) and Bresciani and Valdés (2007) suggest that agricultural growth can be a significant poverty-alleviating tool. Moreover, Galushko and von Cramon-Taubadel (2004) investigated that historical data of 1999-2002 and showed a significant but low in magnitude (0.06% for every 1% increase in TFP) effect of productivity on rural poverty. Therefore, the above papers create an academic background to assume that agricultural growth continued contributing to rural poverty reduction in the years after 2002, while the magnitude and supplementary effects of productivity may differ within its recent growth context.

Second, we studied if the growth of productivity in agriculture makes a significant contribution to inequality. The second hypothesis derives from an inverted U-shape relationship between income inequality and economic growth, established by Kuznets (1955). Developing economies are associated with an upward-sloping part of the curve (Thirtle, Lin and Piesse 2003), thus the agricultural growth in

Ukraine can have an inequality-enforcing effect. The latter finds justification in a previous paper for Ukraine (Galushko and von Cramon-Taubadel 2004), as well as in peer works for other countries and world regions by Ravallion (1997) and Lin, et al. (2001).

Describing econometrics behind the methodology, it should be said that there are various approaches to analyzing the effect of agricultural growth on poverty empirically. For example, Dao (2007) uses both OLS and 3SLS estimations to arrive at the empirical findings of his paper, working with cross-sectional data. Another article by Amare, et al. (2016) is based on correlated random effects model, dealing with the panel type of data. Alternatively, Afolami, Obayelu and Vaughan (2018) apply logit regression model to the similar type of data, alternating the above approach by expressing a poverty measure in the form of a dummy variable.

Discussing the scope and the character of the analyzed in this thesis data, the authors found recursive system of fixed effects panel regressions to match the interest of rayon-level research in the most appropriate way. This decision is motivated by the fact that rayon aggregation brings time−invariant effects into the model causing an issue of endogeneity, with is controlled for with a fixed effects specification (suggested by Hausman test). Alternatively, 2SLS estimation might have been applied to the model, but the main exogenous variables of interest (productivity measures) have a low degree of correlation (0.33 the largest, see appendix B) with endogenous ones (e.g. inequality and wages, which depend on numerous factors beyond productivity), proving it to be a weak instrument. In view of this, the authors estimate a direct effect of poverty, inequality, and related supplementary indicators of rural well-being such as average wage and employment in agriculture.

The model comprises of four separate equations, three of which are specified as fixed effects panel regressions and one is designed as a fixed effects logit regression. Choice of the latter is defined by a dummy dependent variable for poverty and the need to fix for the described above time-invariant endogeneity effects. Commenting on fixed effects panel regressions, all of them take a log-log specification in order to bring variables of different magnitude to the same scale.

The specified above model choice can be justified by the use of similar methodology in the papers by Galushko and von Cramon-Taubadel (2004), as well as Thirtle, Lin and Piesse (2003) and Afolami, Obayelu and Vaughan (2018). The indicated papers also contributed to the choice of variables for the current model, while the difference between them and approach in this thesis is based on available at rayon level data and correlation-causality pattern between the variables.

We start empirical exercise from investigating the effect of productivity on supplementary indicators of rural well-being, such as rural employment and average rayon wages. These are crucial variables in a way they define personal income, thus could provide additional evidence on what stands behind the pattern of inequality and poverty developments. Then, we switch our focus to the latter variables themselves and interpret the effects of agricultural productivity on rural employment, wages, inequality and poverty altogether, allowing to produce a multifaceted academic view on inequality and poverty in rural areas of Ukraine. For the outlined purpose, we first consider fixed effects panel regressions of the below specifications.

Equation for employment:

$$AgriEmpl_{it} = \gamma_0 + \gamma_1 Prod_{it} + \gamma_2 Prod_{it-1} + \gamma_3 Prod_{it-2} + + \gamma_4 AgriWage_{it} + \gamma_5 Popul_{it} + \vartheta_{it}, \quad (1)$$

where both right- and left-hand sides are expressed in logs to bring variables of different magnitude to the same scale, t is a time subscript (year) and i is a rayon index. $AgriEmpl_{it}$ is a rayon agricultural employment variable, which is calculated as average per rayon number of employees at agricultural enterprises using a unique 50-sg firm-level dataset. Referring to what was mentioned above, agriculture tends to hire the majority of rural labor (SSSU 2019), thus agricultural employment acts as an important source of income and indicator of rural well-being. $Prod_{it,it-1,it-2}$ stand for productivity measures, estimated from a 50-sg firm-level dataset and assumed to be exogenous while affecting the level of agricultural employment. The direction of productivity's effect on employment is not clear and can be analyzed within efficiency and technological changes, as suggested by Galushko and von Cramon-Taubadel (2004). On one hand, efficiency growth can lead to a long-run expansion of production and employment of additional labor. On the other hand, extensive use of capital-intensive technologies reduces demand for labor and decreases rural employment. Mindful that no split for skilled (technology-savvy) and unskilled labor is available at rayon level, this thesis estimates an overall effect of intertemporal productivity (as much as 2 lagged productivity values) on agri-firm employment according to the above literature. $AgriWage_{it}$ is average rayon agri-firm monthly wage estimated from the 50-sg firm-level dataset. As it was mentioned above, qualified labor gets higher wages, but less of those are employed (relative to unskilled), while efficiency change entails wage increase together with employment growth (if efficiency is not related to monopolistic employment power of agricultural firms) (Thirtle, Piesse and Gouse 2005).

$Popul_{it}$ is an exogenous rayon rural population variable (from SSSU), suggested for the model by Thirtle, Lin and Piesse (2003) and expected to act as a control for employment relative to population across rayons.

Equation for real wage:

$$Wage_{it} = \alpha_0 + \alpha_1 Prod_{it} + \alpha_2 Prod_{it-1} + \alpha_3 Prod_{it-2} + \\ + \alpha_4 Popul_{it} + \alpha_5 AgriWage_{it} + \xi_{it} \quad (2)$$

where both right- and left-hand sides are expressed in logs to bring variables of different magnitude to the same scale, t is a time subscript (year) and i is a rayon index. $Wage_{it}$ is average rayon monthly wage for every rayon within the covered by thesis years, provided by SSSU. As it was mentioned above, distribution of wages is associated with efficiency and technology changes of productivity. Therefore, by this regression equation the authors intend to investigate an overall effect of agricultural productivity on rayon average wages, as well as supplementary effects of controls. In more detail, it is designed to demonstrate the contribution of agricultural growth in rayon wage development, as well as a weight of $AgriWage_{it}$ (agri-firm wages) in average rayon wages. Additionally, rayon rural population variable $Popul_{it}$ is included to check how the difference in payouts to labor is dependent on the labor resources available (no other proxy is available at the rayon level). The idea behind this equation is supported by Thirtle, Lin and Piesse (2003), where effect of productivity was estimated within the context of GDP per capita as a measure of well-being. Considering that no

GDP estimates are available, average rayon monthly wage is shown within its dependence on agricultural productivity.

Equation for inequality:

$$Gini_{it} = \delta_0 + \delta_1 Prod_{it} + \delta_2 Prod_{it-1} + \delta_3 Prod_{it-2} + \\ + \delta_4 Popul_{it} + \delta_5 AgriWage_{it} + \eta_{it} \quad (3)$$

where both right- and left-hand sides are expressed in logs to bring variables of different magnitude to the same scale, t is a time subscript (year) and i is a rayon index. $Gini_{it}$ stands for Gini inequality estimates based on within-rayon firm-level monthly wage variation and generated by authors using the firm-level dataset. In accordance to the works cited in literature review, Ukraine, falling into the group of developing countries, is presumably located on an upward-sloping part of the inverted U-shape curve describing relationship between income inequality and economic growth (Kuznets 1955). Such an assumption is confirmed by previous literature on Ukraine (Galushko and von Cramon-Taubadel 2004) so that the productivity measures in the above equations are expected to have a positive and significant effect on inequality. Following the logic of previously described regression equations, lagged productivity measures are added into the model, while their significance is to be investigated using empirical estimation procedures. In extension of the productivity measures, exogenous rayon rural population variable $Popul_{it}$ and firm-level dataset average monthly wage $AgriWage_{it}$ are used in the model to account for the effects of population size and wage level on inequality. It should be mentioned that $AgriWage_{it}$ is used here instead of exogenous rayon average wages $Wage_{it}$, because a causal effect of productivity on the latter is studied above, they cannot enter this equation together as one-hand-side variables in a system of recursive fixed effects equations, while 2SLS system is not applicable here (productivity measures have low correlation (0.33 the largest, see appendix B) with $Gini_{it}$, $Wage_{it}$, and $AgriEmpl_{it}$ making it a weak instrument) and tends to produce biased estimations. Alternatively, there are options of SUR and GMM estimation to be considered in the part of this thesis dedicated to robustness testing.

In order to measure a direct effect of productivity on poverty, the following fixed effects logit regression equation (4) is estimated:

$$Poverty_{it} = \beta_0 + \beta_1 Prod_{it} + \beta_2 Prod_{it-1} + \beta_3 Prod_{it-2} + \varepsilon_{it} \qquad (4)$$

where $Poverty_{it}$ is a binary relative poverty measure, taking a value of 1 for rayons with less than 75% of the respective oblast annual median firm-level wages and zero otherwise. Taking into consideration the results of both foreign (López 2007, Bresciani and Valdés 2007) and Ukrainian authors (Galushko and von Cramon-Taubadel 2004), the effect of productivity on relative rural poverty is expected to be positive and significant, with a possible time-lagged extension.

It is worth mentioning that the current model estimates the direct corrected for multicollinearity effect of productivity on poverty, inequality, and supplementary rural well-being indicators, while the models offered by Thirtle, Lin and Piesse

(2003) and Galushko and von Cramon-Taubadel (2004) calculate an indirect effect of productivity and omits it from the equation for poverty using 2SLS. Moreover, SUR estimation method is applied for robustness testing. In addition, the approach differs from the available literature on Ukraine by the use of poverty measure in the form of a binary dependent variable, as well a broader chronological and rayon-level coverage compared to the previous oblast-level works.

Given the fact there are numerous productivity measures available and used in the agricultural scientific practice, the authors of this thesis paper decided to take both partial and total productivity measures to model and study a possible difference in their effects. In more detail, TFP was chosen as a total productivity measure, while labor productivity (revenue per labor) and land productivity (revenue per ha) were taken as partial productivity measures. When compared, the latter usually show higher growth rates than TFP, because growth in land and labor productivity follows not only from TFP but also from involving a higher intensity of other inputs (for example, machinery or fertilizer) (International Food Policy Research Institute 2018). Namely, it could indicate how the change in relative proportion of different inputs can affect poverty (which is, basically, dependent on return to another input – labor).

In addition to the described above methodology, the current model implies a separate estimation of TFP, given the available firm-level data and calculation guidelines by Sendhil, Ramasundaram and Anbukanni (2017).

Chapter 4

DATA DESCRIPTION

The empirical analysis described above is carried out by using Ukraine-wide rayon-level data from the State Statistics Service of Ukraine, as well as a unique 50-sg firm-level dataset provided by the thesis advisor. This dataset is an unbalanced firm-level panel for all rayons of Ukraine over the period of 1995-2018, while the SSSU data are available for the years between 2000 and 2018. In view of the above, the intersection of years between 2000 and 2016 is analyzed in the thesis due to the lack of some crucial firm-level variables for 2017-2018. The above data were merged into an unbalanced panel of rayon-level single thesis dataset. As some control variables do not have observations for selected years between 2000 and 2016, a total number of observations varies across regressions. Descriptive statistics of the key model variables is provided in the Table 1 below.

Table 1. Descriptive statistics of the crucial model variables

Variable	Observations	Mean	Std. Dev	Min	Max
Firm number	8,916	17.43	10.18	1	63
Poverty	8,916	0.11	0.31	0	1
Gini	8,377	0.23	0.10	0	.95
Popul	4,850	48.23	97.25	4.15	1452.89
Wage	8,223	1.54	0.69	.26	6.23
AgriWage	8,383	0.99	5.59	0	468.42
AgriEmpl	8,916	1424.45	1427.53	0	13181
TFP	7,953	1.18	0.31	0.22	10.46
Labor Productivity	7,952	181.28	274.86	0.17	9724.32
Land Productivity	7,938	125.92	2602.11	0.01	148566.9

Source: 50-sg firm-level dataset, SSSU

Starting from the chronological coverage of data, those are almost equally divided between the years 2000-2016 with a mean of 525 observations per year, which shows the average number of rayons (all rayons and some towns of Ukraine) observed over a year. Discussing a geographic dimension, there are 603 distinct rayons and towns, data for which are available in this thesis. Those are the rayons and towns from all the regions of Ukraine apart from Kyiv, Sevastopol and Crimea, as well no observations exist for the occupied parts of Donetsk and Luhansk oblasts after 2014. For the sake of visual understanding, the rayons as they are presented for the year 2016 are plotted in a map (Appendix C) within the context of Gini coefficients (described below).

Discussing the measurement units of data, all non-population related variables are provided in monetary terms (UAH) and adjusted for inflation (2010 was used as a base year). While the thesis dataset is aggregated across rayons, the original firm-level data were expressed in per firm terms. The number of firms within one rayon varied within the range between 1 to 63, but the mean of about 17 firms per rayon gives us a reason to assume the number of firms is normally distributed across rayons with only about 7% of rayon observations having less than 3 firms reported.

In terms of the main variables of interest, those are poverty, inequality and productivity measures, separately estimated by the authors using the firm-level dataset. The *Poverty* variable is a relative poverty dummy taking the value of 1 if the average rayon firm-level monthly wage is less than 75% of the respective oblast median firm-level wages. Analyzing descriptive statistics, one could see that 11% of all rayon and town observations fall into the category of relatively poor.

To evaluate inequality, the authors estimated the rayon-level Gini coefficients, taking values from 0 (no inequality) to 1 (complete inequality), based on the variation in monthly wages of agricultural firms within each rayon for every year under study. Due to the absence of variation for the rayon observations with only one firm reported, Gini coefficients for those take the value of 0, but there are less than 5% of those in the dataset and repetitive zero estimates are controlled for by within regression estimations. It is worth mentioning that no income Gini coefficients are tracked and reported by SSSU at rayon level, those are available for oblasts only. In view of this, agricultural wage Gini coefficients estimated by the authors are used in this thesis and contribute to its the novelty. If compared, the mean values for rayon wage Ginis and oblast income Ginis (SSSU 2019) imply a great extent of proximity – 0.23 and 0.24 respectively (rayon-level outliers close to 0 and 1 are levelled off with a relatively large number of observations). Such a result is a sign of economically and statistically significant approximation of these inequality measures based on wage only and total income measures (agricultural wage serves as a good proxy of income in rural areas). Visually, the distribution of agricultural wage inequality across rayons of Ukraine for 2016 is displayed in a map of Appendix C.

Commenting on the wage variables Table 1 lists, *Wage* and *AgriWage* stand for average rayon monthly level of wages (obtained from SSSU) and average rayon agri-firm monthly wages (estimated from the firms-level data), both reported in real 2010 thousand UAH. Though there are a few outliers in the agricultural wages (related to misreporting of employee number), the mean values of the above two variables suggest that, on average, wages in agriculture are 35% lower compared to other spheres. Moreover, approximately 93% of agri-firm monthly wages lie below the mean value of 1.54 for average SSSU rayon wages. *Popul* corresponds to SSSU rural population of rayons and towns of Ukraine (in thous).

With regard to productivity measures, *Land Productivity* and *Labor Productivity* variables were estimated through dividing the firms' total revenues by the respective land (in ha) and labor (in employees) capacities available to them, then averaged within rayons according to total revenue weights. As a result, they are expressed in thousand UAH per unit of input and take non-negative values, suggesting that revenues per labor are 30% higher than those of per hectare of land used in agriculture. *TFP*, as the third measure of productivity, was calculated as a ratio of deflated individual firms' total revenues to total costs (according to Coelli, et al. 2005)., averaged within rayons according to total revenue weights. Making mention of descriptive statistics on *TFP*, it suggests that average accounting profit of agricultural firms in Ukraine is 18% (1.18 as a ratio of total revenue/total cost), while negative profit is observed in 22% of cases.

Finalizing the variable overview, the authors use lagged productivity variables (generated from the described previously real partial and total measures) in all four equations of the described in methodology recursive system of equations.

Touching upon the potential relations and effects the described variable can have in the model, the authors constructed a correlation matrix provided in Appendix B. As the table suggests, the multicollinearity issue is unlikely to affect the model results to a great extent, as the most of one-hand-side variable combinations have lower than 0.33 correlation coefficients (except for agri-firm rayon employment and average rayon wages, which are not included together into any of the recursive model's equation together). On the other hand, the low correlation serves as an argument against 2SLS estimation, but quite high (close to 0.5) correlation between agri-firm rayon employment and average rayon wages might cause correlation between the residuals of their respective equations and the need to switch from recursive system to a more technical estimation (SUR or GMM, discussed in Robustness Testing part of this thesis).

Discussing the expected signs of relationships between the variables, it is noted that that productivity measures (as well as supplementary indicators of rural well-being as agri-firm employment and wages) have low in magnitude but significant negative correlation with poverty, creating the precondition to expect poverty-reducing effect of agricultural productivity (Lin, et al. 2001). Moreover, the productivity variables have a positive association with inequality, giving the room to expect an inequality increasing effect of productivity growth. Interesting to mention, that poverty and inequality are negatively associated (low in magnitude but significant coefficient), indicating that increases of inequality might eventually lead to poverty reduction (Kuznets 1955). Speaking about the association between agri-firm rayon employment and average rayon wages, negative and relatively large correlation coefficient (-0.45) for them can be considered either as a deviation from Heckscher-Ohlin theorem (assuming agriculture to be labor-intensive) (Ohlin 1933) and monopolistic power of agricultural employers, or excess supply of labor due to technological changes in agriculture (studied in this thesis).

Referring to the potential problems of the research (described in Methodology and Robustness Testing), it is worth mentioning a lack of systematized and ordered data at different levels, such as GDP and agricultural capital investment for rayons, which motivates the use of proxies and limited rayon-level variables. Nevertheless, accounting for the great chronological coverage of the data (17 years) and the number of oblasts, variability in sizes of different variables could be controlled for and produce satisfying statistically and economically significant results.

Chapter 5

ESTIMATION RESULTS

5.1. Total Productivity Measure

Based on the described in the previous chapters theoretical and methodological background, the authors dedicate this chapter to empirical testing on the research hypotheses, starting with effects of total productivity measure (TFP) (Table 2).

Table 2. Effect of TFP on rayon agricultural employment, average wage, inequality and poverty

VARIABLES	(1) $AgriEmpl_{it}$	(2) $Wage_{it}$	(3) $Gini_{it}$	(4) $Poverty_{it}$
$Popul_{it}$	1.000***	-0.227***	-0.027	---
	(0.134)	(0.051)	(0.119)	
$AgriWage_{it}$	-0.120***	0.285***	0.149***	---
	(0.023)	(0.009)	(0.021)	
TFP_{it}	-0.186***	-0.156***	0.067**	-0.12***
	(0.036)	(0.013)	(0.032)	(0.036)
TFP_{it-1}	0.054	-0.012	0.0254	-0.003
	(0.034)	(0.013)	(0.031)	(0.043)
TFP_{it-2}	0.051	0.017	-0.008	-0.058
	(0.036)	(0.013)	(0.032)	(0.038)
Constant	3.195***	1.368***	-1.364***	---
	(0.445)	(0.17)	(0.392)	
Observations	3,316	3,290	3,267	1,843
R-squared	0.053	0.317	0.021	
Number of rayons	514	514	504	171

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Starting from the effect of TFP on agricultural employment, it is estimated to be highly significant and relatively large (0.186) with negative sign. In other words, if total productivity increases by 100%, employment at agricultural enterprises tends to decrease by almost 19%. Such a dependence can be explained within the technological effect of productivity growth – increase in productivity is defined as higher returns to agri-firm owners (TFP calculated as total revenue/total cost ratio), giving them more monetary space to introduce technological changes and replace labor with machines and other agricultural equipment. Such an employment reducing effect is consistent with Galushko and von Cramon-Taubadel (2004), who related it to unskilled labor. In more details, more of those having no knowledge to use machines or agricultural technology are replaced by fewer skilled workers operating machines. Considering the situation of extensive presence of big agricultural holdings in Ukraine (UCAB 2019), this explanation finds additional evidence and is discussed in greater detail in Conclusions and Policy Implications chapter of this thesis. Overall, the negative coefficient on TFP is in line with existing literature (Emran and Shilpi 2016).

Discussing the coefficients on control variables in equation (1), a 100% increase in rural population ($Popul_{it}$) has a one-to-one (100%) translation into agri-firm employment, proving a firm and constant share of agriculture within the structure of rural employment (given that agriculture provides the majority of working places in rural areas). The sign on $AgriWage_{it}$ is highly significant and negative (-0.12), suggesting that increase in wages is associated with drop in employment. This relationship corresponds to the above-mentioned employment effects: higher wages are distributed among qualified labor, thus it has an unskilled labor reducing effect (Galushko and von Cramon-Taubadel 2004).

Commenting on the second regression equation (2), TPF is estimated to have a negative effect on the average level of rayon wages (-22.7% for every 100% TFP increase). First of all, large TFP estimates point at higher prevalence of revenues over cost (lower labor costs for a given level of revenues), which is common to particularly efficient enterprises (or might be a sign of underpaid wages). Given this, the greater rayon average TFP level could indicate a greater extent of agricultural specialization, while wages are generally lower in agriculture across Ukraine (SSSU 2019) and bring lower rayon-average wages. Second, the above labor reducing effect of TFP boosts the supply of rural labor and then there might be an issue of monopolistic power of agricultural firms (to be discussed Conclusions and Policy Implications part), paying low wages to abundant labor. The stated above finds another evidence from the negative effect of rural population on average rayon wages, proving that the supply of abundant labor tends to bring lower wage level. Speaking about the relationship between average agri-firm wages and average rayon wages, it is noted that a 100% raise of agri-firm wages would be responsible for a 28.5% increase in rayon average wage level.

Referring to the equation for inequality (3), the growth of TFP has a positive and significant (at 5% level) effect of inequality. Although its magnitude is relatively low (100% increase in TFP raises inequality by 6.7%), the inequality enhancing effect of TFP is peculiar to developing countries and in line with Thirtle, Lin and Piesse (2003). Considering that Gini coefficients were estimated as cross-firm variation in wages inside rayons, increase of productivity levels produces changes in wage distribution. This effect is confirmed with a positive and significant coefficient on agri-firm wages, increase (or decrease) of which brings additional variance into labor payout levels.

Regression equation for poverty (4) has shown that total productivity measure (TFP) has a highly significant and impact on relative poverty – probability of rayon being considered relatively poor falls down by 12%. Given that relative poverty is defined as dummy taking 1 if average rayon agri-wage level is lower than 75% of the oblast's median, such a result demonstrates that TFP pulls rayons closer to the median agri-wage level. At the same time, supplementary well-being measures such as rayon average wages and agri-employment suffer from decrease, which points out on the importance of partial productivity measures analysis as they take an alternative approach to the firms' cost structure (show a revenue side only). As for a relatively lower number of observations used for regression (4) comparing to the previous ones, it is related to an estimation method (fixed effects logit) which omits multiple iterative outcomes within groups encountered (many rayons never switched from the "relatively poor" to "non-relatively poor" and vice versa).

5.2. Partial Productivity Measures

Having discussed the set of regressions for the recursive system of equations featuring TFP, the authors conduct empirical investigation of the effect partial productivity measures (labor and land productivity) might reveal under the same groups of dependent variables and regressors. When compared, growth in land and labor productivity follows not only from TFP but also feature changes in intensity of the key inputs, which are considered within the contest of revenue developments. The analysis of such effect starts with labor productivity and the below Table 3 exhibits fixed effects regression coefficients for the equations for agri-firm employment (5), average rayon wages (6), inequality (7) and poverty (8).

Table 3. Effect of labor productivity on rayon agricultural employment, average wage, inequality and poverty

VARIABLES	(5) $AgriEmpl_{it}$	(6) $Wage_{it}$	(7) $Gini_{it}$	(8) $Poverty_{it}$
$Popul_{it}$	0.401***	0.052	-0.096	---
	(0.116)	(0.047)	(0.109)	
$AgriWage_{it}$	-0.060**	0.287***	0.192***	---
	(0.024)	(0.009)	(0.022)	
$Labor\ Productivity_{it}$	-0.143***	0.021***	0.001	-0.055***
	(0.011)	(0.004)	(0.01)	(0.01)
$Labor\ Productivity_{it-1}$	0.002	-0.001	-0.01*	0.018
	(0.006)	(0.002)	(0.006)	(0.013)
$Labor\ Productivity_{it-2}$	0.009	0.003	0.002	-0.008
	(0.006)	(0.002)	(0.006)	(0.01)
Constant	5.851***	0.297*	-1.093***	---
	(0.407)	(0.165)	(0.379)	
Observations	3,279	3,253	3,229	1,939
R-squared	0.096	0.294	0.033	
Number of rayons	516	516	505	176

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Considering the equation for $AgriEmpl_{it}$ (5), the signs on regression coefficients are comparable to those for TFP set, while the magnitude of effects vary. It could be noticed that a negative impact of agri-wage increase on agri-firm employment is 25% less pronounced (-0.143) comparing to that of TFP system of equations (-0.186). Such a difference might find its explanation in the approaches to TFP and partial productivity measures estimation. Total productivity relates total revenues to total costs, while labor productivity is a total revenue/labor employed ratio. In more detail, labor productivity does not display the cost side of enterprise operation but reveals that greater revenues per labor are associated with higher labor efficiency and following labor reduction (intuitive connection with technological changes). In view of that, a lower employment-reducing effect of agricultural wages growth (payout to qualified labor) under labor productivity motivates a separate discussion of TFP and partial productivity outcomes within the framework of revenue-cost relationship.

Unlike the negative dependence between TFP and average rayon wages (2), higher revenues per labor of equation (6) are positively associated with overall rayon wage level growth intra-temporarily (lagged terms do not appear to be significant in FE estimations but justify their importance in Robustness Testing part of this thesis). It serves as evidence that a larger revenue side-only tends to increase average wage level across the rayons considered (efficiency changes related to expansion of existing firms and setup of new entities), while addition of cost side to TFP changes the picture (to be discussed in Conclusions and Policy Implications).

Describing the effect of labor productivity on $Gini_{it}$ (7), one could see that it is inter-temporal, low in magnitude, and significant only at 10% level (can be considered marginally significant). While TFP tends to increase inequality intra-temporarily, labor productivity might decrease inequality with lags. The possible explanation lies in a gap of wage allocation between firms (mainly livestock and crop), which redistribute additional income in different periods (livestock operate within a year, while crop producing relies on autumn grain sales). Namely, the firms increasing wages in the same period increase inequality and average wages, while those making it in the next period have a level-off effect (though it is difficult to confirm such effects due to a marginally significant coefficient on labor productivity).

Regression equation for poverty (8) notes that partial (labor) productivity measure decrease probability of rayon being considered relatively poor by 5.5%. This result suggests that labor productivity has a lower median-pulling effect on agri-wage level (compared to TFP), but the supplementary well-being measures of rayon average wages and agri-employment, as well as inequality, demonstrate a more positive for rural population dynamics. It implies that relative poverty decrease is attributed to the growth in real rural wages, which enhance an overall well-being in rural areas. As for TFP, the observed relative poverty-reducing effect might come from the contraction of real wages, bringing rayons closer to the oblast median wage level but in the direction of lower bound.

The regression set in Appendix D shows estimates for the impact of land productivity on studied measures of inequality, poverty, and supplementary rural well-being. Essentially, the direction of both partial productivity measures' effect is the same, while land productivity tends to have lower in magnitude effects across all the coefficients on productivity in the system of equations. In addition, land productivity suggests a greater reliance of rural population on agri-employment as well as a greater responsiveness of the latter to real agri-wage changes (9).

Chapter 6

ROBUSTNESS TESTING

The above recursive system of equations has been estimated through a set of fixed effects regressions, yielding the results which follow the previous literature and provide some data insights for policy implications. Nevertheless, such methodology might encounter additional econometric issues, not covered by the within-estimation techniques and discussed in this chapter of the thesis.

Fixed effects regression equations are used to control for omitted variable bias due to unobserved heterogeneity, connected with time-constant characteristics of rayons and very few variables available at rayon level of observations. Thus, the effect of total and partial productivity measures is captured through their direct inclusion into equations for inequality, poverty, and such supplementary indicators of rural well-being as average rayon wages and agri-firm employment. Unlike Thirtle, Lin and Piesse (2003) and Galushko and von Cramon-Taubadel (2004), productivity measures were not used as instrumental variables in 2SLS estimation due to their low correlation with endogenous variables of *Gini, AgriEmpl, Wage, Poverty* (Appendix B) and large SE the method leads to.

Despite a relatively low correlation (no more than 0.33) between the above variables, the correlation matrix showed close to 0.5 significant correlation between *AgriEmpl* and *Wage*, both acting as dependent variables with the same set of regressors on the right-hand side. It follows that there arises an issue of possible correlation between residuals from equations for *AgriEmpl* and *Wage*, which is empirically confirmed for the system containing TFP estimates (highly significant correlation coefficient of -0.52).

In order to control for the above correlation Kmenta (1997) suggests the use of seemingly unrelated regression model, taking the form of unbalanced panel data in case of this thesis. Dealing with such data, Nguyen (2008) justifies application of -XTSUR- function in Stata, which is tailored for random effects. Given this, the current data were demeaned for each rayon observed to allow for RE estimation within the FE dataset. The obtained SUR estimation results are displated in Table 4 below.

Table 4. SUR estimation for the effect of TFP on rayon agricultural employment, average wage, inequality and poverty

VARIABLES	(13) $AgriEmpl_{it}$	(14) $Wage_{it}$	(15) $Gini_{it}$	(16) $Poverty_{it}$
$Popul_{it}$	0.792***	0.137	-0.247*	-0.584***
	(0.078)	(0.147)	(0.139)	(0.175)
$AgriWage_{it}$	-0.593***	0.474***	0.238***	-0.263***
	(0.013)	(0.017)	(0.018)	(0.022)
TFP_{it}	-0.402***	-0.063'	-0.017	-0.087**
	(0.019)	(0.040)	(0.037)	(0.043)
TFP_{it-1}	-0.025	0.057	0.090**	0.011
	(0.019)	(0.040)	(0.036)	(0.045)
TFP_{it-2}	0.009	-0.006	0.127***	-0.029
	(0.020)	(0.043)	(0.040)	(0.049)
Observations	3,244	3,244	3,244	3,244

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1, 'p<0.12

Looking at the table above one would notice that signs on TFP coefficients are in line with those of FE estimation but their magnitude can differ in view of another approach to estimation. Namely, an employment-reducing effect of TFP more than doubles in magnitude (13), while its wage-decreasing impact halves and becomes marginally significant (14). Regarding eqution 15, SUR suggests that 100% change in TFP would yield an 21.7% inter-temporal increase in inquality, compared to 6.7% in a FE model. Switching to poverty, TFP growth of 100% would decrease the probability of listing a rayon into the group of "relatively poor" by 8.7%, compared to 12% of that of FE.

In view of the above results, application of SUR confirms robust directions of the effects TFP has on the four variables of interest. Inequality-enhancing and poverty-decreasing effects of TFP are observed within the context of highly significant labor-reducing and less significant real wage-contracting effects.

In extension of TFP, SUR specification was employed to test the robustness of results for partitial (labor) productivy effects and reported in Table 5 below.

Table 5. SUR estimation for the effect of Labor Productivity on rayon agricultural employment, average wage, inequality and poverty

VARIABLES	(17) $AgriEmp$	(18) $Wage_{it}$	(19) $Gini_{it}$	(20) $Poverty_{it}$
$Popul_{it}$	-0.020	0.370**	-0.132	-0.023
	(0.142)	(0.174)	(0.183)	(0.10)
$AgriWage_{it}$	-0.407***	0.367***	0.263***	-0.186***
	(0.023)	(0.031)	(0.033)	(0.017)
$Labor\ Productivity_{it}$	-0.229***	0.040***	0.040***	0.007
	(0.011)	(0.012)	(0.012)	(0.006)
$Labor\ Productivity_{it-1}$	-0.008	-0.001	-0.001	0.008**
	(0.006)	(0.006)	(0.006)	(0.003)
$Labor\ Productivity_{it-2}$	-0.008	0.001	0.034***	-0.009***
	(0.006)	(0.006)	(0.007)	(0.003)
Observations	3,206	3,206	3,206	3,206

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Analyzing the table, it is possible to notice coherent with FE signs for effects of labor productvity on agricultural employment (17) and rayon average real wage (18), while those of SUR are larger in magnitude (absolute). The effect on inequality, which changes from marginally significant for FE to highly significant inter-temporarily in SUR. Thus, a 100% increase in revenues per labor would raise inequality by 7.4% across two lagged periods, which is connected to real wage increase and its redistribution through several periods for different agricultural firms. In term of effect on poverty, SUR estimates it to be highly significant but low in magnitude and span across several reriods. The different in signs of inter-temporal effects might derive from lagged response in firm-level wage distribution schemes (as it was discussed in the chapters above).

According to robustness testing (and FE estimation), inequality-enhancing and poverty-decreasing effects of land productivity are confirmed within the context of highly significant labor-reducing (but twice less negative than that of TFP) and real wage-enhancing (comparing to labor-reducing of TFP) effects. This difference gives room for additional investigation and discussion of policy implications based on revenue-cost pattern of agri-firm development and its effect on reduction of rural poverty and inequality in Ukraine.

Referring to alternative models, generalized method of moments (GMM) is suggented to deal with the problem of dimensional mismatch, when the panel dataset has a short time dimension (T=17) and a larger rayon dimension (N=603) (Mileva 2007). Also, GMM allows inclusion of lagged dependent variables as regressors, but involves the use of IVs, while low correlation with endogenous variables indicates potential weakness of productivity measures as IVs. Taking account of the above reasons, SUR was chosen for robustness checking, while there exists academic room for GMM application.

Chapter 7

CONCLUSIONS AND POLICY IMPLICATIONS

7.1. Conclusions

Having conducted this thesis and studied the effect of agricultural productivity, the authors managed to confirm two hypotheses set for the research.

First, agricultural productivity growth has a positive and significant effect on the reduction of rural poverty in Ukraine. The authors showed that both partial and total productivity growth yield a reduction in the level of relative rural poverty. Such a poverty reducing effect, though, is based on different developments in supplementary rural well-being indicators such as average real rayon wages and agri-firm employment. Partial productivity measures tend to decrease relative poverty through increasing the density of wages paid to labor in an upward direction, while the cost-reduction based total productivity growth contracts relative poverty through a downward pressure on average real wage density within oblasts. Moreover, comparing partial and total productivity measures, the latter suggests having twice as large labor-reducing effect as the former (according to SUR). While the direct effect of employment on rural inequality and poverty in Ukraine is not measured, it could become subject to further potential research.

Second, the growth of productivity in agriculture makes a significant contribution to the increase of inequality. The thesis confirms it through, basically, the same mechanism of wage effects as for poverty. Investigation of both inequality and poverty effects pointed out on the necessity of additional analysis of agri-firm revenue-cost structure and the role of labor and land factor owners in it.

7.2. Policy Implications

Considering that this thesis identified differences in the effects of revenue-cost patterns across agricultural enterprises, relevant policy implications could be drawn from analysis of both total and partial measures of productivity. The latter are associated with a gradual decrease in rural employment due to technological changes but raise an overall payout to labor with expansion of production and creation of fewer jobs with a growing overall income level. As for inequality and poverty effects, an increase in the first is relatively low in magnitude and associated with an upward change in wages, while relative poverty decreases due to the same reason. Therefore, an increase in revenues per unit of input employed serves as a good precondition to improvements in rural well-being.

Accounting for the cost side of firms' performance, TFP provides the estimates diverging from those of partial productivity measures. In particular, TFP growth decreases average rayon wage level and has a greater in magnitude negative effect on other variables of interest. The observed discrepancy is attributed to by a magnitude of difference between revenues and costs, meaning that a larger gap in revenue-cost relationship contributes to an overall decrease in rayon wages, reduction of agricultural employment, and drop of inequality and relative poverty, caused by downward change in wages. Thus, an abnormal (revenues several times higher than costs) dominance of revenues over costs might be is a sign of insufficient payments to factor owners (rural labor and its land as inputs).

Referring to official statistics on labor costs as a share of total agricultural costs, during 2000-2016 it has decreased to the value of 5.5% in 2016 (SSSU), while in the USA labor costs as a share of total farm revenues (not even total costs) was about 10% in the same year (USDA 2020). Moreover, labor costs could amount for about 20-30% of total costs in agriculture of selected European countries (Institut der deutschen Wirtschaft Köln 2013). Also, land cost accounted for only 10% of total agri-expenses in 2016, while in the USA it can reach as much as 30% in crop production (e.g. corn, common for Ukraine) (Plastina 2019). The situation was not much different in 2018, with 5.7% and 9.9% of total agri-costs designed for labor and land respectively (SSSU), with the evidence of low rental payments is studied by Ukrainian scholars (Nivievskyi, Nizalov and Kubakh 2016).

Taking notice of the above arguments, there might be a need of implementing policy instruments aimed at the increase of payments to agricultural labor (gain in the fraction of total costs spent for wages and transfers to labor). In particular, it is related to labor cost split between different economic spheres and growth in agricultural wages to the economy average (in 2020 agricultural wages are still 20% below it, according to SSSU). Thus, the thesis motivates the governmental review of production costs and their distribution policies in agriculture.

At the level agricultural enterprises, it would be reasonable to increase motivation of employees to a more productive work through a closer relation between generated revenues and payments to labor, as well as owners of other factor inputs such as land. For this purpose, there could arise additional mechanisms of agricultural wage regulation such as trade unions of agricultural workers or councils of agricultural producers. On top of that, there might be a need of employment projects for laid-off or unemployed rural labor, which have to be coordinated with the recent market adjustments and developments in wages of agricultural labor due to an outflow of labor force in urban areas and abroad.

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APPENDIX A

STRUCTURE OF RURAL HOUSEHOLDS' RESOURCES BY CATEGORY (%), 2010-2018

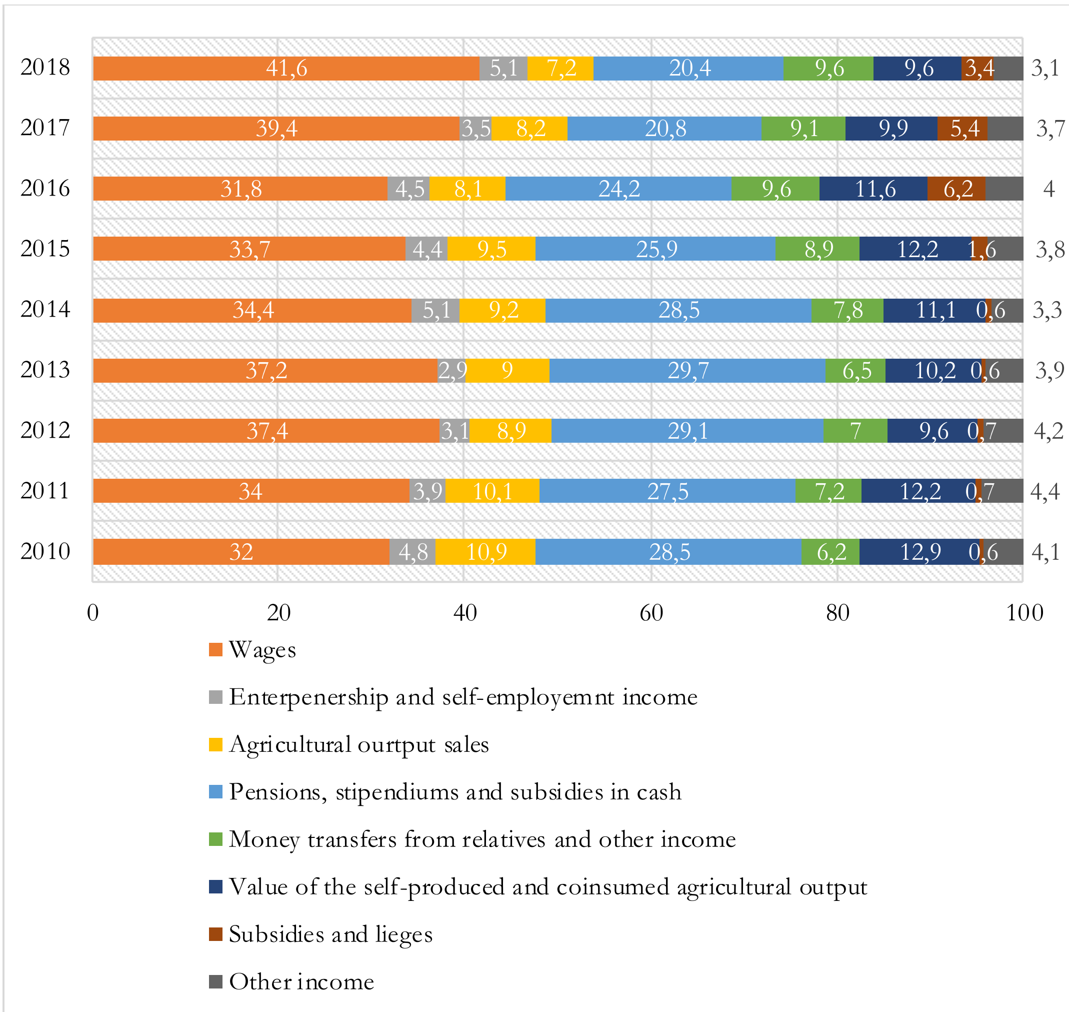

Figure 2. Structure of rural households' resources by category (%), 2010-2018
Source: SSSU

APPENDIX B

CORRELATION MATRIX FOR THE KEY MODEL VARIABLES

Table 6. Structure of rural households' resources by category (%), 2010-2018

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Poverty	1.00								
(2) Gini	-0.06***	1.00							
(3) Popul	0.05***	-0.02	1.00						
(4) Wage	0.017	-0.08***	0.24***	1.00					
(5) AgriWage	-0.03***	0.1***	0.09***	0.07***	1.00				
(6) AgriEmpl	-0.17***	0.1***	0.04***	-0.45***	-0.04***	1.00			
(7) TFP	-0.15***	0.06***	-0.06***	0.13***	0.05***	0.01	1.00		
(8) Labor Productivity	-0.08***	0.1***	0.001	0.33***	0.03***	-0.18***	0.29***	1.00	
(9) Land Productivity	-0.01	0.01	0.001	0.03***	0.001	0.01	0.02	0.04***	1.00

Source: 50-sg firm-level dataset, SSSU

APPENDIX C

DISTRIBUTION OF AGRICULTURAL WAGE INEQUALITY IN UKRAINE

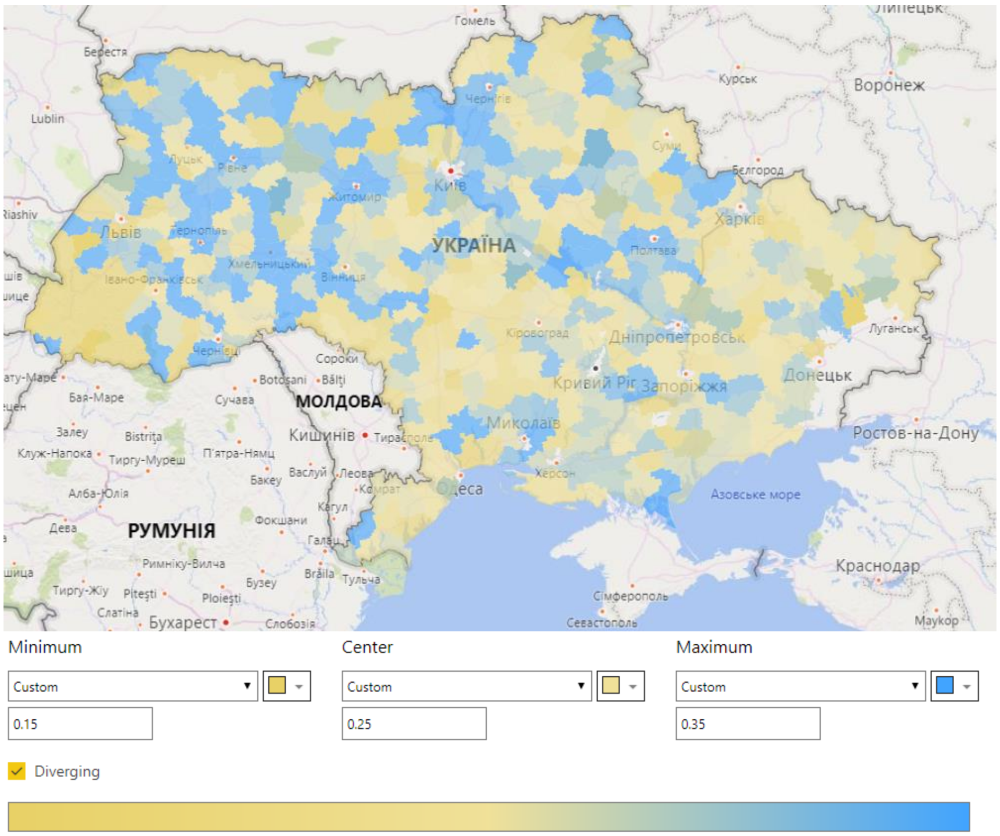

Figure 3. Distribution of agricultural wage inequality (Gini) across rayons of Ukraine* in 2016

Note: *Occupied parts of Eastern Ukraine after 2014 and Crimea not included

APPENDIX D

EFFECT OF LAND PRODUCTIVITY ON THE STUDIED MEASURES OF RURAL WELL-BEING

Table 7. Effect of land productivity on rayon agricultural employment, average wage, inequality and poverty

VARIABLES	(9) $AgriEmpl_{it}$	(10) $Wage_{it}$	(11) $Gini_{it}$	(12) $Poverty_{it}$
$Popul_{it}$	0.779***	0.033	-0.093	---
	(0.116)	(0.046)	(0.105)	
$AgriWage_{it}$	-0.140***	0.294***	0.191***	---
	(0.023)	(0.009)	(0.021)	
$Land\ Productivity_{it}$	-0.013*	0.017***	0.002	-0.043***
	(0.007)	(0.003)	(0.006)	(0.014)
$Land\ Productivity_{it-1}$	0.002	-0.001	-0.009*	0.030**
	(0.006)	(0.002)	(0.005)	(0.014)
Constant	3.953***	0.445***	-1.126***	---
	(0.385)	(0.152)	(0.347)	
Observations	3,268	3,242	3,219	1,923
R-squared	0.041	0.297	0.034	
Number of rayons	515	515	504	175

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1