Effect of Public Subsidies on Productivity of Crop Producing Farms in Ukraine – A Farm-level Difference-in-differences Analysis

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Abstract

The paper investigates the effect of two types of public support measures, production-related subsidies and value added tax (VAT) reimbursements, on productivity of crop production in Ukraine. The analysis is carried out by means of production function difference-in-differences (fixed effects regression) approach using data provided by the State Statistic Service of Ukraine (SSSU) for the time period of 2008-2013. The public support effect is analyzed from different perspectives considering (i) potential differences related to two farm structural characteristics - holding membership and size, and (ii) time-variability. The results indicate that the relationships between both subsidies and VAT reimbursements and farm productivity statistically significantly vary across time periods and farm types. For non-holding farms in general, an increase in the volume of subsidies is found to statistically significantly increase farm productivity. However, entering subsidization is found to have a negative relation to farm productivity. The latter result may imply uncontrolled-for policy selection of farms in greater need for public support. The level of VAT-reimbursements is also found to be statistically significantly and positively related to farm productivity; this result is driven by VAT-reimbursements' productivity impact mainly in the earlier years of the analyzed period. For holding companies, public support effects on farm productivity are found not statistically significant in models on pooled data (over time or only inconsistently statistically significant in some years.

Keywords: **difference-in-differences analysis, production function, subsidies, state support, agriculture**

1 Introduction

Production economists suggest that the effects of different types of public support on productivity of agricultural production may be ambiguous. Several studies indicate that, apart from inevitable market distortions brought about by public subsidies, state support may also reduce farmers' incentives and change their risk attitudes, thus leading to a reduction of technical efficiency (Serra et al., 2008). Others find a positive effect of subsidies on productivity through improved investment capacity of farmers (e.g. Zhu and Oude Lansink, 2010). There are also studies suggesting that subsidies may have no effect on productivity, for example, when productivity improvement is not the primary goal of support policies (Minviel and Latruffe, 2016). Generally, these research results pose further questions about the effectiveness of public support in achieving productivity objectives.

This debate is part of a broader controversy associated with the special role of agriculture in the economic system. Nowadays agriculture enjoys countless privileges not only in the context of agricultural policies but also in the tax, social security and other areas of public policy. Sometimes even special legal provisions apply within the agricultural sector, such as the demarcation of facilities for commercial livestock or the distinction between legal forms of farming (Balmann et al., 2016).

The discussion on reasonability of the privileges is particularly intensive in transition economies such as Kazakhstan, Russia, and Ukraine where agricultural policies are partly responsible for the development of dualistic structures of agricultural production (Gagalyuk, 2017). On the one hand, one can observe the persistence of small-scale subsistence farms specialized in production of milk, eggs, fruit and vegetables. On the other hand, corporate farms specialized in cash crops such as wheat, maize, soybeans, sunflower seeds, rapeseeds and others are rapidly growing. The latter, i.e. corporate farms are often consolidated in the form of the so-called agroholdings – dozens and

hundreds of agricultural enterprises that are coordinated by a mother company and are increasingly considered as more efficient than non-agroholding corporate farms or family farms, especially due to improved access to finance and technologies (Balmann et al., 2013). To this effect, these agroholdings are often among the main recipients of public support, subsidies and tax exemptions (Gagalyuk, 2017).

The motivation for implementation of such policies is to a great extent coherent with self-sufficiency objectives, growing export-orientation and productivity improvements in agriculture of Post-Soviet economies (Rhoe et al., 2008; Nivyevskyi et al., 2015). However, positive productivity effects may be also attributable to a number of other important factors such as enterprise investment growth, organizational transformation, improvement of infrastructure, trade liberalization, etc. (Osborne and Trueblood, 2002). Thus, also against the background of productivity growth, the issue of effectiveness (and efficiency) of public support remains relevant with regard to the following questions: (i) What is the actual effect of support on productivity of agricultural production? (ii) What is the effect of different types of subsidization, i.e. product-specific payments and non-product-specific tax exemptions/refunds? (iii) Does the effect of state support differ between various size and organizational forms of agricultural producers and how? In particular, who are the winners and who are the losers of specific types of public support and under which circumstances?

In order to answer these questions, we conduct ex-post policy impact analysis using 2008-2013 farm-level data from Ukraine and production function difference-in-differences (fixed effect regression) approach. Our model controls for the effects of product-specific subsidies and non-product-specific value added tax refunds on total factor productivity (TFP) of agricultural enterprises over time and considers groups of enterprises by their size and organizational form (i.e. non-agroholding enterprises and agroholding enterprises).

The paper is structured as follows. First, we provide some background information on public support of agricultural production in Ukraine. Then, we describe the data and methodology and follow with presentation of the results of difference-in-differences analysis. The last section discusses the main findings and makes some conclusions.

2 Public support and development of agricultural production in Ukraine

Agricultural policy and public support of agriculture in Ukraine

Agricultural policy making has proved to be a volatile and difficult process in Ukraine (Lerman et al., 2007; World Bank, 2013). Throughout the 1990s it was characterized by ad hoc government intervention in agricultural production, marketing and finance, hindering land and farm reform. Agricultural exports were subject to quotas and licensing through 1996 and state grain procurement survived through 1997 (von Cramon-Taubadel and Zorya, 2001; Sedik et al., 2000). Even after 1997, neither internal nor foreign trade was liberalized. Indicative and recommended prices (minimum export prices) were set by the government for many commodities. Local regional authorities restricted commodity trade by banning sales of commodities to other regions until local commodity quotas had been filled. Large farm enterprises continued to receive state rationed or state guaranteed credits against commodity deliveries (cf. Lerman et al., 2007). When farms fell into heavy debt, debt repayment was used as a justification for expropriation of agricultural commodity stocks (Sedik, 2004).

Beginning in 1999-2000, in parallel with the second wave of land and farm reform that reallocated land use rights from collectives to individuals, Ukrainian agricultural policy underwent a transformation that seemed to pave the way for a new policy regime (OECD, 2003). Indeed, there was a significant improvement in trade policies, particularly for exports, increasing the competitiveness of Ukrainian agricultural products. The government significantly reduced its role in

farm finance, agricultural input supply and grain marketing, thus reducing the inherent inefficiencies of government controlled input supply and marketing systems. By 2002, the predominant form of government finance for the purchase of farm inputs became subsidized interest rates. Further legislation in 2000 transferred the responsibility for social sphere functions from farm enterprises to local governments. The agribusiness privatization program that had been largely completed between 1994 and 1999 began to yield results in terms of increased efficiencies in marketing and input supply chains. For the first time in many years the terms of trade in agriculture, i.e., the index of real agricultural output prices relative to agricultural input prices, increased by 18% in 2000 (Lerman et al., 2007).

Since the reforms implemented in the 1990s failed to produce the expected improvements in agricultural productivity and efficiency, the new wave of agricultural reform began with Presidential Decree of December 1999 (Decree, 1999). The Decree essentially declared that collective agricultural enterprises (CAEs), based on collective land ownership, were incompatible with free market conditions and had to be reorganized into market-compliant forms based on private land ownership: peasant (family) farms and corporate farms (von Cramon-Taubadel and Zorya, 2001).

The reform achieved some very important results for rural residents. First, nearly 7 million rural residents became owners of physical land plots, while Ukraine evolved from exclusive state ownership of land in 1990 through a mix of state and collective ownership in 1993-95 and to a mix of state and private land ownership in 2000-05. Second, the reform provided an important source of income for rural residents, as landowners earn from renting out their land plots to corporate farms (Lerman et al., 2007). Third, the new Land Code, passed in 2001, recognized private land ownership, allowed certain land transactions and eliminated size restrictions for household plots and peasant/family farms. Nevertheless, the moratorium on buying and selling of land has been retained until January 2008 and then prolonged each year until present times. The new Land Code also banned inclusion of agricultural land in the equity capital of newly created businesses – a precautionary measure to counter pressure from farm managers on landowners to transfer their land to a corporate farm, thereby losing legal rights to it. However, the Land Code did not limit the lease term while very long-term leases led to a de facto absorption of land in the corporate equity (OECD, 2003). As a result, huge agroholdings emerged as an important player in the Ukrainian agricultural and land markets (UCAB, 2012).

These profound changes still give no opportunity to consider Ukrainian agricultural policy as reliable and consistent, primarily due to an incomplete land reform (World Bank, 2013) as well as due to authorizing interventions, licensing and quotas at the grain market, e.g. in 2003, 2007, and 2011 (von Cramon-Taubadel, 2003; Nivyevskyi et al., 2015). Furthermore, the government has to act with a careful eye to the public support of agricultural production in order to comply with the WTO rules.

Public support of agriculture in Ukraine is regulated by the Law "On State Support of Agriculture in Ukraine" (No. 1877-IV of June 24, 2004), defining most of the instruments and programs of agricultural support. The public support in general is characterized by modest levels of public expenditures and generous tax benefits. Tax benefits made almost 90% in the total transfers to farmers in 2011-2012. The reason behind this structure is that, according to the WTO which Ukraine entered in 2008, the level of product-specific support must not exceed UAH 3.043 billion annually as per WTO Bound Total Aggregate Measurement of Support (Kobuta et al., 2015). At the same time, non-product-specific support, including preferential taxation, may be exercised up to the level of *de minimis* 5% of gross agricultural production. If it exceeds this threshold, then in the next Ukraine-WTO notification round it should be formally included in the abovementioned aggregate measure of support. Thus, together with the other, product-specific types of support, tax benefits should not exceed UAH 3.043 billion in total (WTO, 2014). This is a tiny figure if one considers the

UAH exchange rate as well as the volumes of public support e.g. in the EU. Hence, of all types of public support of agricultural production in Ukraine, only preferential taxation can be extensively used unless it reaches the *de minimis* level.

Although the law provides for the possibility to choose between a general taxation regime and a preferential tax regime, most agricultural producers in Ukraine chose second option (see Table 1 for detailed description of the preferential taxation regime). These tax benefits generally accrue from two sources: a fixed (flat) agricultural tax (Verkhovna Rada of Ukraine, 1999b) and a special value-added tax (VAT) regime in agriculture (Verkhovna Rada of Ukraine, 1999a). The fixed agricultural tax (FAT) is a flat rate tax that replaces a number of taxes and duties, including profit and land taxes. Its rate varies from 0.09% to 1.00% of the normative monetary value of farmland (as assessed by the State Service of Ukraine for Geodesy, Cartography & Cadaster). In 2012, the FAT resulted in an average tax payment of only roughly 0.8 USD/ha of arable land, leaving farm profits in Ukraine essentially untaxed. As far as VAT is concerned, farmers retain the VAT from their sales to recover VAT on inputs and for any other production purposes. In 2012, the benefits from the VAT accounted for USD 1.4 billion (ca. 9% to farms' receipts from agricultural product sales) (Nivyevskyi et al., 2015).

According to Ukrainian budget plan in agriculture, financing of public services, institutions and infrastructure dominates the public expenditures (without tax benefits) since 2009, being at almost 63% of the expenditures in 2012. The rest is attributable to sub-sector, i.e. product-specific (field crops, pigs, cattle) direct payments to farmers, primarily through payments based on area, animal numbers or output as well as a large concessional credit program1. The budgeting and timing of public expenditures, however, remains ad hoc and undermines trust in the government. The state support programs are considerably underfinanced in Ukraine. The gap between the planned and actual public expenditures has been widening over the last years. Moreover, the rules for public funds allocation under different support programs are usually approved on an annual basis and are often changed from one year to another (Nivyevskyi et al., 2015). See Table 2 and Figure 2 for more information on public support of agriculture.

Overall, the public support in Ukraine as a percentage of farm receipts has been lower than in other countries. The total transfers to farmers were almost 8% of their receipts in 2010-12, while they were 12% in OECD area in the same period. At the same time, Ukrainian farmers receive larger transfers as a percentage of the GDP than their OECD counterparts, i.e. 1.62% in Ukraine compared to 0.34% in OECD countries in 2010-12 (OECD, 2013).

Structural development of agriculture in Ukraine

The share of agriculture in the GDP of Ukraine is at the level of 10%. At the same time, the share of economically active population involved in agricultural production has remained at the level of 17% over the last decade (SSSU, 2015). Despite its role in the national economy, Ukrainian agriculture has been subject to a downturn in 1990's and is currently recovering to the pre-reform levels (Figure 1). In 2000-2013, i.e. after the new wave of agricultural policy reforms started, Ukrainian agriculture has experienced 67% growth of gross agricultural output (GAO). Animal production was particularly affected as a capital-intensive sector with longer return periods. As a result, the structure of agricultural production in Ukraine has substantially changed over the last two decades. While in 1990, animal production and crop production equally contributed to the GAO, in 2014, animal production accounted for only 30% of the GAO (SSSU, 2015).

[1] In subsequent sections, our paper employs a model that incorporates a single variable for the total of direct payments/subsidies irrespective of the type of a subsidy included. Thus, our model generally distinguishes between two types of public support and respectively contains two variables representing this support: subsidies (i.e. direct payments) and VAT regime (i.e. "indirect" support).

The GAO in Ukraine is generated by two groups of producers, i.e. agricultural enterprises and households. Agricultural enterprises, consisting of agroholding corporate farms, non-agroholding corporate farms, and peasant/family farms, dominate the crop production sector whereas rural households produce the major part of animal production in Ukraine (Table 3).

There are more than 4 million small households (having 2.8 ha of land each on average), producing food primarily for subsistence needs, but managing 38% of the Ukraine's total agricultural land and accounting for nearly 45% of the country's GAO. Households dominate the production of the entire range of livestock products. However, the share of households has been shrinking due to the recovery of output of agricultural enterprises. Households also prevail in the production of potatoes, vegetables and fruits. The rest of agricultural output is generated mainly by private agricultural enterprises, since the state-owned agricultural enterprises generate only about 1% of the GAO (Nivyevskyi et al., 2015).

Private agricultural enterprises are represented by two general organizational types in Ukraine: corporate farms and peasant farms. These farms, unlike households, are registered legal entities. There are about 14 thousand corporate farms (mainly the successors of the former kolkhozes and sovkhozes), cultivating about 956 ha of arable land on average and generating 46% of the GAO. There are also about 40 thousand much smaller peasant farms (mainly run by individual farmers) with an average of 105 ha of arable land each, altogether cultivating only about 13% of Ukraine's arable land and generating 8% of the total GAO (ibid.).

In this paper we present the results of corporate farms analysis as (i) peasant farms are not the objects of direct state support and VAT reimbursement; (ii) agricultural enterprises play a leading role in the cultivation of export-oriented crops. For example, they produced 79% of grains, 85% of sunflower seeds, 98% of rapeseeds and 84% of sugar beets in 2013. Peasant farms mainly produce crops rather than livestock, accounting for about 12% of the total grains, 5.6% of sugar beets, 19% of sunflower seeds, 15.5% of soybeans and 18% of rapeseeds, but only 2.6% of the total meat and 1.4% of raw milk produced in 2013.Unlike corporate farms, peasant farms produce agricultural goods mainly for self-consumption. However, despite peasant farms employ the same cropping patterns as corporate farms, yet they produce at similar or lower rates of intensity (ibid.).

Over the last decade, Ukrainian agriculture has been facing the process of land consolidation that has led to the emergence of large, vertically-oriented agroholdings. A large number of the abovementioned corporate (and sometimes even peasant) farms are coming under the control of agroholdings. These agroholdings usually consist of a mother company that, in most cases, is not involved in primary agricultural production but decides on overall strategy, production orientation and investments, and manages access to production factors, including inputs, land and finance, as well as marketing and sales. Such a mother company is typically "holding" a few dozens of individual corporate farms cultivating mostly between 2,000 and 15,000 ha, with the total size of an agroholding varying from 10,000 ha to more than 500,000 ha. The accumulation of these impressive farmland areas is the most visible and publicly discussed feature of agroholdings. In 2014, agroholdings farmed about 6 million ha of agricultural land in Ukraine or 27% of the total area in the use of agricultural enterprises. These super large farms produced about 21% of the GAO, including 18.7% of the total crop output and 24.8% of the total livestock output in 2012 (UCAB, 2014).

Additionally, agroholdings mark the development of export-oriented agriculture that has made Ukraine one of the leading global exporters of cash crops and plant oils (Figure 3). The share of agriculture in total exports increased from 9.8% to 26.3% in 2004-2013. After the country entered WTO in 2008 and had to abandon a substantial portion of subsidies, total agricultural exports continued to grow annually by an average of 17.8% in 2009-2013 (Nivyevskyi et al., 2015).

Growing global demand for food and integration into the world markets have made agriculture a profitable business in Ukraine, even in spite of low volumes of foreign direct investment and limited access to capital. However, high price potential often cannot be tapped by Ukrainian agricultural producers due to increasing production costs. The total cost of agricultural production has been continuously growing in the last years, thus reducing the profitability potentials (Table 4).

In the context of private investments in agriculture, both domestic and foreign investments have increased over the last decade, although agricultural investments as a share of total foreign direct investments (FDI) remains very low – 1.3% (SSSU, 2015). The share of agriculture in domestic capital investments increased from 5.1% in 2007 to 8.6% in 2014 but, in absolute terms, it decreased by some USD 300 million. European countries represent the main source of FDI while investors from China and the Gulf countries are also starting to invest in the sector (OECD, 2015).

Publicly listed agroholdings are another important source of foreign investments in Ukrainian agriculture. Because agroholdings enjoy larger economies of size, they normally have better access to external capital sources. In total, 21 Ukrainian agroholdings have been listed on international stock exchanges from 2005 until present. However, most of the initial public offerings (IPOs) have been made before 2012 because the pricing situation has considerably worsened afterwards due to an ongoing crisis and high country risk of Ukraine. In total, the IPOs helped to raise about $6 billion of additional investments (Gagalyuk 2017).

Overall, access of agricultural producers to finance remains limited in Ukraine, especially for small and medium enterprises. As the banking sector represents 95% of the assets of the financial sector, large input suppliers, producers, retailers and exporters most often use bank loans to access finance, although high and volatile interest rates and the lack of information on borrowers' creditworthiness hinder the growth of bank lending (UCAB, 2015).

Summarizing, the agricultural sector of Ukraine was able to capitalize on upward global trends such as growing demand for food and feed despite inconsequent domestic policies and imperfect factor markets. A full-fledged land market is still absent. Preferential taxation is the major type of public support of agricultural production whereas the use of direct subsidies is substantially limited by the WTO rules and the targets of direct support are changing almost every year. Despite relatively high profitability of (crop) production, corporate farms are constantly dependent on outside capital that is difficult to access due to risky business environment. In this context, the current paper attempts to explore how Ukrainian corporate farms manage to divert the existing public support and available resources into productivity returns. Beside implications for farm management, this analysis aims to provide insights into the effectiveness of implemented policies.

3 Data and Methods

The study is based on farm-level accounting data provided by State Statistic Service of Ukraine (SSSU) for the time period of 2008-2013. It includes data on private agricultural enterprises of various legal forms; very small private farms are, however, in this sample underrepresented. Nevertheless, this sample covers 18.2-18.7 million hectares of agricultural land (86-92% of agricultural land used by agricultural enterprises/legal entities).

We focus our analysis on crop-specialized farms defined as farms with crop production value share in total production value greater than 90% (average specialization rate of farms in the sample is 99%). The dataset then consists of total of 28,519 observations on 4,753 agricultural companies specialized in crop production (balanced panel)[2].

[2] These observation numbers refer to dataset size after data cleaning. Rigorous data cleaning procedure was applied to eliminate observations with missing values and outliers using a set of threshold values of production input-input and input-output ratio indicators. Two standard data cleaning procedures were combined in order to obtain a suitable and

The data further provides unique information on whether a farm is integrated in an agroholding. Agroholding farms represent 7% of the total number of farms in the samples (the same share when compared to the uncleaned sample in total).

Production function difference-in-differences approach (with fixed effects)

Our study represents a quantitative ex-post policy impact analysis. Such analyses are potentially challenged by sample selection that (uncontrolled for) can lead to parameter estimation bias. Sample selection problem refers in this case to the expectation that farms eligible for or farms applying for public subsidy are unlikely random. We employ a difference-in-differences longitudinal data (fixed-effect) estimator to control for the possible sample selection effect and to isolate the subsidy-related treatment effect. In the fixed-effect models, the selection bias is "swept out" by eliminating the influence of time-invariant observed and unobserved heterogeneity in the observation units (Petrick and Zier, 2011), in our case farms. Although this approach requires specification of functional form of the relationship between the treatment and outcome variables, it allows analyzing effects of various subsidy measures simultaneously and in continuous value terms. Alternative approaches, for example non-parametric treatment effect (propensity score matching) methods that do not suffer from the possible bias of functional misspecification, are restricted to investigating individual policy measures in binary form and in isolation.

We specify the panel production function with policy treatment effects as follows:

$$y_{it} = \beta x_{it} + \gamma z_{it} + \delta s_{it-l} + \alpha_i + \mu_t + \varepsilon_{it} \quad (1)$$

where y_{it} denotes (natural logarithm of) the total production volume of a farm i in time t, where t = 1, 2, …T, x_{it} is a vector of (natural logarithms of) input variables, z_{it} is a vector of other control variables, and s_{it-l} denotes a vector of (natural logarithms of) state support volume, in our case direct support and VAT discount or reimbursements (indirect support) in time t-l, where t is as defined above and l = 0, 1, 2. We estimate several specifications of the model varying in mathematical form of the production function (Cobb-Douglas and translog) and with regard to the assumption on s_{it-l} to allow for the possibility of delayed state support effects or time and farm-size variations in the state support effects. The general model specification in equation (1) further includes latent, firm-level fixed effects α_i, that could be correlated with variables in vector x and z; μ_t that denotes macroeconomic, political or (general) time effects that impact all observations at time t equally; and ε_{it} that captures identically and independently distributed (i.i.d.) error term (Blundell and MaCurdy, 1999). By specifying the core regression as a production function, δ represent subsidy-related shifts in the production level holding the levels of all inputs constant. The analyzed treatment outcome can thus be interpreted as *total factor productivity* (TFP).

For the δ parameter to become "difference-in-differences" estimator of the treatment effect, the model specification in (1) is transformed by differencing each observation from group mean resulting in

$$y_{it} - \bar{y}_i = \beta(x_{it} - \bar{x}_i) + \gamma(z_{it} - \bar{z}_i) + \delta(s_{it-l} - \bar{s}_i) + (\mu_t - \mu) + (\varepsilon_{it} - \bar{\varepsilon}_i) \quad (2)$$

This fixed-effect model specification eliminates observable and unobservable time-invariant farm heterogeneity that could be correlated with x, s, and z. It thus allows us to estimate the effects of the farm heterogeneity-unrelated changes in the levels of observable variables over time. Given the inclusion of the fixed effects into the regression model, the state support variables in vector s are assumed exogenous (Besley and Case, 2000; Petrick and Zier, 2011).

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reliable data set - histogram analysis and three standard deviations threshold procedure. More than 20% of enterprises were excluded from the analysis due to missing or extreme input or output values.

In addition to equation (2), we also consider another model specification, in which we allow the treatment effect to be heterogeneous across time and farm size groups. This model allows for an important flexibility in the treatment effect - time-varying and size-group-varying subsidy effect on TFP – that is ignored by previous model specification. These models are specified as follows:

$$y_{it} - \bar{y}_i = \beta(x_{it} - \bar{x}_i) + \gamma(z_{it} - \bar{z}_i) + \delta_s(s_{it-l} - \bar{s}_i) + \\ + \delta_{sg}(s_{it-l} - \bar{s}_i)g + \delta_{st}(s_{it-l} - \bar{s}_i)t + (\mu_t - \mu) + (\varepsilon_{it} - \bar{\varepsilon}_i) \quad (3)$$

where *g* and *t* represent vectors of dummy variables for farm-size groups and time, respectively. We consider the time-varying effect particularly relevant for the empirical case of Ukraine due to the significantly varying amounts and targets of subsidies provided to farms between years of the analyzed period.

All variables discussed in general terms in this section are listed and described in more detail in Table 5a. It is important to note that the core variables of interest, i.e. production related subsidies and indirect support in the form of VAT reimbursements are transformed into two variables each to control for the high frequency of zero-value observations. We follow methodology of Battese (1997) that suggests using an additional dummy variable that identifies observations with zero values in continuous explanatory variables when these occur frequently. In the continuous policy support variables, zero values are replaced by value of one. In the case of VAT reimbursements, the dummy variable *dv_novatreturns* is mainly a control variable that loses an economic-political content, since (as suggested by policy experts) in majority of case, zero values in VAT reimbursements in the official SSSC database results from farms choosing not to report this information. The variable *dv_novatreturns* thus has mainly a control purpose and will not be interpreted. Other variables are further described in Table 5a and their summary statistics provided in Table 5b.

4 Results

We present and discuss the results of multiple production function (Cobb-Douglas or translog) model specifications with state support measures modelled as contextual factors shifting farm output. Such model specification assumes that the state support measures impact the farm output given input quantities, i.e. farm total factor productivity (TFP). We will refer in this section simply to farm productivity. Table 6 and Table 7 deliver the estimation results for selected model specifications for two distinguished groups of farms, non-agroholding and agroholding farms, respectively. It is assumed that both groups of farms produce under different corporate conditions and may systematically choose different technologies[3]. This would suggest that pooling observations of both farm groups for estimating production function may result in biased production function parameter estimates.

First two models in Table 6 and Table 7 represent Cobb-Douglas and translog production functions, respectively, with the state support variables (production subsidies and VAT reimbursements) affecting farm output in time *t* only ($l = 0$). These effects are assumed uniform across different farm sizes and time periods and also no effect delays are permitted. Tests of joint parameter significance suggest that translog production function specification is a more suitable specification of production behavior of non-agriholding farms, while simpler Cobb-Douglas production function is a sufficient modeling framework for the analysis of productivity effects of state support in the case of

[3] We tested the statistical significance of the differences in group-specific production function parameters in a pooled model (in both specifications Cobb-Douglas as well as translog). The statistically significant differences in production function parameters support our hypothesis of significantly different technologies between non-agroholding and agroholding farms.

agroholding farms. The other models in the result tables thus take on the respective functional forms of the production technologies. For both farm groups, non-agroholding and agroholding farms, the production function estimates provide theoretically consistent results in terms of non-negative (average) input elasticities.[4] The technologies are characterized by increasing returns to scale (RTS) suggesting that Ukrainian farms command over productivity potentials attainable through farm growth (proportional with regard to all inputs). Agroholding farms display different production technology with slightly greater RTS than non-agroholding farms – 1.070 compared to 1.054. The input elasticities suggest that given technologies, the largest productivity increase from proportional increase in inputs will originate from arable land growth in agroholding enterprises while, in non-agroholding farms, the greatest production returns are associated with the more intensive use of material variable inputs (such as fertilizers, pesticides or other chemicals) and machinery. The structure of the output elasticities with regard to the three inputs reflects the more intensive use of material inputs and capital (per hectare as well as labor unit) and not yet optimally adjusted use of labor in agroholding farms.

Due to the differences in the suitable functional forms of the production functions, we interpret the results of the estimates of parameters with regard to state support variables in the context of a translog production function in the case of non-agroholding farms and Cobb-Douglas function in case of agroholding farms.

In the group of non-agroholding farms, the parameter on the production subsidy-related dummy variable indicates that dropping out of subsidization (entry into subsidization) has a statistically significant positive (negative) relation to farm productivity. While this may suggest that subsidized farms may be dis-incentivized to increase their productivity, it may be also related to the policy agenda and targets allocating transfers mainly to farms in greater financial distress (due to market price and demand changes or structural developments, e.g. niche products decline). Indeed, it may be unreasonable to assume that farms would rely on state support and could afford to lower productivity due to subsidy receipt in highly politically vulnerable environment with annual agricultural policy agenda. The negative sign may thus imply unobserved and uncontrolled-for policy selection. This interpretation is supported by the estimate of parameter with regard to the level of product-specific subsidies that indeed indicates that an increase in the volume of subsidies statistically significantly increases farm productivity. Last parameter of interest, parameter with regard to the level of received VAT reimbursements, is statistically significant and positive implying that an increase in the volume of VAT refunds statistically significantly increases farm productivity. These results will further be refined by allowing effect delays and greater variation in the policy impacts over time and farm size groups.

Among agroholdings, all three parameters with regard to the core state support variables of interest – *dv_nosubsidy*, *ln(subsidies)*, *ln(vatreturns)* - are found statistically insignificant. The data thus does not support a significant relationship between state support and farm productivity in the case of farms affiliated with holding companies.[5]

The next two models in Tables 6 and 7 include time-lags in the state support variables to analyze possible ex-post productivity effects of provided production subsidies to farms. Among non-agroholding farms an increase in the subsidy volume has a statistically significant positive effect on productivity with a two year delay (this refines previous result) (possibly related to structural or production adjustments). A more detailed analysis allowing for time varying effects of lagged subsidy variables reveal that this effect is specific for the initial years of the analyzed period and refers particularly to the delayed effect of subsidies allocated in year 2008, i.e subsidies with the

[4] Only in case of agroholding farms, output elasticity with regard to labour is small and negative but not statistically significant.

[5] It is important to note, that these results may be affected by smaller number of observations in the group of agroholding farms, particularly those receiving production support in the period 2009 to 2013.

widest scope (over 70 % of farms receiving subsidies in this year, compared to 4-13 % of farms in the years 2009-2013). The effect of the dummy variable for not receiving subsidy and the variable for the level of VAT reimbursements remain statistically significant and positive in the year of receipt as identified in previous model. In the group of agroholding farms, the inclusion of lagged policy support variables does not add any additional statistically significant information on policy impact to the previous static model specification.

The production function model specification with time-varying productivity effect of policy support variables providing statistically significant variation in the policy impacts of time suggests that the productivity effect of state support should not be considered neutral to changes in the policy design and time. The extent as well as aims of the policy support had, as discussed in Section 2, significantly changed over the analyzed period. Still, some policy effects remained monotonous over time. This refers mainly to the statistically significant positive effect of the level of the product-related subsidies on farm productivity in the group of non-agroholding farms that was already discussed in the context of the basic model and that remains unchanged over the analyzed period. What varies significantly over time in this group of farms is the effect of farm participation in the product-related subsidy regimes. Firstly, this effect found statistically significant positive in the basic model is found to be statistically significant first in the time-period 2010-2011 and is found further higher in the years 2012-2013. This would suggest that the policy selection of farms into the production subsidy-form support is introduced with later (2010 and later) policies that are also highly restrictive in their scale. In the case of agroholding farms, neither this model specification delivers evidence of a statistically significant policy impacts on farm productivity.

Last model specification in Table 6 and Table 7 allows for a farm-size specific policy impact analysis. Parameter estimates show statistically significant differences in the support impacts on farm productivity between groups of smaller and larger farms in the samples of both agroholding and non-agroholding farms. This model thus also significantly refines the analysis, although it imposes restrictions of policy effect time-variation. This restriction together with found statistically significant time-variation in policy impact discussed with previous model motivated a more in-depth analysis of farm-size specific subsidy-productivity relationship for each two successive years (still allowing for difference-in-differences analyses) that are provided in Tables 8 and 9. We now discuss the results of the last column in Tables 6 and 7 together with their more detailed (year-specific) counterparts in Tables 8 and 9.

In contrast to the results of previous models, smaller companies are characterized by a statistically significant negative relationship between non-participation in the subsidy regime and farm productivity. In other words, losing (receiving) policy support is found to result in a productivity reduction (increase). This result holds for both agroholding and non-agroholding farms. In the group of non-agroholding farms, this relationship remains statistically significant over the entire analyzed period (see Table 8) and shows an increasing tendency in size. Among smaller agroholding farms, this relationship is driven mainly by statistical significance of the effect of policy changes between years 2011 and 2012. For smaller (particularly non-agroholding) farms production subsidies were (consistently) therefore important determinants of productivity change.

In the group of non-agroholding farms, however, the statistical significant negative parameter with regard to the relationship between farm productivity and subsidy level simultaneously suggests possible negative productivity impact of the production subsidies once received. As Table 8 shows, this result refers mainly to results of subsidy effects starting in 2011. This may again indicate a policy selection, where the narrowly targeted policies in the later years of the analyzed period may support with greater production subsidies farms in greater financial distress. This interpretation is supported by the finding that beginning in 2011, smaller non-agroholding farms receiving greater amount of subsidies (normalized by total revenues or total production cost) are significantly less profitable in the year preceding the support than farms in the same group receiving smaller amount

of subsidies. Among smaller agroholding companies, the relationship between farm productivity and the level of production subsidies is found statistically insignificant in the model with pooled data over the entire time period, and statistically significantly positive in the years 2009-10 when analyzed for each two subsequent years separately.

Among larger farms, the production subsidy effects on farm productivity are found statistically significantly different in size (and even direction) to those found for smaller farms. As a result, abolishment of state support to larger farms is found related to greater productivity. This result was transmitted to the basic model discussed above. The year-specific model estimates show that this result is consistently statistically significant (an increasing in size) for larger non-agroholding companies over the entire analyzed period of 2008-2013, and for years 2011-2013 in case of larger agroholding companies. It may suggest that (i) larger companies receiving subsidies have lower incentives to improve productivity or (ii) mainly companies in need seek subsidies (self-selection) or (iii) mainly companies in need are targeted by policy (policy selection). The last reasoning seems again most plausible since allocation of production subsidies in Ukraine has been highly volatile and degressive over time to represent soft-budget incentives. More importantly we find systematic relationship between lower profitability and production subsidy allocation to prevail among larger farms (see Table 10 for tests of group mean difference in profitability between farms receiving and not-receiving production subsidies). Also in contrast to results for smaller farms, the level of production subsidies is found to have a statistically significant positive effect on farm productivity starting in 2011, but only in the group of larger non-agroholding farms. In the group of larger agroholding farms, the data does not confirm any statistically significant effect of subsidization on farm productivity, and due to missing data, it cannot be tested in the last two years of the analyzed period.

Finally, we are interested in the farm-size specific relationship between farm productivity and the level of VAT reimbursements. In the sub-sample of smaller non-agroholding farms, the parameters with regard to the size of VAT reimbursements are found statistically insignificant. Therefore, we cannot confirm any significant relationship between this type of indirect support and farm productivity in case of smaller farms. This holds for the entire analyzed period even when time-specific effects are permitted by the model specification. Statistically significant positive relationship between the size of VAT reimbursements and farm productivity is, however, found among larger farms. In the group of larger farms, an increase in the level of VAT reimbursements results in an increase of farm productivity but only until 2010. Beginning with 2011, this relationship is found statistically insignificant.

The relationship between VAT reimbursements and farm productivity is found statistically significantly negative in the group of smaller agroholding farms (see Table 7). As Table 9, however, shows, this result mainly reflects the effect of VAT reimbursement changes between years 2009 and 2010[6]. In the group of larger agroholding farms, this effect is in this specific year statistically significantly greater than in the group of smaller agroholding farms, resulting in a close to zero VAT reimbursement effect on larger agroholding farm productivity. In all remaining years, in which this effect is testable (due to sufficient number of observations), the changes in the level of VAT reimbursements are found to have only statistically insignificantly different effects to those found for small agroholding farms and thus to have only statistically insignificant contribution to farm productivity changes.

In summary, the farm size-specific results regarding agricultural support effect on farm productivity imply that, where policy selection is less likely to influence the results, production subsidies have a statistically significant positive effect on farm productivity. The policy selection seems to vary

[6] Agricultural companies reported about significant delays with VAT reimbursement in 2009- first half of 2010. State Treasury of Ukraine substantiated this situation by lack of funds due to large payments for imported gas.

among farm sizes. While in case of smaller farms, financial distress (lower profitability) seems to play an important role for the amount of subsidies allocated to farms, in case of larger companies financial distress is a factor influencing subsidy's allocation (whether or not a subsidy gets allocated to a farm). The results on VAT reimbursement-farm productivity relationship were found to vary statistically significantly across time periods and groups of farms. It was only larger non-agroholding farms that were found extracting statistically significant productivity increases from the increases in VAT reimbursements and only for limited period of time, concretely until 2010. In more recent years there is no statistically significant evidence of a positive relationship between farm productivity and the level of VAT reimbursements.

5 Discussion and conclusion

The general objective of our paper was to investigate the productivity implications of state support of two major forms – product-specific subsidies and VAT refunds – for different types of crop producing farms in Ukraine during a period of turbulent agricultural policy changes between 2008 and 2013. Our results indicate that the effects of state support were generally minor and varied across years and farm sizes given volatile policy changes and preferences. Our findings are also signaling that a policy may enhance higher (and long-term) productivity returns if it disposes of a broader set of support measures. For example, the positive effect of subsidies was found statistically significant if their volume was considerable (as was the case particularly in 2008). However, the country's obligation to cut this type of support in terms of WTO agreements suggests its further limited use and, apparently, it is mainly used to support the farms or sectors in (financial) distress.

VAT refunds that essentially remained a sole measure of subsidization after 2008 demonstrated low or no impact on farm productivity. This result can be explained by the fact that the enterprises get VAT refund rather to compensate for the effects of imperfect markets that are persistent in Ukraine, i.e. considerably high interest rates on bank (particularly short-term) loans and the moratorium on land sales that makes it impossible to invest in land or use farmland as collateral.

As our results further suggest, VAT refunds (as well as subsidies) are particularly supportive for large non-agroholding enterprises that are technologically close to agroholding farms but, at the same time, face larger barriers to access finance than their agroholding counterparts. Agroholding farms have better access to bank loans and other types of commercial finance; thus, state support serves them rather as additional or complementary funds that can be channeled towards targeted or specialized production lines that ultimately cause increases in TFP and benefits from economies of scope.

Against the background of the ongoing political discussion on the abolishment of VAT refunds for agricultural producers in Ukraine, it is likely that the potential effect of this reform on TFP of crop production will be rather negligible given the minor role VAT refunds play in TFP growth. According to our results, the current level of input use intensity in agroholdings suggests that, their large size notwithstanding, growth is primarily possible for them through further area expansion. On the one hand, this conclusion raises concerns with respect to the future of other farms, in particular large non-agroholding enterprises that prove efficient in converting state support into high productivity returns. On the other hand, if opportunities of extensive growth for agroholdings are limited, further productivity improvements in this type of producers will be possible through adjustments based on opportunity cost of production factors.

6 References

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7 Appendix

Table 1. Indirect state support of agriculture in Ukraine

	Fixed agricultural tax (FAT)	Special VAT regime
Year of introduction	1999	1999-2000
Key conditions	• Simplification of tax accounting due to substitution of profit tax, land tax, regulatory social insurance (excluded from 2005) etc. by single payment; • Sum of payment coupled with land area; • Tax is distributed considering the seasonality of production[7]; • Possibility to pay tax with produced goods.	• Agricultural producers have become able to leave the sum of VAT on own accounts instead of paying it to the budget; • This money should have been spent on purchasing material resources for agricultural production.
Which enterprises were able to use this preference	Agricultural producers that have more than 50% (from 2005 - 75%) of revenues from agricultural goods sale	Agricultural producers that have more than 50% (from 2009 - 75%) of revenues from agricultural goods sale
Way of calculation	Corresponding percent of NMA per hectare	Sum of a subsidy = VAT liability[8] – VAT credit[9]
Example of calculation (FAT - average values, VAT – example values)	For arable land: *In the year of introduction:* 0.5% of 6707.8 UAH/ha = 33.5 UAH/ha (7.8 USD/ha) *2008:* 0.15% of 9631.9 UAH/ha = 14.4 UAH/ha (2.3 USD/ha) *2013:* 0.15% of 20635 UAH/ha = 31 UAH/ha (3.9 USD/ha)	Sum of purchased material resources for agricultural production: 1000 UAH (incl. VAT – 200 UAH) Sum of goods sold: 2000 UAH (incl. VAT – 400 UAH) Sum of a subsidy: 400 UAH – 200 UAH = 200 UAH
Total sum of received benefits	N/a due to a way of reporting	23.3 bln UAH (3 bln USD) during the analyzed period

Sources: Verkhovna Rada of Ukraine (1997), Verkhovna Rada of Ukraine (1999a), Verkhovna Rada of Ukraine (1999b), Verkhovna Rada of Ukraine (2000), Verkhovna Rada of Ukraine (2010), own presentation

[7] I quarter of a year – 10% of the total sum, II quarter – 10%, III quarter – 50% and IV quarter – 30%.
[8] VAT paid within the purchase of material resources (20%)
[9] Sum of the VAT within the price of goods sold (20%)

Table 2. Budgetary and other transfers to agriculture in Ukraine, 2004-2012, USD million

	2004	2005	2006	2007	2008	2009	2010	2011	2012
Transfers to producers	1,141.4	1,247.0	1,574.1	1,945.6	2,065.2	1,372.6	1,813.8	1,699.5	2,076.5
Payments based on output*	298.7	432.1	444.2	725.1	784.1	176.5	258.6	4.5	75.0
Payments based on area/animal/receipts/income *	379.8	290.9	578.2	468.6	431.5	106.5	352.9	393.1	437.0
Subsidies to variable inputs and on farm services**	412.3	412.7	466.5	603.3	669.7	1,023.4	1,066.5	1,183.4	1,444.3
Transfers reducing the on-farm investment cost*	50.6	111.3	85.2	148.7	179.9	66.2	135.8	118.5	120.2
Other producer support	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Financing of public services, institutions and infrastructure	361.1	557.4	509.4	666.5	714.4	485.7	613.3	675.8	774.8
Agricultural knowledge generation and transfer	134.0	204.0	172.7	236.4	367.4	245.8	264.3	302.7	355.0
Food inspection and control	86.7	153.4	116.3	146.7	152.6	92.0	169.0	171.5	199.2
Development and maintenance of rural infrastructure	110.5	169.1	189.2	230.3	160.0	116.0	127.5	150.0	162.3
Marketing and promotion	1.3	1.3	1.5	1.6	4.7	6.5	6.2	2.0	4.6
Other general support	28.6	29.6	29.7	51.5	29.6	25.3	46.4	49.5	53.6
Transfers to consumers from taxpayers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total budgetary and other transfers	1,502.5	1,804.4	2,083.4	2,612.1	2,779.6	1,858.3	2,427.1	2,375.2	2,851.3
Total budgetary and other transfers as a share of value of production at producer prices	10.6	10.1	10.3	10.5	8.6	8.2	8.2	6.3	8.2

Source: OECD (2013)

**Direct support of agricultural production*

***"Indirect" support of agricultural production*

Table 3. Structure of agricultural production by types of agricultural producers, % of total

	2000	2005	2010	2012	2013	2014
			Agricultural enterprises			
Agricultural production – total	38.4	40.5	48.3	50.7	54.0	55.3
crop production	49.3	48.6	53.6	55.0	58.6	59.4
animal production	21.0	26.2	38.8	41.8	43.5	45.5
			Households			
Agricultural production – total	61.6	59.5	51.7	49.3	46.0	44.7
crop production	50.7	51.4	46.4	45.0	41.4	40.6
animal production	79.0	73.8	61.2	58.2	56.5	54.5

Source: SSSU (2015)

Table 4. Total index of agricultural production cost, % to previous year

	2000	2005	2010	2011	2012	2013	2014
Total index of agricultural production cost	131.9	120.9	116.9	117.0	106.8	101.0	117.9
incl. material cost	137.4	114.5	115.5	118.6	107.7	99.7	120.0

Source: SSSU (2015)

Table 5a. Description of variables and main summary statistics

	Variable	Description
y	ln(crop prod. value)*	Natural logarithm of crop production value, tsd UAH
x_1	ln(material & capital expenses)*	Natural logarithm of expenses for material inputs and depreciation in crop production, tsd UAH
x_2	ln(land)	Natural logarithm of harvested area, ha
x_3	ln(labor)	Natural logarithm of number of employees in crop production, person units
z_1	harvested area to total rented area	Share of harvested land in total rented land
z_2	share of animal prod. in total prod. value	Share of animal prod. value in total prod. value
z_3	share of niche crops in crop prod. value	Share of niche crop prod. value in total crop prod. value
z_4	share of services in crop prod. expenses	Share of expenses for services in crop production provided by third parties in total crop production expenses
z_5	dv_corn belt	Dummy variable for corn belt region – 1; 0 – otherwise
z_6	dv_climzone2	Climatic zone dummy: 1 – climatic zone 2, 0 – otherwise
s_1	dv_nosubsidy	Dummy variable for farms that received no production-related subsidies – 1, 0 for farms that received any positive amount of subsidies.
s_2	ln(subsidies)*	Natural logarithm of the total value of received subsidies, tsd UAH, zero values of subsidies are replaced with value of 1.
s_3	dv_novatreturns	Dummy variable for farms that were not eligible to or did not report VAT reimbursements – 1, 0 for farms that reported any amount of VAT reimbursements greater than 0.
s_4	ln(vatreturns)*	Natural logarithm of the total value of received VAT reimbursement, tsd UAH, zero values are replaced with value of 1.
g	dv_farmsize	Dummy variable for two farm size groups: 0 = size of a company smaller than 2497.6 tsd UAH in total crop production value (sample median), 1 = otherwise
t	td2010-11, td2012-13	Time dummies for corresponding time periods, base period is period of years 2008-09.

Table 5b. Main summary statistics

Variable	Mean	Std. Dev.	Min	Max
Non-agroholding farms (26,549 obs.)				
ln(crop prod. value)	7.612	1.233	-1.791	11.112
ln(material & capital expenses)	7.148	1.217	0.617	9.903
ln(land)	6.792	0.954	1.792	9.602
ln(labor)	2.774	1.027	0.000	6.091
share of animal prod. in total prod. value	0.009	0.022	0.000	0.100
share of niche crops in crop prod. value	0.098	0.189	0.000	1.000
share of harvested area in total rented area	0.825	0.183	0.017	1.000
share of services in crop prod. expenses	0.137	0.152	0.000	1.000
dv_nosubsidy	0.788	-	0	1
ln(subsidies)	0.269	1.066	-2.754	10.532
dv_novatreturns	0.616	-	0	1
ln(vatreturns)	0.546	1.700	-2.800	10.038
Agroholding farms (1970 obs.)				
ln(crop prod. value)	8.668	1.074	4.016	10.959
ln(material & capital expenses)	8.282	1.062	3.506	9.903
ln(land)	7.609	0.887	3.258	9.925
ln(labor)	3.616	0.918	0.000	6.052
share of animal prod. in total prod. value	0.008	0.021	0.000	0.100
share of niche crops in crop prod. value	0.080	0.180	0.000	1.000
share of harvested area in total rented area	0.826	0.210	0.034	1.000
share of services in crop prod. expenses	0.217	0.177	0.000	1.000
dv_nosubsidy	0.799	-	0	1
ln(subsidies)	0.288	1.143	-0.847	7.212
dv_novatreturns	0.700	-	0	1
ln(vatreturns)	0.487	1.657	-2.122	8.945

Note: *values converted into real prices of 2008.

Table 6. Estimates of crop production functions with total subsidies and vat returns effects (DID approach) of Ukrainian non-agroholding farms in 2008-2013

Dependent variable: *ln(crop prod. value)*	M1: Basic model – Cobb-Douglas prod. function	M2: Basic model – translog prod. function	M2 with *t-1* lagged support effect	M2 with *t-1* and *t-2* lagged support effect	M2 model with time-varying support effect	M2 model with farm size-varying support effect
ln(material & capital expenses)	0.586***	0.496***	0.524***	0.580***	0.488***	0.558***
	(0.00637)	(0.0368)	(0.0439)	(0.0557)	(0.0368)	(0.0356)
ln(land)	0.423***	0.491***	0.563***	0.450***	0.506***	0.578***
	(0.0103)	(0.0597)	(0.0719)	(0.0931)	(0.0597)	(0.0576)
ln(labor)	0.0447***	0.159***	0.0754	0.0326	0.167***	0.128***
	(0.00653)	(0.0440)	(0.0540)	(0.0688)	(0.0440)	(0.0425)
ln(material & capital expenses)^2		0.0183***	0.0275***	0.0216***	0.0180***	0.00994**
		(0.00512)	(0.00604)	(0.00745)	(0.00511)	(0.00494)
ln(land)^2		-0.00796	-0.00410	0.0105	-0.00954	-0.0145
		(0.00966)	(0.0116)	(0.0151)	(0.00966)	(0.00931)
ln(labor)^2		0.0184***	0.0102*	0.00859	0.0189***	0.0173***
		(0.00505)	(0.00614)	(0.00791)	(0.00504)	(0.00486)
ln(material & capital expenses)* ln(land)		-0.00409	-0.0278*	-0.0323*	-0.00237	-0.00698
		(0.0123)	(0.0147)	(0.0189)	(0.0123)	(0.0118)
ln(material & capital expenses)* ln(labor)		-0.0524***	-0.0558***	-0.0337***	-0.0516***	-0.0423***
		(0.00703)	(0.00837)	(0.0107)	(0.00703)	(0.00678)
ln(land)* ln(labor)		0.0235**	0.0437***	0.0292*	0.0211**	0.0171*
		(0.0104)	(0.0124)	(0.0157)	(0.0104)	(0.0100)
share of animal prod. in total prod. value	-1.025***	-1.063***	-1.394***	-1.632***	-1.040***	-0.952***
	(0.171)	(0.171)	(0.202)	(0.251)	(0.171)	(0.165)
share of niche crops in crop prod. value	-0.0409**	-0.0391**	-0.00197	-0.0179	-0.0351*	-0.0368*
	(0.0197)	(0.0197)	(0.0228)	(0.0288)	(0.0197)	(0.0190)
share of harvested area in total rented area	0.156***	0.159***	0.189***	0.216***	0.156***	0.143***
	(0.0196)	(0.0196)	(0.0231)	(0.0292)	(0.0195)	(0.0189)
share of services in crop prod. expenses	-0.364***	-0.368***	-0.373***	-0.375***	-0.370***	-0.344***
	(0.0185)	(0.0186)	(0.0215)	(0.0259)	(0.0185)	(0.0179)
dv_cornbelt	0.0553	0.0505	-0.000335	-0.0124	0.0504	0.00506
	(0.158)	(0.158)	(0.170)	(0.181)	(0.157)	(0.152)
dv_climzone2	-0.120	-0.126	-0.0491	-0.0494	-0.116	-0.0782
	(0.152)	(0.152)	(0.180)	(0.192)	(0.152)	(0.146)
td2009	-0.0302***	-0.0313***	0.0584***		-0.0160**	-0.0232***
	(0.00725)	(0.00725)	(0.00965)		(0.00782)	(0.00701)
td2010	-0.0774***	-0.0766***	0.00765	0.000571	-0.101***	-0.0689***
	(0.00757)	(0.00756)	(0.00773)	(0.0108)	(0.0142)	(0.00731)
td2011	-0.00748	-0.00536	0.0840***	0.0819***	-0.0320**	-0.00807
	(0.00798)	(0.00802)	(0.00652)	(0.00730)	(0.0145)	(0.00774)
td2012	-0.128***	-0.126***	-0.0374***	-0.0360***	-0.185***	-0.119***
	(0.00839)	(0.00849)	(0.00596)	(0.00628)	(0.0204)	(0.00821)
td2013	-0.0885***	-0.0866***			-0.147***	-0.0839***
	(0.00882)	(0.00897)			(0.0210)	(0.00866)
dv_nosubsidy	0.0192***	0.0186***	0.0325***	0.0433***	-0.00587	-0.0850***
	(0.00685)	(0.00685)	(0.00852)	(0.0114)	(0.00879)	(0.00808)
ln(subsidies)	0.00507**	0.00467**	0.00456	0.00223	0.00575**	-0.0173***
	(0.00233)	(0.00234)	(0.00440)	(0.00532)	(0.00269)	(0.00481)
dv_novatreturns	-0.0219***	-0.0213***	-0.00697	-0.00905	-0.0386***	-0.0868***
	(0.00589)	(0.00588)	(0.00706)	(0.00854)	(0.00901)	(0.00707)
ln(vatreturns)	0.00402**	0.00424**	0.00474**	0.00490**	0.00354	-0.00163
	(0.00176)	(0.00176)	(0.00201)	(0.00239)	(0.00282)	(0.00331)
L.dv_nosubsidy			0.00867	-0.00394		
			(0.00716)	(0.00948)		
L2.dv_nosubsidy				-0.00879		
				(0.00828)		
L.ln(subsidies)			0.00346	0.00556		
			(0.00242)	(0.00476)		

Table 6 continued

L2.ln(subsidies)				0.00648**		
				(0.00260)		
L. dv_novatreturns			0.0115*	0.0173**		
			(0.00659)	(0.00843)		
L2. dv_novatreturns				0.0198**		
				(0.00790)		
L.ln(vatreturns)			0.000884	0.000313		
			(0.00194)	(0.00237)		
L2.ln(vatreturns)				0.00344		
				(0.00237)		
td2010-11* dv_nosubsidy					0.0476***	
					(0.0138)	
td2010-11* ln(subsidies)					-0.00520	
					(0.00574)	
td2012-13* dv_nosubsidy					0.0559***	
					(0.0204)	
td2012-13* ln(subsidies)					-0.0147	
					(0.00949)	
td2010-11*					0.00477	
dv_novatreturns					(0.0109)	
td2010-11* ln(vatreturns)					-0.00218	
					(0.00336)	
td2012-13*					0.0469***	
dv_novatreturns					(0.0111)	
td2012-13* ln(vatreturns)					0.00229	
					(0.00324)	
dv_farmsize* dv_nosubsidy						0.187***
						(0.00818)
dv_farmsize* ln(subsidies)						0.0358***
						(0.00520)
dv_farmsize*						0.138***
dv_novatreturns						(0.00866)
dv_farmsize* ln(vatreturns)						0.0131***
						(0.00358)
Constant	0.693	0.645	0.139	0.297	0.605	0.434
	(0.445)	(0.464)	(0.538)	(0.585)	(0.463)	(0.447)
N	26549	26549	20470	15178	26549	26549
R^2	0.644	0.645	0.615	0.600	0.646	0.671
F	1921.3	1448.0	831.0	484.5	1090.5	1388.9

Note: Standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; L. in the variable name stands for time lag *t-1*, L2. in variable name stands for time lag *t-2*; *td* and *dv* in the variable names stand for time dummy and dummy variable, respectively.

Table 7. Estimates of crop production functions with total subsidies and vat returns effects (DID approach) of Ukrainian agroholding farms in 2008-2013

Dependent variable: *ln(crop prod. value)*	M1: Basic model – Cobb-Douglas prod. function	M2: Basic model – translog prod. function	M2 with *t-1* lagged support effect	M2 with *t-1* and *t-2* lagged support effect	M2 model with time-varying support effect	M2 model with farm size-varying support effect
ln(material & capital expenses)	0.506***	0.504***	0.527***	0.454***	0.506***	0.437***
	(0.0262)	(0.184)	(0.0320)	(0.0415)	(0.0263)	(0.0259)
ln(land)	0.569***	0.613***	0.514***	0.596***	0.568***	0.537***
	(0.0381)	(0.227)	(0.0486)	(0.0643)	(0.0383)	(0.0367)
ln(labor)	-0.00430	-0.127	-0.0673**	-0.108***	-0.00565	-0.0136
	(0.0253)	(0.195)	(0.0294)	(0.0381)	(0.0254)	(0.0243)
ln(material & capital expenses)^2		-0.0209				
		(0.0206)				
ln(land)^2		-0.0594				
		(0.0400)				
ln(labor)^2		-0.000510				
		(0.0231)				
ln(material & capital expenses)* ln(land)		0.0707				
		(0.0509)				
ln(material & capital expenses)* ln(labor)		-0.0599*				
		(0.0361)				
ln(land)* ln(labor)		0.0831*				
		(0.0468)				
share of animal prod. in total prod. value	-1.404*	-1.469**	-1.246	-1.787	-1.169	-1.184*
	(0.720)	(0.721)	(0.857)	(1.143)	(0.731)	(0.693)
share of niche crops in crop prod. value	-0.280***	-0.275***	-0.278***	-0.283***	-0.271***	-0.210***
	(0.0681)	(0.0685)	(0.0732)	(0.0857)	(0.0686)	(0.0656)
share of harvested area in total rented area	0.0933	0.0883	0.151*	0.281**	0.0903	0.0548
	(0.0699)	(0.0721)	(0.0858)	(0.117)	(0.0701)	(0.0673)
share of services in crop prod. expenses	-0.391***	-0.376***	-0.427***	-0.383***	-0.390***	-0.346***
	(0.0616)	(0.0624)	(0.0664)	(0.0813)	(0.0618)	(0.0591)
dv_cornbelt	-0.776**	-0.777**	-0.837***	-1.007***	-0.766**	-0.693**
	(0.326)	(0.326)	(0.316)	(0.338)	(0.327)	(0.315)
td2009	0.0771**	0.0703**	0.102**		0.103***	0.0682**
	(0.0312)	(0.0315)	(0.0408)		(0.0346)	(0.0300)
td2010	0.0000904	-0.00819	0.00933	0.0251	-0.0861	-0.0155
	(0.0328)	(0.0331)	(0.0307)	(0.0480)	(0.0718)	(0.0315)
td2011	0.114***	0.106***	0.120***	0.102***	0.0243	0.110***
	(0.0351)	(0.0354)	(0.0263)	(0.0302)	(0.0737)	(0.0337)
td2012	-0.0341	-0.0368	-0.0494**	-0.0683**	-0.0789	-0.0307
	(0.0362)	(0.0363)	(0.0251)	(0.0274)	(0.113)	(0.0348)
td2013	0.0138	0.0118			-0.0292	0.0203
	(0.0388)	(0.0391)			(0.115)	(0.0373)
dv_nosubsidy	0.0311	0.0367	0.00143	0.103*	-0.00574	-0.137***
	(0.0305)	(0.0306)	(0.0376)	(0.0591)	(0.0379)	(0.0500)
ln(subsidies)	0.0108	0.0104	-0.00258	0.0128	0.0155	0.00606
	(0.00917)	(0.00917)	(0.0177)	(0.0227)	(0.0102)	(0.0524)
dv_novatreturns	-0.00570	-0.00289	-0.0188	-0.000888	-0.0279	-0.175***
	(0.0235)	(0.0236)	(0.0269)	(0.0336)	(0.0404)	(0.0444)
ln(vatreturns)	0.000631	0.00102	0.00441	0.00393	-0.0145	-0.0606**
	(0.00687)	(0.00688)	(0.00789)	(0.0102)	(0.0116)	(0.0283)
L.dv_nosubsidy			-0.00135	0.0397		
			(0.0312)	(0.0437)		
L2.dv_nosubsidy				0.0509		
				(0.0370)		
L.ln(subsidies)			-0.00683	-0.0106		
			(0.00853)	(0.0192)		
L2.ln(subsidies)				0.00543		
				(0.00929)		

Table 7 continued

L. dv_novatreturns			0.0286	0.0316		
			(0.0262)	(0.0341)		
L2. dv_novatreturns				0.0493		
				(0.0328)		
L.ln(vatreturns)			-0.00486	-0.0120		
			(0.00677)	(0.00897)		
L2.ln(vatreturns)				-0.00201		
				(0.00857)		
td2010-11* dv_nosubsidy					0.111	
					(0.0699)	
td2010-11* ln(subsidies)					0.00539	
					(0.0248)	
td2012-13* dv_nosubsidy					0.0425	
					(0.109)	
td2012-13* ln(subsidies)					-0.0248	
					(0.0442)	
td2010-11* dv_novatreturns					0.00862	
					(0.0493)	
td2010-11* ln(vatreturns)					0.0222	
					(0.0154)	
td2012-13* dv_novatreturns					0.0424	
					(0.0506)	
td2012-13* ln(vatreturns)					0.0219	
					(0.0144)	
dv_farmsize* dv_nosubsidy						0.204***
						(0.0450)
dv_farmsize*ln(subsidies)						0.00761
						(0.0527)
dv_farmsize* dv_novatreturns						0.212***
						(0.0464)
dv_farmsize* ln(vatreturns)						0.0660**
						(0.0287)
Constant	0.715**	0.770	1.213***	1.141***	0.749**	1.525***
	(0.292)	(0.663)	(0.328)	(0.396)	(0.294)	(0.289)
N	1970	1970	1597	1206	1970	1970
R^2	0.710	0.711	0.669	0.664	0.711	0.735
BIC	165.3	199.4	-152.9	-195.5	217.4	17.67
F	199.9	148.3	106.0	60.20	136.0	182.9

Note: Standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; L. in the variable name stands for time lag *t-1*, L2. in variable name stands for time lag *t-2*; *td* and *dv* in the variable names stand for time dummy and dummy variable, respectively.

Table 8. Years-specific estimates of crop production functions with total subsidies and vat returns effects (DID approach) of Ukrainian non-agroholding farms in 2008-2013

	M2 model with farm size-varying support effect				
	2008-09	2009-10	2010-11	2011-12	2012-13
ln(material & capital expenses)	0.501***	0.308***	0.517***	0.790***	0.458***
	(0.0953)	(0.0933)	(0.0796)	(0.0869)	(0.0953)
ln(land)	0.770***	0.952***	0.768***	0.158	0.639***
	(0.167)	(0.142)	(0.120)	(0.137)	(0.147)
ln(labor)	0.277***	0.308***	0.0505	0.101	0.235**
	(0.105)	(0.111)	(0.101)	(0.113)	(0.120)
ln(material & capital expenses)^2	-0.00547	0.0343***	0.0147	-0.00420	-0.0259*
	(0.0139)	(0.0127)	(0.0114)	(0.0109)	(0.0144)
ln(land)^2	-0.0433*	-0.0293	-0.0162	0.0259	-0.0695***
	(0.0250)	(0.0224)	(0.0197)	(0.0222)	(0.0262)
ln(labor)^2	0.00364	0.0259**	0.00428	0.0143	0.000620
	(0.0129)	(0.0124)	(0.0120)	(0.0128)	(0.0133)
ln(material & capital expenses)* ln(land)	0.0240	-0.0173	-0.0259	-0.0179	0.0818**
	(0.0316)	(0.0294)	(0.0266)	(0.0273)	(0.0340)
ln(material & capital expenses)* ln(labor)	-0.0420**	-0.0656***	-0.0368**	-0.0106	-0.0569***
	(0.0190)	(0.0185)	(0.0158)	(0.0164)	(0.0184)
ln(land)* ln(labor)	0.00701	0.00571	0.0320	-0.00581	0.0278
	(0.0264)	(0.0250)	(0.0219)	(0.0245)	(0.0280)
share of animal prod. in total prod. value	-1.427***	-2.246***	-1.046**	-2.144***	-2.450***
	(0.411)	(0.441)	(0.439)	(0.478)	(0.485)
share of niche crops in crop prod. value	-0.0323	0.0387	-0.00213	-0.133***	0.128***
	(0.0497)	(0.0445)	(0.0459)	(0.0455)	(0.0451)
share of harvested area in total rented area	0.0184	-0.0357	-0.0481	0.170***	0.270***
	(0.0522)	(0.0472)	(0.0453)	(0.0479)	(0.0517)
share of services in crop prod. expenses	-0.278***	-0.420***	-0.265***	-0.314***	-0.387***
	(0.0517)	(0.0434)	(0.0447)	(0.0380)	(0.0422)
dv_cornbelt					-0.0828
					(0.201)
dv_climzone2					-0.258
					(0.201)
td2009	-0.0264***	0.0448***			
	(0.00911)	(0.00580)			
td2010			-0.0867***		
			(0.00662)		
td2011				0.122***	
				(0.00649)	
td2012					-0.0335***
					(0.00609)
dv_nosubsidy	-0.0480***	-0.0552***	-0.0951***	-0.125***	-0.0991***
	(0.0141)	(0.0175)	(0.0191)	(0.0232)	(0.0274)
ln(subsidies)	0.00186	-0.0182	-0.0425**	-0.0590**	-0.0692***
	(0.00685)	(0.0199)	(0.0209)	(0.0270)	(0.0250)
dv_novatreturns	-0.146***	-0.0556***	-0.0255	-0.0760***	-0.0568***
	(0.0154)	(0.0187)	(0.0160)	(0.0179)	(0.0189)
ln(vatreturns)	-0.0113	-0.00882	-0.00188	0.0113	0.0120
	(0.00754)	(0.00887)	(0.00798)	(0.00772)	(0.00771)

Table 8. continued

dv_farmsize* dv_nosubsidy	0.0820***	0.106***	0.211***	0.257***	0.267***
	(0.0169)	(0.0201)	(0.0193)	(0.0203)	(0.0205)
dv_farmsize*ln(subsidies)	0.00458	0.0195	0.0548**	0.0824***	0.107***
	(0.00771)	(0.0207)	(0.0216)	(0.0291)	(0.0270)
dv_farmsize* dv_novatreturns	0.226***	0.144***	0.0585***	0.0751***	0.0737***
	(0.0186)	(0.0220)	(0.0203)	(0.0224)	(0.0236)
dv_farmsize* ln(vatreturns)	0.0325***	0.0253***	0.00405	-0.00520	-0.00516
	(0.00831)	(0.00951)	(0.00874)	(0.00812)	(0.00819)
Constant	-0.0281	-0.402	0.0663	0.609*	1.068
	(0.414)	(0.337)	(0.305)	(0.341)	(0.654)
N	8453	8623	8960	9088	9136
R^2	0.559	0.542	0.620	0.626	0.594
F	193.0	182.2	264.7	275.6	225.6

Note: Standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; *td* and *dv* in the variable names stand for time dummy and dummy variable, respectively.

Table 9. Years-specific estimates of crop production functions with total subsidies and vat returns effects (DID approach) of Ukrainian agroholding farms in 2008-2013

	M2 model with farm size-varying support effect				
	2008-09	2009-10	2010-11	2011-12	2012-13
ln(material & capital expenses)	0.394***	0.327***	0.337***	0.480***	0.374***
	(0.0638)	(0.0495)	(0.0613)	(0.0796)	(0.0925)
ln(land)	0.725***	0.568***	0.616***	0.516***	0.501***
	(0.113)	(0.0723)	(0.0871)	(0.110)	(0.137)
ln(labor)	-0.0551	-0.0228	-0.0154	0.0351	-0.223***
	(0.0756)	(0.0484)	(0.0550)	(0.0769)	(0.0791)
share of animal prod. in total prod. value	-1.673	-0.285	-0.311	-7.484***	-0.563
	(1.607)	(1.376)	(2.253)	(2.313)	(2.547)
share of niche crops in crop prod. value	0.430*	0.0161	-0.0480	-0.945***	0.211
	(0.242)	(0.131)	(0.101)	(0.173)	(0.272)
share of harvested area in total rented area	-0.186	-0.0409	0.111	0.225	0.436*
	(0.185)	(0.133)	(0.167)	(0.199)	(0.223)
share of services in crop prod. expenses	-0.208	-0.339***	-0.191	-0.634***	-0.454***
	(0.189)	(0.0991)	(0.150)	(0.180)	(0.125)
dv_cornbelt					-0.838**
					(0.402)
td2009	0.0456	0.0762***			
	(0.0438)	(0.0194)			
td2010			-0.162***		
			(0.0261)		
td2011				0.142***	
				(0.0257)	
td2012					-0.0521*
					(0.0299)
dv_nosubsidy	0.00744	-0.0697	-0.188	-0.533***	-0.140
	(0.0937)	(0.126)	(0.115)	(0.157)	(0.200)
ln(subsidies)	-0.102	0.857***	0.0472	0.00508	0.000907
	(0.0712)	(0.258)	(0.269)	(0.0404)	(0.0615)
dv_novatreturns	-0.179*	-0.396***	-0.0545	0.163	-0.125
	(0.0972)	(0.125)	(0.101)	(0.108)	(0.125)
ln(vatreturns)	-0.0172	-0.599***	0.0639	0.0112	0.0154
	(0.0437)	(0.157)	(0.167)	(0.0176)	(0.0194)
dv_farmsize* dv_nosubsidy	0.0871	0.0729	0.311***	0.548***	0.279**
	(0.0906)	(0.129)	(0.104)	(0.121)	(0.127)
dv_farmsize*ln(subsidies)	0.129*	-0.834***	-0.00436		
	(0.0720)	(0.255)	(0.268)		
dv_farmsize* dv_novatreturns	0.165	0.431***	0.0612	-0.135	0.264**
	(0.101)	(0.129)	(0.107)	(0.123)	(0.131)
dv_farmsize* ln(vatreturns)	0.00931	0.612***	-0.0661		
	(0.0444)	(0.158)	(0.167)		
Constant	0.241	1.819***	1.223***	0.720	2.736***
	(0.565)	(0.440)	(0.443)	(0.684)	(0.724)
N	645	711	738	682	587
R^2	0.701	0.739	0.773	0.657	0.704
BIC	-402.4	-841.3	-650.6	-563.6	-427.3
F	33.80	47.01	56.40	31.79	31.85

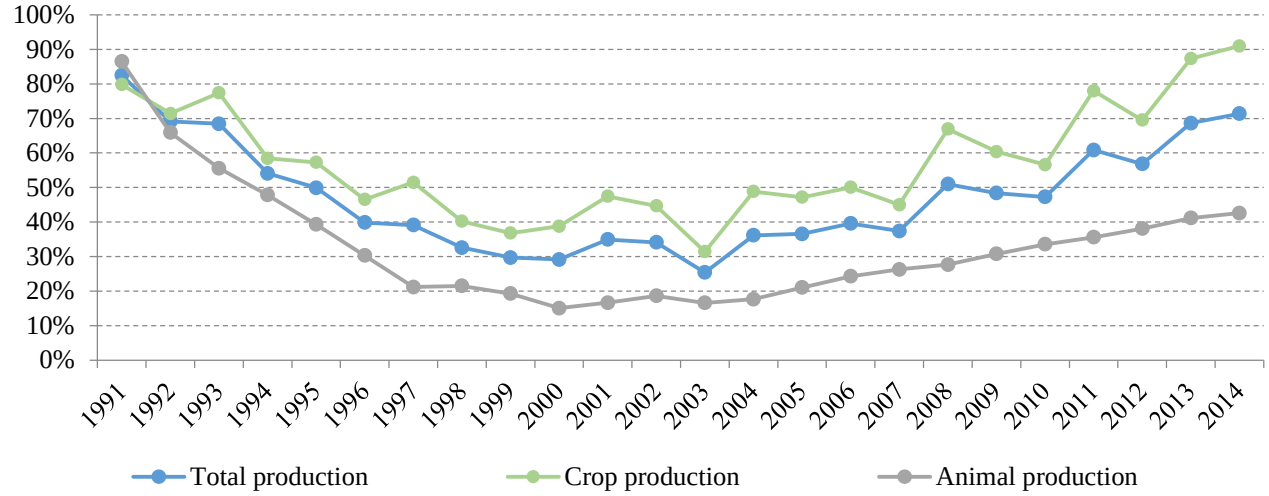
Note: Standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; *td* and *dv* in the variable names stand for time dummy and dummy variable, respectively.

Table 10. Test of Ukrainian farms' group mean differences in profitability in 2008-2013 (unequal variance assumption)

	Non-agroholding farms				
	Group of smaller farms receiving NO producting subsidies		Group of smaller farms receiving producting subsidies		Two-sample t test[1)]
year	profitability of crop production	number of observations	profitability of crop production	number of observations	p value
2008	0.096	826	0.132	1,432	0.028
2009	0.076	2,082	0.058	325	0.367
2010	0.237	2,414	0.196	229	0.149
2011	0.267	2,345	0.196	116	0.074
2012	0.191	2,356	0.159	106	0.398
2013	0.092	2,228	0.177	37	0.164
	Group of larger farms receiving NO producting subsidies		Group of larger farms receiving producting subsidies		Two-sample t test[1)]
2008	0.298	279	0.313	1,774	0.574
2009	0.275	1,264	0.257	642	0.293
2010	0.450	1,430	0.333	434	0.000
2011	0.477	1,963	0.333	277	0.000
2012	0.384	1,959	0.306	215	0.006
2013	0.204	2,361	0.212	98	0.805
	Agroholding farms				
	Group of smaller farms receiving NO producting subsidies		Group of smaller farms receiving producting subsidies		Two-sample t test[1)]
year	profitability of crop production	number of observations	profitability of crop production	number of observations	p value
2008	0.066	22	-0.018	30	0.504
2009	-0.059	66	0.468	3	-
2010	-0.021	68	-0.187	6	-
2011	0.131	84	-	0	-
2012	-0.011	67	-	0	-
2013	-0.004	53	0.025	1	-
	Group of larger farms receiving NO producting subsidies		Group of larger farms receiving producting subsidies		Two-sample t test[1)]
2008	0.024	27	0.068	219	0.542
2009	0.007	213	0.117	72	0.039
2010	0.216	262	0.208	36	0.894
2011	0.264	294	0.273	10	0.918
2012	0.149	241	0.017	16	0.025
2013	-0.004	234	-0.022	5	-

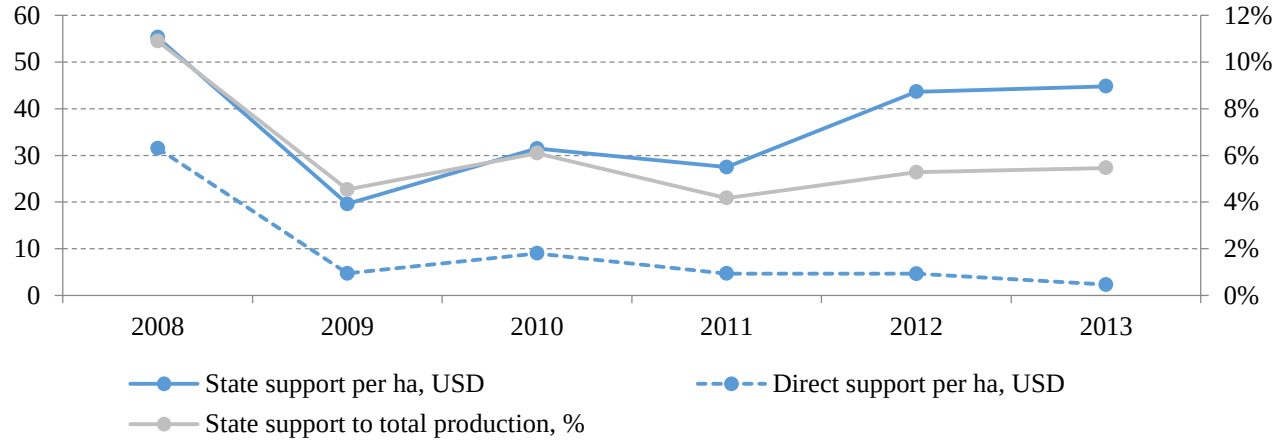
Note: [1)] assuming unequal variances.

Figure 1. Indexes of agricultural production volumes by agricultural enterprises, 1990 = 100



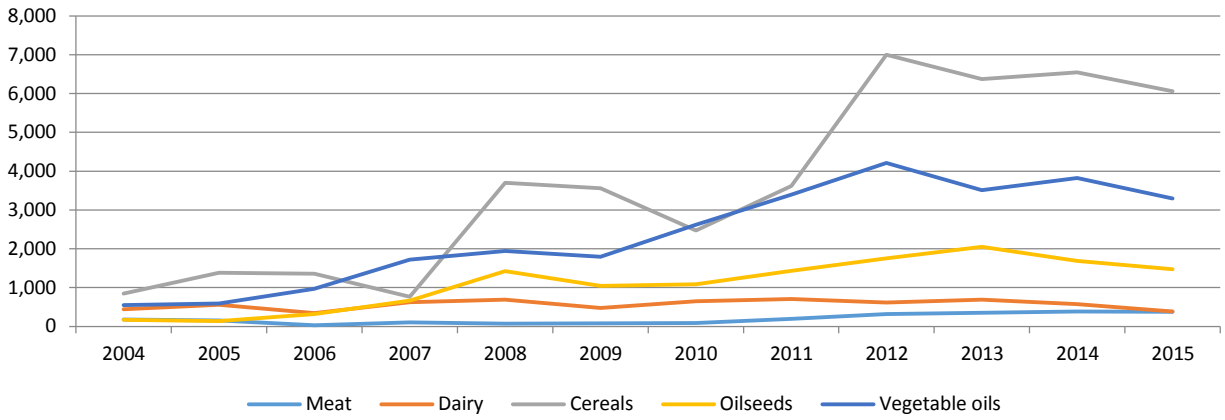
Source: own presentation based on the data of State Statistic Service of Ukraine (2016)

Figure 2. Public support of agriculture per hectare and to total production value



Source: SSSU (multiple years), own presentation

Figure 3. Development of main Ukrainian agri-food exports in 2004-2015, million USD



Source: United Nations Comtrade database