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Subsidies and Employment: Exploring the experience of corporate and family farms in Russia

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The paper investigates whether agricultural enterprises and the family farm sector respond differently to agricultural subsidies in respect of agricultural employment. Results show that investment subsidies work in a conventional capital - labour substitution framework reducing employment in the sector to which they are applied but indirectly increasing employment in the alternative agricultural sector. Production subsidies increase employment in the family sector characterised by low labour elasticity, but reduce it in the more labour elastic enterprises sector. The remaining covariates have opposing signs in the two models, indicating a qualitative difference between the agricultural enterprises and the family sector.

Keywords: subsidies, agricultural enterprises, family sector, employment, Russia

JEL Classifications: *C23, C26, E24, Q18*

1 Introduction

Rural development is a central socio-economic challenge in Russia. It is considered not only as a condition for ensuring social stability in rural areas, but also as a factor of sustainable agricultural development (Serova 2020). In Russia, the problem of rural employment is identified as one of the key limiting factors of rural development (Serova 2023; Wegren 2016). In terms of rural employment support, the state programme "Integrated development of rural areas", approved in 2019, includes a separate section with an earmarked budget and specific targets devoted to employment[1]. However, first, the employment policy measures, provided by this programme, do not go beyond the agricultural[2] (Saraikin *et al.* 2023), and second, agricultural subsidies to producers remain

[1] In particular, the programme specifies the target indicator of rural employment rate of people 15 years of age or older as 55% to be achieved by 2030. For reference, the rate in 2021 was 52.2% (https://mcx.gov.ru/activity/state-support/programmes /).

[2] Programme section "Rural employment promotion" includes compensation to agricultural producers and processors for the costs of training of their employees and the costs associated with the payment of labour and accommodation of student interns.

the main item of budget expenditures on agriculture and rural development. And, moreover, over time, support has been increasingly shifted from general services to agriculture sector to subsidies to producers (Shik 2020). Therefore, since agricultural subsidies are the main policy measure it is important to investigate how they may affect agricultural employment. This will provide a better understanding of the unintended consequences of subsidies to agricultural producers, either positive or negative, in terms of rural employment.

In view of the above, the objective of this paper is to evaluate the potential employment effects of agricultural subsidies. This issue is considered in the light of distinctiveness of two sectors typical for Russian agriculture, i.e. agricultural enterprises (corporate farms) and the family sector. It is expected that the employment effects of agricultural support policies differ amongst these heterogeneous modes of production organisation.

Employment outcomes are indirect effects of agricultural policy support (Rizov *et al*. 2018). The stated aims of agricultural subsidies could be, e.g. income support, output increase to enhance food security, import substitution and export enhancement, farm diversification or farm modernisation (e.g. for investment subsidies). Irrespective of what the stated aims of such support measures might be, they often lead to other positive or negative consequences. The main assumption in this paper is that one of these indirect consequences is the effect on employment which requires more research in order to reveal the direction of the effect and, most importantly, the extent to which it is similar or differing in the agricultural enterprise sector and in the family run one.

The effect on employment could take place via at least two distinct channels. First, policy measures which are aimed at income support without explicit link to production (decoupled income support) can affect employment levels. The effect arises through a decreased risk, increased wealth which may boost farm investment, increased

creditworthiness and, thus, improved access to credit (Bhaskar and Beghin 2009). Second, when the support regime is explicitly aimed at enhancing output, both employment increasing and employment decreasing effects are possible. Employment reducing effects can result from a capital-labour substitution process if the subsidies change the relative prices of the factors of production. Finally, when subsidies lead to changes in output mix or to changes in technology, these may also result in employment effects, since the resulting output mix might be beneficial or detrimental to employment.

To our best knowledge this is the first paper on Russian agriculture exclusively focussed on the indirect effect of agricultural policy on employment. The analysis comprehensively includes both agricultural enterprises (corporate farms) and the family sector in all Russian regions. The paper adds to the previous research in the following aspects. First, it accounts for the bipolar agricultural production structure in Russia. The effect is analysed according to agricultural sectors, which are defined in this paper as agricultural enterprises (corporate farms) and the family sector, comprising of family farms and household plots. Additionally, Russian farm employment is characterized by the presence of people simultaneously working in the corporate and family sectors (mainly on household plots). In this way, the income from employment in the agricultural enterprises is complemented via work on the household plots. Such a practice suggests the complementarity of employment in the two agricultural subsectors.

The paper models separately agricultural enterprises and the family sector since it assumes a difference in their objective function – profit maximisation in agricultural enterprises and household utility maximisation in the family sector – which may result in qualitatively different policy responses. Such difference policy responses may be due to underlying difference in motivations (Dressler and Tauer, 2015), differential farming efficiency (Kostov et al., 2019), or the existence of non-economic factors (Glover and

Reay, 2015). Two econometric issues are dealt with - endogeneity and heterogeneity due to the panel nature of the dataset. The strategy in the paper follows the approach suggested by Lewbel (1997) who proved that nonlinear transformations of exogenous variables present in the endogenous regression model can be used to construct a wider set of potential instruments.

The effect of three types of subsidies, used in Russia, is analysed, i.e. investment, production and other. Results show that investment subsidies trigger a capital-labour substitution effect which reduces employment in the sector where they are directly applied but increases it in the alternative sector (indirect effect). Production subsidies, on the other hand, have different effects on the enterprises and family sector by restricting employment in the enterprise sector and increasing it in the family sector. Other subsidies, which are small and declining, act as infrastructure improvement increasing employment in agricultural enterprises but decreasing it in the family sector. One of the interesting results is that the other covariates, e.g. relative income, population, unemployment, have opposing signs in the two models supporting the assumption of a qualitative difference between the agricultural enterprises and the family sector.

The structure of the paper is as follows. The next section includes some brief lessons from previous studies and the following two sections provide the necessary background of agricultural subsidies and agricultural employment in Russia. Section 5 presents the theoretical model and section 6 the empirical considerations. Section 7 presents the data used and section 8 deals with the econometric issues. Section 9 discusses the results and section 10 concludes.

2 Short literature background

There is an extensive debate in the economic literature on the effect of agricultural subsidies on farm employment (e.g. Bojnec and Ferto 2022; Garrone *et al*. 2019;

European Parliament 2016; Dupraz and Latruffe 2015; Olper *et al*. 2014; Petrick and Zier 2011, 2012). A few studies have investigated the agricultural policy impact on employment beyond agriculture (Rizov *et al*. 2018; Blomquist and Nordin 2017; Mattas *et al*. 2011). Vigani *et al*. (2019) summarised the studies on the impact of agricultural policy on agricultural and rural jobs from a west European perspective, published in the last three decades. Their conclusions, similarly to the conclusions from the studies referred above, is that there is not a clear-cut answer. The effect can be positive or negative depending on the type of policy measure and the way it is implemented at national or regional level. Berlinschi *et al*. (2011) organised the previous studies in three groups according the their conclusions – those that argue there is not a statistically significant effect of agricultural subsidies on employment, those that claim a positive effect through the survival of more farms, and a third group showing a negative effect due to accelerated capital-labour substitution. However, all these studies focused on countries with a more homogenous farm structure dominated by family farms. This has overlooked the effect on distinctly different agricultural sectors, as existent in Russia. Still, there are important insights provided by the previous studies, informing this paper, that the way the support policies are implemented, subsidies type and the type of farm labour may affect the employment outcomes.

Concerning Russia the issue is under-researched. At a normative level, a number of authors stated that Russian policy has ignored the issues of decrease in agricultural employment and did not provide support for non-agricultural rural employment (Lerman *et al.* 2008; Serova *et al.* 2008). Serova and Zvyagintsev (2006) pointed out the inefficiency of supporting household plots to ensure employment and income of the rural dwellers.

Concerning empirical analysis, Svetlov *et al.* (2019) have investigated the effects of agricultural policy support on revenues of agricultural enterprises only in 14 regions in Russia, revealing, apart from direct effects, the indirect ones via labour and capital. The

authors concluded that positive effects on revenues were prevalent, however, the negative effects were related to the decrease in labour following the receipt of subsides. Studying one-off policy measure in Russia, introduced in 2014, i.e. the ban of western food imports, Kotyrlo *et al.* (2021) revealed that it only had a shortterm positive impact on stabilization of agricultural employment. In a rather descriptive opinion paper on the effect of market reforms starting in 1990s up to the Russia accession to WTO in 2012, Kalugina (2014) claims that Russian agricultural policy in 2000s produced a sharp increase in rural unemployment and informal employment.

The present paper tries to fill the gap in the study of the effect of Russian agricultural policy on employment providing new empirical evidence.

3 Overview of agricultural subsidies in Russia

Russia has a long-standing record of spending large amounts on subsidies to agriculture, maintaining the revenue of agricultural producers higher than what it would have been in the case without public policy support (Liefert and Liefert 2007). Despite this generous support, neither the output growth nor technical change were closer to those in industrialised economies (Lerman *et al.* 2001). According to social cost benefit ratio (see e.g. Masters and Winter-Nelson 1995) Russia had a comparative disadvantage in agriculture in comparison to agricultural inputs (fertilisers and energy) (Liefert 2002). It was not until 2006 when agriculture was included in the priorities for country development that the funding for the sector started increasing (Liefert and Liefert 2012).
Since then, the support to producers has fluctuated substantially but since 2014 it has stabilised between 9 and 13 per cent of gross farm receipts (OECD 2020).

Three State Programmes for Development of Agriculture have been implemented for the period of study in this paper – 2006-2007 (National Priority Project), 2008-2012 and 2013-2020 (currently extended to 2025). These programmes set the national priorities.

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At the aggregate level, Russian agricultural support programmes did not explicitly target farm/rural employment. The formal objectives of the programmes were to: (i) ensure food independence; (ii) achieve import substitution; (iii) raise competitiveness of Russian produce on domestic and international markets; (iv) ensure food security through agricultural growth; (v) increase value added; (vi) increase exports; (vii) increase capital investments (World Bank 2020). However, since 2002 rural development has been included explicitly in the State Programmes. It tackles the problems of a lack of rural jobs and deterioration of physical infrastructure in rural areas. Rural development programmes, active during the study period, set qualitative goals in terms of rural employment, i.e. "Expansion of the labour market in rural areas and ensuring its attractiveness" and "Promotion of the creation of high-tech jobs in rural areas". However, they have not included quantitative targets. The latter appeared much later, in the programme "Integrated development of rural areas", adopted in 2019.

What is important for the empirical analysis in this paper, is that policy implementation procedures vary regionally since agricultural support programmes are defined at a regional level but in principle they are co-financed by the federal budget. Co-financing rates vary by regions and individual support measures (projects). In addition to the support included in the State Programmes, regions implement and finance their own regional support measures (OECD 2020). The federal budget supports directly some central institutions, veterinary and sanitary control, land reclamation etc., but the major share is allocated to regional co-financing (e.g. in 2017 66 per cent of federal budget spent on agriculture were transfers to regions) (World Bank 2020). The regional share of agricultural subsidies is defined by various indicators, including local agricultural intensity, the degree to which a region can cover their budgetary expenditures by regional tax collection, and some coefficients set by the Ministry of Agriculture. However, the

World Bank (2020:71) indicates that in the period 2012-2018 the distribution of subsidies followed closely the regional share of the value of the livestock production in the national livestock value and the support was concentrated on agricultural enterprises "while production on family (peasant) farms for the most part is unsupported". In practice, the subsidy allocation procedure is complex (Kvartiuk and Herzfeld 2021) and the level of co-financing is open to lobbying with a particular lobbying power exercised by the richer regions.

Not all producers are eligible for support – only those who are officially recognised as agricultural producers according to three criteria (i) share of revenue from the sale of agricultural products (raw and processed) not less than 70 per cent/year; (ii) no outstanding payments to workers' wages and/or tax authorities and (iii) delivery of financial reports to the regional authorities.

Broadly the budgetary support for agriculture includes support to producers, support to the general support services, and support to consumers from the taxpayers (e.g. school feeding programme, milling subsidies) (World Bank 2020; Shik 2020).

Data is available both from OECD PSE estimations and the Federal State Statistics Service (Rosstat). They are broadly similar, a slight discrepancy between the estimation of budgetary amounts spent on agriculture between the OECD and Rosstat is due to the inclusion of fisheries and rural development expenditure in Rosstat figures. Large part of the budgetary support to the recognised agricultural producers has taken the form of market price support and variable input subsidies (Figure 1).

Figure 1 around here

Such subsidies have been repeatedly criticised due to their market distorting character (World Bank 2006; OECD 2011, 2020). The output subsidies were coupled and have been implemented as per tonne payments on marketed output. They have been used

primarily for livestock products, namely milk, and due to their more labour intensive production might have had a positive employment effect (Serova *et al*. 2004; Uzun 2012; Sedik *et al*. 2017). The eligibility requirements for output subsidies included either a minimum output sold or an obligation to increase the sold quantities. If these requirements were not satisfied, producers had to return the subsidy. The bulk of the support has been absorbed by agricultural enterprises which almost automatically fulfil the eligibility requirement. Shagaida and Uzun (2017) indicate a bias in support distribution not only towards agricultural enterprises but towards the largest enterprises most of which are part of agroholdings. Additionally, the approval of output subsidies required multiple documents, thus creating substantial transaction costs for smaller producers.

The second typical form of support, often claimed as a more successful one (Serova et al. 2004; World Bank 2006), have been loan subsidies, initially introduced for working capital for seasonal crop production and later extended to short-term and investment loans to agriculture and agricultural processing companies. OECD treats loan subsidies as part of the payments based on input use and, consequently, in Figure 1

they are included in the latter group.

According to OECD, interest subsidies are one of the largest measures in budgetary terms used in the State Programmes for Development of Agriculture. In 2015, they accounted for nearly 50 per cent of the total federal allocations for the State Programme (OECD 2016). In substance, they have been interest subsidies given to borrowers on long-term investment loans, defined in Russian policy as loans for a period between 1 and 8 years (nearly three-quarters of interest subsidies were spent on subsidizing investment

loans) (OECD 2017)[3]. In order to be eligible for interest subsidies, the beneficiaries have to follow a prescribed use of the loan, e.g. purchase of agricultural machinery and equipment, conversion to gas, construction and modernisation of specialised agricultural buildings and processing facilities. About 90 per cent of these subsidies were allocated to large agricultural enterprises and the downstream sector (OECD 2011). Russia does not stipulate a limit to the number of beneficiaries of investment subsidies and in the past, if necessary, the government either allocated additional funds or redistributed funds from other forms of agricultural support. In such a case, producers may have considered investment subsidies as almost certain transfer which would affect their production decisions.

It should be noted that agricultural policy in Russia has been rather unstable with the introduction of frequent changes in the rules and mechanisms of policy support which has affected responses of producers.

4 Short overview of agricultural employment in Russia

Employment in agriculture in Russia includes those employed/self-employed in agricultural enterprises, family farms and household plots. Agricultural employment has exhibited a downwards trend similar to the one typical for industrialised countries.

During the study period 2006-2010 and 2012-2015, employment in agriculture decreased by 29 per cent (2 million people), while the number of employed in the economy as a whole increased. In relative terms, in the same period, the role of agriculture decreased from 9.9 per cent of the total employment to 6.7 per cent. In rural areas, although the largest employer is the public sector, agriculture created the largest number of jobs in the private sector, i.e. 22.1 per cent in 2015. Hence, although at a national level the significance of agriculture has decreased, it still has an important role in the rural economy. Within agriculture, a lot of low-skilled staff has retired, whilst at the same time there were jobs for

[3] This was the implementation of investment subsidies in the period analysed in this paper. After 2017, support was disbursed under the form of reduced interest rates fixed by the government, combined with a financial compensation to lending banks (OECD 2020).

qualified workers but there was shortage of specialists. The accelerated outflow of jobs from agriculture from the lower quintile (the least skilled and least paid) has led to a significant improvement in the structure of jobs in the entire Russian economy (Gimpelson and Kapeliushnikov 2016). At the same time, workers leaving the agricultural sector have been poorly absorbed by the local rural economy (Serova and Zvyagintsev 2006). Despite the existing absolute surplus of workers in rural areas, many employers in agriculture complain of a shortage of qualified workers and especially young specialists (Kvartiuk *et al.* 2020; Bednaříková et al. 2016). Private initiatives to attract qualified personnel and invest in the acquisition of human capital have only been available to large farms and agricultural holdings (Kvartiuk *et al.* 2020; Malakhov 2014). Against the backdrop of these general development, the dynamics of agricultural employment has varied significantly depending on the region and the type of agricultural producers.

Concerning the two sectors – enterprises, and family farms along with household plots – the number of employees decreased at the highest rate in agricultural enterprises – by 55 per cent in the period 2005-2015 (Figure 2[4]), which was due to the higher rates of labour productivity growth in comparison to the other sector (Uzun and Shagaida 2019).

The decline in the family farms was 49 per cent, whilst in household plots employment even increased slightly – by 3.5 per cent despite the lowest profitability and labour productivity, since due to the scarce opportunities for alternative employment in rural areas some of the employees released by agricultural enterprises moved to the household plots. There is no data on the flow of employees from one agricultural sector to another. Nevertheless, several characteristics of the Russian rural labour market support this conjecture[5].

[4] In Figure 2 data are based on total employment in agriculture as the main (only) job. This number is close to the full-time equivalent (FTE). Thus, according to Rosstat data on the number of hours actually worked (compendium "Labor force, employment and unemployment

[5] The main indicators of rural employment are consistently lower than urban ones. Thus, labour force-to-population ratio and employment rate in rural areas were 65.9 per cent and 60.7 per cent in 2015, respectively (aged 15-72 years). For comparison, urban indicators were 70.2 per

First, there is a consistently higher rural unemployment rate than the one in urban area (in 2015 it was 7.9 per cent compared to 4.8 per cent in cities). In addition, the evidence shows that the main share of population in rural areas were people of working age (Rosstat b). These two facts suggest poor employment opportunities in

in Russia") in 2007 the equivalent of full-time employment in agriculture, forestry and fishing in was 5.8 million while the headcount was 6.3 million people; in 2015 – 4.3 million and 4.9 million respectively. Bogdanovski (2005) argues that those employed in the informal sector of agriculture, i.e. in household plots oriented towards their own consumption, practically double the number of people employed in the sector. Thus, in 2007 FTE in subsistence oriented household plots was 7.6 million people, in 2015 – 5.1 million people (calculation based on Rosstat a data, compendium "Labor force, employment and unemployment in Russia"). In our research, however, those employed in the informal subsistence oriented agricultural sector are not included in the data set.

rural labour market. Second, the dispersion of settlements and underdeveloped transport infrastructure determine the high opportunity costs of employment (Malakhov 2014). As a result, the employment alternatives for those who have been forced to leave one of the agricultural sectors have been either employment in the other agricultural sector, or employment outside agriculture. Given the extremely limited number of nonagricultural jobs in rural economy (Serova *et al*. 2008), able-bodied people have been forced to migrate to urban areas (Nefedova *et al.* 2016). The latter might have been unacceptable for some rural dwellers due to financial, family, health or other constraints. Thus, labour released from the corporate agricultural sector – mostly the least skilled workers – are likely to be forced to move to the family sector. The reverse movement is less common,

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cent and 66.8per cent, respectively. At the same time, the problem of rural poverty persists. In 2015, the average per capita disposable resources of rural households were by 35 per cent lower than the resources of urban ones. As a result, living in rural areas is one of the three risk factors for falling into a state of chronic low-paid employment in Russia (Gimpelson *et al*., 2018).

but it does occur in the case of, for example, the production expansion of agricultural enterprises.

In addition to the dynamics of the decrease in employment, labour in agriculture also differ in qualification, staffing requirements and wage levels. The qualification level can be traced through indicators of the education. In general, it has increased in all agricultural sectors. However, it is highest in agricultural enterprises, where in 2016 the share of managers with higher agricultural education was 53 per cent and with secondary vocational education in agriculture – 5 per cent, while among the heads of family farms these percentages were 34 and 12, respectively (Rosstat a). Education and qualifications greatly determine wages in the agricultural sectors.

The level of real wages in agricultural enterprises grew faster than in the economy as a whole - 2.0 and 1.4 times in the period 2006-2015, respectively. Nevertheless, by 2015 even in agricultural enterprises wages were only 56 per cent of the average for the economy. There are no statistics on wages (incomes) in family farms or household plots. However, based on the fact that wages in agriculture grew in proportion to the growth of labour productivity (Serova and Zvyagintsev 2006), as well as data on labour productivity by sector (Uzun and Shagaida 2019), it can be argued that wages (income) in family farms were on average lower than in agricultural enterprises, and in household plots – lower than in family farms. This factor has determined the low attractiveness of agriculture and this has acted as a driver of the employment decline from the supply side.

The dynamics of employment by sector have implications for the analytical approach adopted in this paper. First, the comparison of the employment changes across different sectors confirms that while agricultural enterprises are business oriented and correspondingly implement productivity enhancements, household plots are largely absorbing labour with low opportunity costs and their employment remained much more

stable, in a sense it reduced as well but not to a similar extent. Family farms appear to be somewhere in-between the above two extremes since they may share characteristics of both business enterprises and household plots. Given the fact that household plots have much larger numbers and a larger relative share of employment in comparison to family farms, it could be expected that the behaviour and the response of the family sector used in the analysis, which comprises of both household plots and family farms, will mimic that of the household plots.

The other implication is that since the period under study is characterised by a significant reduction in agricultural employment in all sectors, when we talk about employment effects we actually mean effects compared to a case when no public support was provided.

5 Conceptual framework

The main issue in the paper is to reveal the anticipated effects of agricultural subsidies on employment. To this end we follow a microeconomic logic, relying upon the concept of a "representative" farm and model its behaviour with regard to the economic stimuli provided by subsidies. We employed microeconomic logic due to Russian dualistic or, in other words, heterogeneous agricultural structure. In the presence of such underlying heterogeneity macroeconomic models might not be useful since their basic assumptions are not met.

The main point of interest is the effect of investment subsidies, which, together with short-term loan subsidies, are identified as the most important agricultural support measures in Russia and also as one of the largest budgetary transfers of the PSE (OECD 2011-2016). The farm output can be viewed as a function of equipment, labour, and real estate, the latter containing land and structure capital which are spatially fixed. For increased analytical tractability we assume a homogeneous (of degree 1) Cobb-Douglas type of production technology, which allows for easy decomposition of the underlying effects.

Hence, the output can be represented as:

$$Q=AR^{\alpha}M^{\beta}L^{1-\alpha-\beta} \quad (1)$$

where Q is the output, R is the real estate (combination of land and structure), M is equipment/machinery, while L is labour. The real estate values themselves are also assumed to combine structures and land via a Cobb-Douglas technology i.e. $R = BS^{\gamma}N^{1-\gamma}$, where N is land and S is the structure variable (immovable capital assets), A and B in the equations above refer to other effects on production.

By setting $C = AB^{\alpha}$ and rearranging the terms we can combine the above into:

$$Q=CS^{\alpha\gamma}M^{\beta}L^{1-\alpha-\beta}N^{\alpha(1-\gamma)} \quad (2)$$

Therefore, the capital contributions (consisting of structure and machinery) is $S^{\alpha\gamma}M^{\beta}$ while that of labour is $L^{1-\alpha-\beta}$. Note that due to the Cobb-Douglas functional assumption the parameters $\alpha\gamma$ and β can be interpreted as the corresponding elasticities of structures and machinery use (i.e. capital elasticities). $1-\alpha-\beta$, on the other hand, is the elasticity of labour.

Let us now consider an investment subsidy. The exact way in which such investment subsidy is applied will have implication for the model structure. In the case of Russian agriculture it takes the form of low-interest finance (i.e. subsidised loan interest rate). Other finance support such as capital grants and loan guarantees can be subsumed in the same structure.

In order to express the optimal behaviour of a profit-maximising farm we need the underlying prices for the production factors. Let us denote the prevailing wage rate as *w*, the price of machinery/equipment as *q*, the price of structure construction as *r*, and the price of (agricultural) land as *v,* while μ is the investment subsidy (in relative/percentage terms). This investment subsidy will affect the price of machinery and structure but also of land, since structure is attached to land.

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Let us now consider a typical profit-maximizing farm. It will adjust its mix of production factors in such a way that the ratio of their corresponding marginal products equates to their price ratios. This means that if we take some target level of output (i.e. conditional on the output), after normalising the price of output to one and setting

$D=\overline{C\alpha\alpha}\left(\gamma\right)\ \left(\overline{1-\gamma}\right)\ \left(\beta\right)\left(1\_\_\_\_-\alpha-\beta\right)$ then expressing the marginal products as equal to price ratios and applying some arithmetical manipulation, the optimal values for the production factors can be written in the following compact form:

$$N=\frac{(1-\alpha-\beta)(1-\mu)\ \ DQ}{w}\qquad(3)$$

$$M=\frac{\alpha\mu DQ}{q(1-\mu)}^{1-\alpha+\beta}\qquad(4)$$

$$S=\frac{\beta DQ}{r(1-\mu)}^{1-\alpha+\beta}\qquad(5)$$

$$L=\frac{\alpha(1-\mu)DQ}{v(1-\mu)}^{1-\alpha+\beta}\qquad(6)$$

The main point of interest in this paper is the optimal value of labour (L) in equation 6. The amount of labour for a given output is decreasing in investment subsidies (i.e. μ) and capital elasticities (both $\alpha\gamma$ and β,since $\gamma>0$), while machinery, structure and land are all increasing in the subsidy, as it is to be expected. Alternatively, we can say that the amount of labour is increasing in its elasticity (i.e. $1-\alpha-\beta$) and decreasing in investment subsidies.

If we were to abandon the conditioning on output and no longer consider it fixed, then the above proposition that the subsidy reduces labour use does not necessarily hold. However, for the opposite effect to materialise, the increase in output due to a capital subsidy needs to overcome the effect of the capital/labour substitution. The exact conditions under which this can happen are subject to the values of the optimal

parameters, but in general this would be more likely if $(1-\mu)^{\alpha+\beta}$ is small. In practice, this means lower capital elasticities or higher labour elasticity. The other precondition for positive labour effects with output increases is if the wage rate is low.

Therefore, investment subsidies are expected to lead to a capital/labour substitution which would decrease employment in agriculture unless they are disbursed to a low wage sector with a high labour elasticity. Estimating a full production function for the different types of agricultural holdings in Russia is beyond the scope of the present study. However, changes in labour use over the recent years provide some hints about their relative labour elasticity (see Figure 2). The most elastic sector with regard to labour appears to be the enterprise one. With regard to the wage rates, in addition to factors discussed in the previous section, due to the possible inclusion of non-economic considerations and possible cross-subsidisation of labour in household based forms of organisation (such as household plots and family farms), one may expect that wages would be relatively higher in the enterprise sector. Therefore, the two pre-requisites for positive labour effect of investment subsidies do not hold for any of the two agricultural sectors. More specifically, the high labour elasticity is violated for the family sector, while the low wage is unlikely to hold for the enterprise sector. Due to this, we can expect that such positive effects are unlikely to materialise and therefore investment subsidies can be expected to reduce agricultural employment.

Let us now further consider the case of the two agricultural sectors. The general conclusion from the above model is that investment subsidies should reduce employment in the sector they are provided to. Through sectors interaction (competition over a common pool of agricultural labour), they should increase labour availability to the non-subsidised agricultural sector, thus, depressing its price and therefore increasing its use.

Considering production subsidies, their effect would be essentially to reduce the price of the output and therefore increase its quantity. If we were to capture the possible effects in a theoretical model similar to the above one, we would need to free the price of output but condition on the production technology itself. To save space and since production subsidies are not the main focus we will not elaborate this in detail, but note that conditioning on (i.e. fixing) the production technology is equivalent to using it directly.

$$L = \left(\frac{Q}{{}_{\alpha\gamma}\,{}_{\beta} N_{\alpha(1-\gamma)}\, CS\, M} \right)^{\frac{1}{1-\alpha-\beta}} \quad (7)$$

This means that labour will increase with , i.e. $\frac{1}{1-\alpha-\beta}$ decrease with its elasticity $1-\alpha-\beta$. In other words, labour use will increase more for less labour elastic farms. Similarly, labour use will increase with capital elasticities. Therefore, the net effect could turn out to be negative for farms characterised by both low capital elasticities and high labour elasticity. Considering the historical changes presented in Figure 2 this means that we can expect that production subsidies will lead to increase of labour use in the family sector, characterised with smaller labour elasticity (since it did not historically reduce its labour usage to the same extent as the enterprise sector), but possibly lead to negative labour effects for the enterprise sector which has higher labour elasticity and is likely to exhibit lower capital elasticity.

Finally, there is the issue of other types of subsidies. Since these are a collection of heterogeneous support measures, their combined effect may not be ascertained a priori. There are subsidies aimed at employment (e.g. the co-financing of construction of houses for young agricultural professionals) but they are limited in size and scope. It is clear that

such subsidies will increase employment. Several other subsidies can be broadly classified as “infrastructure enhancing”. These are not easy to cast in the above framework since they would affect many of the model parameters with ambiguous direction of such effects. We may, however, consider such “infrastructure enhancing” subsidies as affecting the terms of trade of agriculture in general. This should be improving employment prospects, thus, the effect of such subsidies can be expected to be inversely related to the general unemployment rate.

6 Empirical specification

The first issue to consider in the empirical specification is that of background variables that drive employment flows. A number of variables affect sectoral employment. In order to derive a corresponding empirical specification, it is necessary, first, to find adequate proxies bearing in mind data availability constraints, and second, to measure them. The first driver affecting sectoral employment is the value of job searches proxied by relative wages in agriculture compared to the rest of the economy. It is assumed that there are some limits to the workforce movements between agriculture and the rest of the economy which would ensure the exogeneity of these relative wages. However, since the same relative wage is used as a proxy for search values in the different agriculture sectors, it is also necessary to account for the interdependence of the agriculture sectors. The unemployment rate was chosen to account for the interdependence. First, it can be viewed as a proxy for the value of job searches in the same way as the relative wage (see e.g. Kroft and Notowidigdo 2016). Second, the unemployment rate can be thought as part of the general labour dynamics mechanism, which allocates labour to unemployment and employment in different sectors and which is simultaneously determined with sectoral employment. This is particularly relevant to the case of Russia where a large ~~semi-subsistence~~ agricultural sector (namely the household plots) can effectively absorb excess

labour, thus reducing the interaction between agriculture and unemployment as suggested by data presented in the overview of agricultural employment in Russia. Hence, we can use the unemployment rate not only to capture the effects of sectoral employment flows, but also to indirectly account for the trade-offs between the different agriculture sectors - enterprises, family farms and household plots.

We provide a measure of the pressures on the relative availability of labour, i.e. the regional population density. Additionally, we employ another measure of the relative importance of agricultural employment, namely labour intensity measured as the labour used to produce a unit of agricultural output (the latter expressed in 2006 real prices). Depending on the reliability of the main measure of labour pressure on agricultural employment, this additional variable may be significant or not in the empirical specification.

Another driver of sectoral employment are technological (productivity) shocks. Government subsidies are assumed to create such shocks. The exact nature of such shocks will depend on the way such subsidies affect the production system, something that can also be expected to be specific and different in the different sectors. It would be necessary to disaggregate the subsidies into relatively homogeneous groups (types) in order to assess their effect.

7 Data

The main unit of analysis in this paper is the region since all data is measured at regional level. The dataset covers 78 regions[6] over the period 2006-2010, 2012-2015 for which there is data availability, thus including 702 observations for each of the measured

[6] All regions in Russia as of 2014 with the exception of federal cities (Moscow, Saint Petersburg) and autonomous districts that are part of regions.

variables. There is no published data for 2011 since not all the regions provided data for that year (see also Kvartiuk and Herzfeld 2021). Data sources are the Ministry of Agriculture of the Russian Federation in respect to the data on subsidies and Rosstat for the covariates.

Generally, data in Russia classifies as employed all those who spend at least 1 hour a week on activities related to production of goods or services for payment or profit, i.e. the data does not capture separately full and part-time employment. However, for our period of study the number of hours worked on average per week per person in agriculture was stable – 33 hours. This suggests that during the study period there were not significant changes in the relation between full- and part-time employed.

Regional trends in agricultural employment are shown in Figure 3. If we ignore the North Caucasian and Far-Eastern regions, Figure 3 shows a clear negative relationship between the level of subsidisation and agricultural employment. This is consistent with the increasing share of investment and production subsidies in the total subsidy pool (see Figure 4), since as we have already discussed these types of subsidies are expected to reduce agricultural employment. The latter is of course a hypothesis that we test empirically in this paper.

Figure 3 around here

Looking at mode detail at the regional picture, Northwest, Ural and Volga Federal Districts witnessed the highest decrease in agricultural employment – a reduction of 18 per cent or more during the study period. The most stable situation has been observed in the Southern and North Caucasian districts, in the latter agricultural employment even increased. This has been due both to the steady development of production in regions favourable for agriculture, and to the high household plots share, where employment grew slightly (Figure 2). Regionally, logically some correlation between the dynamics of

agricultural employment and climatic conditions for agriculture has been observed, namely, the more favourable the conditions are, the smaller the reduction in agricultural employment. However, conditions in individual regions are highly specific and the development of agriculture, and hence agricultural employment, depends on regional policy, production specialisation, the history of certain large enterprises, and so on up to the personality of regional agriculture ministers (Kvartiuk and Herzfeld 2022; Svetlov *et al.* 2019). For example, in Yakutia (Far Eastern district), the stabilisation of agricultural employment, despite the lack of most favourable climatic conditions, has been associated with the active support of the industry by regional authorities and the prevalence of specific employment in reindeer husbandry (Naumov et al. 2020). Thus, as presented in Figure 3, the regional dynamics of agricultural employment in Russia does not follow any single pattern.

Ideally, separate data on employment in agricultural enterprises, family farms and household plots would have been necessary. However, official statistics provides the total number of people (headcount) employed in agriculture and separately those employed in agricultural enterprises. This means that the data allows to calculate employment in family farms and household plots together. Thus, the family sector is more heterogeneous than the enterprise one as it includes both family farms, registered as legal persons, and household plots that are not legal entities. Therefore, the analysis covers two agriculture sectors: agricultural enterprises and what we refer to as a "family" sector, consisting of both family farms and household plots. The latter may create some conceptual difficulties, since the family farms are expected to behave in many ways similarly to agricultural enterprises, while the household plots may exhibit different behaviour. Consequently, the expected policy response of the family sector may aggregate contradictory underlying behaviour and will in general depend on the relative balance between family farms and

household plots. But as stated previously, since household plots have much larger numbers and a larger relative share of employment in comparison to family farms, their behaviour and response are expected to affect stronger the overall response of the family sector.

Table 1 around here

The data used (variables, description and summary statistics) are presented in Table 1. The table indicates that in the analysed period there was a negative minimum and mean rate of change of employment in the agricultural enterprises, and a negative minimum employment rate in the family sector.

In the dataset subsidies were split into investment and other. This classification ensures consistency and comparability between the different agriculture support programmes over the period under study. Investment subsidies are relatively homogeneous as required by our empirical specification. Furthermore, we have split the investment subsidies into two components directly received by the enterprises and the family sector, namely invsub and smallsub in Table 1. This was necessary to study empirically the interactions between the two sectors.

Other subsidies, however, are a mixed group including: (i) subsidies based on input use; (ii) coupled output payments per tonne of output sold; (iii) subsidies for short-term loans; (iv) subsidies for social development of rural areas, land improvement, etc. We have separated the coupled production enhancing subsidies (prodsub) due to their homogeneous nature and retained the reminder of the agricultural support as other subsidies (othersub2) not contained elsewhere. Figure 4 shows the main types of subsidies in the classification we have taken for 2006-2015. These funds include both regional and federal subsidies.

Figure 4 around here

During the study period, investment and production subsidies have increased more than two times. The growth rate of these subsidies has exceeded the growth rate of general support. Production subsidies have included support for animal husbandry, a priority industry in both state programmes operating during the period under study, as well as support for crop production, the financing of which has increased especially since 2013 with the introduction of a per-hectare subsidy. Subsidies to the family sector accounted for an average of 3 per cent of total support, which reflects the priority of the corporate sector given by the Russian agricultural policy. The dynamics and structure of agricultural subsidies in our data correspond to the patterns of support for agricultural producers reflected in the OECD[7], which confirms the validity of the data set on subsidies used in this paper.

The distribution of budget support by region is imbalanced (Figure 3). The lowest share of budget support in gross agricultural output was in Krasnodar Krai (Southern district and traditionally the so-called breadbasket of the country) – less than 3 per cent on average for the period under study, and the highest – in Chukotka Autonomous Okrug (Far Eastern district, Far North region), where this share was close to 100 per cent. The regional distribution of the subsidies level shows that agricultural policy, on the one hand, locally supports the most successful individual projects and enterprises, which are mainly concentrated in the most climatically favorable regions, on the other hand,

[7] The average annual deviation of the total agricultural subsidies according to the Ministry of Agriculture, which we use in the study, from the PSE minus market price support is 12.5 per cent up. The deviation may be due to differences in the classification of subsidies, and the inclusion of fisheries and part of rural development subsidies in the consolidated subsidies by region in the data of the Ministry of Agriculture.

supports producers in marginal regions in terms of competitive farming. Shik (2020) came to similar conclusions in a paper on state support regionalisation in Russia.

8 Empirical model and econometric issues

Two separate models are estimated one for agricultural enterprises and one for the family sector; the logic behind this decision, as we indicated earlier, was the assumption of different objective functions. The two dependent variables are expressed as "growth" rates, i.e. as an annual change in the rate of employment in the corresponding sector (enterprises of family). The subsidies are measured as a share of the value of the regional agricultural output[8]; the relative income is a ratio of wages in agriculture to the average regional wages in current prices, population density is expressed in thousands of persons/km^2, while the labour intensity is the number of people used to produce 1m rubble (RUB) output expressed in 2006 prices.

There are two econometric issues that have to be considered in this specification. These refer to: i) the possible endogeneity and ii) individual or time heterogeneity due to the panel nature of the data set. These two issues are inseparable, i.e. they have to be simultaneously and concurrently examined. In practice, this means that the endogeneity implementation depends on correct specification of the corresponding panel data effects, while the tests for these subsume the endogeneity issue by using modelling specification that accounts for it.

Endogeneity may arise from the fact that employment in the enterprises and in the family sector are driven by the same underlying job allocation process that is not explicitly modelled here. The same process drives the overall unemployment. This means that a

[8] Official statistics provides the regional agricultural output as a monetary value in current prices of the sum of crop and livestock output of all agricultural producers.

common process drives general unemployment and the two agriculture sectoral employment rates. Econometrically, this leads to simultaneous determination of the endogenous unemployment rate and the dependent variable, which is the corresponding sectoral employment. The conventional approach to dealing with endogeneity relies upon instruments. It is however difficult to find appropriate instruments that can fully identify the variation in the endogenous variable. The obvious and quite common reliance upon lagged values of the covariates did not in that instance provide a valid identification. Owing to this, the strategy in this paper follows the approach suggested by Lewbel (1997).

Lewbel (1997) showed that a subset of exogenous variables present in the endogenous regression model can be used to construct a wider set of potential instruments. These instruments are only valid if the endogenous variable has a skewed distribution. Otherwise, the same approach and justification as in conventional instrumental variables estimation apply. More specifically, these instruments are:

$[Y-E(Y)]\ [P-E(P)]$

$[G(Z)-E(G(Z))]\ [P-E(P)]$

$G(Z)-E(G(Z))$

$[G(Z)-E(G(Z))]\ [Y-E(Y)]$

$[P-E(P)]^2\ [Y-E(Y)]^2$ where Y is the dependent variable, P is the endogenous variable(s) and $G(.)$ is any nonlinear function that has finite third moments. In practice, by replacing the expectation operator with a sample mean one can obtain a wide range of instruments. Although relying on a more restrictive assumption about the endogenous variables in terms of skeweness, this method gives an opportunity to construct and test a large number of non-linear instruments and thus alleviate the issues related to the search of identification.

In this paper the models are identified by using the first two of the above listed types of instruments.

The first is $(Y - \bar{Y})(P - \bar{P})$. The second is of the form $(G - \bar{G})(P - \bar{P})$, where G is some nonlinear function for a given exogenous covariate. By varying the exogenous covariates and the corresponding non-linear transformation one can obtain multiple instruments. The specific choices for G depend on the variable being explained and the empirical specification. For the enterprise employment these are

1/*popul* (i.e. $popul^{-1}$)

1/*prodsub* (i.e. $prodsub^{-1}$)

1/*othsub_2* (i.e. $othsub\_2^{-1}$)

1/*labour_intensity* (i.e. $labour\_intensity^{-1}$)

$invsub^2$

The instrument set for the family sector employment is created similarly, but the last instrument is replaced by $smallsub^2$ in the theoretical model. Hence, we have four distinct instruments common to both models and one specific to each of the sectors. We can carry out a battery of specification tests, explained in the next section, so that the correct panel data modelling specification can be decided upon.

The other issue one may want to address is that of the general model specification. Recently Schultheiss *et al*. (2023) proposed a partial goodness of fit test, which fits nicely within our estimation framework. They formally assess whether, and if so, which causal effects can be assessed even under conditions of hidden confounding. In plain English this means assessing the reliability of the individual coefficient estimates for causal inference purposes. In simple terms, their method compares the OLS estimator (regressing y on X) to the higher order OLS (HOLS) estimator which is obtained from an auxiliary regression

of Xy on XX. The logic of the approach is that in correctly specified model the two estimators should be identical and therefore one can test the difference in the estimates. In practice, the partial version of the HOLS test that we use, obtains the coefficients of interest from a series of partial regressions, thus only testing one particular coefficient at a time. This amounts to testing whether using higher order moments information results in significantly different estimates. Since a Gaussian distribution is fully defined by its first two moments, such a test will be non-identifiable under multivariate normality where higher order moments do not contain any extra information (see e.g. Peters *et al.* 2014). Since in the partial test implementation X is usually Gaussian, the test requires that the dependent variable in the statistical model under question deviates from Gaussianity. This pre-requisite is similar to the nonGaussianity requirement for the endogenous variables, but applies to the dependent variable instead and was tested for before implementation.

The partial HOLS test checks whether the coefficient for the variable in interest can be used for inference purposes. The main source for rejecting the null hypothesis, would be the presence of hidden con-founders (i.e. missing variables). There are two possible reasons for missing variables, namely model misspecification and endogeneity. Note that under otherwise correctly specified model, the issue of missing con-founders i essentially means endogeneity. Hence, individual HOLS test statistics can be used to infer the potential endogeneity of specific variables. Similarly, if there is no endogeneity (e.g. when all endogenous variables have been properly identified), the HOLS test is a test on the model specification, since then the omitted confounding variables issue becomes equivalent to model misspecification. We can therefore apply the HOLS test consecutively to isolate the above two sources. In particular, we can use it to determine the variables which are potentially endogenous, correct for endogeneity and then by testing the corrected (for) model we can test for model specification.

9 Results

The tests related to the panel data model specification are presented in Table 2 suggesting that the model requires time but not individual, i.e. regional effects. Due to the computational requirements, the panel data specification tests are restricted to the Lagrange Multiplier (LM) type of tests which only require estimating the pooled versions of the endogenous model specification, thus greatly reducing the computational load. We have applied a battery of LM test, proposed by Breusch and Pagan (1980),

Gourieroux *et al.* (1982), Honda (1985), and King and Wu (1997).

Table 2 around here

All tests in Table 2 indicate that while there is a need to account for panel data effects (all two-way tests are highly significant), individual effects are rejected in favour of time effects. Furthermore, the Hausman tests (which are the original version of Hausman (1978) and auxiliary-regression-based version in Wooldridge (2010, Section 10.7.3)) indicate that these time effects are correlated which means that fixed effects specification for the latter is required. The presence of only time effects can be expected since the dependent variable is constructed as a change in the corresponding employment rates. Such a change, which is essentially a first order time difference, should effectively remove any regional fixed effects if these are present in the data.

Therefore, it is necessary to account for time heterogeneity. Since such time effects are not of primary interest in this paper, we omit them from further discussion. As a result, the estimated model is simplified by transforming the data prior to estimations in order to remove the time effects. More specifically, all variables were demeaned by subtracting their time means. Applying a standard pooled regression to the transformed data is able to obtain the same results as a model with time effects as long as we correct the degrees of

freedom in calculating the standard errors. This procedure is standard since most software implementations of panel data estimators internally apply such data transformations.

Table 3 presents the estimated models together with the appropriate instruments validity tests and the P-values for the individual coefficients partial HOLS tests. HOLS0 refers to tests applied to the specification that ignores the possible endogeneity, while the HOLS refers to the tests applied to our final actual specification. In the latter case these are essentially the tests on the second stage coefficients.

The initial case, i.e. when ignoring endogeneity, shows that the coefficients of the unemployment rate and the employment change in the other agricultural sector are unreliable. Under correct model specification, this is is equivalent to finding that these two variables are endogenous. Note, however, that the P-value of the unemployment rate in the family sector is 0.086. This suggests that the effect of possible confounding is not that significant in this case, which does not necessarily imply lack of endogeneity, but rather local as opposed to global confounding. Yet, when we apply the partial HOLS tests to our estimation, all these are insignificant indicating that the effects of interest are correctly identified. This basically means two things. First, the endogeneity correction did not simply work (what the tests in Table 3 tell us) but it did fully recover the parameters under interest. In simple terms, when instruments are valid, they change the estimates away from the OLS ones. Conventional instrumentation tests only identify whether such a change was significant. They do not however provide any indication about whether it was sufficient. For example, let us imagine that the true coefficient of an endogenous variable is 10, while ignoring endogeneity produces an estimate of 6. Correcting for endogeneity should change the estimate. Let us now assume that this changed estimate is 8. Standard test (say Wu_Hausman) would correctly determine that the estimate correction (from 6 to 8) was statistically significant. However, in this case the corrected estimate is still away

from the true value (of 10). So corrected estimates are closer to the truth, but still wrong, probably because the instruments did not fully identify all sources of variation in the endogenous variable. Similarly, if the corrected estimate was e.g. 12, we would have "overshooting" and still get the wrong estimate.

Applying partial HOLS tests on the corrected for endogeneity estimates in contrast asks directly the question of whether they are significantly different from their true values. Thus, it tests whether the method used to account for endogeneity was successful in achieving its aim, something that standard tests are unable to do.

The instruments validity tests are all satisfactory. The instruments do not suffer from a weak instrumentation problem, the Wu-Hausman tests indicate that they are valid as they provide significant correction in the estimated coefficient to account for the endogeneity effect, and finally they are coherent which can be seen in the Sargan test for over-identification.

Table 3 around here

The other implication of the HOLS tests is that the estimated effects are essentially correct in that they are non-contaminated by missing variables or general misspecification. To explain this consider the following. We presented above that in the final specification the instruments are valid which suggests there is no remaining exogeneity problem. Therefore, under the lack of endogeneity, the only other reason for obtaining unreliable effects is that of incorrect specification which alongside missing variables also includes functional form misspecification. Since the partial HOLS tests fail to detect such a problem, we can therefore conclude that the employed model specification is reliable.

The modelling specification includes interaction effects as the employment rate in the other agricultural sector is included. These interaction effects are significant and have the expected negative signs. Nevertheless, the other estimated effects are not sensitive to

the inclusion of interaction. This can be verified by comparing the main specification results in Table 3 to a specification with no interaction effects presented in Appendix 1.

The estimated effects indicate different responses to support payments in different sectors. The first point of interest is the effect of the investment subsidies. The expectation was that these would create a capital/labour trade-off in the sector where they are implemented, and hence, should have a negative effect on employment. Indeed, looking only at the signs of the estimated coefficients, this appears to be the case with negative effect of invsub on enterprises employment and similarly of smallsub on family sector employment. However, while the above effect is statistically significant for the family sector, it is not so for the enterprises. There are several possible explanations for the lack of statistical significance of this effect on employment in agricultural enterprises. One is that the production systems employed in agricultural enterprises are much more complex that those in the family sector and hence the effect of investment subsidies may take longer to materialise. Furthermore, since in general the family sector is already more labour intensive (its employment did not contract to the same extent as in the agricultural enterprises, as demonstrated in Figure 2) it is easier to displace labour at the margin, while this may not be so in the agricultural enterprises. Finally, agricultural enterprises may have some non-agricultural activities, hence aggregating heterogeneous types of employment. Our results are to some extent consistent with Svetlov *et al*. (2019). The authors analysed microdata for the period 2013-2015 of fourteen regions. They reported a negative effect of investment subsidies on enterprise employment only in four regions; in the rest of the studied regions no statistically significant effect on employment was found.

Furthermore, the indirect effect of the two types of investment subsidies (i.e. effect of smallsub on enterprises and invsub on family employment) are both positive, which supports the conjecture of direct substitution of labour in one sector, which increases the

availability of labour and, hence, relative employment in the other agricultural sector. Therefore, although invsub do not show a direct statistically significant effect on enterprises employment, their positive contribution to family sector employment gives some support to the argument that they inherently facilitate a capital/labour substitution in the enterprises. When we estimated a restricted specification with no sectoral interaction effect (see Appendix 1), this one and virtually all other effects did not change qualitatively. In addition to providing evidence that these findings are not sensitive (i.e. are robust) to the model specification, this provides further justification of a capital/labour trade-off, since a comparison of Table 3 with Appendix 1 demonstrates that the indirect effects of investment subsidies are not constrained to sectoral interactions only, but do derive from a more general capital induced effects.

The effects of the other subsidies on the two sectors are diametrically opposite (Table 3). In particular, production subsidies reduce enterprise employment but increase family sector employment, while the other subsidies work the other way around. The result for the other subsidies fits with our interpretation that they can be mostly viewed as infrastructure improvements. Since the other subsidies are heterogeneous and have decreased over time, we focus on the effect of production subsidies. The labour increasing effect of these on the family sector is to be expected. Due to its higher reliance on labour and its lower labour elasticity, the family sector has to increase its labour use to meet the increased output requirements to be eligible for production subsidies. The effect on the agricultural enterprises however is not so straightforward. Due their more capital-intensive nature they are expected to rely more heavily on capital to meet such requirements. Another possible reason is that the environment of relatively stable expectations of production subsidies may induce technological change which substitutes capital for labour. The theoretical pre-requisites for obtaining a net negative effect, discussed in the

conceptual framework, i.e. high labour elasticity and low capital elasticities, are present in the enterprises.

The other covariates have opposing signs in the two equations demonstrating the qualitative difference between the two agricultural sectors. Relative income reduces employment in the enterprise sector but increases it in the family sector. Since this is a relative income in agriculture compared to the rest of the economy, this means that when it increases the wage bill of the agricultural enterprises will also increase and this may force managers to reduce employment in order to control the labour cost. For the family sector, the outcome is a result of an interplay of two factors. First, due to the increased relative wage households may become more competitive and face an increased demand for their output and, thus, engage more household members since they do not need to pay a market wage rate. Second, the decreasing differential between agricultural and non-agricultural incomes reduces the pressure on labour migration out of agriculture, thus, keeping employment in the family sector.

Population density which reflects population flows is assumed to follow the formal job opportunities. It increases employment in the enterprise sector and reduces it in the family one. The availability of formal job opportunities attracts labour to formal enterprises. The family sector reacts to the better employment opportunities outside the family by releasing labour. On the other hand, the general unemployment rate reduces employment in the enterprise sector but increases it in the family sector. Higher unemployment means less job opportunities particularly in the formal sector and, hence, people go back to their family farms, and mainly household plots, which flexibly absorb excess labour, a process well-documented during the reforms of Central and Eastern European countries, resulting in low labour productivity and incomes.

Finally, the second measure of the pressure on the relative availability of labour, the labour intensity, increases employment in the enterprise sector but it is not significant

in terms of the family sector employment.[9] This result suggests that a more labour intensive (regional) product mix increases labour requirements in agricultural enterprises. In practice, this means that the employment allocation mechanism, assumed in this paper, does vary with the difference in the labour intensity of regional agricultural activities.

10 Conclusions

Whilst there are many studies on the effect of agricultural subsidies on farm employment in the EU, characterised by mainly family farms, little attention has been paid on their differential effect on the corporate and family farms. The paper evaluated the employment outcomes of agricultural subsidies in the two distinct sectors typical for Russian agriculture – agricultural enterprises and the family sector. Empirically, two separate models were estimated for the two agricultural sectors due to the assumption of profit maximising behaviour in the enterprise sector and utility maximising in the family one. The study controlled for endogeneity and time heterogeneity. Two types of subsidies were explicitly defined and analysed. The first type were investment subsidies which were defined in terms of the sector they were applicable to. The second type were production subsidies which due to the data limitations could not be split by destinations. The study also included the so-called other subsidies, a heterogeneous group acting in different directions. The effect of these other subsidies was not of primary interest in the paper.

Results indicated that investment subsidies work in a conventional capital/labour substitution framework in that they reduced employment in the sector to which they directly applied, but also indirectly increase employment in the alternative agricultural

[9] This is the only difference to the reduced (no interactions specification) in Appendix 1, where this effect is not significant for both agricultural enterprises and the family sector.

sector. Production subsidies reduced employment in the enterprise sector, but increased it in the family sector, reflecting the different reliance on labour of these two sectors and the predominance of household plots in the family sector.

One of the general conclusions of the study is that from employment point of view the family sector acted as a "residual" sector driven by the developments in agricultural enterprises and in the wider economy. This conclusion suggests that policymakers should be aware of the consequences for the family sector of public support to agricultural enterprises, since the family farms and household plots are important to keep population in rural areas and might mitigate the push for rural out migration under the circumstances of the underdeveloped rural non-agricultural labour market.

We have used Russia as a case study since the heterogeneity in climatic and environmental conditions for agriculture make it interesting to study the effect of subsidies on employment. It is necessary to do similar research on other countries with dual agricultural structure to understand whether policy conclusions are generalisable.

Disclosure Statement

The authors report there are no competing interests to declare.

Data Availability Statement

The data is provided by the Russian Ministry of Agriculture and, according to the terms of use, is not open access data.

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Appendix 1. Simplified model specification

	Enterprises employment		Family employment	
	Estimate	P Value	Estimate	P Value
Invsub	-0.584	0.274	1.779	0.049 *
smallsub	10.309	0.001 ***	-19.058	0.000 ***
Prodsub	-0.233	0.012 *	0.356	0.026 *
othsub_2	0.678	0.006 **	-1.298	0.003 **
Income	-0.260	0.002 **	0.473	0.001 **
Popul	1.405	0.002 **	-2.632	0.001 ***
unemploym	-2.648	0.000 ***	4.849	0.000 ***
labour._intensity	0.005	0.126	-0.008	0.161
	Statistic	P Value	Statistic	P Value
Weak Instruments	2.968	0.005 **	2.420	0.019 *
Wu-Hausman	54.773	0.000 ***	132.279	0.000 ***
Sargan	4.558	0.602	5.357	0.499

Tables

Table 1. Summary statistics

Variable	Description	Mean	Min	Max	SD
empl_ent	change in enterprises employment rate	-0.069	-0.566	0.425	0.084
empl_fam	change in family sector employment rate	0.051	-0.775	0.698	0.092
Invsub	enterprises investment subsidies rate	0.013	0.000	0.099	0.014
smallsub	family sector investment subsidies rate	0.003	0.000	0.049	0.005
prodsub	production subsidies	0.037	0.000	1.565	0.095
Othsub2	other subsidies rate	0.075	0.004	1.841	0.120
Income	relative income of agriculture	0.598	0.170	1.131	0.170
Popul	population density	0.029	0.000	0.166	0.029
unemploym	unemployment rate	0.080	0.020	0.677	0.063
labour._intensity	number of people for unit of output	4.468	0.366	18.711	2.054

Table 2. Panel data effects tests

Test	Enterprises employment Test statistic	P Value	Family employment Test statistic	P Value
LM test - two-ways effects Gourieroux et al.	118.410	0.000	24.483	0.000
LM tests – Honda two-ways effects	6.994	0.000	3.217	0.001
individual effects	-0.990	0.839	-0.399	0.655
time effects	10.881	0.000	4.948	0.000
LM tests – Breusch-Pagan two-ways effects	119.390	0.000	24.643	0.000
individual effects	0.981	0.322	0.159	0.690
time effects	118.410	0.000	24.483	0.000
LM tests – King and Wu two-ways effects	10.053	0.000	4.587	0.000
individual effects	-0.990	0.839	-0.399	0.655
time effects	10.881	0.000	4.948	0.000
Hausman test	53.659	0.000	45.610	0.000
Regression-based Hausman test	53.485	0.000	45.068	0.000

Table 3. Estimation results

	Enterprises employment				Family employment			
	Estimate	P Value	HOLS0	HOLS	Estimate	P Value	HOLS0	HOLS
empl_ent					-0.859	0.000 ***	0.013	0.138
empl_fam	-0.690	0.000 ***	0.000	0.374				
Invsub	-0.089	0.743	0.821	0.379	1.875	0.011 *	0.562	0.362
smallsub	4.769	0.002 **	0.754	0.621	-16.406	0.000 ***	0.387	0.253
prodsub	-0.157	0.001 ***	0.268	0.299	0.294	0.025 *	0.210	0.206
othsub_2	0.269	0.035 *	0.986	0.190	-1.113	0.002 **	0.944	0.732
Income	-0.129	0.003 **	0.580	0.950	0.409	0.001 ***	0.504	0.418
Popul	0.650	0.005 **	0.459	0.909	-2.291	0.000 ***	0.385	0.160
unemploym	-1.182	0.001 **	0.025	0.776	4.106	0.000 ***	0.086	0.471
labour._intensity	0.005	0.007 **	0.482	0.986	-0.008	0.103	0.216	0.521

	Statistic P Value	Statistic P Value
Weak Instruments	2.892 0.006 **	2.419 0.019 *
Wu-Hausman	28.199 0.000 ***	298.028 0.000 ***
Sargan	8.786 0.186	1.765 0.940

Figures

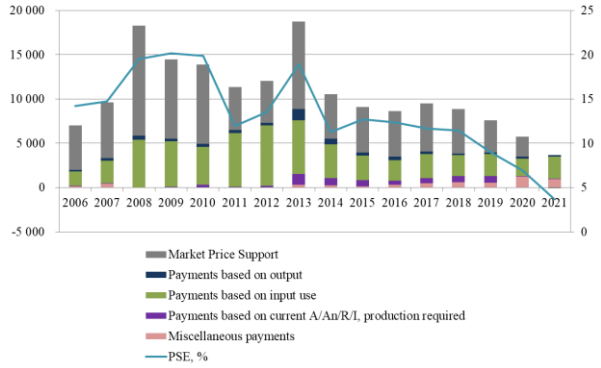

Figure 1. Level and PSE composition by support categories, Million USD

Figure 1 Alt Text: Five main categories of support for agricultural producers in Russia, of which market price support accounts for the bulk and the second largest category is payments based on input use.

Source: OECD Agriculture statistics (database)

Figure 2. Structure of employment in agriculture (as a main occupation) according to types of producers, 2005-2015, Million People*

Figure 2 Alt Text: Two histograms for the initial and final year of the study period reflecting employment decline in agriculture, especially in agricultural enterprises.

* Without employees in forestry, fishing and aquaculture enterprises to ensure comparability with the data from the agricultural census.
Source: Russian Federal State Statistics Service, Russian agricultural census (2006, 2016).

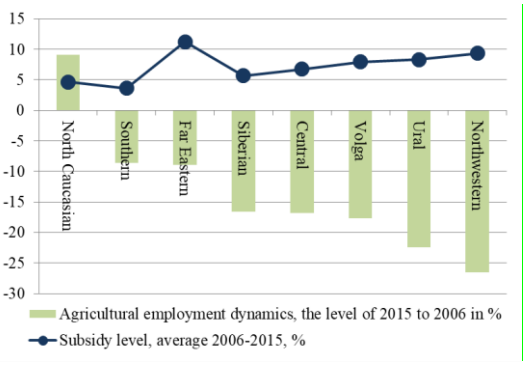

Figure 3. Agricultural employment dynamics and subsidy level by Russian Federal Districts, %

Figure 3 Alt Text: A histogram of Russian Federal Districts showing the largest decrease in agricultural employment in the Northwestern and Ural districts with a high agricultural subsidies level there, which are higher only in the Far East district.

Source: data from the Ministry of Agriculture of the Russian Federation and Rosstat.

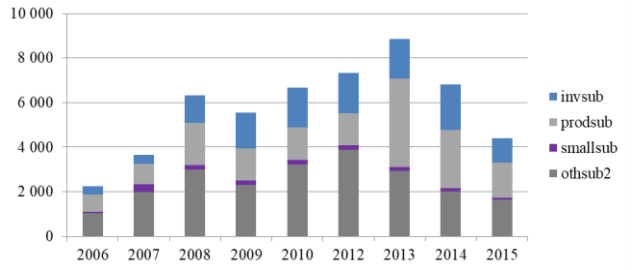

Figure 4. Distribution of agricultural subsidies, Million USD

Figure 4 Alt Text: The amounts for the four types of subsidies by the years of the study period, where the main subsidies of interest production and investment have increased over time.

Source: Ministry of Agriculture of the Russian Federation