The Level and Composition of Agricultural Support Policies: Their Impact on the Performance of the Agriculture Sector and an Exploration of their Causes

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2021

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Facultad de Agronomía e Ingeniería Forestal

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Thesis
to obtain the degree of

Doctor
en Ciencias de la Agricultura

Santiago, Chile, April 2021

Thesis presented as part of the requirements for the degree of Doctor in Agricultural Science, approved by the

Thesis Committee

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Santiago, April 2021

Dedication

To my family, especially my mother Marta, my wife Silvia and my children Jorge Alejandro, Joselyn Denise, Andrea Eugenia and Ángel Agustín. Thank you for all your love and support.

This work was initially supported financially by the Inter-American Development Bank, through a research project carried out in 2015 with the department of agricultural economics of the Universidad Católica de Chile (UC): The impact of public expenditure on agricultural sector in Latin American and the Caribbean. I appreciate the financial support of Vicerrectoría Académica of UC during the years 2014 to 2017.

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Abbreviations

AGRIMONITOR	Agricultural Policies Monitoring System
BTS	Budget Transfers and Subsidies direct to producers
ERP	Effective Rate of Protection
FAO	Food and Agricultural Organization of the United Nations
GSSE	General Support Estimate
IDB	Inter-American Development Bank
IFPRI	International Food Policy Research Institute
LAC	Latin America and the Caribbean
NRP	Nominal Rate of Protection
MPS	Market Price Support
OECD	Organization for Economic Co-operation and Development
PSE	Producer Support Estimate
TSE	Total Support Estimate
WTO	World Trade Organization

General Abstract

Historically governments have intervened in the agricultural sector, either through the regulation of the prices or public expenditures. The objective of this study is to analyze the effects of government expenditures, its composition on agricultural income and productivity, and its institutional and political causes. The thesis is organized in four chapters and two annexes. In the first Chapter we present the conceptual and methodological framework. In the second, we present a descriptive analysis of the trends and current situation of the level and composition of agricultural support policies, using data from 35 countries from 1986 to 2018. In the third and four Chapters we present the empirical analysis, using several approaches to model estimation and the 35 country panel data. The results confirm previous studies regarding the positive effect on farm sector performance of the level of public spending, and, more importantly, the negative effect of spending directed towards private goods. In terms of estimation strategies, results also show that measuring agricultural productivity by sectoral value added per farm worker, in contrast to value added per rural inhabitant, leads to more robust estimation with greater statistical significance. The results also indicate that explanatory variables related to political institutions explain the level and composition of government spending. We found that political institutions with a proportional election rule and presidential system tend to have greater overall support for the agricultural sector and greater spending on private subsidies. Also, economic development is associated with greater public agricultural spending.

Key words: Public expenditure, public goods, private subsidies, electoral rules, forms of government, instrument choice.

Chapter 1. Conceptual and Methodological Framework

Abstract
Historically, governments have heavily intervened in the agricultural sector, either through the regulation of the prices (international and domestic markets) or directly using fiscal resources. The literature indicates that price distortions create economic inefficiencies and that spending directed at private goods contributes little to the performance of the sector or to economic development. The decisions of governments with respect to the levels and composition of their support of agriculture can be explained by institutional factors, both economic and political. While the effects of market distortions are widely documented, especially within a single-market context, the effects on the performance of the agricultural sector of the level of public spending and composition are less well studied. The objectives of the research presented in this thesis are to analyze the effects of government expenditures and its composition on agricultural income and productivity, and to examine the institutional causes of the levels and mix of agricultural spending. This first chapter reviews the relevant literature regarding the effects of agricultural policies and presents the theoretical model and empirical method on which subsequent chapters are generally based.

Keywords: Public expenditure, public goods, private subsidies, OECD, Agrimonitor

Introduction

A widespread model of national economic development focuses on the problem of the complementarity and coordination between the roles of the state, the market and civil society. Some authors call this the fundamental triangle of development (De Janvry and Sadoulet, 2016). According to this model, the paradox of the role of the state is that its proper functioning influences and at the same time depends on the level of development, but it is precisely in the poorest countries where the functioning of the state is weakest. Historically, agriculture has been one of the sectors with the greatest state intervention. There are two views regarding the role of governments in the promotion of agricultural and rural development. The first, as illustrated by (Lewis 1955), is relatively pessimistic, emphasizing the tendency of policies toward an industrial and urban bias and seeing the rural sector as a reservoir of abundant labor supply, low wages, and limited opportunities for growth. Development strategies deriving from this perspective point to the extraction of economic surplus from the agricultural sector and to accelerated industrialization (Rosenstein-Rodan, 1943; Rostow, 1960; Fei & Ranis, 1964; Matsuyama, 1992). The second view, based on Schultz, (1953) and sometimes called agriculturist, is an optimistic one regarding the role of agriculture. Increasing the supplies of food and fiber, both for domestic and international markets, and increasing farm productivity are keys to structural change and economic

development (Johnston and Mellor, 1961; Timmer, 1988; Mellor, 1996; Mundlak, 2000, among others). Empirical evidence, however, indicates that the role of agriculture in national economic growth depends on the level of a country's development, the size of the rural population, the degree of access to international markets, and the relative viability and costs of importing food (World Bank, 2007; Gollin, 2010; De Janvry and Sadoulet, 2016).

The main interventions in the agricultural sector can be classified into two types: (i) price regulations, such as controlling prices at the border (tariffs, taxes, quotas, etc.) or in domestic markets (taxes, subsidies, limit prices); and (ii) government spending via transfers to producers, either with the excuse of resolving market failures, or with subsidies aim at specific interests. Historically, developed countries have had price and spending policies with a "protectionist" bias toward the sector, while in developing countries price policies have been "anti-sector," combined with government expenditures sometimes in support of the sector. Even though there are important differences, Anderson, Rausser, and Swinnen (2013) note that price-distorting policies have been reduced in developing and developed countries, in part driven by international trade agreements. In developed countries price-distortions have been replaced by "decoupled" transfers, where transfers are more apt to be neutral with respect to farm production decisions. Despite various reforms, each year many countries continue to allocate a significant proportion of total public spending to support of the agricultural sector and a most allocate a considerable proportion to subsidizing private goods.

The research presented in this thesis focuses on studying the causes and effects of public spending in a sample of 35 countries for the period 1990-2018. In the literature, one encounters few studies that have contributed to understanding the aggregate effects of both the level and the composition of government spending on agricultural and rural development. There are a handful of studies on which this present analysis is based. The first is that of López and Galinato (2007), who find evidence of the negative effect of the proportion of rural public spending aimed at subsidizing private goods in Latin American and the Caribbean (LAC) countries. The second is that of Dennis and Işcan (2011), who find an effect of price distortions on structural change and economic growth in a group of countries worldwide. More recently Anríquez et al., (2016) and Anríquez, Foster and Ortega (2020) updated the study by López and Galinato (2007), using updated data from LAC countries and introducing econometric improvements for the treatment of endogeneity. The present study makes use of government spending data collected by the Organization for Economic Co-operation and Development (OECD) and the Inter-American Development Bank (IDB). This thesis makes four main research contributions. First, the database is expanded to OECD countries and other Asian and African countries and compared with the results for LAC countries. Second, in addition to examining the effects of spending on the traditional indicator of rural development, agricultural value added per rural capita, two additional indicators of rural development and three indicators of agricultural productivity (values per agricultural worker) are introduced. Third, in contrast to previous studies on this topic, we focus on

estimating the causal effects of the level and composition of public expenditure, using different sets of control variables and different econometric methods to test the robustness of the estimates. Fourth, expanding the analytical framework of previous work, the institutional causes that explain the government's support for the agricultural sector are studied.

This chapter turns to a review of the relevant bibliography, followed by a discussion of the hypotheses and objectives of the research. The remainder of the chapter presents the theoretical model underlying the empirical analyses detailed in later chapters.

Literature review

In this section we present a brief review of three topics from the literature related to this research: (a) price policies in the agricultural sector; (b) government spending, economic growth, and performance of the agricultural sector; and (c) the causes of price policies and government spending in the agricultural sector.

Price policy in the agricultural sector

The measurement and political economy of price distortions in agriculture is well documented in the literature, from the pioneering work of Anderson and Hayami (1986), the widely disseminated study by Krueger, Schiff, and Valdés (1992), to the recent Anderson and Valenzuela (2008). Anderson, Rausser and Swinnen (2013) present a current review of this issue, indicating that traditionally developing countries had anti-agricultural policies, while developed countries had pro-agricultural policies. The main changes mentioned by the authors are the following:

- Developing countries have reduced their anti-agricultural policies and some have increased their protection.
- In developed countries, border support (prices) has been reduced due to decoupled support.
- Anti-trade distortions persist (Doha Round has not been entirely successful).

The study by Krueger, Schift and Valdés (1992) had a notable impact in showing the problem of government-policy-induced distortions to incentives. According to Dennis and Işcan (2011), however, there are very few studies that show evidence of the impact of these distortions on the rate of economic development. Using updated information from Anderson and Valenzuela (2008), Dennis and Işcan (2011) find a negative impact of these distortions on structural change and economic growth.

Government spending, economics growth and development of the agricultural sector

In the late 1980s and early 1990s there were several studies showing mixed effects of government spending on economic growth. Two of the most relevant were the Aschauer (1989) and Barro (1990). Aschauern (1989) find that the net capital stock has the greatest

effect on productivity, more than the level of government spending. Studying the determinants of endogenous economic growth, Barro (1990) found a positive effect of spending on public services and a negative effect of spending on private services or non-productive spending. More recently, Schmidt-Hebbel and Tello (2014) study the role of public spending and taxes in economic growth. These authors develop a dynamic general equilibrium political economy model to determine the optimal size and composition of spending in terms of growth and inequality. They find that there is a threshold of inequality that determines that voters select more distorting spending (transfers for consumption in private goods) than productive spending (public goods or productive government services).

With regards to rural areas and the agricultural sector, the Food and Agricultural Organization of the United Nations (FAO) and the International Food Policy Research Institute (IFPRI) presents a compilation of studies on the role of public spending in Latin America and the world (FAO, 2006 and IFPRI, 2008). Many authors have studied the effect of spending on specific public programs, for example Fan and Rao (2003) study the impact of various forms of public spending, mainly on irrigation and agricultural research. The spending in agricultural research is one of the most studied areas, where high rates of return are found (e.g., Alston et al., 2000; Evenson, 2001).

In a more aggregated form, Rausser (1982, 1992) presents a conceptual framework to understand the coexistence and interaction of two types of agricultural policies: the "predatory policies" or political-economic-seeking transfers policies (PESTs), that intent transfers wealth or income to special interest groups; and the "productive policies" or political-economic resource transactions policies (PERTs), that intended to correct market failures or to provide public goods. In the same way, López and Galinato (2007), based on the conceptual framework of López (2004, 2005) and using a novel database of rural and agricultural public expenditure in 15 LAC countries, respectively, for the period 1985 to 2001 (FAO 2006), present an approach to analyze the impacts of the size and composition of rural spending, classifying spending into two types: spending on public goods (infrastructure, research and development, environment, etc.) and spending on private goods (subsidies on credit and for the purchase of fertilizers, irrigation, equipment, and machinery, etc.). According to López and Galinato (2007), the subsidy on private goods has three negative effects on private and public investment and therefore on economic growth: investment in public goods is displaced; private investment is delayed or is less than expected due to the anticipation of government providing what private investors would otherwise finance; and governments tend to subsidize private investments and good that have a low social return. Empirically, these authors find a positive effect of the total level of spending on agricultural value added per rural inhabitant, but a negative effect of a higher proportion of spending on subsidies. Moreover, shifting the composition of spending to private goods has a negative effect on the income of the poorest.

In line with the results of López and Galinato (2007), several recent studies, using microdata, show the positive impact of public spending on public goods, particularly spending on rural infrastructure: large represses in India (Duflo and Pande, 2007); electrification in Brazil, India and South Africa (Lipscomb et al., 2013; Rud, 2012; Dinkelman, 2011); roads and highways in China (Banerjee, Duflo, and Qian 2012); rural roads in Vietnam and India (Mu and van de Walle, 2011; Datta, 2012). Recently Anríquez et al., (2016) and Anríquez, Foster and Ortega (2020) present updates to the study by López and Galinato (2007). These authors used a more up-to-date FAO database on rural spending (FAO 2006), including data up to 2012 and expanding the country coverage from 12 to 19. They combine public spending in the agricultural sector from FAO with data from the IDB's Agrimonitor, which follows the OECD methodology. The rule for the allocation of total spending is also modified to include public goods, semi-public (mixed) goods and private goods. They use the same theoretical model and estimate the reduced form of agricultural value added per rural inhabitant. Three econometric improvements are included:

- The level and composition of spending are instrumented using the OLS method. The predicted values are used in the reduced model of agricultural GDP per capita.
- A sensitivity analysis is included to test the robustness of the results using two additional methods: time-varying fixed effects model and dynamic model with GMM.
- Separated the share of private goods in rural public expenditure in two components: the share of private goods in Agricultural spending and the share of private goods in non-agricultural rural spending.

The results of these studies confirm the López and Galinato (2007) findings: After a decade of structural reforms in LAC, the composition of spending continues to have significant impacts on the performance of the sector: a 10-point change in the percentage of spending in favor of public goods would increase agricultural value added per capita by 5 percent. And this negative impact is due for the agricultural component of the share of private goods in total rural expenditure.

Determinants of prices distortions and government spending

Economic policies such as price distortions and government spending, are the result of political decisions of politicians and their strategic interaction with economic actors. Some authors, like De Gorter and Swinnen (2002), Rausser, Swinnen, and Zusman (2011), Anderson, Rausser and Swinnen (2013), and Swinnen (2018), describe the theoretical advances and empirical applications of the political economy of agricultural policies. Broadly speaking, agricultural price distortions are associated with higher levels of income disparity and the size of agriculture relative to the rest of the economy, where government institutions and political organizations mediate these effects. Political economy is useful to explain the

general trend in the trajectory of economic development, such as the move from taxing agriculture to subsidizing the sector, and the shift from anti-trade policies to other instruments to reduce the volatility of farmer returns. This line of political economic analysis aids in understanding patterns in income distributions the bias of policy toward counter-cyclical rural and agricultural spending. It explains in part the move from taxing agriculture in developing countries to the sectors subsidization in developed countries, with a shift to decoupled measures.

Regarding the determinants of government spending in general, the most studied theories are political economy models of the structural characteristics of constitutions and, in the context of the historical distribution of wealth, and their effects on political influence trading (e.g., lobbying). Within the structural characteristics of constitutions, the most used model is that of electoral competition and legislative negotiation (e.g., Persson and Tabellini, 2003, 2004). This model emphasizes the importance of electoral rules (e.g., proportional versus majority) and the nature of executive control of government power (e.g., presidential versus parliamentary systems). The main prediction of the theory of political institutions is that proportional electoral systems and parliamentary regimes should be associates with larger size of government, more public goods, and larger and more universalistic welfare programs. The reasons for this prediction are that, under proportional election rules, the size of the districts and the electoral formula induce politicians to seek a broader coalition. In the case of the parliamentary regime, the parliamentary coalitions are more stable and therefore a broader support is generated for most of the voters. In the agricultural and food sector, Olper and Raimondi (2013) analyze this theory, finding that proportional democracies and presidential democracies – compared to majoritarian and parliamentary democracies – give more public support to agriculture and less to food consumers.

Another approach to explaining public spending is the political theory of instrument choices, based on better micro-foundations for analyzing political economy decision-making or government-industry interaction (Foster and Rausser, 1993; Grossman and Helpman, 1994). In this theory there are a trade-off between transaction costs and distortions of the policies, and internal and external political constraints. Swinnen et al., (2016) develop one model for agricultural and food policy based in this theory, when the main prediction is that less institutional development and less trade balance is associated with more distorting policy (like more market price support and more private subsidies). López (2005) develop a conceptual framework for understanding why governments systematically under-invest in public goods in agricultural and rural areas, using the interactions between market failure and political economy mechanisms: the key factor behind the under-invest in public goods is the highly unequal capacity of the poor *versus* the elites to lobby governments.

Using the FAO database of agricultural and rural public expenditure (FAO 2006), some authors studied the factors that explain the level and composition. Allcott et al., (2006), and Santos-Rocha and Ortega (2006) simultaneously estimate the effect of the level and composition of rural spending (using FAO database) on GDP per capita and some political-economy determinants of spending. These determinants are whether the observation is an

election year, wealth distribution, the number of years of democratic stability, whether there is a presidential regime and proportional electoral system, a measure of accountability (freedom of the press), an indicator of technocracy (population studying in USA), and other controls (e.g., federalism, demographic, and ethnolinguistic fractionality). These authors find a significant effect of these factors on the level and composition of spending. Finally, Anríquez (2006) studies the effect of corruption as a determinant of the level and composition of rural public spending, finding that the more corruption, the lower the proportion of spending on public goods, and therefore the lower the effectiveness of public spending on agricultural growth and rural development.

Research hypothesis and objectives

There are two main hypotheses addressed in this research effort. The first is that government spending aimed at private subsidies in the agricultural sector negatively affects agricultural productivity and income generation. The second hypothesis is that there are economic and institutional factors that explain the differences in the levels and composition of public spending. These factors are related to the economic development of the country, its position in international trade and electoral rules and forms of government.

The general objective of the research is to determine the causes and effects of government spending (level and participation in private subsidies) in the agricultural sector in LAC, OECD countries and other countries. The specific objectives are the following:

- Determine the effect of the level of expenditures and participation of private subsidies on agricultural productivity and rural development.
- Determine the causes that explain the level of spending and private subsidies in the agricultural sector.

Materials and Methods

In this section we describe the theorical model, the general empirical strategy of estimation and the data sources.

Theorical model

To link government spending to the agriculture sector's performance, the analysis in this thesis begins with the theorical models presented in López and Galinato (2007) and followed by Anríquez et al., (2016) and Anríquez, Foster and Ortega (2020). The aggregate level of agricultural output, *Q*, is modeled as a concave, linearly homogeneous function of three basic factors of production deriving from the sector itself and aggregated intermediate inputs. The sector-specific factors are labor, *L*, land, *Z*, and capital, *K*. At the sector level the labor force, land and capital are considered constant in the short run. Aggregate intermediate inputs, X, are acquired from other sectors and are variable. Given the price of the output, *p*, and a price

of intermediate inputs, *v*, and a productivity indicator, *A*, the decision rule implicit in the model is that all else held constant, intermediate inputs are chosen by individual, price-taking, profit-maximizing producers with the result of maximizing the sector's aggregate returns to sector-specific factors, or sectoral value added:

$$G(p, v, L, Z, K|A) = \max_{x} p \cdot Q(L, Z, K, X|A) - v \cdot X \qquad (1.1)$$

Government policies can affect output and input prices as well as the productivity levels. We focus on three summary indicators of policy: total sectoral expenditures, *E*, the share of spending on private goods, *S*, and trade policy as measured as trade openness, *T*. In addition, domestic prices are, at least to some degree, influenced by world prices, p_w, v_w; and both domestic prices and productivity are influenced by conditions in non-agricultural sectors, *Y*.

Making use of the linear homogeneity of the production function, one can write the per worker value added in terms of sector-specific capital intensity per worker, $k = K/L$, and land per worker, $z = Z/L$. The final, generic specification for a reduced-form expression of per-capita value added becomes:

$$g = \frac{G}{L} = g(p_w, v_w, E, S, T, Y, k, z) \qquad (1.2)$$

In estimating the equation 1.2 there is a likelihood of the joint endogeneity of some variables. In this study, identifying instruments are used for the level of land per worker and the indicator for non-agricultural sector conditions, which we measure in terms of per capita GDP in the rest of the economy. One should also consider the possibility that the level of total expenditures per worker (or per rural habitant) is endogenous. *A priori* one expects that sectoral performance should increase with output price, total government expenditures, the performance of the rest of the economy, and the levels of sector-specific factors capital and land per capita. Additionally, the analysis in this thesis extends the model to include Barro-Lee's indicator of a country's level of human capital as a factor that would tend to enhance the performance of agriculture (Barro and Lee 2013). The sector's performance should decrease with increases in the price of intermediate inputs, and the share of government spending on private goods. The impact on sectoral performance of an increase in trade openness is ambiguous.

For the analysis of the institutional causes that explain the policy of prices and public spending on the agricultural sector, we follow the theoretical model and predictions of political institutions or constitutional structure (electoral rules and forms of government) by Persson and Tabellini (2003, 2004), and the model of political economic theory of instrument choices of Swinnen et al., (2016), based on better micro foundations for analyzing political economy decision-making or government-industry interaction (Foster and Rausser, 1994;

Grossman and Helpman, 1994). From these theoretical results, the present study begins with a simple reduced form to explain indicators of government policies (total value and composition of rural expenditures): $P = f(I)$, where I represent variables related with political institutions and the instrument choices model.

Empirical model

To implement theorical model, one should account for three empirical issues. First, prices of farm outputs are represented by FAO's single index of the per-unit value of agricultural production, *p*. Second, data are unavailable for sector-specific capital, and so we further concentrate the estimated reduced form by excluding the variable *k*. In effect, the analysis posits a long-run equilibrium relationship, where the regression coefficients account for the equilibrium, reduced-form relation between per capita sector-specific capital and the exogenous variables. Third, there are undoubtedly unobserved country-specific determinants of the aggregate production function and the influence of the aggregate measures of government policy (e.g., climate, culture, and institutions). The study, therefore, takes a panel regression approach, where these country-specific factors are captured by fixed-effects terms.

The empirical analysis follows López and Galinato (2007), Anríquez et al., (2016) and Anríquez, Foster and Ortega (2020), applying linear models to panel data, but incorporating some innovations. First, we extend the country sample of Latin America and the Caribbean to other two groups: OECD countries and other non-OECD but emerging countries. Second, additionally indicators of rural agricultural income (per rural inhabitant) as dependent variables, we include indicators of agricultural productivity (agricultural income per agricultural worker); in addition to value added as an indicator of agricultural income, we also include the value of agricultural production at the farm level and the net value of agricultural production. Third, following Angrist and Pischke's (2010) influential paper on "Credibility Revolution in Empirical Economics," we focus on estimating the causal effects of the level and composition of public expenditure and using different sets of control variables. Fourth, we use different estimation methods to control for non-observables. We implemented the Post-Lasso method to select the best predictive controls, prior to including them in the regression analyzes (Belloni and Chernozhukov, 2013 and Belloni et al., 2016). We apply the non-parametric method of binned scatterplot or binscatter to show graphically the conditional correlation between the dependent variable and key explanatory variables (Stepner, 2014; Starr and Goldfarb, 2020). We apply three types of methods (one-way fixed effects, two-way fixed effects, and instrumental variables) to estimate the long-run effects using data averaged in five-year periods (for more details, see Chapter 3). We extend this analysis to annual data and incorporate dynamic and heterogenous trend effects, using two additional methods (Chapter 4): the Arellano and Bond (1991) estimator (difference GMM) and the random trend or heterogeneous model (Wooldridge 2010).

In the case of estimating the institutional causes of support policies for the agricultural sector, we follow a similar strategy using panel data models. We estimate one and two-way fixed effects models, and models with dynamic effects of the Arellano-Bond type. Additionally, in order to include controls that do not change over time, we implement the correlated random effects model (Wooldridge, 2010; Wooldridge, 2019). Different treatments and control variables were included, which are explained in more detail in Chapter 5.

Data sources

The public spending data was obtained from the OECD monitoring of agricultural policies and from the Agrimonitor database of the IADB[1]. The outcome variables and control variables were obtained from the world development indicators of the World Bank, FAOSTAT of FAO and other sources.[2] The data of education indicators were obtained from Barro-Lee Educational Attainment Dataset (Barro and Lee 2013).[3] The data for the institutional variables were obtained from Polity V, and from a new database of democracy indicators, the V-Dem Dataset v10 (Coppedge et al., 2020; Pemstein et al., 2020) and the Database of Political Institutions 2017-DPI2017 (Scartascini, Cruz and Keefer, 2018).[4] Chapter 2 presents a descriptive analysis of the public spending data and the criteria used to calculate the indicators of participation of spending on public and private goods.

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Chapter 2. Characterization of the Agricultural Support Policies in the World

Abstract

Intervention in agricultural markets is a global phenomenon. To guide this intervention, governments use expenditure and incentive policies to stimulate competitive productive development of the agricultural sector and support lower-income groups. Other policies aimed at international trade and macroeconomic management of the economy are sometimes also of great importance for agriculture. This chapter makes a descriptive analysis of the trends and current situation of the level and composition of agricultural support policies. The analysis is based on data from the agricultural policy monitoring of the Organization for Cooperation and Development (OECD) and the Agrimonitor database of the Inter-American Development Bank (IDB). The sample includes 35 countries and a maximum period of 32 years (1986-2018). The indicators include the Total Support Estimate (TSE), the Producer Support Estimate (PSE) and its components (Market Price Support- MPS - and Budget Transfers and Subsidies direct to producers-BTS), and General Support Estimate- GSSE. From these, the indicator of total public spending and the proportion allocated to public goods and private subsidies were constructed. In general, the results show a reduction in total support and public spending, and a change in the composition towards more BTS, GSSE and more public goods. However, the proportion of private subsidies is still high, greater than 60%, in most countries.

Keywords: OECD, Agrimonitor, Total Support Estimate, Public Expenditure, Share Private Subsidies.

Introduction

A key element in assessing the impact and cost of agricultural policy is examining the extent to which governments influence prices, competitiveness, investment, and farmers' profitability. The traditional analysis distinguishes between three possible biases in public policies towards the sector, relative to other sectors. On the one hand, the degree of government spending allows the provision at a level of "equilibrium" of the so-called "public goods" for the development of the sector and rural areas, including research, roads and communications, plant health services and animal, education, and health. Another component is associated with price incentive policies, specifically associated with foreign trade policy, exchange rate, input and credit subsidies, and price interventions. A third component is made up of direct social programs aimed at reducing rural poverty, such as vouchers, housing, health and drinking water subsidies, including support for small farmers. A relatively little studied component of support to the sector is the financing of programs that could be considered "public goods", including agricultural research and extension, phytosanitary

control, information system, roads and ports, support to universities, part of the subsidy to irrigation, and others.[5] A central question in these components is to what degree are distortions observed, in the sense of underinvestment in some programs (in relation to their potential social return) and in which significant transfers are observed through programs that constitute private "goods" "Is it that they do not generate positive externalities? To what degree, through some of these three components, does public policy favor or disadvantage the agricultural sector relative to a neutral treatment between sectors?

The incidence of each category of these interventions varies significantly between countries and over time. Broadly speaking, historically the objectives of agricultural policy can be summarized as (a) reduce the instability of farmers' income, (b) preserve the vitality of rural communities, (c) preserve the economic survival of family farming, (d) environmental protection, (e) reduce dependence on food imports, and (f) promote efficiency in agricultural production. Promoting these objectives requires allocating public and private resources that could be used in other programs and sectors, and then the importance of subjecting agricultural policies to scrutiny regarding their cost-effectiveness and compatibility with other policies.

Assessments of support to agriculture, both in developed and underdeveloped countries, have generally been critical of intervention instruments and their effectiveness. In developed countries due to their high cost and possible regressive effect and the concern that a large part of the subsidies will be capitalized in an increase in the value of the land, raising their equity rather than stimulating greater productivity. In underdeveloped countries, for its anti-export bias and low level of support because of a possible under-investment in public goods.

Since approximately the 1970s, economics as a discipline has developed a variety of indicators, usually called "protection measures" for an activity, in which the reference is the international prices for each tradable product compared to domestic prices, adjusted for difference in quality and margins. Historically, the most used indicators are the so-called Nominal Rate of Protection (NRP) and Effective Rate of Protection (ERP), the latter when the analysis also includes the impact of interventions on the prices of "tradable" inputs (fertilizers, fuels, machinery, etc.) measured by the impact on the "added value" per ton produced (Corden, 1971). Various studies have complemented the diagnosis by adjusting for distortions in the exchange rate and the impact on relative agricultural-non-agricultural incentives resulting from the protection of the industrial sector (Krueger, Schiff and Valdés, 1992).

However, especially in the context of the agricultural policy of the European Union and the United States in the 1980s and associated with the negotiations in the Uruguay Round of the

[5] "Public goods" are services / goods that are freely offered to the community in which there is no exclusion, such as defense, foreign relations, statistical systems, and goods not provided by private agents as they do not generate profits, except for special cases offered by foundations.

World Trade Organization (WTO), it was observed that it concentrated exclusively on the impact of Price policies (NRP and ERP) offered a useful but incomplete picture of support to agriculture, in countries with investment subsidies and direct transfers to producers, for which the proposal arose to measure, based on a common methodology , a monitoring system of support to the sector using what was called the PSE (Producer Subsidy Equivalent later called Producer Support Estimate), initially adopted by FAO and then by the OECD in 1987. This measurement is updated annually by the OECD for each member country and exceptionally for some non-member countries (Brazil, India, Argentina, Russia, and others) of influence in international agricultural markets (OECD, 2019).

The objective of this chapter is to offer a quantitative basis that contributes to the diagnosis of the bias (positive or negative) of public policies during the last decade. Its results have direct implications for the diagnosis of the sector's performance, employment, and foreign trade flows, and it contributes to identifying and quantifying the implicit economic "transfers" between producers, consumers, and the State. It also contributes to the diagnosis of the cost-effectiveness of public spending on certain programs. The analysis is based on data collected by the OECD and complemented with data, following the same methodology, from Agrimonitor, which is a database managed by the IDB. The sample includes 35 countries and covers a maximum period of 32 years (1986-2018).[6]

The chapter is structured as follows: section 2 describes the definition of the main indicators of support to agriculture; the section describes the main trends and current situation, finally the main conclusions are presented.

Classification of state support to the agricultural sector

The central indicator used by the OECD is the so-called Producer Support Estimate (PSE), estimated annually for each member country. The PSE represents the annual monetary value of the transfers to the agricultural producer, measured in prices at the farm level, expressed as a percentage of the gross value of agricultural and forestry production (alternatively as a percentage of GDP). That is, it measures the impact of agricultural public policies on farmers' gross (annual) income, expressed in absolute value in local currency and as a percentage of the gross value of production. The PSE has two components: the Market Price Support (MPS) and the Budget Transfers and Subsidies direct to producers (BTS).

[6] The OECD collects data from its 35 member countries, six from non-OECD countries but members of the European Union and 10 countries with emerging economies. From Latin America, Mexico and Chile are member states of the OECD, and emerging countries include Brazil, Colombia and Costa Rica (https://www.oecd.org/agriculture/topics/agricultural-policy-monitoring-and-evaluation/). The Agrimonitor database collects data from 21 additional countries in Latin America and the Caribbean (https://agrimonitor.iadb.org/en).

In addition, the OECD reports two complementary measures to the PSE, the nominal protection coefficient for the producer (NPC, nominal protection coefficient) and the coefficient for nominal assistance to the producer (NAC). The NPC is a relationship between border prices with and without support, while the NAC is a relationship of the value of production with and without support, both measured at the farm level. The NPC is directly related to the MPS (in the PSE) and by subtracting the unit, it becomes the nominal protection rate (NRP or TPN as indicated above); the NAC, on the other hand, captures both the MPS and BTS supports and by subtracting the unit it becomes the nominal attendance rate (NAR).[7]

A second indicator measured by the OECD is the so-called GSSE (General Services Support Estimates), which is not part of the PSE, and which includes general support services to the agricultural sector rather than to specific items. This includes research and development, agricultural extension, training, phytosanitary control, irrigation infrastructure and other types of infrastructure (excludes major infrastructure works such as reservoirs and roads), export promotion, and others. The GSSE does not allocate payments to individual producers and is therefore not part of the PSE.

The OECD adds a third indicator, the CSE (Consumer Support Estimate) that has two components. The first tries to measure the transfer from consumers to producers in situations of domestic prices higher than the border prices. Japan, Norway, and Switzerland have the highest CSEs, but they are also relatively high in the European Union. A second component of the CSE is the transfer from taxpayers to consumers through food subsidies. Finally, the OECD estimates an indicator of total support to the agricultural sector (TSE) that has two variants. The first is on the origin of the resources, which are three types: transfers from consumers, transfers from taxpayers, and an indicator of budget allocation. The second and most interesting for our objectives is the destination of the support and these are: the PSE, the GSSE and (to avoid double counting), it includes transfers to consumers from taxpayers (TCT). Figure 2.1 represents this second interpretation of the TSE and its components, described above.

The sum of PSE and GSSE is the total support to agricultural production, which includes, as described above, price interventions and transfers. While the sum of the BTS and GSSE represents the total public spending towards the agricultural sector. A fundamental question is to what degree support programs via public spending are oriented towards the provision of "public goods", versus "private" transfers or subsidies. Some of the programs classified as GSSE are public goods, but others are rather semi-public (e.g., agricultural extension), and some programs classified as BTS are private subsidies, but others may have some public component (e.g., training). To classify spending public goods vs. private goods, the approach

[7] The OECD, FAO-MAFAP; The IDB, the World Bank and IFPRI created in 2017 a Consortium of International Organizations to measure the environment of "protection" for agriculture (http://www.ag-incentives.org/), whose main indicator is the rate protection rating (NPR). The Consortium records estimates for 57 countries during 2005-2015

of López and Galinato (2007) was followed and modified by Anríquez et al., (2016), which consists of classifying program spending into four categories: private, mostly private, public, mostly public, and mixed. Then the *total expenditure on private goods* is obtained from the following weighted sum: *private goods + 2/3 mostly private + 1/3 mostly public goods + 1/2 mixed.* Table 2.1 presents the breakdown of the public spending categories based on data from OECD and Agrimonitor, indicating as an example some standard programs in each category.

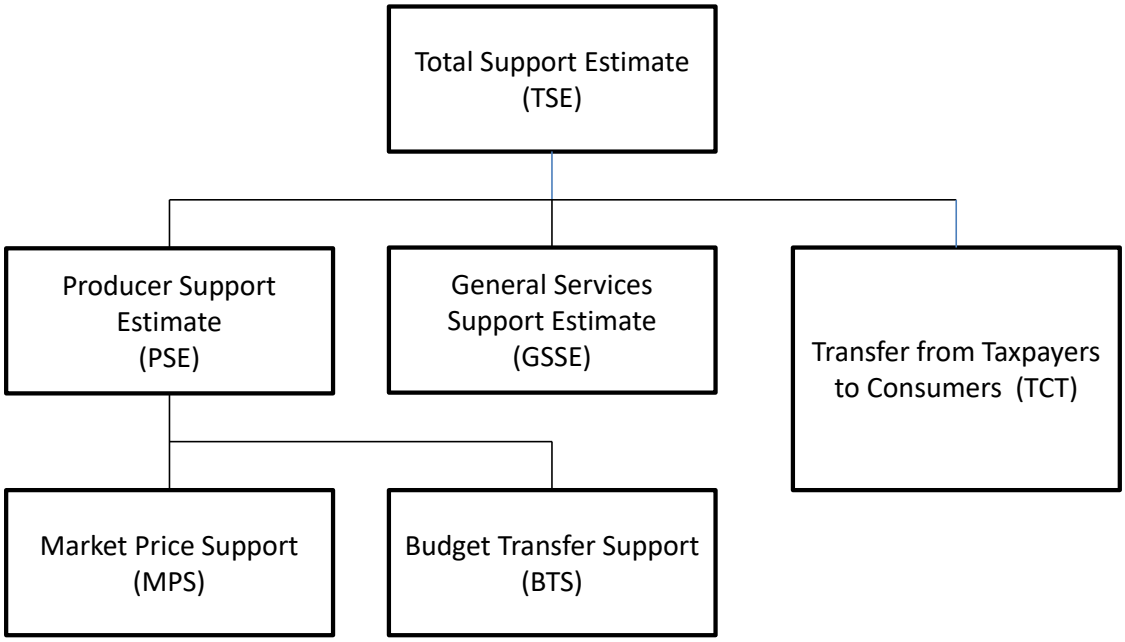

Figure 2.1 Classification of State support to the agricultural sector according to destination.
Note: the sum of BTS + GSSE represents the total public expenditure to the agricultural sector.
Source: OECD

Table 2.1 Classification of Public Expenditure in the agricultural sector

Types of support OECD	Types of Public Expenditure	Types of programas
1. Budget transfers support (BTS)		
1.1 Payments based on output	Private	Credit and subsidies for agricultural emergencies
1.2 Variable input use	Private	Investment support, credit and subsidies to credit and insurance
1.3 Fixed capital formation	Private	Support for investment in irrigation and soil
1.3 On-farm services	Mostly private	Support for training, technical assistance and entrepreneurship
1.4 Other BTS	Mixed	Special credit for agricultural emergencies.
2. General Services Support Estimate (GSSE)		
2.1 Agricultural knowledge and innovation system		
Agricultural knowledge generation	Public	Research and Development
Agricultural knowledge transfer	Mostly public	Education and extension
2.2 Inspection and control		
Agricultural product safety and inspection	Public	Export inspection and certification, border controls and risk analysis
Pest and disease inspection and control	Public	Modernization animal and plant inspection
Input control	Mostly public	Control of residues, pesticides and phytosanitary standards
2.3 Development and maintenance of infrastructure		
Hydrological infrastructure	Mixed	Irrigation programs and infraestructure
Storage, marketing and other physical infrastructure	Mostly private	Storage and other
Institutional infrastructure	Mostly public	Land regulation
2.4 Marketing and promotion	Mostly private	Export promotion
2.5 Other GSSE	Mixed	Other general supports

Note: BTS = producer support via direct transfers (decoupled payments); GSSE = support to the agricultural sector via general transfers. Criteria for classifying government spending, according to the proportion of goods or services involved: private (100% private), mostly private (66.7% private and 33.3% public), mixed (50% private and 50% public), mostly public (66.7% public and 33.3% private) and public (100% public).
Source: Based on Anríquez et al., (2016).

Global trend of the Agricultural Policy and current situation

In general terms, the level of total support to the agricultural sector has been decreasing since the early 2000s, mainly due to distortions in the international market, shifting towards direct transfers to producers or decoupled support and support in general services and goods. public (Figure 2.2 and Figure 2.3). Although subsidies for private goods have been reduced, they remain at values above 50% of total spending.

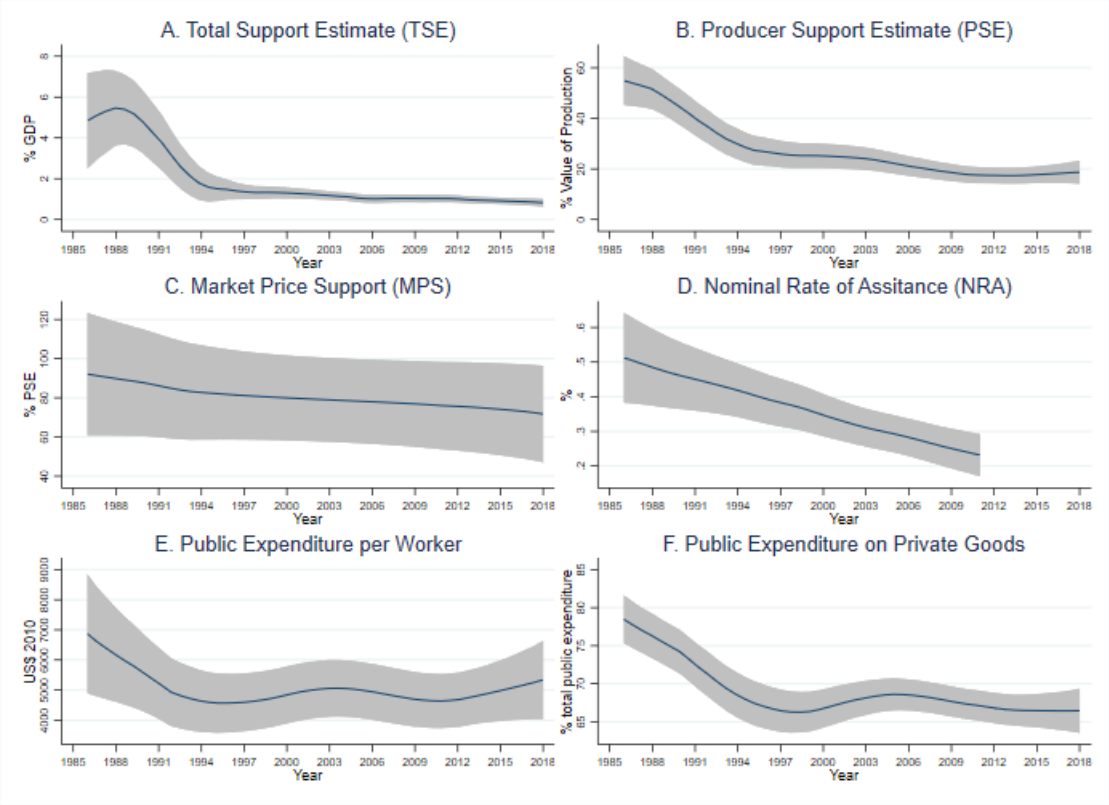

Figure 2.2 Global trend of agricultural policies, 1986-2018
Source: based on OECD and Agrimonitor

Figure 2.3. Changes of composition of agricultural policy support, 1986-2018

Note: MPS=Market Price Support; BTS= Budget Transfer Support; GSSE= General Services Support Estimate; TCT= Transfer from Taxpayers to Consumers.
Source: based on OECD and Agrimonitor

Therefore, the main instrument of agricultural policy in the countries is public spending. The data show different trends between countries, both in level and in spending compilation (Figure 2.4). Some countries such as Argentina, Chile, China, and the European Union show an increase in the level of spending, while in the other countries, especially Russia and the United States, the opposite is observed. In the composition of spending, Brazil, Chile and the United States show a reduction in the proportion of spending towards private subsidies, while in Mexico and the European Union there is a certain increase or stabilization, but above 80%.

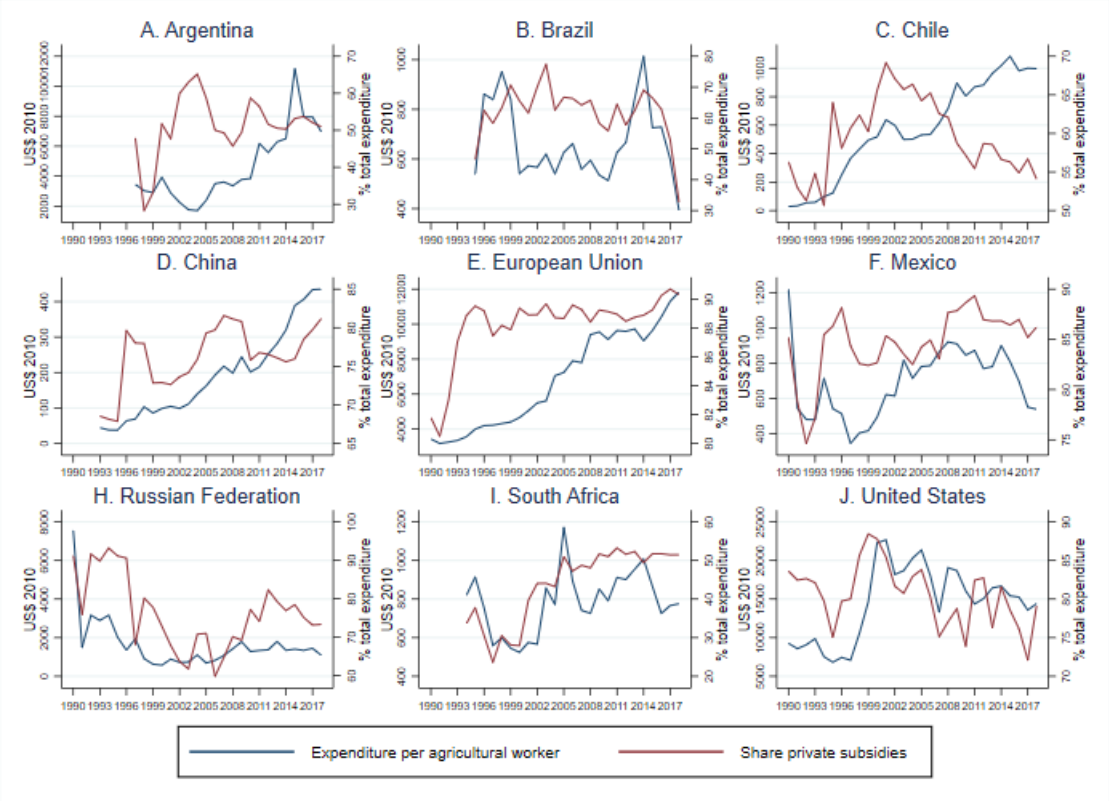

Figure 2.4. Trends of public expenditure in some selected countries, 1990-2018
Source: based on OECD and Agrimonitor

Currently, there is great heterogeneity between countries in the level of support and its composition (Figure 2.5). Argentina, Vietnam, and Ukraine have negative support for the sector, while countries such as Nicaragua, the Philippines and Indonesia have total support greater than 2.5% of GDP. In most of the countries, except for Australia, Chile, New Zealand, support via market prices continues to be the main support. In the United States, support for consumers represents a little more than 50% of support.

Regarding public spending, Guatemala, Vietnam, and Nicaragua present the least support, while the opposite occurs with the United States, the Czech Republic and Norway (Figure 2.6 and Figure 2.7). Figure shows that most of the OECD countries have spending levels of more than 5,000 dollars per worker and more than 60% of it is assigned to private goods. Except for Argentina, most LAC countries, and the other group of countries, have levels of support below $ 5,000 and spending on private goods greater than 50%. There are three countries that allocate less than 40% of spending to private goods: Costa Rica, Uruguay, and New Zealand. The latter country is the only one that allocates less than 20% to private goods, that is, more than 80% of it allocates to public goods.

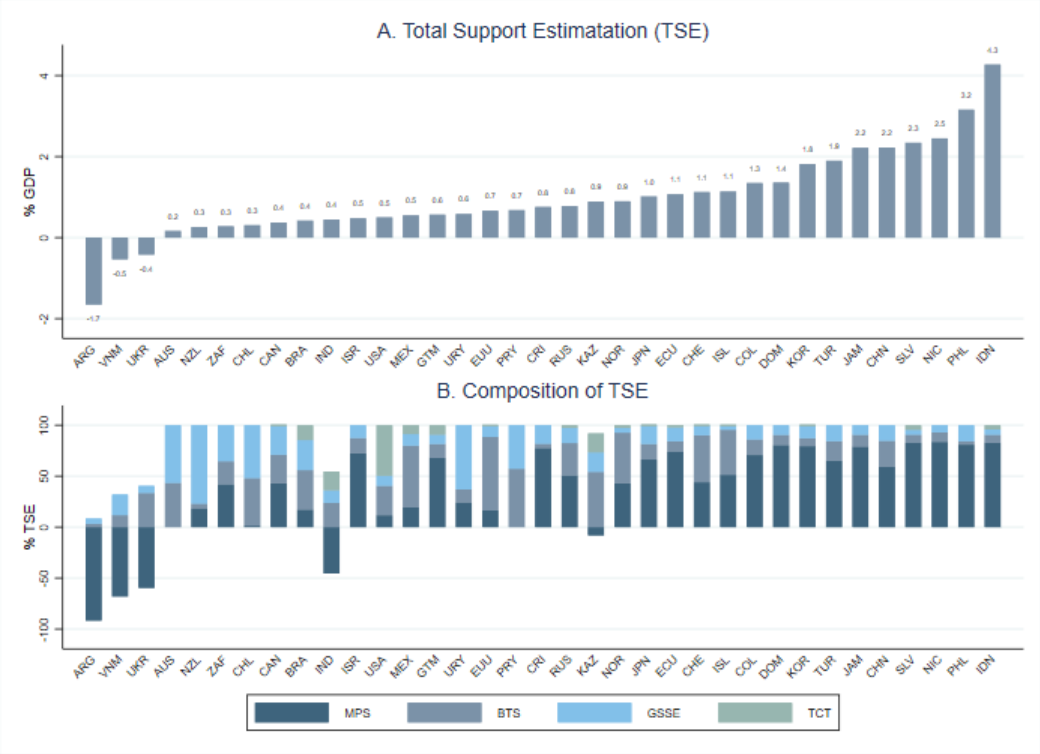

Figure 2.5. Current situation in total support estimation, average 2014-2018
Source: based on OECD and Agrimonitor

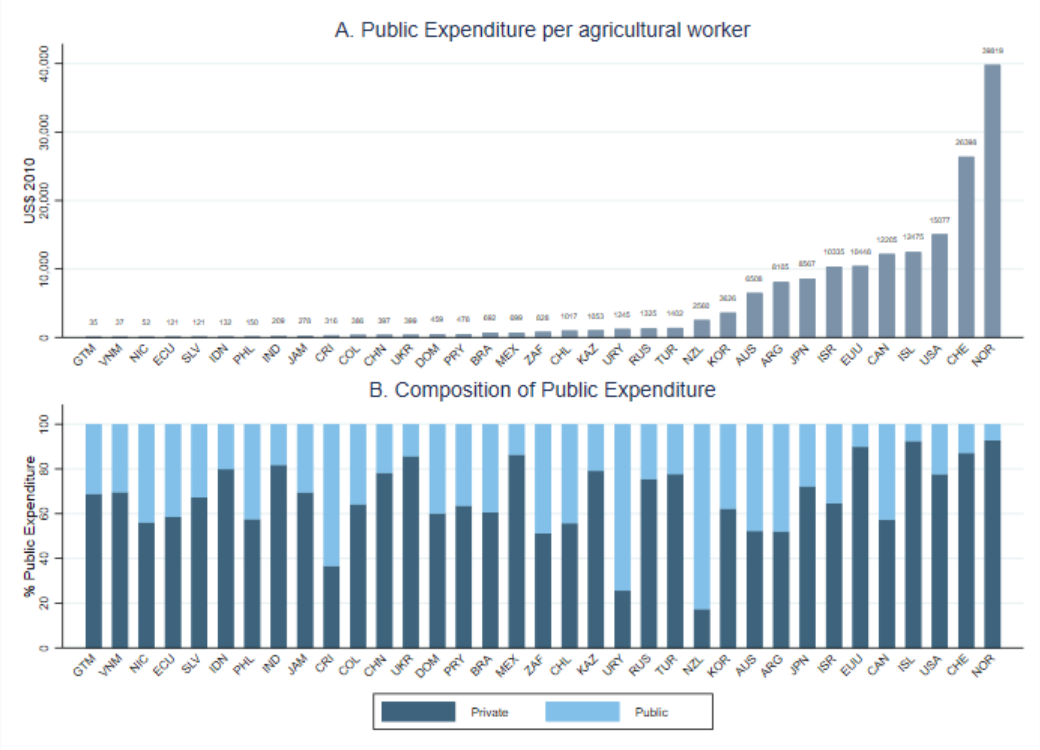

Figure 2.6. Current situation of Public Expenditure, average 2014-2018
Source: based on OECD and Agrimonitor

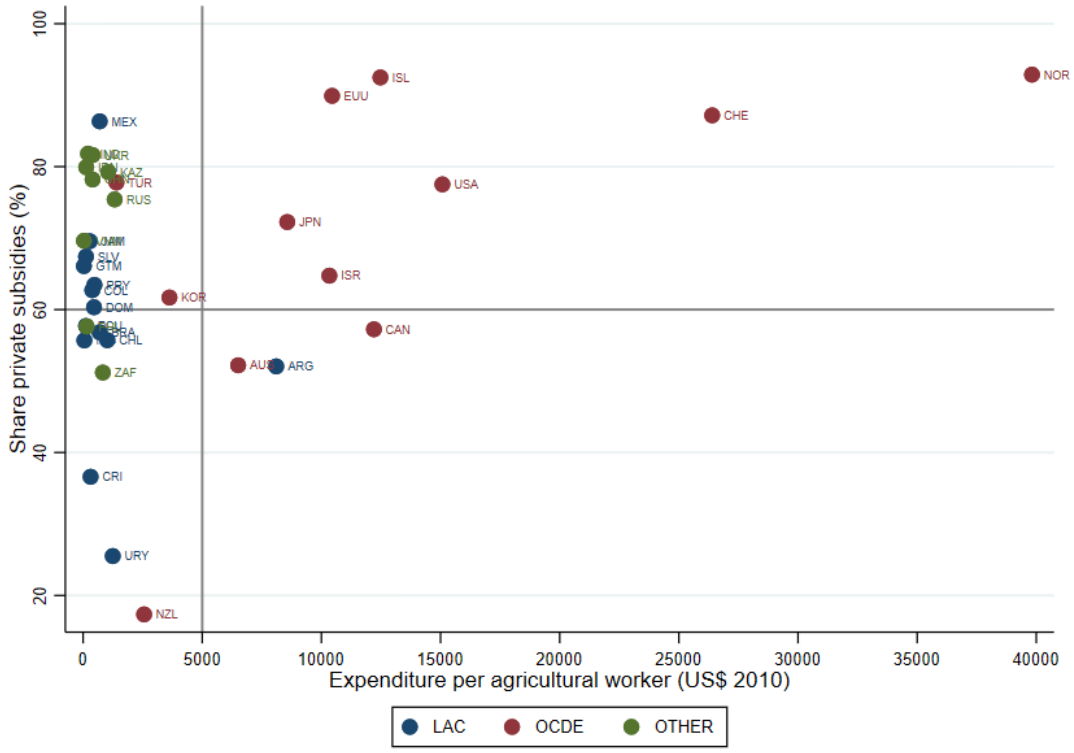

Figure 2.7. Group of countries according to the level and composition of public spending, average 2014-2018
Source: based on OECD and Agrimonitor

Conclusions

In general, it can be concluded that the level of support for the agricultural sector has been decreasing, and proportionally this has been directed towards direct transfers to producers and slightly greater support for public goods. However, most OECD countries have still high levels of public spending and private subsidies represent more than 60% of total spending in most countries. Costa Rica, New Zealand, and Uruguay are three countries that allocate less than 40% of spending to private goods. From the above, the question arises about the impact that the level of spending and its composition is having on agricultural productivity and rural development.

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Chapter 3. The effects of the Agricultural Public Expenditure on Agricultural Performance

Abstract

This chapter analyzes the effects of the level and composition of public spending on rural agricultural income per capita and agricultural productivity, using five-year averages and annual data for a panel of 35 countries from 1990 to 2018. Several panel data models are empirically estimated with six different outcome indicators and different sets of control variables. With five-year average data we estimate the long run effects and test if there are differences between groups of countries. With annual data we include distinct trends across countries and dynamic effects with a lagged dependent variable that captures the shorter-term inertia of lagged shocks not apparent in five-year averages. This analysis extends previous studies by increasing the sample of countries from a set of Latin American and Caribbean (LAC), to include countries from the Organization for Economic Co-operation and Development (OECD) and other emerging economies. Furthermore, instead of simply using the agricultural value added per rural inhabitant as a dependent variable, as done in the literature, the analysis examines additional indicators of agricultural sector performance (sectoral value added from national accounts, the total value of production from the OECD, the net value of production from FAO, and the three previous values per agricultural worker). In addition to the one-way, country fixed effects model used in previous studies, a two-way, country and year fixed effects model is also included. The results confirm previous studies regarding the positive effect of the level of public spending, and, more importantly, the negative effect of spending directed towards private goods on agricultural performance indicators. Moreover, the null hypothesis that country groups respond similarly to changes in the level and composition of spending cannot be rejected at standard levels of significance (p-values > 0.15). Results also show that using values per agricultural worker (versus per rural inhabitant) and using the two-way fixed effects method (versus one way) leads to more robust estimation with greater statistical significance. The model estimation using yearly data and allowing for distinct country trends yields results for the effects on per-worker agricultural productivity of the size and composition of expenditure that are more precise, more robust to different model specifications and estimation methods, and of greater magnitude.

Keywords: Public Expenditure, private subsidies, OECD, Agrimonitor, Latin America and Caribbean.

Introduction

Market price regulation and public spending policies are the main instruments to support the agricultural sector. Even though there are important differences, Anderson, Rausser, and Swinnen (2013) note that price-distorting policies have been reduced in developing and developed countries, in part driven by international trade agreements. In developed countries price-distortions have been replaced by "decoupled" transfers, where transfers are more apt to be neutral with respect to farm production decisions. Rausser (1982, 1992) presents a conceptual framework to understand the coexistence and interaction of two types of agricultural policies: the "predatory policies" or political-economic-seeking transfers policies (PESTs), that seek to transfer wealth or income to special interest groups; and the "productive policies" or political-economic resource transactions policies (PERTs), that intended to correct market failures or to provide public goods. In the same way, López (2004, 2005) develop a conceptual framework to analyze the impacts of the size and composition of rural spending, classifying spending into two types: spending on public goods (infrastructure, research and development, environment, etc.) and spending on private goods (subsidies on credit and for the purchase of fertilizers, irrigation, equipment, and machinery, etc.).

Despite various reforms, each year many countries continue to allocate a significant proportion of total public spending to support the agricultural sector and most allocate a considerable share of that spending to subsidizing private goods. In chapter 2 it was shown that even though support through market prices is still important in many countries, they have been reduced, giving a greater role to public spending, mostly in the form of subsidies to private goods and general support services or public goods. Even though private subsidies have also been reduced, they still represent on average more than 60% of total spending in the countries analyzed.

Previous studies such as those by López and Galinato (2007), Anríquez, et al., (2016) and Anríquez, Foster and Ortega (2020), have documented the negative effect of private subsidies on rural development for Latin America and the Caribbean. These studies show that a reduction of 10 percentage points in spending on private goods would mean a 5% increase in agricultural income per rural inhabitant. This means that agriculture can have a greater impact on rural well-being if the efficiency and effectiveness of public spending is improved.

This chapter analyzes the effects of the level and composition of public spending on rural agricultural income per capita and agricultural productivity, using five-year averages and annual data for a panel of 35 countries from 1990 to 2018. We extend the above-mentioned studies with three main contributions. First, the database is expanded to OECD countries and other Asian and African countries and compare previous results from LAC countries. Second, in addition to examining the effects of spending on the traditional indicator of rural development, agricultural value added per rural capita, two additional indicators of rural development and three indicators of agricultural productivity (values per agricultural worker)

are introduced. Third, in contrast to previous studies on this topic, we focus on estimating the causal effects of the level and composition of public expenditure, using different sets of control variables and different econometric methods to test the robustness of the estimates. The main methodological contributions are: the use of the two-way fixed effects estimation method; the use of the two-way fixed effects method with instrumental variables, where the instruments are calculated as the "jackknifed average" of the level of spending and composition of spending in the region of each country; the prediction of some endogenous control variables, using the random forest method; and finally the inclusion of a human capital index as an additional control variable. Additionally, with annual data we implemented other methodological innovations to estimate the causal effect: the use of nonparametric methods to show the conditional correlation between the variables of interest; the consideration of dynamic effects by including one or two lags of the dependent variable, using a two-way fixed effect model and the Arellano-Bond dynamic model (Arellano and Bond, 1991); the heterogeneity in the trend between countries, using a random trend model or heterogeneous trend model (Wooldridge 2010); the use of a lags of the control variables to control for potential contemporary endogeneity.

This chapter is divided into four sections. The second section describes the empirical model and the data used for the analysis. The third section shows the results accompanied by a discussion, and finally the conclusions are presented in the last section.

Materials and Methods

Theorical and empirical model

We follow the theorical models of López and Galinato, (2007) presented in the Chapter 1, and the basic empirical analysis with some methodological innovations. With five-year average data we focus on estimating the long-run causal effects of the level and composition of public expenditure, applying a linear model to panel data for three groups of countries, and empirical model take the form:

$$\ln g_{it} = \beta_E E_{it} + \beta_S S_{it} + \gamma X_{it} + \mu_i + \varepsilon_{it} \qquad (3.1)$$

where, for country i averaged during five-year period t:

$\ln g_{it}$= represents the log of per capita agricultural GDP, or per capita value of production.

E_{it}= per capita agricultural government spending.

S_{it}= the share of subsidies in private goods in government expenditures.

X_{it} = represents a set of control variables derived by the theoretic model: T_{it} – an index of trade policy openness (exports plus imports relative to GDP); Y_{it} – per capita non-agricultural GDP; z_{it} – per capita agricultural land, and q_{it} – real price index of agricultural production.

μ_i – country fixed effect.

ε_{it} – identically and independently distributed shocks.

We define per capita as values per rural capita (indicators of rural agricultural income) and values per agricultural worker (indicators of agricultural productivity). The identification strategy of this empirical model, known as the one-way fixed effects model, is based on estimating the causal effect of the level and composition of public spending, conditional on country fixed effects and on a set of control variables, that are derived from the theoretical model. For some endogenous control variables (trade share, non-agricultural GDP per capita and land per capita) we calculated the predicted value using the random forest method, which is a machine learning tool for better predictions (Breiman, 2001). This strategy is extended to a two-way fixed effects model, which includes country-specific effects, μ_i, and time-specific effects, δ_t, to capture unobserved five-year period-specific shocks common across countries:

$$lng_{it} = \beta_E E_{it} + \beta_S S_{it} + \gamma X_{it} + \mu_i + \delta_t + \varepsilon_{it} \qquad (3.2)$$

With annual data we incorporate two additional empirical considerations. First, we include dynamic effects to capture the effect of preconditions on the level and composition of spending. For this, a two-way fixed effects model is estimated, with a lag in the dependent variable ($\ln g_{it}$) and a lag in the control variables (X_{it-1}):

$$lng_{it} = \alpha lng_{it-1} + \beta_E E_{it} + \beta_S S_{it} + \gamma X_{it-1} + \mu_i + \delta_t + \varepsilon_{it} \qquad (3.3)$$

To control for the endogeneity of the lag of the dependent variable and the level and composition of spending, a dynamic Arellano-Bond model is also estimated (Arellano and Bond 1991).

Second, we considered the possibility that the spending follows a different trend for each country, implementing a random or heterogeneous trend model (Wooldridge, 2010):

$$lng_{it} = \alpha lng_{it-1} + \beta_E E_{it} + \beta_S S_{it} + \gamma X_{it-1} + \mu_i + \delta_i t + \varepsilon_{it} \qquad (3.4)$$

where t = 1, 2,…T years. To estimate this model, the first difference was calculated, which removes the country fixed effect (μ_i). Then a one-way fixed effects model was estimated that removes the trend variable, t, leaving a fixed effect for each country (δ_i):

$$\Delta lng_{it} = \alpha \Delta lng_{it-1} + \beta_E \Delta E_{it} + \beta_S \Delta S_{it} + \gamma \Delta X_{it-1} + \delta_i + \Delta \varepsilon_{it} \qquad (3.5)$$

Data

The public spending data was obtained from the OECD monitoring of agricultural policies and from the Agrimonitor database of the IDB. The outcome variables and control variables were obtained from the development indicators of the World Bank, FAO, and other sources. For the present analysis we used five-year simple average. **¡Error! No se encuentra el o rigen de la referencia.** and **¡Error! No se encuentra el origen de la referencia.** presents descriptive statistics for our variables separately for group of countries and periods, respectively. The data shows some well-known patterns, including, for example, that OECD countries have greater agricultural value-added and populations with higher average years of schooling. Also, the Tables show the pattern described in Chapter 2: on average, compared to the other groups of countries, OECD countries have higher levels of public expenditures in agriculture with a larger share oriented toward to private subsidies; and the average level of public expenditure and the share of private subsidies has decreased over time.

Table 3.1 Summary statistics of main variables by regions, using five-year average data, 1990-2018

Variables	LAC			OECD			Other		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
Agriculture value added per rural capita (US$ 2010)	78	2,639	3,702	72	8,964	13,131	54	671.5	384.2
Agriculture value added per worker (US$ 2010)	78	37,477	144,135	72	49,247	35,609	54	3,404	3,349
Public expenditure per rural capita (US$ 2010)	54	163.2	198.4	71	1,249	1,154	47	111.7	198.6
Public expenditure per agricultural worker (US$ 2010)	54	1,140	3,631	71	10,436	9,548	47	493.3	646
Share of public expenditure on private goods (% total total public expenditure)	54	59.5	15.16	71	71.63	19.39	47	68.22	15.46
Trade openness index	78	68.21	16.5	72	60.95	23.1	54	91.37	25.48
Non agricutural GDP per capita non-rural (US$ 2010)	78	7,909	3,314	72	49,679	26,710	54	6,591	4,278
Non agricutural GDP per non-agricultural worker (US$ 2010)	78	16,230	7,379	72	81,167	35,106	54	10,373	6,575
Agricultura land per capita rural (ha)	78	1.845	3.105	72	3.029	4.269	54	1.236	1.527
Agricultura land per agricultural worker (ha)	78	45	188.3	72	28.33	43.09	54	6.164	7.386
Agricultural exports price index	78	82.64	27.39	72	90.74	128.8	54	78.69	17.22
Human capital index	78	2.344	0.375	72	3.268	0.432	54	2.516	0.504

Source: Based on OECD, Agrimonitor, World Bank, FAO and other sources.

Table 3.2 Summary statistics of main variables by periods, using annual data, 1990-2018

Variables	Period 1990-1999			Period 2000-2018		
	N	Mean	SD	N	Mean	SD
Agriculture value added per rural capita (US$ 2010)	479	3,711	9,075	665	4,458	8,509
Agriculture value added per worker (US$ 2010)	479	25,856	87,923	665	33,633	136,091
Public expenditure per rural capita (US$ 2010)	260	886.8	1,106	588	564.7	916.1
Public expenditure per agricultural worker (US$ 2010)	260	5,169	7,728	588	5,080	8,828
Share of public expenditure on private goods (% total total public expenditure)	260	70.36	19.05	588	67.4	17.19
Trade openness index	490	67.4	21.8	665	72.71	27.04
Non agricutural GDP per capita non-rural (US$ 2010)	479	18,127	21,752	665	23,375	26,736
Non agricutural GDP per non-agricultural worker (US$ 2010)	479	31,257	36,877	665	38,783	40,149
Agricultura land per capita rural (ha)	482	1.966	3.314	665	2.079	3.369
Agricultura land per agricultural worker (ha)	482	28.79	137.4	665	27.4	163.7
Agricultural exports price index	490	68.37	23.25	665	91.82	173.1
Human capital index	490	2.47	0.604	665	2.802	0.56

Source: Based on OECD, Agrimonitor, World Bank, FAO and other sources.

¡Error! No se encuentra el origen de la referencia. shows the unconditional correlation between i ndicators of agricultural productivity and rural agricultural income per capita and the level and composition of public expenditures, separated by country groups using different colors (blue for LAC, red for OECD, and green for other countries). There is a strong positive correlation between the level of public expenditure and the value added of agricultural per rural capita (Panel A) and per agricultural worker (Panel C). It is also observed that there is a negative correlation between the share of private subsidies and the same response variables (Panel B and D, respectively). The empirical strategy described above aims to determine whether this crude correlation identifies a causal relationship or not.

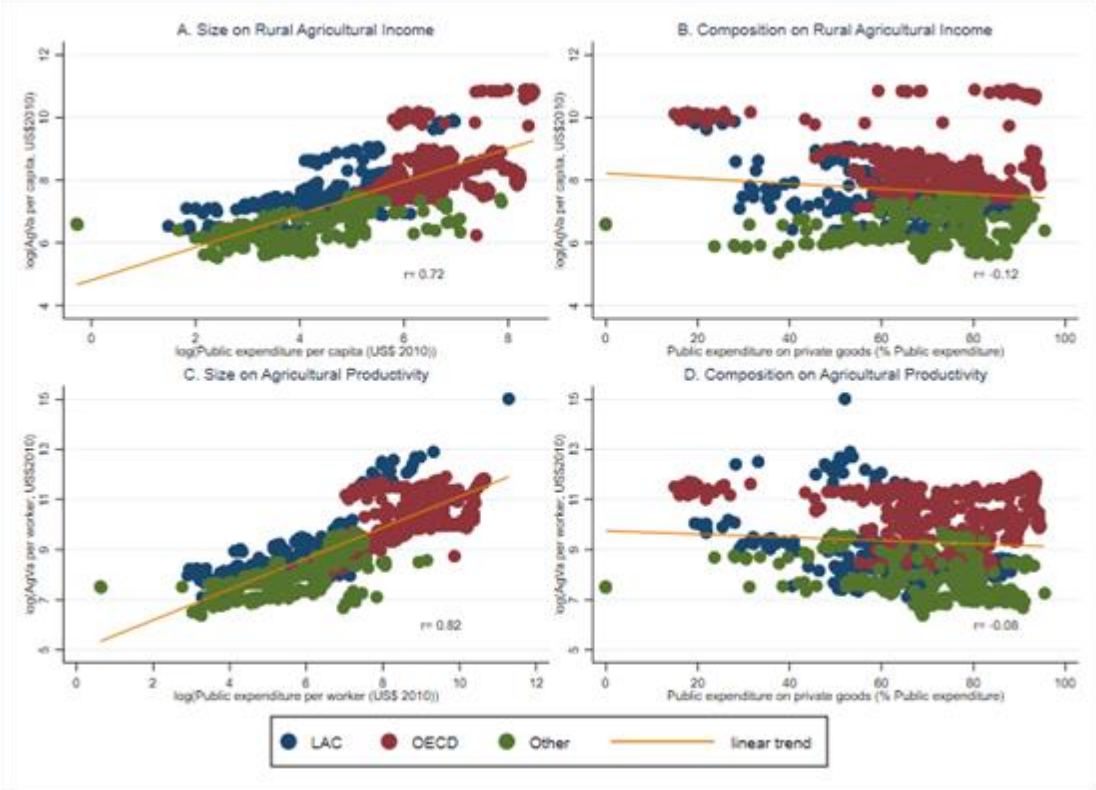

Figure 3.1. Correlation of public expenditure with Rural agricultural income and agricultural productivity, using annual data (1990-2018).

Note: This graph shows the unconditional correlation between public expenditure and rural agricultural income (per rural inhabitant) and agricultural productivity (per agricultural worker), using annual data. The name of size in the sub-graphs refers to public spending per capita (per rural inhabitant or per agricultural worker, respectively), while composition refers to the percentage of spending directed towards the subsidy of private goods.
Source: based on OECD, Agrimonitor and World Development indicators

Additionally, Figure 3.2 shows a conditional correlation analysis, using the nonparametric method of binned scatterplot or binscatter, that has become a very popular methodology in applied microeconomics and offers a flexible, yet parsimonious way of visualizing and summarizing in regression settings (Cattaneo et al., 2019a, 2019b; Starr and Goldfarb, 2020). In this analysis we use the method described by Stepner (2014). In the analysis we condition on the level or share variable of public expenditure, respectively, and by country a year fixed effect. Then we can interpret this correlation as causal effect. This Figure 4.2 confirm the unconditional correlation and show the coefficient of its effects: increasing 1% of the level of public expenditure per unit, increase the value added per unit in 0.11% for the indicator of rural development and 0.27% for agricultural productivity (Panels A and C); on the other hand, increasing of 1 percentage point of share of private subsidies, decrease this development indicators in 0.36% and 1.02 %, respectively (Panels B and D). With the empirical strategy described above we will confirm this causal effect in parametric regression models.

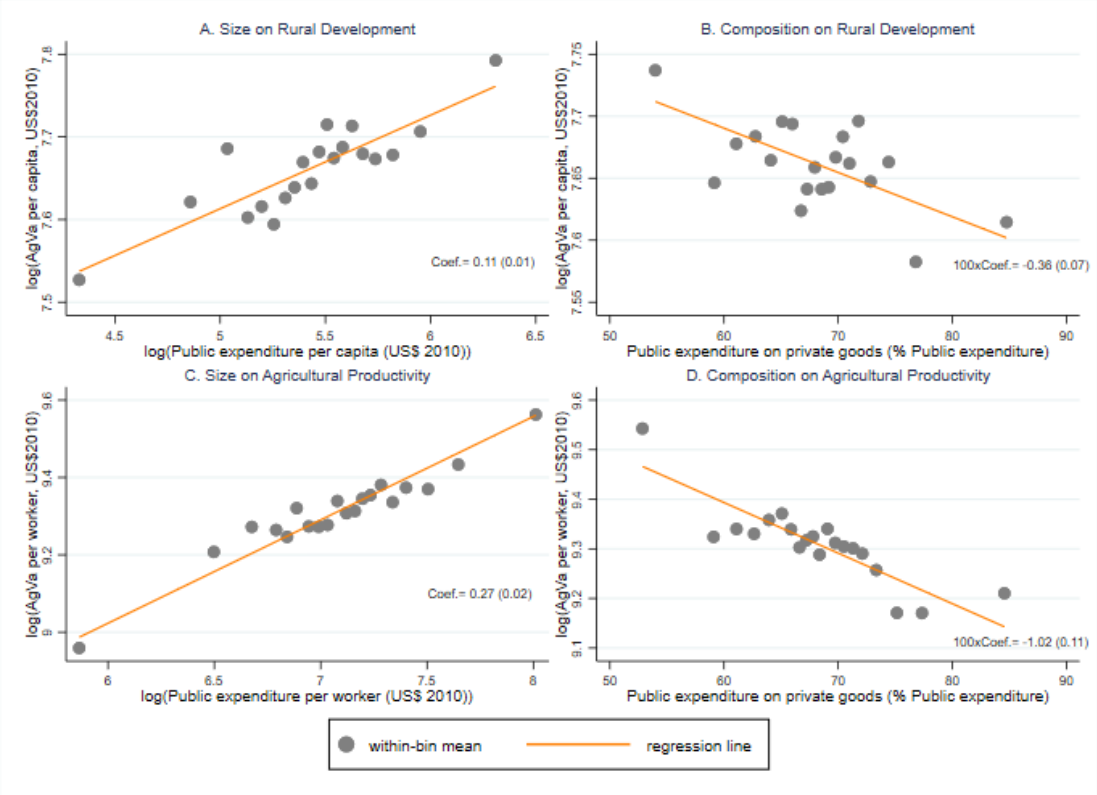

Figure 3.2 Effects of public expenditure with rural agricultural income and agricultural productivity, using annual data (1990-2018)

Note: this Figure show the conditional correlation between public expenditure and value added of agricultural per rural inhabitant a per agricultural worker, using annual data. We use a non-parametric method of *binned scatterplots or binscatter* (Stepner, 2014), with country and time fixed effects, and the size and composition of public expenditure as control variables, respectively.
Source: based on OECD, Agrimonitor and World Development indicators

Results and Discussions

Long-run effects using five-year average data

Table 3.3 presents the results of the one-way fixed effects model on agricultural value added per rural inhabitant, separated by group of countries. This is the model used in previous studies, although now applied to more than LAC countries. The specification that replicates the regression equation presented in López and Galinato (2007), Anríquez, et al., (2016) and Anríquez, Foster and Ortega (2020), for Latin America and the Caribbean, is shown in column 5. Column 6 shows

this base model but includes the human capita variable as an additional control. The results of the relevant parameter (size of public expenditure and share on private subsidies) in column 6 agree with the findings in Anríquez et al., (2016) and Anríquez, Foster and Ortega (2020) in terms of signs, orders of magnitude and statistical significance of the estimated coefficients. In the base model of all countries and LAC countries (columns 1 and 4), the effect of size of public expenditure are statistical significance, but the share of private subsidies is not significance in other models.

When the two-way fixed effects model is applied, the statistically significance of the results for Latin America and the Caribbean improve (Table A.1 of Appendix A, columns 4, 5 and 6). This means that there are unobservable period effects, which affect the estimation results. In the other groups of countries and in all countries the results are not statistically significant. Nevertheless, for Latin America and the Caribbean the sign and order of magnitude of the effect of spending on private subsidies are consistent with previous studies, varying between –0.003 to –0.077, while in previous studies it was around –0.005. This means that by increasing spending on private subsidies by 10 percentage points, the growth in value added per rural inhabitant is reduced by between 3% and 7%.

When using the indicator of agricultural productivity (agricultural value added per worker), the statistically significant results improve considerably in two-way fixed effects models (Table 3.4) and one-way fixed effects (Table A.2 of Appendix A). Here the size of spending and the share of private subsidies are statistically significant, mainly for all countries and for the OECD countries. The order of magnitude of the effects is higher than those shown above. In this case, the value of the coefficient associated with private subsidies varies between –0.009 and –0.027, which means that when spending on private subsidies increases by 10 percentage points, the agricultural value added per worker is reduced between 9% and 27%. And the effect on the size of expenditure is also statistically significant in most estimates, varying between 0.15 and 0.50, which means that by increasing the size of expenditure by 10% the agricultural value added per worker increases between 1.5 and 5 percent.

The F tests of these tables also show that there are no statistically significant differences in the estimated parameters between groups of countries, but there are differences between periods. In the case of agricultural productivity analysis, the one-way fixed effects model shows that there are statistically significant differences in the parameters between groups of countries, but this difference disappears in the two-way fixed effects models. This means that in the sample of countries considered, it is not necessary to separate the analysis by groups of countries, but it is necessary to include time fixed effects. However, it is very likely that there is heterogeneity between countries, and this issue is addressed below with annual data for the same sample of countries.

Table 3.3 Effects of agricultural public expenditure on rural agricultural income, using One-way Fixed Effects estimator with five years periods. Dependent variable: log of agricultural value added per rural capita (US$ 2010)

	All countries			LAC countries			OECD countries			Other countries		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
log of public expenditure per rural capita	0.203**	0.005	0.070	0.314***	-0.035	0.110**	0.196	0.018	0.017	0.074	-0.049	-0.008
	(0.077)	(0.050)	(0.045)	(0.060)	(0.115)	(0.048)	(0.181)	(0.125)	(0.128)	(0.124)	(0.041)	(0.078)
Share of public expenditure on private goods (%)	-0.004	-0.003	-0.004	-0.006	-0.003	-0.003*	-0.008	-0.004	-0.004	0.008	0.004**	0.003
	(0.004)	(0.003)	(0.003)	(0.006)	(0.003)	(0.002)	(0.006)	(0.007)	(0.007)	(0.006)	(0.002)	(0.003)
Trade openness index (predicted)		-0.002	-0.005		-0.004	-0.005		-0.006	-0.006		0.003	0.001
		(0.003)	(0.004)		(0.005)	(0.004)		(0.007)	(0.007)		(0.003)	(0.005)
Agricultural exports price index		0.120*	0.063		0.093	0.044		0.106	0.101		0.053	0.013
		(0.066)	(0.078)		(0.111)	(0.033)		(0.104)	(0.120)		(0.118)	(0.113)
log of non agricutural GDP per capita non-rural (predicted)		0.769***	0.476***		1.240***	0.312**		0.689***	0.640**		0.713***	0.610***
		(0.086)	(0.093)		(0.137)	(0.133)		(0.207)	(0.223)		(0.063)	(0.158)
log of agricultural land per capita rural (predicted)		0.237**	0.170*		0.292	0.206*		0.188	0.177		0.268**	0.251**
		(0.099)	(0.094)		(0.228)	(0.110)		(0.151)	(0.175)		(0.088)	(0.092)
Human capital index			0.403**			0.796***			0.058			0.182
			(0.154)			(0.070)			(0.383)			(0.220)
Constant	6.837***	1.662	3.030***	6.471***	-1.350	4.075**	7.700***	2.513	2.796	5.593***	1.589	2.139
	(0.349)	(1.103)	(1.033)	(0.451)	(1.589)	(1.746)	(0.960)	(2.009)	(1.758)	(0.309)	(1.151)	(1.747)
Observations	186	186	186	55	55	55	82	82	82	49	49	49
Number of id_country	34	34	34	13	13	13	12	12	12	9	9	9
Adjusted R-squared	0.129	0.556	0.587	0.354	0.779	0.911	0.019	0.296	0.287	0.196	0.804	0.805
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Period FE	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
AIC	-39.30	-160.6	-173.4	-29.50	-84.90	-134.2	-5.200	-28.70	-26.70	-11.50	-77.10	-76.60
BIC	-32.90	-141.3	-150.8	-25.50	-72.90	-120.2	-0.400	-14.30	-9.900	-7.700	-65.70	-63.30
Prob > F total	0.039	0.000	0.000	0.001	0.000	0.000	0.401	0.000	0.000	0.042	0.000	0.000
Prob > F groups of countries	0.122	0.142	0.447									

Notes: The OECD countries excluded Chile and Mexico, because are included in Latin America region. Columns 1, 4, 7, and 10 do not include control variables; Columns 2,5,8 and 11 use the control variables derived from the model of López and Galinato (2007); Columns 3,6,9 and 12 extend the above by including a human capital variable. The F tests for groups of countries are not statistically significant, indicating that there are no differences in the estimated parameters between these groups. The random forest method was used to predict the value of three explanatory variables (trade openness, non-agricultural GDP per capita and land per capita). Robust standard errors in parentheses, using countries as clusters. *** p<0.01, ** p<0.05, * p<0.1

Table 3.4. Effects of agricultural public expenditure on agricultural productivity, using Two-way Fixed Effects estimator with five years periods. Dependent variable: log of agricultural value added per agricultural labor (US$ 2010)

	All countries			LAC countries			OECD countries			Other countries		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
log of public expenditure per agricultural labor	0.240***	0.159***	0.178***	0.381***	0.225**	0.282***	0.466**	0.331**	0.337**	0.066	0.037	0.016
	(0.075)	(0.052)	(0.050)	(0.119)	(0.074)	(0.045)	(0.193)	(0.111)	(0.120)	(0.069)	(0.068)	(0.080)
Share of public expenditure on private goods (%)	-0.009*	-0.009**	-0.010**	-0.010	-0.005	-0.004	-0.015	-0.020***	-0.019***	-0.001	0.001	0.001
	(0.005)	(0.004)	(0.004)	(0.008)	(0.006)	(0.005)	(0.009)	(0.006)	(0.006)	(0.005)	(0.005)	(0.006)
Trade openness index (predicted)		-0.002	-0.005		-0.001	0.004		-0.015*	-0.014		0.002	0.008
		(0.004)	(0.005)		(0.011)	(0.010)		(0.008)	(0.009)		(0.008)	(0.009)
Agricultural exports price index		0.042	0.040		0.159	0.188**		0.113	0.117*		-0.413	-0.390
		(0.071)	(0.077)		(0.091)	(0.084)		(0.068)	(0.060)		(0.365)	(0.364)
log of non agricutural GDP per capita non-agricultura labor (predicted)		-0.035	-0.061		-0.739	-0.072		0.706**	0.790**		-0.073	-0.012
		(0.090)	(0.075)		(0.492)	(0.401)		(0.293)	(0.346)		(0.157)	(0.138)
log of agricultura land per agricultural labor (predicted)		0.596***	0.556***		0.734***	0.712***		0.652***	0.679***		0.248	0.223
		(0.121)	(0.127)		(0.239)	(0.213)		(0.150)	(0.152)		(0.270)	(0.302)
Human capital index			0.349			1.329***			-0.176			-0.553
			(0.217)			(0.309)			(0.301)			(0.418)
Constant	7.609***	11.995***	11.273***	6.707***	18.326***	8.151	7.102***	4.757	4.367	6.823***	10.834**	10.826**
	(0.412)	(1.119)	(1.275)	(0.938)	(5.127)	(4.742)	(1.032)	(3.527)	(3.853)	(0.292)	(3.261)	(3.304)
Observations	186	186	186	55	55	55	82	82	82	49	49	49
Number of id_country	34	34	34	13	13	13	12	12	12	9	9	9
Adjusted R-squared	0.746	0.825	0.828	0.694	0.841	0.890	0.778	0.866	0.865	0.865	0.866	0.871
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Period FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
AIC	-63.80	-129.4	-132.3	-21.20	-54.20	-73.70	-20.20	-60.10	-60.50	-46	-51.70	-55
BIC	-38	-90.70	-90.40	-7.100	-32.10	-49.60	-1	-33.60	-34	-30.80	-36.60	-39.90
Prob > F total	0.000	0.000	0.000									
Prob > F time periods	0.000	0.000	0.251	0.000	0.000	0.019	0.152	0.143	0.204	0.000	0.000	0.011
Prob > F groups of countries	0.370	0.058	0.040									

Notes: The OECD countries excluded Chile and Mexico, because are included in Latin America region. Columns 1, 4, 7, and 10 do not include control variables; Columns 2,5,8 and 11 use the control variables derived from the model of López and Galinato (2007); Columns 3,6,9 and 12 extend the above by including a human capital variable. The F tests for groups of countries are not statistically significant, indicating that there are no differences in the estimated parameters between these groups (except in column 3). The F tests of time periods are statistically significant, indicating that we need to use the Two-Way Fixed Effects method. The random forest method was used to predict the value of three explanatory variables (trade openness, non-agricultural GDP per capita and land per capita). Robust standard errors in parentheses, using countries as clusters. *** p<0.01, ** p<0.05, * p<0.1.

In the Table 3.5 we show a summary of the estimated coefficients of the effect of private subsidies on different indicators agricultural productivity. This table includes the fixed effects and two-way fixed effects estimation methods, with three different indicators of agricultural productivity and three different set of control variables. Considering the possibility of endogeneity in public spending, we also include the two-way fixed effects estimation method with instrumental variables. As has been argued by Acemoglu et al. (2019), one should consider the possible persistence of institutional effects in groups of countries that share in a common political evolution (e.g., OECD). This institutional persistence can introduce possible endogeneity of the public expenditure, in particular the share of subsidies in private goods, since these tend to change more slowly than the level of public spending; additionally, we consider that the level of spending is more likely to be exogenous, conditional on the country and period fixed effects, and on the control variables.

Then for the endogenous explanatory variable of share of subsidies in private goods we follow the approach of Acemoglu et al. (2019) and include two instruments, using the "jackknifed average" of the levels of spending and composition of spending in each group of countries in period t. The jackknifed average is calculated for a given country and period t as the average of expenditures in its country group (LAC, OECD, and "others") but excluding that country. The country-specific jackknifed average for the level of spending is multiplied by that country's initial level; and the country-specific jackknifed average for the share of expenditures on private subsidies is multiplied by that country's initial share. The justification and assumptions of these instruments are that the share of subsidies in private goods in each country is influenced by its initial conditions and by other countries that share similar economic and political conditions (relevance conditions), but these factors do not directly influence the performance of the agricultural sector (exclusion condition). These are similar to the Bartik instruments or shift-share instruments, which are one of the most widely used instrumental variable designs in empirical analyzes (Bartik, 1991; Goldsmith-Pinkham, Sorkin, and Swift, 2020) .In the estimation of the two-way fixed effects with instrumental we use the Kleibergen-Paap rk LM statistic for under-identification test, and Hansen J statistic for overidentification test. In general, the hypothesis of under-identification is not rejected, except for the group of OECD countries, so the instruments are weak; however, the hypothesis of overidentification is not rejected either, so the instruments are valid. In short, the instruments are valid, but weak.

In general, the coefficients of the Table 3.5 vary between -0.009 to -0.044, which means that by increasing private subsidies by 10 percentage points, the value added per agricultural worker would decrease between 9 and 44 percent. In the case of rural agricultural income indicators (Table A.3 of Appendix A), there are fewer statistically significant results, but in those that are significant the coefficients vary between -0.003 to -0.03, which means that by increasing private subsidies by 10 percentage points, the value added per rural inhabitant would decrease between 3 and 30 percent. The results obtained with the method are less significant and robust than the other

methods, so these should be considered preliminary, since there is the possibility of improving the instruments by having a better grouping of countries and not only in the three groups. considered in this analysis.

In summary, as indicated above, the results are more robust for indicators of agricultural productivity (values per agricultural worker) than for rural agricultural income (values per rural inhabitant). This means that spending in the agricultural sector has a greater impact on sector performance indicators than on broader rural development.

Table 3.5. Summary of Effects of share of public expenditure on private goods (%) on different indicators of agricultural productivity, methods and groups of countries, using five years average.

	All countries			LAC countries			OECD countries			Other countries		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A. log of agricultural value added per agricultural worker												
Fixed Effects	-0.017***	-0.011**	-0.012***	-0.011	-0.005	-0.004	-0.027***	-0.019***	-0.019***	0.014	0.008	0.003
	(0.005)	(0.005)	(0.004)	(0.007)	(0.006)	(0.004)	(0.005)	(0.005)	(0.005)	(0.012)	(0.006)	(0.005)
Two-Way Fixed Effects	-0.009*	-0.009**	-0.010**	-0.010	-0.005	-0.004	-0.015	-0.020***	-0.019***	-0.001	0.001	0.001
	(0.005)	(0.004)	(0.004)	(0.008)	(0.006)	(0.005)	(0.009)	(0.006)	(0.006)	(0.005)	(0.005)	(0.006)
Two-Way Fixed Effects with instrumental variables	-0.019	-0.023	-0.033	-0.023**	0.014	0.003	-0.010	-0.016***	-0.015***	-0.009***	-0.013**	-0.010
	(0.013)	(0.015)	(0.024)	(0.010)	(0.011)	(0.004)	(0.009)	(0.006)	(0.006)	(0.003)	(0.006)	(0.008)
Kleibergen-Paap rk LM statistic: Pr > Chi-sq	0.303	0.189	0.229	0.152	0.219	0.167	0.034	0.033	0.021	0.080	0.061	0.062
Hansen J statistic: Pr > Chi-sq	0.237	0.407	0.896	0.155	0.526	0.733	0.330	0.307	0.400	0.377	0.667	0.376
Panel B. log of agricultural production value per agricultural worker												
Fixed Effects	-0.015**	-0.013**	-0.013**	-0.012	-0.004	-0.004	-0.026**	-0.023**	-0.023**	-0.001	-0.007	-0.009
	(0.006)	(0.005)	(0.005)	(0.009)	(0.005)	(0.006)	(0.009)	(0.009)	(0.009)	(0.015)	(0.011)	(0.009)
Two-Way Fixed Effects	-0.011*	-0.013**	-0.013***	-0.005	0.001	0.002	-0.023*	-0.025**	-0.026***	-0.007	-0.007	-0.007
	(0.006)	(0.005)	(0.005)	(0.010)	(0.005)	(0.005)	(0.010)	(0.009)	(0.008)	(0.009)	(0.009)	(0.008)
Two-Way Fixed Effects with instrumental variables	-0.037**	-0.044**	-0.051**	-0.016	0.031**	0.018***	-0.021**	-0.024***	-0.025***	-0.013	-0.022*	-0.022*
	(0.018)	(0.017)	(0.022)	(0.013)	(0.014)	(0.006)	(0.009)	(0.008)	(0.007)	(0.014)	(0.013)	(0.012)
Kleibergen-Paap rk LM statistic: Pr > Chi-sq	0.303	0.189	0.229	0.152	0.219	0.167	0.034	0.033	0.021	0.080	0.061	0.062
Hansen J statistic: Pr > Chi-sq	0.633	0.902	0.580	0.243	0.609	0.832	0.730	0.459	0.795	0.102	0.058	0.078
Panel C. log of net agricultural production value per agricultural worker												
Fixed Effecs	-0.013**	-0.009**	-0.009**	-0.010	-0.006	-0.005	-0.024***	-0.018**	-0.018***	0.008	0.013**	0.009
	(0.005)	(0.004)	(0.003)	(0.006)	(0.006)	(0.004)	(0.007)	(0.006)	(0.005)	(0.013)	(0.005)	(0.005)
Two-Way Fixed Effects	-0.005	-0.005*	-0.006**	-0.015*	-0.010	-0.009*	-0.013	-0.015**	-0.016**	0.002	0.007	0.008
	(0.004)	(0.003)	(0.003)	(0.007)	(0.006)	(0.005)	(0.009)	(0.006)	(0.006)	(0.005)	(0.004)	(0.005)
Two-Way Fixed Effects with instrumental variables	-0.056	-0.039	-0.014	-0.043***	-0.004	-0.010*	-0.011	-0.015***	-0.016***	-0.005***	-0.009**	0.000
	(0.041)	(0.030)	(0.014)	(0.014)	(0.009)	(0.005)	(0.007)	(0.005)	(0.005)	(0.002)	(0.004)	(0.007)
Kleibergen-Paap rk LM statistic: Pr > Chi-sq	0.405	0.372	0.323	0.152	0.219	0.167	0.034	0.033	0.021	0.137	0.093	0.107
Hansen J statistic: Pr > Chi-sq	0.276	0.192	0.023	0.545	0.073	0.077	0.609	0.680	0.985	0.066	0.081	0.037

Notes: This table shows the estimated coefficients of the effect of share of public expenditure on private goods (%) on different indicators of agricultural productivity (in log scale): the coefficient must be multiplied by 100, which is interpreted as the effect of the change of one percentage point in explanatory variable on the percentage change of the dependent variable. The OECD countries excluded Chile and Mexico, because are included in Latin America region. Columns 1, 4, 7, and 10 do not include control variables; Columns 2,5,8 and 11 use the control variables derived from the model of López and Galinato (2007); Columns 3,6,9 and 12 extend the above by including a human capital variable. For the method of Two-Fixed Effects with instrumental variables we use as instrument the "jackknifed average" of the level of spending and composition of spending in the region of each country (following Acemoglu et al. 2019). We use the Kleibergen-Paap rk LM statistic for under-identification test and Hansen J statistic for overidentification test. In general, the hypothesis of under identification is not rejected, except for the group of OECD countries, so the instruments are weak; however, the hypothesis of overidentification is not rejected either, so the instruments are valid. In short, the instruments are valid, but weak. Robust standard errors in parentheses, using countries as clusters. *** p<0.01, ** p<0.05, * p<0.1.

Incorporating dynamic effects and heterogeneous trend with annual data

Table 3.6 and Table 3.7 show the basic results of the estimates for all countries in general. In general, the models show an adequate fit, with an adjusted R^2 of between 0.5 to 0.77, the magnitude of the lag of the dependent variables varies between 0.6 and 0.75, which shows a high degree of persistence. The Arellano-Bond tests for autocorrelation (AR1 and AR2), confirmed the presence of first order, but no second order, serial correlation, suggesting that the dynamic model is correctly specified. Moreover, the standard Hansen test confirms that in all cases our set of Arellano-Bond instruments is valid, because the test of the null hypothesis of overidentification is not rejected.

In the case of the effect public expenditure on rural agricultural income (Table 3.6), only the dynamic model with fixed effects shows statistically significant results at 90 and 95 percent confidence. The elasticity of the size of expenditure is 0.11, which means that by increasing the size of expenditure by 1%, the value added per rural inhabitant increases by 0.11%. The effect of spending on private goods is -0.004, which means that by increasing spending on private goods by 10 percentage points, the agricultural value added per rural inhabitant is reduced by 4%. The Figure A.1 of Appendix A show that in general, using different estimation methods, outcome indicators and groups of control variables, de effects of public expenditure on rural agricultural income is not statistically significant.

While in the effect on agricultural productivity (Table 3.7), all the models present statistically significant results at 99% confidence. The elasticity of the size of expenditure varies between 0.22 and 0.75, which means that by increasing the size of expenditure by 10%, the value added per agricultural worker increases between 2.2 and 7.5 percent. The effect of spending on private goods varies between -0.009 and -0.018, which means that by increasing spending on private goods by 10 percentage points, the agricultural value added per agricultural worker is reduced by between 9 and 18%.

And a summary of the coefficients for the effects on agricultural productivity, using different estimation methods, outcome indicators and groups of control variables are shown in Figure 3.3. In the Appendix A we disaggregated these figures by group of countries (Figure A.2 and Figure A.3). These figures confirm what is presented in the previous tables (3.6 and 3.7) and the results with five-year average data: when using agricultural productivity indicators are statistically more significant and robust than when using rural development indicators. Furthermore, with annual data the estimates of the effect of public spending on agricultural productivity are more statistically significant, more robust, and more accurate than those using five-year averages. In summary, by increasing spending on private subsidies by 10 percentage points, income per worker is reduced by between 9% and 18%.

Table 3.6 Effects of agricultural public expenditure on rural agricultural income, using different estimators with annual data. Dependent variable: log of agricultural value added per rural capita (US$ 2010)

	Dynamic Two-way FE		Arellano-Bond		Random Trend Model		Dynamic Random Trend Model	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
L.Dependent variable	0.780***	0.732***	0.816***	0.744***			-0.160**	-0.166**
	(0.077)	(0.094)	(0.063)	(0.069)			(0.068)	(0.067)
L2.Dependent variable			0.131**	0.115**				
			(0.056)	(0.054)				
log of public expenditure per rural capita (US$ 2010)	0.023*	0.019	0.007	0.010	0.004	0.002	0.012	0.009
	(0.013)	(0.015)	(0.012)	(0.011)	(0.016)	(0.016)	(0.014)	(0.013)
Share of public expenditure on private goods (%)	-0.001	-0.001	0.000	-0.000	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
L.Trade openness index (predicted)		0.000		0.000		-0.001		-0.000
		(0.001)		(0.001)		(0.001)		(0.001)
L.Agricultural exports price index		0.018		-0.001		-0.012		0.002
		(0.025)		(0.011)		(0.019)		(0.006)
L.log of non-agricultural GDP per capita (predicted)		0.067		0.027		0.172**		0.181***
		(0.050)		(0.028)		(0.065)		(0.064)
L.log of agricultural land per capita rural (predicted)		0.062**		0.022		0.009		0.036
		(0.029)		(0.015)		(0.036)		(0.022)
L.Human capital index		0.113		0.114***		-0.147		-0.344
		(0.081)		(0.039)		(0.253)		(0.263)
Constant	1.573***	1.435***			0.021***	0.021***	0.022***	0.026***
	(0.559)	(0.454)			(0.000)	(0.005)	(0.002)	(0.005)
Long run effects								
log of public expenditure per rural capita (US$ 2010)	0.106**	0.069	0.127	0.073	0.004	0.002	0.012	0.009
	(0.042)	(0.045)	(0.199)	(0.072)	(0.016)	(0.016)	(0.014)	(0.013)
Share of public expenditure on private goods (%)	-0.003	-0.004*	0.004	-0.002	-0.001	-0.001	-0.001	-0.001
	(0.002)	(0.003)	(0.008)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)
Observations	827	825	778	777	806	799	792	786
Number of id_country	35	35	35	35	35	35	35	35
Adjusted R-squared	0.867	0.874			-0.001	0.005	0.046	0.066
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	NO	NO	NO	NO
AIC	-1885	-1930			-1710	-1690	-2164	-2157
BIC	-1725	-1770			-1701	-1657	-2150	-2120
Test for AR(1): Pr > z			0.000	0.000				
Test for AR(2): Pr > z			0.728	0.793				
Hansen overid: Pr > chi2			1.000	1.000				

Notes: this table show the estimated coefficient and the long run effects of agricultural public expenditure on rural agricultural income, using annual data. For the share of public expenditure on private goods (%), the coefficient must be multiplied by 100, which is interpreted as the effect of the change of one percentage point in explanatory variable on the percentage change of the dependent variable. Columns 1, 3, 5 and 7 do not include control variables; Columns 2,4,6 and 8 use the control variables derived from the model of López and Galinato, (2007), but including a human capital indicator as additional control. The random forest method was used to predict the value of three explanatory variables (trade openness, non-agricultural GDP per capita and land per capita). For the Arellano-Bond method, we included tests for first and second order autocorrelation, and the Hansen tests for overidentification. Robust standard errors in parentheses, using countries as clusters. *** p<0.01, ** p<0.05, * p<0.1.

Table 3.7 Effects of agricultural public expenditure on agricultural productivity, using different estimators with annual data. Dependent variable: log of agricultural value added per agricultural worker (US$ 2010).

	Dynamic Two-way FE		Arellano-Bond		Random Trend Model		Dynamic Random Trend Model	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
L.Dependent variable	0.615***	0.585***	0.615***	0.554***			-0.184*	-0.147**
	(0.097)	(0.113)	(0.187)	(0.193)			(0.107)	(0.066)
L2.Dependent variable			0.168	0.118				
			(0.147)	(0.134)				
log of public expenditure per agricultural worker capita (US$ 2010)	0.156**	0.183**	0.163**	0.175**	0.392***	0.262***	0.360***	0.253***
	(0.067)	(0.076)	(0.070)	(0.075)	(0.138)	(0.071)	(0.122)	(0.069)
Share of public expenditure on private goods (%)	-0.005*	-0.006**	-0.004*	-0.005**	-0.009**	-0.006***	-0.008***	-0.006***
	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.002)
L.Trade openness index (predicted)		0.001		0.000		0.000		0.001
		(0.002)		(0.002)		(0.002)		(0.002)
L.Agricultural exports price index		0.009		-0.020		0.018		0.032**
		(0.047)		(0.036)		(0.018)		(0.013)
L.log of non-agricutural GDP per nonagricultural worker (predicted)		-0.075		-0.035		-0.173		-0.238
		(0.081)		(0.074)		(0.178)		(0.141)
L.log of agricultural land per agricultural worker (predicted)		-0.011		-0.036		0.548***		0.516***
		(0.047)		(0.042)		(0.118)		(0.101)
L.Human capital index		0.403**		0.415***		0.014		-0.144
		(0.151)		(0.128)		(0.561)		(0.568)
Constant	2.628***	2.365*			0.025***	0.022	0.032***	0.031**
	(0.598)	(1.338)			(0.003)	(0.014)	(0.004)	(0.014)
Long run effects								
log of public expenditure per agricultural worker (US$ 2010)	0.405***	0.441***	0.754***	0.535***	0.392***	0.262***	0.304***	0.221***
	(0.091)	(0.091)	(0.121)	(0.112)	(0.138)	(0.071)	(0.097)	(0.059)
Share of public expenditure on private goods (%)	-0.014***	-0.016***	-0.018***	-0.016***	-0.009**	-0.006***	-0.007***	-0.005***
	(0.005)	(0.004)	(0.007)	(0.005)	(0.003)	(0.002)	(0.002)	(0.001)
Observations	827	824	778	777	806	798	792	786
Number of id_country	35	35	35	35	35	35	35	35
Adjusted R-squared	0.832	0.838			0.334	0.527	0.362	0.566
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	NO	NO	NO	NO
AIC	-580.7	-622.1			-635.1	-894.1	-784.6	-1074
BIC	-420.3	-461.8			-625.7	-861.3	-770.6	-1036
Test for AR(1): Pr > z			0.003	0.003				
Test for AR(2): Pr > z			0.138	0.192				
Hansen overid: Pr > chi2			1.000	1.000				

Notes: this table show the estimated coefficient and the long run effects of agricultural public expenditure on agricultural productivity, using annual data. For the share of public expenditure on private goods (%), the coefficient must be multiplied by 100, which is interpreted as the effect of the change of one percentage point in explanatory variable on the percentage change of the dependent variable. Columns 1, 3, 5 and 7 do not include control variables; Columns 2,4,6 and 8 use the control variables derived from the model of López and Galinato (2007), but including a human capital indicator as additional control. The random forest method was used to predict the value of three explanatory variables (trade openness, non-agricultural GDP per capita and land per capita). For the Arellano-Bond method, we included tests for first and second order autocorrelation, and the Hansen tests for overidentification. Robust standard errors in parentheses, using countries as clusters. *** p<0.01, ** p<0.05, * p<0.1.

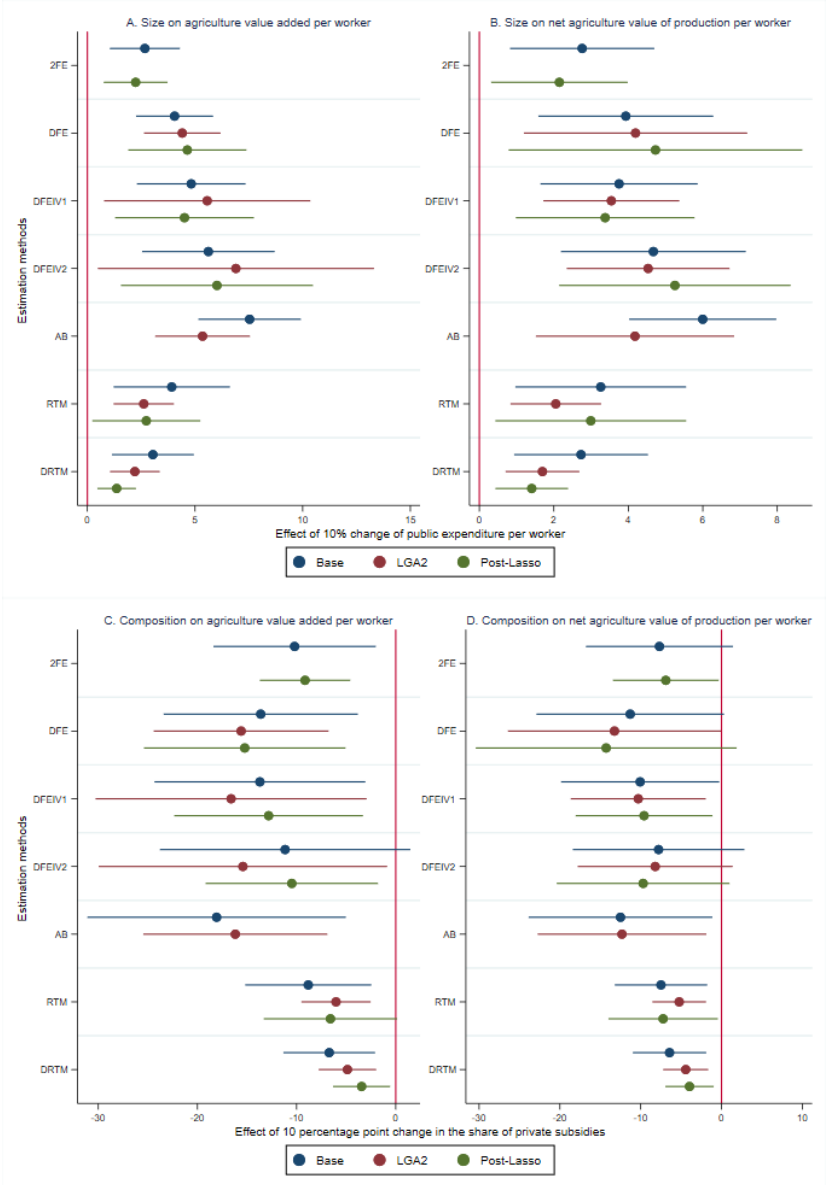

Figure 3.3 Effect of the size and composition of public expenditure per agricultural worker (US$2010) on agricultural productivity indicators (US$2010)

Note: This figure plots the effects of the size of public expenditure (public expenditure per agricultural worker) and share private subsidies (% total public expenditure) on two indicators of agricultural productivity. The original estimates are rescaled by 10 and 10x100 in the size and share, respectively. The horizontal bars are 95% confidence intervals. The y-axes show different estimation methods: 2FE= two-way fixed effects; DFE= dynamic 2FE; DFEIV1= DFE with instrumental variables (IV) for the lagged dependent variable (Ly); DFEIV2= DFEIV1 and IV for the share of public expenditure on private goods (share); DFDIV1= dynamic first-differenced with IV for Ly; DFDIV2= DFDIV1 and IV for the share variable; AB= Arellano-Bond; RTM= random trend model; DRTM= dynamic RTM; DRTMIV1= DRTM with IV for the Ly. The legend show different controls variables: Base=without controls; LGA2= derived from the model of López and Galinato (2007), a human capital indicator as additional control; Post-Lasso=controls selection with Post-LASSO method (Belloni and Chernozhukov, 2013; Belloni et al., 2016).

Conclusions

The results shown in this chapter confirm what was obtained in the previous studies by López and Galinato (2007), Anríquez et al., (2016) and Anríquez, Foster and Ortega (2020): an increase in the level of expenditure has a positive effect on sector performance, but the effect is negative when subsidies to private goods or PESTs policies are increased.

Using five- year average data we find that a reduction in private subsidies by 10 percentage points could generate an increase in value added per agricultural worker of between 9 and 44 percent. The order of magnitude and robustness of the estimates in rural income indicators is lower, varying between 3 to 30 percent. In the analysis by groups of countries (LAC, OECD, and others) we found no evidence of statistically significant differences in the parameters associated with the level and composition of public spending.

With annual data the results are more robust when agricultural productivity indicators are used than indicators of rural income. The results indicate that by decreasing proportional spending on private subsidies by 10 percentage points, expected value added per worker increase by between 9% and 18%. We found evidence of the existence of dynamic effects and heterogeneous trends between countries. These results are statistically more significant, and more accurate than those obtained with five-year average data. The results are also more robust to different estimation methods, different outcome indicators, and different groups of control variables.

An interesting result is that with both types of data (five-year average and annual data) the use of agricultural productivity indicators was more statistically significant than the use of rural income indicators. A possible explanation that can be analyzed in future studies is that, as countries develop, agricultural activity is less important in the income of rural inhabitants. Therefore, future analyzes should also consider including non-agricultural spending in rural areas, as in other previous studies. This will require that the data collected by the OECD on agricultural policy monitoring be complementary to other data sources.

The analysis of the effect of public spending on rural and national development also requires the development of a structural model of two sectors (agricultural and non-agricultural), with the aim of analyzing the interactions between both sectors and their relationship with the effects and causes. of public spending. Finally, a territorial analysis of public spending is suggested, especially in large countries or with greater decentralization in public spending policies (e.g., United States, European Union, Mexico, Brazil, Chile, and others).

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Chapter 4. Institutional and Economic Factors underlying Government Agricultural Support

Abstract

In this chapter we study the institutional and economic factors that explain support policies for the agricultural sector, particularly with respect to the size and composition of public expenditures. We apply panel data from 35 countries for the period 1990-2018 to test two theories, not mutually exclusive. The first is the theory that expenditures depend on political structures and/or slowly changing constitutional rules, focusing on the roles of electoral rules and forms of government. The second is a political-economic theory where policy choices evolve with the level of economic development and the net trade position of the agri-food sector. In addition to indicators of economic development, we also introduce indicators of political forms associated with contemporary popular notions of liberal democracy. The results indicate that explanatory variables related to political institutions explain agricultural public spending in the countries considered. We found that systems with proportional election rules and presidential regimes tend to have greater support for the agricultural sector and larger shares of spending on private subsidies. In the political economic theory of instrument choice, we found that economic development is associated with more size of public agricultural spending. No evidence was found that indicators of liberal democracy are determinants of the level or composition of agricultural spending.

Keywords: Agricultural support policy, electoral rules, forms of government, instrument choice, government-industry interactions.

Introduction

There is an extensive literature on the political, institutional, and economic factors that explain agricultural and food policies and their composition (De Gorter and Swinnen, 2002; Rausser, Swinnen, and Zusman, 2011; Anderson, Rausser, and Swinnen, 2013; and Swinnen, 2018). There are two widely used theories that link political factors to agricultural policy. The first is that of political institutions or constitutional structures (electoral rules and forms of government) developed in detail by Persson and Tabellini (2003, 2004). The second is based on a political economic model of instrument choice, based on the micro foundations for analyzing political economy decision-making or government-industry interaction (Rausser and Foster, 1990; Foster and Rausser, 1993; Grossman and Helpman, 1994).

The main prediction of the theory of political institutions is that proportional electoral systems and parliamentary regimes should be associated with a larger size of government, more public goods and larger and more universalistic welfare programs (Persson and Tabellini, 2004). In the theory of political economic of instrument choices, we follow the model derived by Swinnen et al., (2016), which predicts that less economic development and

a lower net value of agricultural trade is associated with more distorting policies (e.g., higher market price support and greater levels of private subsidies).

In Chapter 2 we showed the main trends of the size and composition of public spending, indicating that, although private subsidies are declining overall, still more than 60 percent of spending is directed towards subsidies. In Chapter 3 we showed the negative effect that private subsidies have on agricultural productivity and rural agricultural income. The objective of this chapter is to study the institutional and political causes of public spending and other support to the farm sector. The main contributions of this chapter are four. First, we present a test of the predictions of the institutional theory and the political-economic theory of instrument choices in a set of wealthy (OECD) and middle-income (LAC and others) countries. Second, we include new indicators of political forms associated with contemporary popular notions of liberal democracy as possible causal factors of the level and composition of public spending. Third, as in Chapter 3, we introduce the use of nonparametric methods to show the conditional correlation between the variables of interest; and we also consider dynamic effects by including one lag of the dependent variable, using a two-way fixed fact model and the Arellano-Bond dynamic model (Arellano and Bond, 1991). And fourth, we introduce the Correlated Random Effects (CRE) model to consider time-invariant control variables (Wooldridge, 2010 and 2019).

This chapter is divided into four sections. The second section describes the empirical model and the data used for the analysis. The third section shows the results and discussion, and finally the conclusions are presented.

Materials and Methods

In this Chapter we follow the theorical model presented in Chapter 1 regarding the causes of agricultural support policy. Specifically, we test the predictions of two theories: the theory of political institutions (electoral rules and forms of government) of Persson and Tabellini (2003; 2004), and the model of instrument choices as condensed by Swinnen et al. (2016) from the political economy theory of decision-making or government-industry interaction theory (Rausser and Foster, 1990; Foster and Rausser, 1993; Grossman and Helpman, 1994). Additionally, we test the effect of indicators of liberal democracy as supplementary indicators of political institutions. These liberal democracy indicators have the advantage that, being quantitative, they present greater variation within and between countries than the dummy variables of electoral rules and forms of government. The inclusion of these indicators can also be motivated by the hypothesis of Acemoglu et al. (2019) that a greater propensity for politicians in more liberal-democratic regimes to invest in public goods is one mechanism for stimulating economic growth. We make use of panel data for expenditures and political systems for 35 countries between 1986 and 2018 (see Chapter 2).

For the empirical analysis, first we use a two-way fixed effects model. The dependent variable is an indicator of agricultural support for country *i* in year *t*, S_{it}, either the level of public spending (in log of public expenditure per agricultural worker, US$2010), or the share of private subsidies (% total agricultural expenditures). Additionally, we use other four indicators: the OECD's total support estimate (% GDP), producer support (% value of production), and market price support (% PSE), and the World Bank's nominal rate of protection (%). The explanatory variables are of three types. First are dummy variables for electoral rules (majority representation) and forms of government (presidential systems), as used by Persson and Tabellini (2003, 2004), PT_{it} . Second are indices of economic development and agricultural trade position used by Swinnen et al., (2016), GH_{it} : the log of GDP per capita relative to United States in the 1960s and 1970s, and net agricultural export status (measured as share of net agricultural export, % agricultural production). Other control variables account for both political institutions and factors influencing instrument choice, entering as lagged variables, X_{it-1}: structural socio-economic conditions (Gini index, share of agricultural labor, and the labor productivity gap between the agricultural and non-agricultural sectors), time-invariant variables (absolute value of latitude, a measure of ethno-linguistic fractionalization, a dummy for being a former British colony, a dummy for having a federal system, a dummy for being a member of GATT/WTO), and a simple dummy for the period 1998-2000 during which countries were entering the WTO and conforming to the norms of the organization with respect to policies. We also include country fixed effects, μ_i.

$$S_{it} = \beta_I PT_{it} + \beta_2 GH_{it} + \gamma X_{it-1} + \mu_i + \delta_t + \varepsilon_{it} \qquad (4.1)$$

where ε_{it} – identically and independently distributed shocks. There is likely persistence in policies due to the cyclic nature of elections and political turnover, and in annual data there might be possible path dependency in both expenditures. This suggests the introduction of a lag of the dependent variable and the estimation of a dynamic two-way fixed effects model:

$$S_{it} = \alpha S_{it-1} + \beta_I PT_{it} + \beta_2 GH_{it} + \gamma X_{it-1} + \delta_t + \mu_i + \varepsilon_{it} \qquad (4.2)$$

To control for the endogeneity of the lag of the dependent variable and the level and composition of spending, a dynamic model (Arellano and Bond, 1991) is also estimated following the equation 4.2.

For a robustness analysis, we consider the possibility of including time invariant control variables (e.g., dummy of GATT/OMC). For this we use the Correlated Random Effects (CRE) model, which includes the country-average of the explanatory variables

($\overline{PT_\iota}, \overline{GH_\iota}$ *and* $\bar{X}_\iota$) and estimated it by a random effects model in the static forms (Wooldridge, 2010 and 2019):

$$S_{it} = \beta_I PT_{it} + \beta_2 GH_{it} + \gamma X_{it-1} + \theta_1 \overline{PT_\iota} + \theta_2 \overline{GH_\iota} + \theta_3 \bar{X}_\iota + \delta_t + \mu_i + \varepsilon_{it} \quad (4.3)$$

And finally, we include dynamic effects of this CRE model:

$$S_{it} = \alpha S_{it-1} + \beta_I PT_{it} + \beta_2 GH_{it} + \gamma X_{it-1} + \theta_1 \overline{PT_\iota} + \theta_2 \overline{GH_\iota} + \theta_3 \bar{X}_\iota + \delta_t + \mu_i + \varepsilon_{it} \quad (4.4)$$

Data

The data for the agricultural public spending was obtained from the OECD monitoring and evaluation program of agricultural policies[8] and from the Agrimonitor database of the Inter-America Development Bank (see Chapter 2 for detail). The indicators of electoral rules and forms of government were obtained from the IADB's Database of Political Institutions 2017 (DPI2017) (Scartascini, Cruz and Keefer, 2018). GDP per capita and the importance of agricultural exports, important to test the instrument choice theory, were constructed from data from the World Bank and FAO. Finally, we use democratic governance indicators from the Polity Project maintained by the Center for Systemic Peace[9] and the V-Dem Dataset v10 produced by the Kellogg Institute for International Studies (Coppedge et al., 2020; Pemstein et al., 2020; Claassen, 2020). This latter database is relatively new and has the advantage of being more transparent than traditional measurements; it captures five dimensions of democracy based on political theory (electoral, participative, deliberative, liberal, and egalitarian).

Table 4.1 shows the descriptive statistics of the data used in this analysis, comparing averages and standard deviations for the periods 1985-1999 and 2000-2018. The indicators of political systems do not vary over time, and their explanatory value is found in their cross-sectional variation (see the Table B.1. of the Appendix B for the list of countries and political institution indicators). Most have election rules by proportional representation (versus representatives elected by majority vote). Most OECD countries have parliamentary forms of government, while the other groups are dominated by the presidential system. Figure 4.1 shows for the period 1990-2018 the for selected countries GDP per capita and net agricultural exports (% of total production value), two indicators used in the instrument choice theory (Swinnen et al., 2016). Figure 4.2 shows the tendency over this time-period of the democracy indicators. Different patterns are observed between countries. For example, while in all countries the relative development index has increased, net agricultural exports have increased in some countries (e.g., Chile), but have decreased in others (e.g., China, European

[8] https://www.oecd.org/agriculture/topics/agricultural-policy-monitoring-and-evaluation/
[9] https://www.systemicpeace.org/polityproject.html

Union). Greater variation is observed in the democracy indicator V-Dem than in Polity5, and while most countries have increased and tended to stabilize, in others, such as Argentina, and Russia it has decreased.

Table 4.1 Summary statistics of main variables by periods

Variable	Period 1985-1999			Period 2000-2018		
	N	Mean	SD	N	Mean	SD
Share of Total Support Estimate -TSE- (% GDP)	256	2.71	5.69	590	1.03	1.30
Share of Producer Support Estimate -PSE- (% value of Production)	260	35.35	37.77	590	19.97	27.45
Share of Market Price Support -MPS- (% TSEp)	260	59.53	111.40	580	59.15	401.10
Nominal rate of assistance (NRA)	366	0.45	0.89	316	0.28	0.46
Public expenditure per ag worker (US$ 2010)	260	5169	7728	588	5080	8828
Share of public expenditure on private goods (% total public spending)	260	70.36	19.05	588	67.40	17.19
Majority Representation (dummy)	443	0.17	0.38	623	0.14	0.35
Presidential system (dummy)	472	0.65	0.48	630	0.66	0.47
GDP per capita relative to United States in 1960s and 1970s	472	0.68	0.85	630	0.91	1.06
Share of net agricultural export (% ag production)	472	-5.09	56.14	595	-15.11	70.96
Revised Combined Polity Score-Polity2(-10 to 10)	474	6.07	5.23	665	7.08	4.55
Electoral democracy index (0-1)	481	0.62	0.25	665	0.68	0.22
Liberal democracy index (0-1)	481	0.49	0.27	665	0.56	0.25
Participatory democracy index (0-1)	481	0.42	0.20	665	0.47	0.18
Deliberative democracy index (0-1)	481	0.51	0.25	665	0.58	0.23
Egalitarian democracy index (0-1)	481	0.46	0.25	665	0.52	0.23
Gini index (0-100)	487	39.01	10.22	665	41.69	9.45
Share of agricultural labor (% total labor)	315	22.46	17.39	665	17.09	14.38
Productivity ratio agriculture to non-agriculture (index)	479	1.20	5.84	665	1.00	6.30

Source: OECD, Agrimonitor, World Bank, Polity-V, V-Dem Indices and other

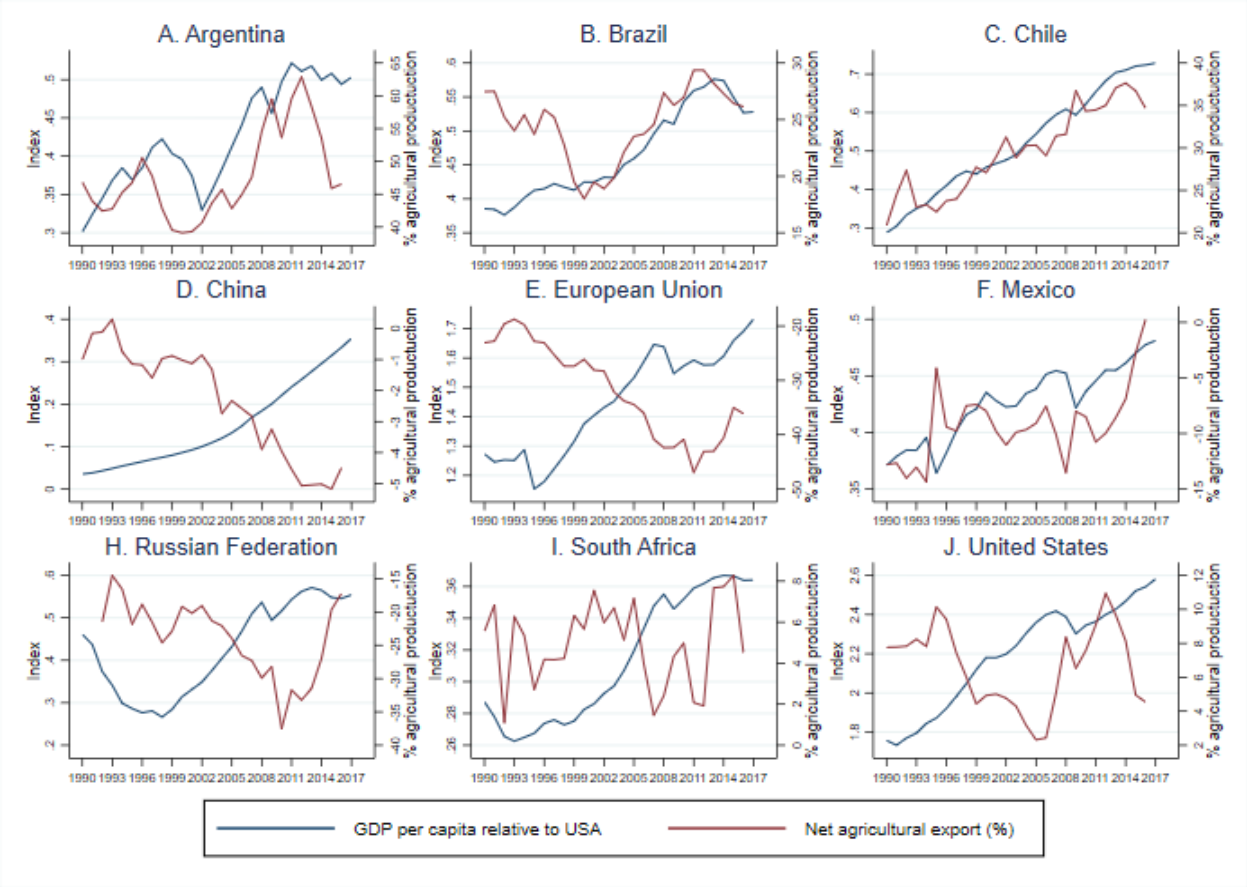

Figure 4.1 GDP per capita and net agricultural exports (% of total production value) in selected countries

Note: This graph shows the evolution of the two indicators used in the instrument choice theory (Swinnen et al., 2016): the institutional development, measure as GDP per capita relative to United States (1960-1970), and the net trade status, measure as net agricultural exports (% total agricultural production).
Sources: World Development Indicators of World Bank, and FAOSTAT from FAO.

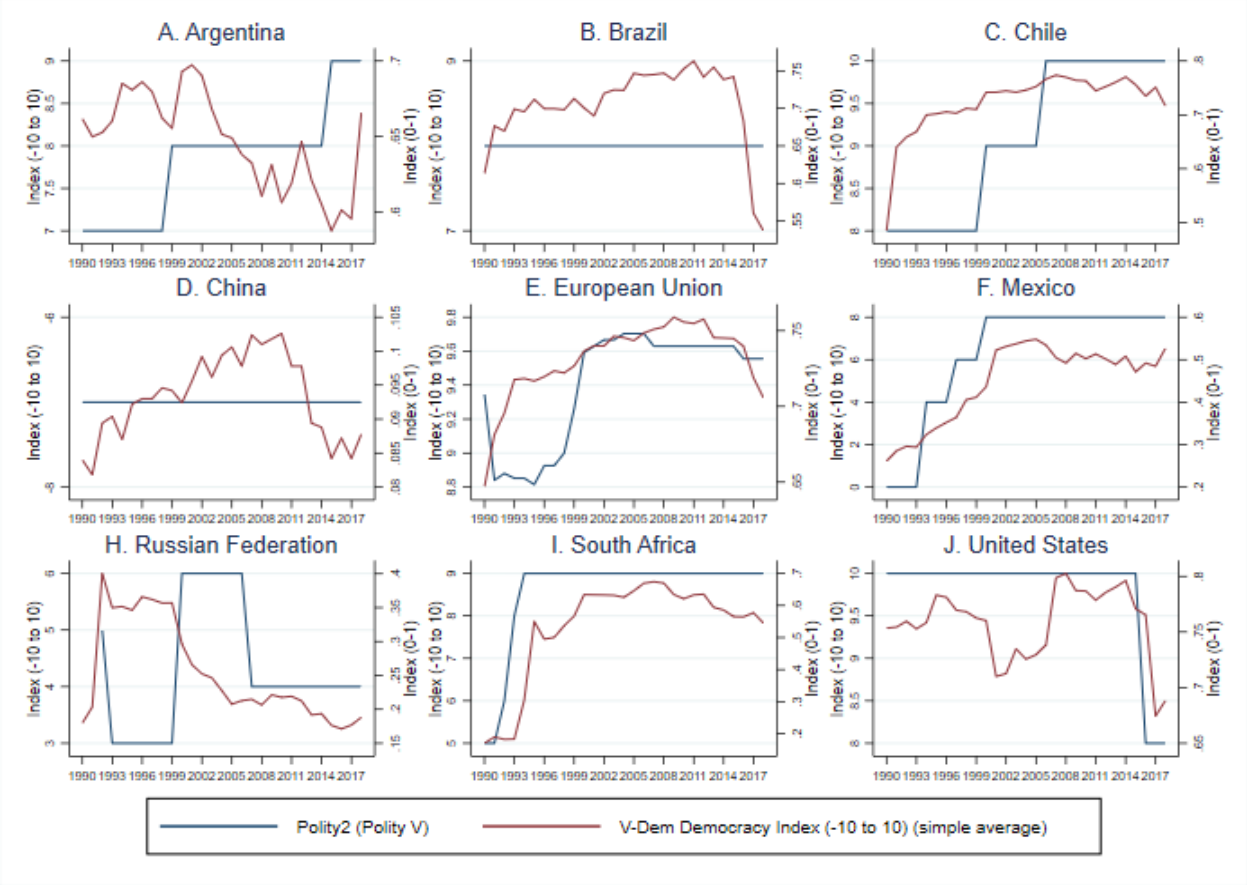

Figure 4.2 Trends of Democracy indicators in some selected countries.

Note: this graph shows the evolution of the two indicators two democracy indicators: the Polity2 of Polity 5 Project and the simple average of the five dimensions of the V-Dem Democracy Index.
Source: Polity5 Project (https://www.systemicpeace.org/csprandd.html) and V-Dem Dataset v10 (Coppedge et al., 2020; Pemstein et al., 2020).

Figure 4.3 and Figure B.1 of the Appendix B show the conditional and unconditional correlations, respectively, between the size and composition of public spending and the indicators of political institutions and the instrument choices indicators. The Figure 4.3 shows that electoral rules and forms of government do not have any statistically significant correlation with the size and composition of public spending. As expected, the institutional development has a statistically significant positive correlation with both public spending indicators (Panels C and G). And the net agricultural exports have an expected negative significative correlation with the composition of public expenditure (Panel H), but no correlation with the size.

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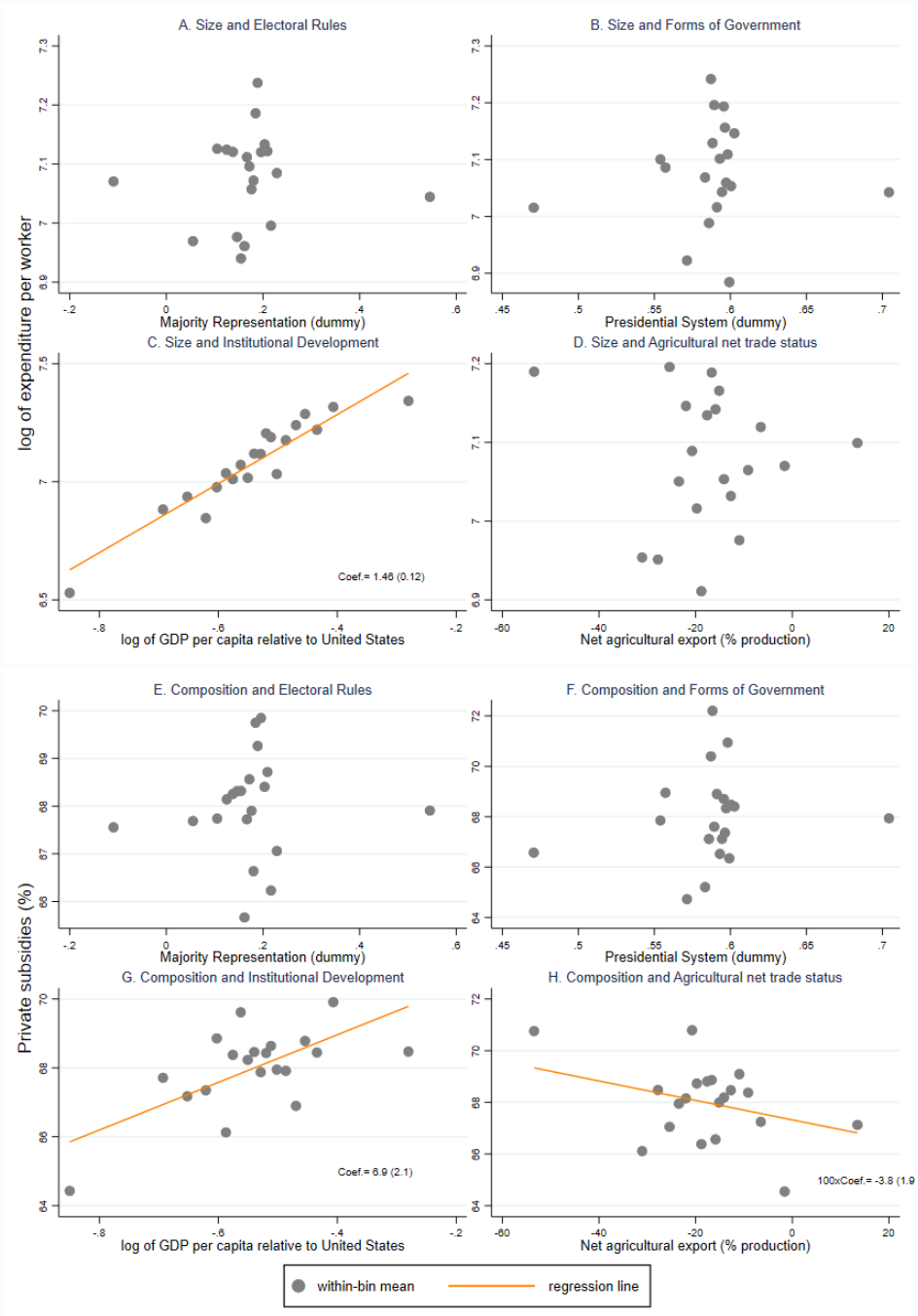

Figure 4.3 Conditional correlation of size and composition of public expenditure with Political institutions and instrument choices indicators.

Note: Panels A-D show the correlation with the size of public expenditure, while panels E-H show the correlation with the composition of public expenditure. The conditional correlations were making using a non-parametric method of *binned scatterplots or binscatter* (Stepner 2014), with country and time fixed effects, and the other as control variables, respectively (see Chapter 4 for detail of this method).
Source: based on database of Political Institutions 2017-DPI2017 (Scartascini, Cruz, and Keefer 2018), World Development Indicators of World Bank, and FAOSTAT from FAO.

Figure 4.4 and Figure B.2 of the Appendix B show the conditional and unconditional correlations, respectively, between the size and composition of public spending and some indicators of democratic development. The unconditional correlations show, as expected, a positive correlation with the size of expenditure and a negative correlation with the proportion destined for private subsidies. However, in the conditional correlations only the deliberative and egalitarian democracy indices have an expected positive and significative correlation with the size of public expenditure (Panels E and F), but the electoral democracy index has a no expected negative correlation (Panel B). Only the liberal democracy index has a no expected negative and significative correlation with de composition of public expenditure (Panel I).

These initial graphical results will be tested using the regression-based parametric empirical analysis strategy described above. It should be noted that the indicators related to democratic government, although they capture conceptually different political dimensions, are highly correlated. A principal component analysis (Figure B.3 in the Appendix B) shows that the first component captures more than 96 percent of the variance, with four indicators (electoral, participative, deliberative, and liberal) receiving nearly equal weightings. For this reason, in the empirical analysis, a simple average of these four indicators is constructed and serves as a single-dimension indicator of the degree of democracy.

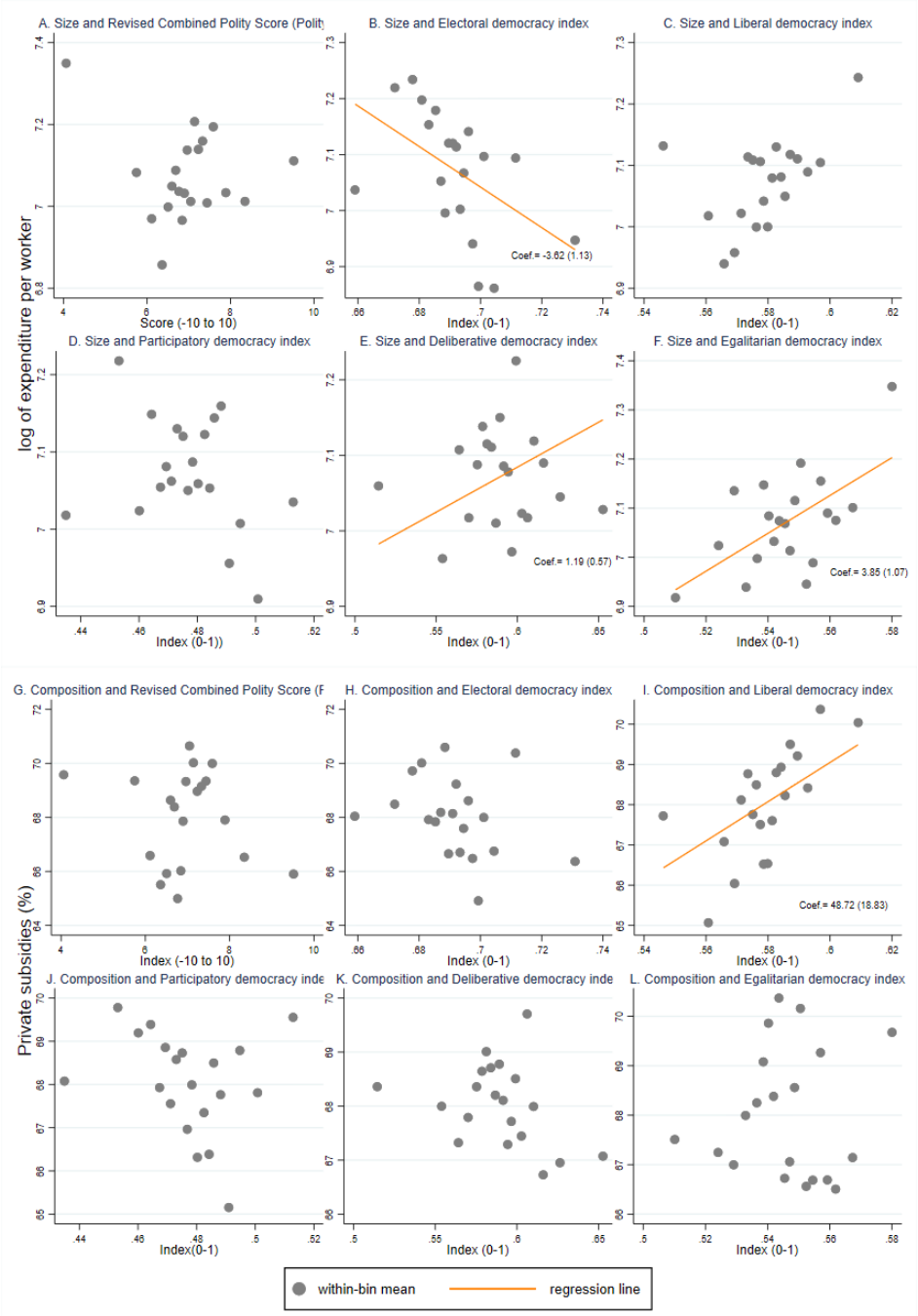

Figure 4.4 Conditional correlation of public expenditure per worker with Democracy Indices

Note: Panels A-F show the correlation with the size of public expenditure, while panels G-L show the correlation. With the composition of public expenditure. The conditional correlations were making using a non-parametric method of *binned scatterplots or binscatter* (Stepner 2014), with country and time fixed effects, and the other as control variables, respectively (see Chapter 4 for detail of this method).
Source: based on Polity5 Project (https://www.systemicpeace.org/csprandd.html) and V-Dem Dataset v10 (Coppedge et al. 2020; Pemstein et al., 2020), World Development Indicators of World Bank, and FAOSTAT from FAO.

Results and discussion

Determinants of agricultural public expenditures

Table 4.2, Table **4.3** and Table **4.4** present the basic results of the regression analyses of the determinants of the size and composition of public spending, using the two-way fixed effects model and two dynamic models (two-way FE with lag dependent variable and Arellano-Bond). In general, the dynamic models show better performance in terms of adjustment (the adjusted R^2 of varies between 0.5 to 0.77) and statistical significance, although the sign and order of magnitude of the parameters of interest are similar., This means that there is a high degree of temporal persistence of the public expenditure indicators, which is reflected with the, the magnitude of the parameter of lag of the dependent variables, that varies between 0.6 and 0.75. The Arellano-Bond tests for autocorrelation (AR1 and AR2), confirmed the presence of first order, but no second order, serial correlation, suggesting that the model dynamic is correctly specified. Moreover, the standard Hansen test confirms that in all cases our set of instruments is valid, because the hypothesis of overidentification is not rejected. However, only the indicators of political institutions (Table 4.2) and the indicator of institutional development (Table 4.3) are statistically significant at 95 percent confidence and above. We did not find any statistically significant effect of the indicators of democratic development (Table 4.3).

The long-term effects of political institutions (Table 4.2) show a negative and statistically significant effect of majority representation (versus proportional) in the size of spending and in the share of private subsidies. A shift towards majority representation means a reduction in the size of spending between 43 to 100 percent, and a reduction in the percentage of private subsidies of between 10 and 19 percentage points. The negative effect on the size of public expenditure is consistent with the predictions of the theory of Persson and Tabellini (2003, 2004), but not the negative effect on private subsidies, since the theory predicts the opposite. However, this last result agrees with Olper and Raimondi (2013) who find that proportional election rules tend to support producers more and therefore spend more on private goods, compared to majority election rule. These results are also consistent with the Rausser and Roland (2010) prediction of agricultural and food policy for poor countries: majority rule has less support and less transfer to producers.

In the case of the forms of government, the estimates show a positive and statistically significant effect of the presidential system (versus parliamentarian) on the size of spending and in the proportion of private subsidies. This means that the shift to a presidential system increases the size of spending by between 14 and 29 percent, and an increase in the percentage of private subsidies by between 7 and 9 percentage points. In other words, the order of magnitude of the forms of government is a little lower than that of the electoral rules. In this case, the consistency of the results is the opposite with the predictions of the forms of government of Persson and Tabellini (2003, 2004): the positive effect of the presidential system on the share of private subsidies is consistent with the theory, but not their effect on the size of expenditure, which should be negative. The positive effect on share of private subsidies is also consistent with that reported by Olper and Raimondi (2013), who finds that presidential systems tend to support producers more and therefore spend more on private goods, compared to parliamentary systems. These results are also consistent

with the Rausser and Roland (2010) prediction of agricultural and food policy for rich countries: Presidential system has more support and more transfer to producers.

Regarding institutional development (Table 4.3), the results show a positive and statistically significant effect on the size of public spending, but not private subsidies. The results show an elasticity of the size of spending with respect to the level of development, measured as GDP per capita relative to the United States in the 1960s and 1970s, of between 1.6 to 2.2 percent. This means that an increase in the level of development of 1%, the expense increases between 1.6 to 2.2 percent. This analysis matches with the conditional and un-conditional correlations shown above (**Figure 4.3** Conditional correlation of size and composition of public expenditure with Political institutions and instrument choices indicators.Figure 4.3 and Figure 4.4). These results are consistent with what was expected, since the more developed the governments tend to support the agricultural sector more. However, the model of Swinnen et al., (2016) is not fully supported because we do not find a statistically significant effect of institutional development on spending on private goods, and neither do we find a statistically significant effect of net agricultural exports.

The parametric results of Table 4.2 and Table 4.3 are consistent with the correlation analysis in the case of Presidential system and Institutional development, but are opposite in the case of Majority representation (Figure 4.3and Figure 4.4). This last result probably because not all the controls used in the parametric analysis were included in the non-parametric analysis. Future non-parametric analyzes using *binned scatterplot or binscatter* can include other control variables and test the new estimation method proposed by Cattaneo et al., (2019a) and Cattaneo et al., (2019b), that improves on the popular widely used method (Stepner, 2014; Starr and Goldfarb, 2020).

Regarding the non-significant results of the democratic indicators, these are consistent with previous studies where a weak relationship has been found between democracy per se, economic growth and economic policies (Persson, 2005; Persson and Tabellini, 2008; Acemoglu et al., 2008). For this reason, there has been a tendency to look for some specific conditions of democracy such as electoral rules and forms of government. However, future research is necessary to deepen the analysis of these democratic indicators, or to build new specific institutional indicators for agricultural and food policies.

Table 4.2 Effects of political institutions (electoral rules and forms of government) on the size and composition of agricultural public expenditure.

	log of agricultural public expenditure per worker			***share of private subsidies (% total public expenditure)***		
	Two-Way FE	Dynamic Two-way FE	Arellano-Bond	Two-Way FE	Dynamic Two-way FE	Arellano-Bond
	(1)	(2)	(3)	(4)	(5)	(6)
L.Dependent variable		0.740***	0.744***		0.591***	0.601***
		(0.035)	(0.041)		(0.044)	(0.045)
Majority representation (dummy)	-0.638	-0.228***	-0.254***	-14.773***	-7.613***	-7.370***
	(0.547)	(0.081)	(0.091)	(4.684)	(1.254)	(1.339)
Presidential system (dumy)	0.325***	0.076**	0.014	7.215***	3.641***	2.812***
	(0.066)	(0.029)	(0.028)	(1.168)	(0.737)	(0.350)
L.Gini index	0.008	0.004	0.005	0.253	0.288**	0.260**
	(0.018)	(0.010)	(0.011)	(0.174)	(0.109)	(0.111)
L.Agricultural labor (% employment)	-0.024	-0.000	-0.013***	-0.398**	-0.099	-0.082
	(0.023)	(0.005)	(0.004)	(0.178)	(0.061)	(0.051)
L.log ratio agricultural to non-agricultural productivity	0.263	-0.030	0.007	-2.913***	-0.647	-0.938*
	(0.184)	(0.046)	(0.040)	(0.996)	(0.611)	(0.511)
Constant	6.858***	1.478***		58.045***	17.454***	
	(0.794)	(0.294)		(8.505)	(5.314)	
Long run effects						
Majority representation (dummy)	-0.638	-0.876***	-0.991***	-14.773***	-18.597***	-18.453***
	(0.547)	(0.258)	(0.316)	(4.684)	(2.186)	(2.421)
Presidential system (dumy)	0.325***	0.290***	0.053	7.215***	8.894***	7.041***
	(0.066)	(0.108)	(0.104)	(1.168)	(1.547)	(0.608)
Observations	721	704	669	721	704	669
Number of id_country	35	35	35	35	35	35
Adjusted R-squared	0.338	0.746		0.144	0.524	
Country FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
AIC	783.3	90.80		4693	4127	
BIC	916.2	227.5		4826	4263	
Test for AR(1): Pr > z			0.000			0.000
Test for AR(2): Pr > z			0.558			0.877
Hansen overid: Pr > chi2			1.000			1.000

Notes: this table show the estimated coefficient and the long run effects of political institutions (electoral rules and forms of government) on the size and composition of agricultural public expenditure, using annual data. Columns show two different specifications for each dependent variable and estimation method. For the Arellano-Bond method, we included tests for first and second order autocorrelation, and the Hansen tests for overidentification. Robust standard errors in parentheses, using countries as clusters. *** p<0.01, ** p<0.05, * p<0.1

Table 4.3 Effects of instrument choice indicators (Institutional development and agricultural net trade status) on the size and composition of agricultural public expenditure.

	log of agricultural public expenditure per worker			***share of private subsidies (% total public expenditure)***		
	Two-Way FE	Dynamic Two-way FE	Arellano-Bond	Two-Way FE	Dynamic Two-way FE	Arellano-Bond
	(1)	(2)	(3)	(4)	(5)	(6)
L.Dependent variable		0.684***	0.683***		0.634***	0.635***
		(0.030)	(0.029)		(0.050)	(0.050)
log GDP per capita relative to United States	2.325***	0.702***	0.698***	0.900	-0.172	0.185
	(0.537)	(0.156)	(0.110)	(9.266)	(2.543)	(1.639)
net agricultural export (% ag production)	0.002	0.000	0.000	-0.009	-0.009	-0.010
	(0.002)	(0.001)	(0.000)	(0.023)	(0.010)	(0.008)
L.Gini index	-0.001	0.002	0.001	0.072	0.175	0.163
	(0.014)	(0.007)	(0.006)	(0.224)	(0.129)	(0.127)
L.Agricultural labor (% employment)	0.038***	0.014***	0.015***	-0.478***	-0.148**	-0.114**
	(0.012)	(0.005)	(0.005)	(0.161)	(0.062)	(0.056)
L.log ratio agricultural to non-agricultural productivity	0.403***	0.023	0.017	-3.988***	-0.912	-1.114**
	(0.116)	(0.042)	(0.043)	(1.289)	(0.714)	(0.555)
Constant	8.375***	2.404***		68.722***	20.273***	
	(0.729)	(0.338)		(13.620)	(5.757)	
Long run effects						
log GDP per capita relative to United States	2.325***	2.223***	2.203***	0.900	-0.469	0.507
	(0.537)	(0.459)	(0.307)	(9.266)	(6.911)	(4.528)
net agricultural export (% ag production)	0.002	0.000	0.001	-0.009	-0.025	-0.027
	(0.002)	(0.002)	(0.002)	(0.023)	(0.028)	(0.021)
Observations	700	681	646	700	681	646
Number of id_country	35	35	35	35	35	35
Adjusted R-squared	0.444	0.770		0.071	0.505	
Country FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
AIC	691.4	0.100		4691	4031	
BIC	823.4	135.9		4823	4167	
Test for AR(1): Pr > z			0.000			0.000
Test for AR(2): Pr > z			0.732			0.928
Hansen overid: Pr > chi2			1.000			1.000

Notes: this table show the estimated coefficient and the long run effects of instrument choice indicators (Institutional development and agricultural net trade status) on the size and composition of agricultural public expenditure, using annual data. Columns show two different specifications for each dependent variable and estimation method. For the Arellano-Bond method, we included tests for first and second order autocorrelation, and the Hansen tests for overidentification. Robust standard errors in parentheses, using countries as clusters. *** p<0.01, ** p<0.05, * p<0.1

Table 4.4 Effects of Democratic indices (V-dem Democratic indices) on the size and composition of agricultural public expenditure.

	log of agricultural public expenditure per worker			***share of private subsidies (% total public expenditure)***		
	Two-Way FE	Dynamic Two-way FE	Arellano-Bond	Two-Way FE	Dynamic Two-way FE	Arellano-Bond
	(1)	(2)	(3)	(4)	(5)	(6)
L.Dependen variable		0.757***	0.773***		0.636***	0.636***
		(0.029)	(0.026)		(0.052)	(0.054)
V-Dem Democracy Index, simple average four indices (0-1)	-0.761	0.014	0.013	-6.766	-9.259	-11.206
	(1.772)	(0.506)	(0.527)	(15.231)	(8.983)	(8.432)
Egalitarian democracy index (0-1)	1.786	0.250	0.272	20.801	17.667	21.771
	(2.089)	(0.586)	(0.651)	(23.000)	(14.867)	(13.242)
L.Gini index	0.000	0.003	0.004	0.068	0.217*	0.183
	(0.016)	(0.006)	(0.007)	(0.227)	(0.128)	(0.123)
L.Agricultural labor (% employment)	-0.032	-0.003	-0.012***	-0.491*	-0.101	-0.077
	(0.023)	(0.004)	(0.004)	(0.285)	(0.068)	(0.056)
L.log ratio agricultural to non-agricultural productivity	0.133	-0.119	-0.088	-3.924***	-0.994	-1.333**
	(0.222)	(0.083)	(0.072)	(1.336)	(0.633)	(0.567)
Constant	6.926***	1.323***		61.492***	14.368*	
	(1.024)	(0.303)		(15.801)	(7.542)	
Long run effects						
V-Dem Democracy Index, simple average four indices (0-1)	-0.761	0.056	0.057	-6.766	-25.420	-30.761
	(1.772)	(2.079)	(2.327)	(15.231)	(26.584)	(25.397)
Egalitarian democracy index (0-1)	1.786	1.028	1.202	20.801	48.504	59.763
	(2.089)	(2.382)	(2.835)	(23.000)	(43.401)	(39.276)
Observations	760	741	706	760	741	706
Number of id_country	35	35	35	35	35	35
Adjusted R-squared	0.263	0.737		0.083	0.513	
Country FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
AIC	1010	146.7		5094	4393	
BIC	1154	294.1		5238	4540	
Test for AR(1): Pr > z			0.003			0.000
Test for AR(2): Pr > z			0.364			0.887
Hansen overid: Pr > chi2			1.000			1.000

Notes: this table show the estimated coefficient and the long run effects of Democratic indices (V-dem Democratic indices) on the size and composition of agricultural public expenditure, using annual data. The four V-Dem indices used for simple average are: Electoral democracy index, Liberal democracy index, Participatory democracy index, and Deliberative democracy index. Columns show two different specification for each dependent variable and estimation method. For the Arellano-Bond method, we included tests for first and second order autocorrelation, and the Hansen tests for overidentification. Robust standard errors in parentheses, using countries as clusters. *** p<0.01, ** p<0.05, * p<0.1

Explanatory factors for other agricultural support policies and robustness analysis

A summary of the estimated coefficients of the key explanatory variables for five indicators of agricultural support policy, including the size and composition of public expenditure, and different estimation methods and set of control variables, are presented in Figures B.4 to B.9 in the Appendix B. The majority voting rule generally presents negative and statistically significant results for most of the support policy indicators, except for the nominal attendance rate (Figure B.4). These results support the theories for the spending size indicators, but not for the distorting policies (MPS and private subsidies). In the presidential system of government (Figure B.5), the results are positive and statistically significant for PSE, the size of spending and private subsidies; in this case only the positive effect on private subsidies coincides with the theory.

Institutional development (Figure B.6) presents positive and statistically significant results for NRA and size of expenditure, supporting the theory in the latter case. Net agricultural exports have a statistically positive effect on PSE and NRA (Figure B.7); this last result does not support the predictions of the theory. Finally, the indicators of democratic development present a statistically significant effect on the TSE and PSE, but not on the other indicators. The 4 V-Dem indicator has a positive effect (Figure B.8), while the equal democracy indicator has a negative effect (Figure B.9).

Conclusions

The main conclusion of this chapter is that public spending is explained mainly by the theory of political institutions and by the level of institutional development of the instrument choice theory. The proportional election rule and the presidential system tend to have greater support for the agricultural sector and greater spending on private subsidies. These results mixed support the general prediction of Persson and Tabellini (2003, 2004) and the particular prediction for agricultural policies of Olper and Raimondi (2013) and Rausser and Roland (2010). On the other hand, in the model of Swinnen et al., (2016), we found that greater institutional development is associated with greater the support for the agricultural sector, but not for the share of private subsidies. These results are similar for the other policy indicators used.

The indicators of democratic development have no effect on public expenditure, but there are some effects on the total support estimate (TSE) and the producer support estimate (PES). Future research is necessary to deepen the analysis of these democratic indicators, or to build new specific institutional indicators for agricultural and food policies.

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General Discussion and Conclusion

Summary of Key Findings

The objective of this thesis is to analyze the effects of government expenditures, its composition on agricultural income and productivity, and its institutional and political causes. In the third and four Chapters we present the empirical analysis, and the main results.

In Chapter 3 we analyze the effects of the level and composition of public spending on rural agricultural income per rural inhabitant and agricultural productivity per farm worker, using five-year averages and annual data for a panel of 35 countries from 1990 to 2018. This analysis extends previous studies by increasing the sample of countries from a set of Latin American and Caribbean (LAC) to include countries from the Organization for Economic Co-operation and Development (OECD) and other emerging economies. The results confirm previous studies regarding the positive effect on agricultural performance indicators of the level of public spending, and, more importantly, the negative effect of spending directed towards private goods (López and Galinato, 2007; Anríquez et al., 2016; and Anríquez, Foster and Ortega, 2020). Results also show that using values per agricultural worker (versus per rural inhabitant), using the two-way fixed effects method (versus one way), and annual data with dynamic effects leads to more robust estimation with greater statistical significance. The results indicate that by decreasing the proportion of spending dedicated to private subsidies by 10 percentage points, expected value added per worker increase by between 9% and 18%. We find evidence of the existence of dynamic effects and heterogeneous trends between countries.

In Chapter 4 we study the institutional and economic factors that explain support policies for the agricultural sector, particularly with respect to the size and composition of public expenditures. We test the predictions of two theories: the theory of political institutions (electoral rules and forms of government) of Persson and Tabellini (2003; 2004), and the model of instrument choices as condensed by Swinnen et al. (2016) from the political economy theory of decision-making or government-industry interaction theory (Rausser and Foster, 1990; Foster and Rausser, 1993; Grossman and Helpman, 1994). Additionally, we test the effect of indicators of liberal democracy as supplementary indicators of political institutions. The results indicate that explanatory variables related to political institutions explain agricultural public spending in the countries considered. We found that systems with proportional election rules and presidential regimes tend to have greater support for the agricultural sector and larger shares of spending on private subsidies. Related to the political economic theory of instrument choice (as developed by Swinnen et al., 2016), we found that economic development is associated with greater public agricultural spending. No evidence was found that indicators of liberal democracy are determinants of the level or composition of agricultural spending. Future research is necessary to deepen the analysis of these democratic indicators, or to build new specific institutional indicators for agricultural and food policies.

Future Directions and Conclusions

An interesting result is that with both types of data (five-year average and annual data) the use of agricultural productivity indicators was more statistically significant than the use of rural income indicators. A possible explanation to be analyzed in future studies is that, as countries develop, agricultural activity is less important in the income of rural inhabitants. Therefore, future analyses should also consider including non-agricultural spending in rural areas, as in other previous studies. This will require that the data collected by the OECD and Agrimonitor on agricultural policy monitoring should be complementary with other data sources and with data of less development countries in Africa and Asia.[10]

The analysis of the effect of public spending on rural and national development also requires the elaboration of structural models of two sectors (agricultural and non-agricultural), with the aim of analyzing their interactions and relationship with the public spending. A territorial analysis would also allow testing of the impact of the composition of government spending, especially in large countries or with greater decentralization in public spending policies (e.g., United States, European Union, Mexico, Brazil, and others).

Regarding the institutional and political causes of the level and composition of public spending, the results obtained are exploratory. It is necessary to compile indicators that are more specific to the dynamics of the agricultural sector and analyze their conditional effect on the more general institutional and political variables of each country. In this sense, it would be useful to measure the behavior of different economic and political interest groups that influence public spending decisions (e.g., producer associations, large exporting firms, consumer groups). Understanding the political and institutional variables can contribute to "Smart Governance" in the design of a agricultural policy portfolios, which combines support for public and private goods, as proposed in a recent paper by Rausser, Foster, and Zilberman (2021).

It is necessary to carry out a comprehensive econometric analysis, derived from a structural model, where the causes and effects of public spending and other support policies for the agricultural sector are studied, also extending the modeling structure to the rural economy more generally. This will require an analysis of simultaneous equations with an adequate identification of the exogenous and endogenous variables and instruments.

In conclusion, the results deriving from this study support previous studies on the negative effects of spending directed at private goods. Given that these supports are still greater than 50 percent in most countries, there is an opportunity to improve the performance of public spending as a tool for the transformation and modernization of the agricultural sector. However, it is important to consider the political and institutional variables that explain the levels and composition of public spending, and this study shows some exploratory results, but it is necessary to deepen the analysis.

[10] The data and analysis compiled by FAO's program Monitoring and Analysing Food and Agricultural Policies (MAFAP) for countries in Africa and Asia can be very useful (http://www.fao.org/in-action/mafap/home/en/).

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Appendices

Appendix A. Additional results of the Effects of Public Expenditures on Agricultural Performance

Table A.1 Effects of agricultural public expenditure on rural agricultural income, using Two-way Fixed Effects estimator with five years periods. Dependent variable: log of agricultural value added per rural capita (US$ 2010)

	All countries			LAC countries			OECD countries			Other countries		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
log of public expenditure per rural capita	0.142***	0.056	0.060	0.098	0.050	0.087*	-0.060	-0.067	-0.105	0.150	0.010	0.003
	(0.034)	(0.040)	(0.045)	(0.057)	(0.056)	(0.044)	(0.197)	(0.180)	(0.168)	(0.090)	(0.064)	(0.067)
Share of public expenditure on private goods (%)	-0.003	-0.003	-0.003	-0.007**	-0.006*	-0.005*	0.002	0.000	0.003	-0.005	0.000	0.000
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.009)	(0.011)	(0.010)	(0.005)	(0.003)	(0.003)
Trade openness index (predicted)		-0.002	-0.002		-0.006	-0.005		-0.004	-0.000		0.004	0.007
		(0.003)	(0.004)		(0.005)	(0.004)		(0.005)	(0.004)		(0.003)	(0.005)
Agricultural exports price index		0.027	0.026		0.027	0.036		0.054	0.060		-0.256	-0.253
		(0.079)	(0.080)		(0.071)	(0.051)		(0.114)	(0.102)		(0.151)	(0.150)
log of non agricutural GDP per capita non-rural (predicted)		0.420***	0.409***		0.090	0.425		0.294	0.669**		0.358*	0.394**
		(0.081)	(0.106)		(0.341)	(0.275)		(0.247)	(0.264)		(0.156)	(0.150)
log of agricultural land per capita rural (predicted)		0.229***	0.221***		0.168	0.192		0.189	0.333*		0.290**	0.268*
		(0.067)	(0.068)		(0.107)	(0.117)		(0.156)	(0.161)		(0.116)	(0.129)
Human capital index			0.048			0.788***			-0.772			-0.237
			(0.242)			(0.166)			(0.434)			(0.282)
Constant	6.784***	4.939***	4.880***	7.140***	7.982**	3.289	8.392***	6.858*	6.054*	6.037***	6.224***	6.046***
	(0.296)	(0.988)	(0.950)	(0.345)	(3.600)	(3.112)	(0.833)	(3.441)	(3.336)	(0.368)	(1.429)	(1.194)
Observations	186	186	186	55	55	55	82	82	82	49	49	49
Number of id_country	34	34	34	13	13	13	12	12	12	9	9	9
Adjusted R-squared	0.550	0.600	0.598	0.859	0.861	0.904	0.315	0.310	0.335	0.782	0.855	0.856
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Period FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
AIC	-156.2	-174.7	-172.8	-110.1	-107.7	-127.3	-29.10	-27.20	-31.30	-70.40	-95.60	-97.10
BIC	-130.4	-136	-130.9	-96	-85.60	-103.2	-9.900	-0.700	-4.900	-55.30	-80.50	-82
Prob > F total	0.000	0.000	0.000									
Prob > F time periods	0.000	0.012	0.021	0.000	0.008	0.669	0.025	0.698	0.505	0.001	0.008	0.054
Prob > F groups of countries	0.511	0.361	0.422									

Notes: The OECD countries excluded Chile and Mexico, because are included in Latin America region. Columns 1, 4, 7, and 10 do not include control variables; Columns 2,5,8 and 11 use the control variables derived from the model of López and Galinato (2007); Columns 3,6,9 and 12 extend the above by including a human capital variable. The F tests for groups of countries are not statistically significant, indicating that there are no differences in the estimated parameters between these groups (except in column 3). The F tests of time periods are statistically significant, indicating that we need to use the Two-Way Fixed Effects method. The random forest method was used to predict the value of three explanatory variables (trade openness, non-agricultural GDP per capita and land per capita). Robust standard errors in parentheses, using countries as clusters. *** p<0.01, ** p<0.05, * p<0.1.

Table A.2 Effects of agricultural public expenditure on agricultural productivity, using One-Way Fixed Effects estimator with five years periods. Dependent variable: log of agricultural value added per agricultural labor (US$ 2010)

	All countries			LAC countries			OECD countries			Other countries		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
log of public expenditure per agricultural labor	0.499***	0.152*	0.206***	0.491***	0.201	0.273***	0.859***	0.355***	0.371***	0.020	-0.081	0.047
	(0.103)	(0.076)	(0.049)	(0.079)	(0.123)	(0.059)	(0.079)	(0.098)	(0.107)	(0.222)	(0.053)	(0.066)
Share of public expenditure on private goods (%)	-0.017***	-0.011**	-0.012***	-0.011	- .005	-0.004	-0.027***	-0.019***	-0.019***	0.014	0.008	0.003
	(0.005)	(0.005)	(0.004)	(0.007)	(0.006)	(0.004)	(0.005)	(0.005)	(0.005)	(0.012)	(0.006)	(0.005)
Trade openness index (predicted)		-0.001	-0.008		0.015	0.001		-0.013*	-0.012*		-0.000	-0.009
		(0.005)	(0.005)		(0.010)	(0.008)		(0.006)	(0.006)		(0.008)	(0.008)
Agricultural exports price index		0.233***	0.098		0.349*	0.139*		0.136*	0.149**		0.241	0.044
		(0.068)	(0.063)		(0.163)	(0.070)		(0.072)	(0.056)		(0.213)	(0.176)
log of non agricutural GDP per capita non-agricultura labor (predicted)		0.345**	0.018		0.355	-0.390		0.728***	0.874***		0.259*	0.051
		(0.156)	(0.073)		(0.369)	(0.273)		(0.205)	(0.262)		(0.128)	(0.073)
log of agricultura land per agricultural labor (predicted)		0.908***	0.589***		1.043***	0.686***		0.631***	0.672***		1.085***	0.652**
		(0.167)	(0.145)		(0.287)	(0.219)		(0.164)	(0.160)		(0.177)	(0.199)
Human capital index			0.877***			0.948***			-0.219			0.876***
			(0.123)			(0.081)			(0.301)			(0.197)
Constant	6.928***	9.468***	9.255***	6.647***	8.090*	12.306***	4.860***	3.857	2.933	6.826***	10.856***	9.070***
	(0.755)	(2.135)	(1.473)	(0.546)	(3.937)	(3.375)	(0.557)	(2.887)	(3.109)	(0.819)	(1.712)	(1.616)
Observations	186	186	186	55	55	55	82	82	82	49	49	49
Number of id_country	34	34	34	13	13	13	12	12	12	9	9	9
Adjusted R-squared	0.377	0.748	0.813	0.569	0.761	0.894	0.694	0.864	0.863	0.072	0.733	0.780
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Period FE	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
AIC	97	-67.60	-122.2	-5.600	-34.50	-78.60	0.600	-61.90	-60.60	43.10	-14.40	-23
BIC	103.4	-48.30	-99.60	-1.600	-22.50	-64.50	5.500	-47.40	-43.80	46.90	-3	-9.700
Prob > F total	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.236	0.000	0.000
Prob > F groups of countries	0.002	0.000	0.001									

Notes: The OECD countries excluded Chile and Mexico, because are included in Latin America region. Columns 1, 4, 7, and 10 do not include control variables; Columns 2,5,8 and 11 use the control variables derived from the model of López and Galinato (2007); Columns 3,6,9 and 12 extend the above by including a human capital variable. The F tests for groups of countries are not statistically significant, indicating that there are no differences in the estimated parameters between these groups (except in column 3). The random forest method was used to predict the value of three explanatory variables (trade openness, non-agricultural GDP per capita and land per capita). Robust standard errors in parentheses, using countries as clusters. *** p<0.01, ** p<0.05, * p<0.1.

Table A.3 Summary of Effects of share of public expenditure on private goods on different indicators of rural agricultural income, methods, and groups of countries, using five years average

	All countries			LAC countries			OECD countries			Other countries		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A. log of agricultural value added per capita rural												
Fixed Effects	-0.004	-0.003	-0.004	-0.006	-0.003	-0.003*	-0.008	-0.004	-0.004	0.008	0.004**	0.003
	(0.004)	(0.003)	(0.003)	(0.006)	(0.003)	(0.002)	(0.006)	(0.007)	(0.007)	(0.006)	(0.002)	(0.003)
Two-Way Fixed Effects	-0.003	-0.003	-0.003	-0.007**	-0.006*	-0.005*	0.002	0.000	0.003	-0.005	0.000	0.000
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.009)	(0.011)	(0.010)	(0.005)	(0.003)	(0.003)
Two-Way Fixed Effects with instrumental variables	-0.030	-0.019	-0.026	0.013	0.010	0.005	0.005	0.003	0.006	-0.011***	-0.009***	-0.008***
	(0.020)	(0.021)	(0.036)	(0.011)	(0.008)	(0.005)	(0.009)	(0.010)	(0.010)	(0.003)	(0.003)	(0.002)
Kleibergen-Paap rk LM statistic: Pr > Chi-sq	0.227	0.200	0.389	0.165	0.201	0.183	0.037	0.032	0.017	0.123	0.115	0.131
Hansen J statistic: Pr > Chi-sq	0.603	0.764	0.634	0.849	0.675	0.976	0.849	0.573	0.335	0.083	0.079	0.082
Panel B. log of agricultural production value per capita rural												
Fixed Effects	-0.007*	-0.008*	-0.008**	-0.007	-0.004	-0.004	-0.013	-0.014	-0.014	-0.002	-0.004	-0.005
	(0.004)	(0.004)	(0.004)	(0.006)	(0.004)	(0.004)	(0.008)	(0.009)	(0.009)	(0.013)	(0.009)	(0.006)
Two-Way Fixed Effects	-0.007*	-0.009**	-0.009**	-0.002	-0.001	0.001	-0.015	-0.016*	-0.019**	-0.008	-0.005	-0.005
	(0.004)	(0.004)	(0.004)	(0.005)	(0.003)	(0.004)	(0.008)	(0.008)	(0.008)	(0.011)	(0.006)	(0.006)
Two-Way Fixed Effects with instrumental variables	-0.033**	-0.032*	-0.046	0.023	0.027**	0.020**	-0.017**	-0.018**	-0.021***	-0.009	-0.012	-0.015
	(0.014)	(0.017)	(0.035)	(0.019)	(0.013)	(0.009)	(0.008)	(0.008)	(0.008)	(0.012)	(0.010)	(0.010)
Kleibergen-Paap rk LM statistic: Pr > Chi-sq	0.227	0.200	0.389	0.165	0.201	0.183	0.037	0.032	0.017	0.123	0.115	0.131
Hansen J statistic: Pr > Chi-sq	0.911	0.641	0.467	0.975	0.725	0.892	0.125	0.055	0.118	0.153	0.239	0.266
Panel C. log of net agricultural production value per capita rural												
Fixed Effects	-0.002	-0.001	-0.003	-0.003	0.001	0.000	-0.010	-0.007	-0.007	0.008	0.006**	0.004
	(0.004)	(0.002)	(0.002)	(0.007)	(0.004)	(0.002)	(0.006)	(0.005)	(0.005)	(0.008)	(0.002)	(0.004)
Two Fixed Effects	-0.001	-0.002	-0.003	-0.004	-0.003*	-0.002	-0.003	-0.005	-0.007	-0.004	0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.005)	(0.006)	(0.005)	(0.005)	(0.004)	(0.004)
Two-Way Fixed Effects with instrumental variables	-0.028*	-0.012	-0.007	0.007	0.005	0.002	-0.005	-0.007	-0.009*	-0.009***	-0.010***	-0.008**
	(0.016)	(0.010)	(0.008)	(0.008)	(0.005)	(0.003)	(0.005)	(0.005)	(0.005)	(0.003)	(0.004)	(0.004)
Kleibergen-Paap rk LM statistic: Pr > Chi-sq	0.106	0.055	0.034	0.165	0.201	0.183	0.037	0.032	0.017	0.123	0.102	0.112
Hansen J statistic: Pr > Chi-sq	0.219	0.315	0.129	0.714	0.687	0.802	0.526	0.316	0.612	0.040	0.022	0.022

Notes: This table shows the estimated coefficients of the effect of share of public expenditure on private goods (%) on different indicators of rural agricultural income (in log scale): the coefficient must be multiplied by 100, which is interpreted as the effect of the change of one percentage point in explanatory variable on the percentage change of the dependent variable. The OECD countries excluded Chile and Mexico, because are included in Latin America region. Columns 1, 4, 7, and 10 do not include control variables; Columns 2,5,8 and 11 use the control variables derived from the model of López and Galinato (2007); Columns 3,6,9 and 12 extend the above by including a human capital variable. For the method of Two-Fixed Effects with instrumental variables we use as instrument the "jackknifed average" of the level of spending and composition of spending in the region of each country (following Acemoglu et al., 2019). We use the Kleibergen-Paap rk LM statistic for under-identification test and Hansen J statistic for overidentification test. In general, the hypothesis of under-identification is not rejected, except for the group of OECD countries, so the instruments are weak; however, the hypothesis of overidentification is not rejected either, so the instruments are valid. In short, the instruments are valid, but weak. Robust standard errors in parentheses, using countries as clusters. *** p<0.01, ** p<0.05, * p<0.1.

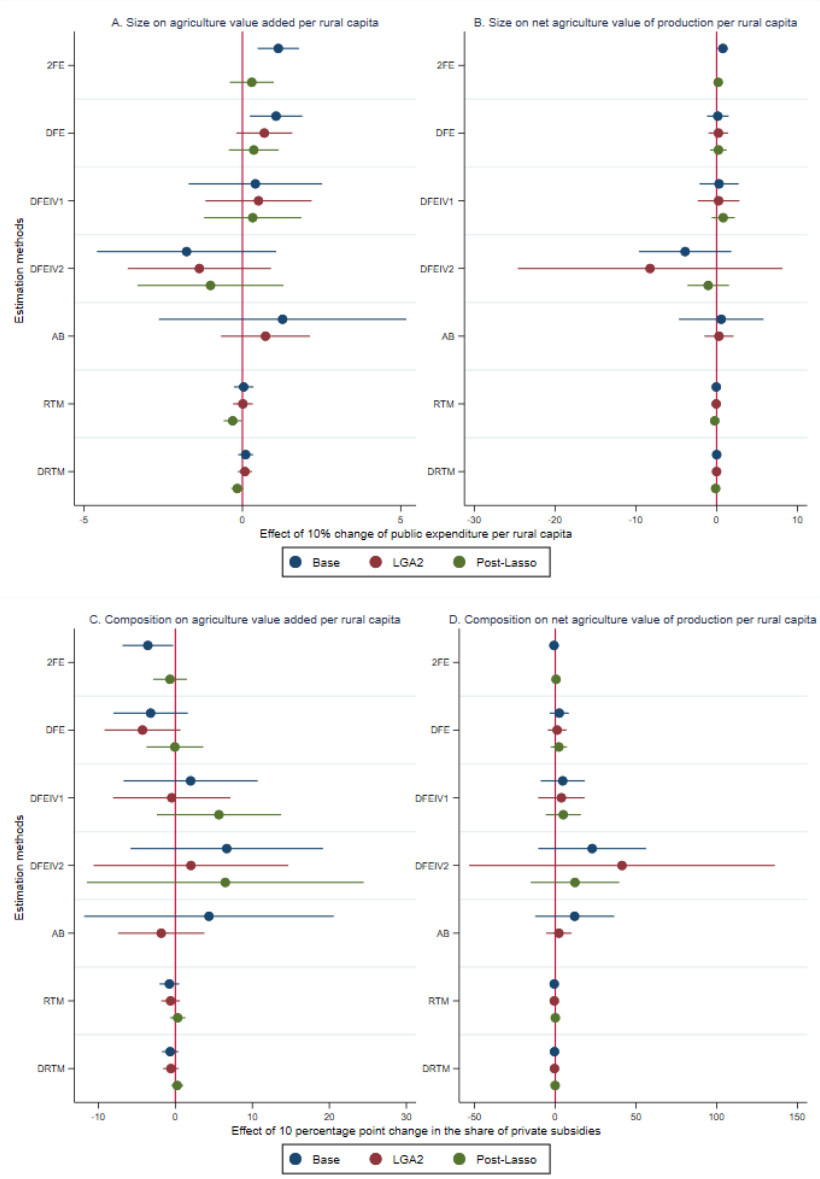

Figure A.1 Effect of the size and composition of public expenditure per rural capita (US$2010) on agricultural rural income indicators (US$2010)

Note: This figure plots the effects of the size of public expenditure (public expenditure per rural capita) and share private subsidies (% total public expenditure) on two indicators of rural agricultural income. The original estimates are rescaled by 10 and 10x100 in the size and share, respectively. The horizontal bars are 95% confidence intervals. The y-axes show different estimation methods: 2FE= two-way fixed effects; DFE= dynamic 2FE; DFEIV1= DFE with instrumental variables (IV) for the lagged dependent variable (Ly); DFEIV2= DFEIV1 and IV for the share of public expenditure on private goods (share); DFDIV1= dynamic first-differenced with IV for Ly; DFDIV2= DFDIV1 and IV for the share variable; AB= Arellano-Bond; RTM= random trend model; DRTM= dynamic RTM. The legend show different controls variables: Base=without controls; LGA2= derived from the model of López and Galinato, (2007), a human capital indicator as additional control; Post-Lasso=controls selection with Post-LASSO method (Belloni and Chernozhukov, 2013; Belloni et al., 2016).

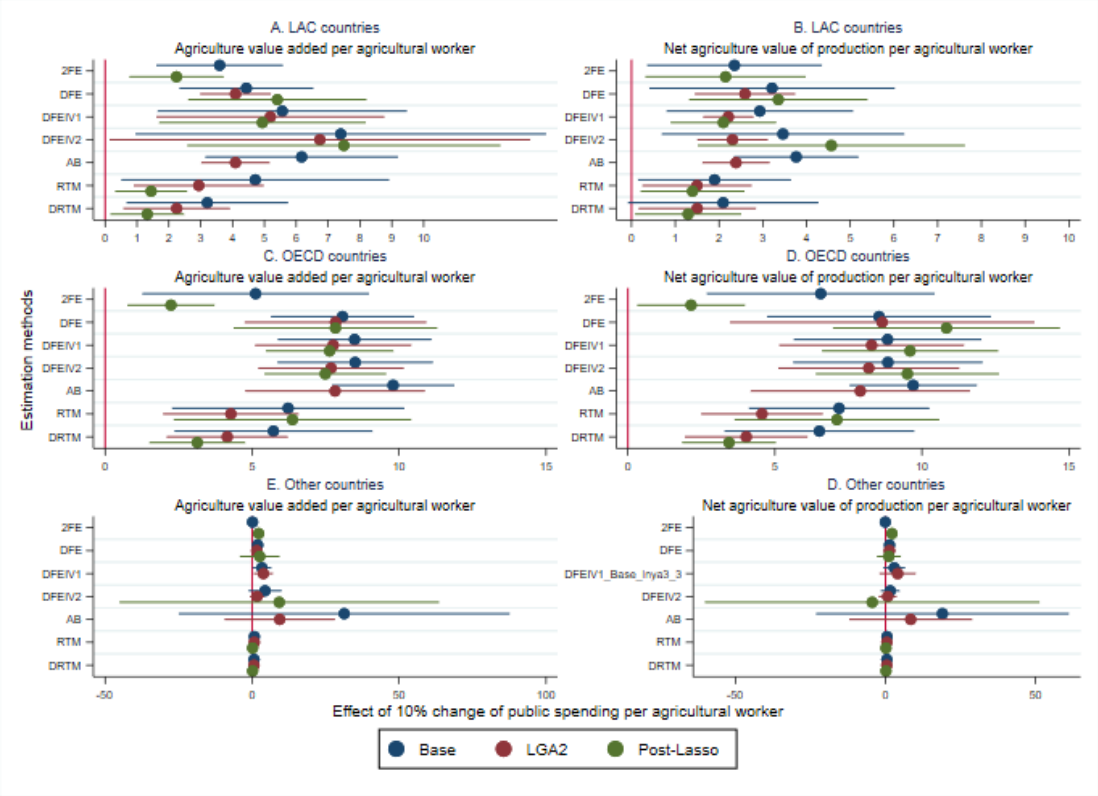

Figure A.2 Effect of the size of public expenditure per agricultural worker (US$2010) on agricultural productivity indicators (US$2010). Used different estimation methods and controls variables by group of countries.

Note: This figure plots the effects of the size of public expenditure on two indicators of agricultural productivity. The original estimates are rescaled by 10. The horizontal bars are 95% confidence intervals. The y-axes show different estimation methods: 2FE= two-way fixed effects; DFE= dynamic 2FE; DFEIV1= DFE with instrumental variables (IV) for the lagged dependent variable (Ly); DFEIV2= DFEIV1 and IV for the share of public expenditure on private goods (share); DFDIV1= dynamic first-differenced with IV for Ly; DFDIV2= DFDIV1 and IV for the share variable; AB= Arellano-Bond; RTM= random trend model; DRTM= dynamic RTM; DRTMIV1= DRTM with IV for the Ly; DRTMIV2= DRTMIV1 and IV for the share variable. The legend show different controls variables: Base=without controls; LGA2= derived from the model of López and Galinato (2007), a human capital indicator as additional control; Post-Lasso=controls selection with Post-LASSO method (Belloni and Chernozhukov, 2013; Belloni et al., 2016).

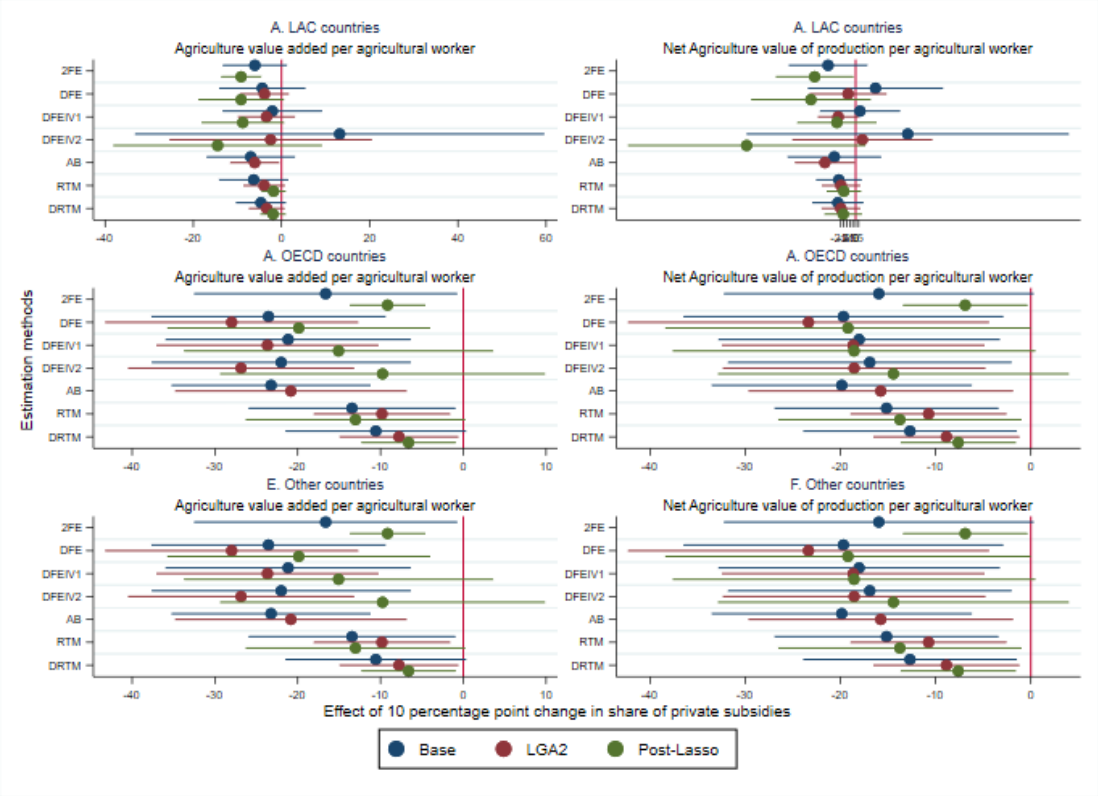

Figure A.3 Effect of share private subsidies (%) on agricultural productivity indicators (US$2010). Used different estimation methods and controls variables

Note: This figure plots the effects of the share of private subsidies on two indicators of agricultural productivity. The original estimates are rescaled by 10x100. The horizontal bars are 95% confidence intervals. The y-axes show different estimation methods: 2FE= two-way fixed effects; DFE= dynamic 2FE; DFEIV1= DFE with instrumental variables (IV) for the lagged dependent variable (Ly); DFEIV2= DFEIV1 and IV for the share of public expenditure on private goods (share); DFDIV1= dynamic first-differenced with IV for Ly; DFDIV2= DFDIV1 and IV for the share variable; AB= Arellano-Bond; RTM= random trend model; DRTM= dynamic RTM; DRTMIV1= DRTM with IV for the Ly; DRTMIV2= DRTMIV1 and IV for the share variable. The legend show different controls variables: Base=without controls; LGA2= derived from the model of López and Galinato (2007), a human capital indicator as additional control; Post-Lasso=controls selection with Post-LASSO method (Belloni and Chernozhukov, 2013; Belloni et al., 2016).

Appendix B. Additional results of the Institutional and Economic Factors that Explain Government Agricultural Support

Table B.1. Electoral rules and forms of government by countries, 1999 and 2017

Country	1999		2017	
	Majoritie representation	Presidential System	Majoritie representation	Presidential System
Argentina	0	1	0	1
Australia	0	0	0	0
Brazil	0	1	0	1
Canada	1	0	1	0
Chile	1	1	1	1
China	0	1	0	1
Colombia	0	1	0	1
Costa Rica	0	1	0	1
Dominican Republic	0	1	0	1
Ecuador	0	1	0	1
El Salvador	0	1	0	1
European Union	0	0	0	0
Guatemala	0	1	0	1
Iceland	0	0	0	0
India	0	0	0	0
Indonesia	0	1	0	1
Israel	0	0	0	0
Jamaica	1	0	1	0
Japan	0	0	0	0
Kazakhstan	.	.	0	1
Korea, Rep.	0	1	0	1
Mexico	0	1	0	1
New Zealand	1	0	0	0
Nicaragua	0	1	0	1
Norway	0	0	0	0
Paraguay	0	1	0	1
Philippines	1	1	0	1
Russian Federation	.	.	0	1
South Africa	0	1	0	1
Switzerland	0	0	0	0
Turkey	0	0	0	0
Ukraine	.	.	0	1
United States	1	1	1	1
Uruguay	0	1	0	1
Vietnam	.	1	1	1

Note: this table shows the country's status (dummy variables) according to electoral rule (majorotie vs. proportional representation) and forms of government (presidential vs. parliamentarian system.
Source: Database of Political Institutions 2017-DPI2017 (Scartascini, Cruz, and Keefer 2018)

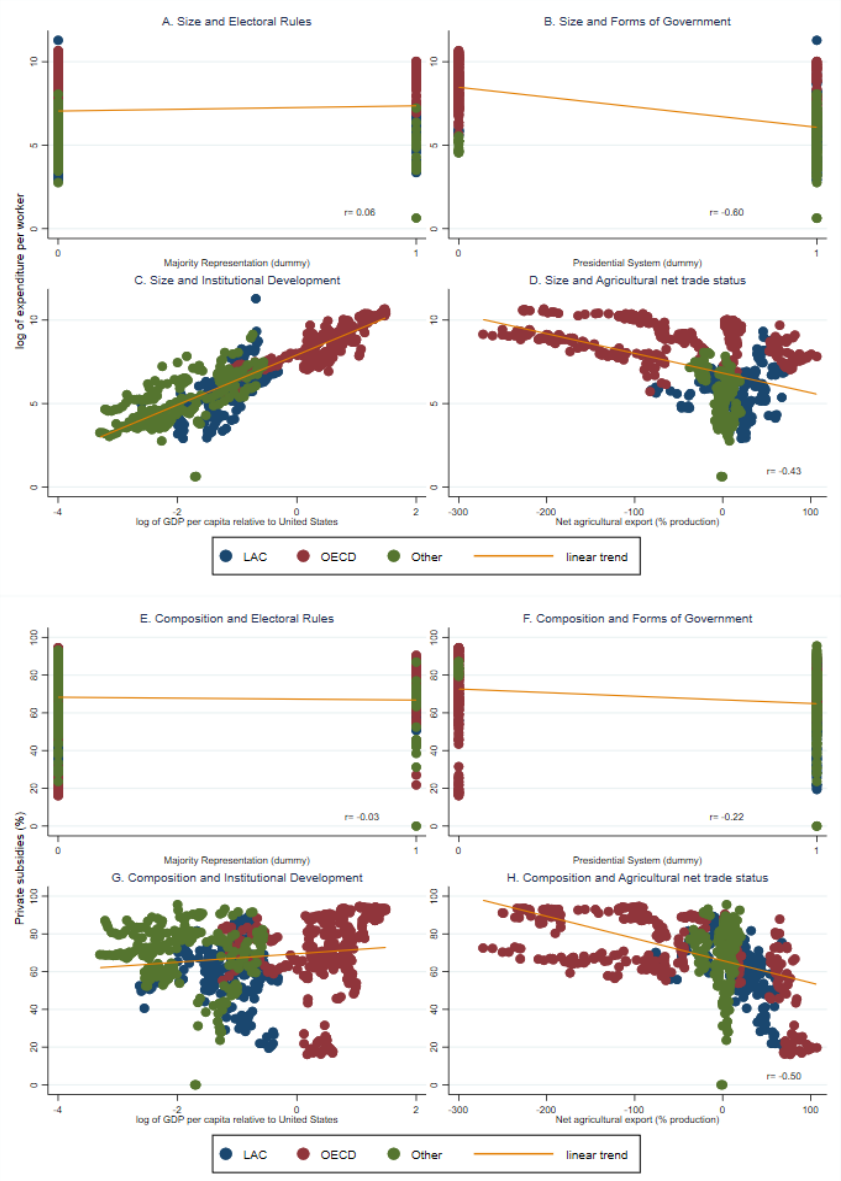

Figure B.1 Correlation of size and composition of public expenditure with Political institutions and instrument choices indicators.

Note: This graph shows the unconditional correlation between size and composition of public expenditure with Political institutions and instrument choices indicators, using annual data. The name of size in the sub-graphs refers to public spending per agricultural worker, while composition refers to the percentage of spending directed towards the subsidy of private goods.
Source: based on database of Political Institutions 2017-DPI2017 (Scartascini, Cruz, and Keefer, 2018), World Development Indicators of World Bank, and FAOSTAT from FAO.

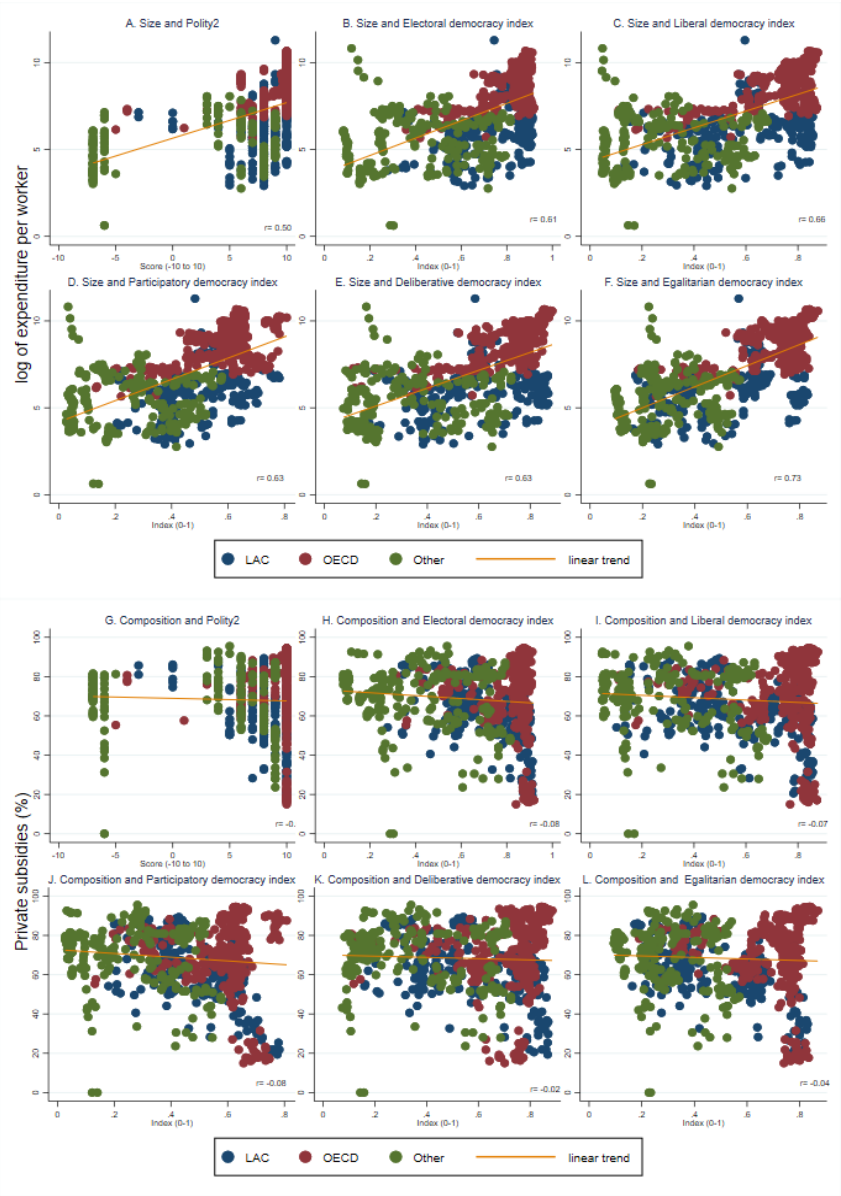

Figure B.2 Unconditional correlation of public expenditure per worker with Democratic Indices

Note: This graph shows the unconditional correlation between public expenditure per worker with Democratic Indices, using annual data. The name of size in the sub-graphs refers to public spending per agricultural worker, while composition refers to the percentage of spending directed towards the subsidy of private goods.
Source: based on Polity5 Project (https://www.systemicpeace.org/csprandd.html) and V-Dem Dataset v10 (Coppedge et al., 2020; Pemstein et al., 2020), World Development Indicators of World Bank, and FAOSTAT from FAO.

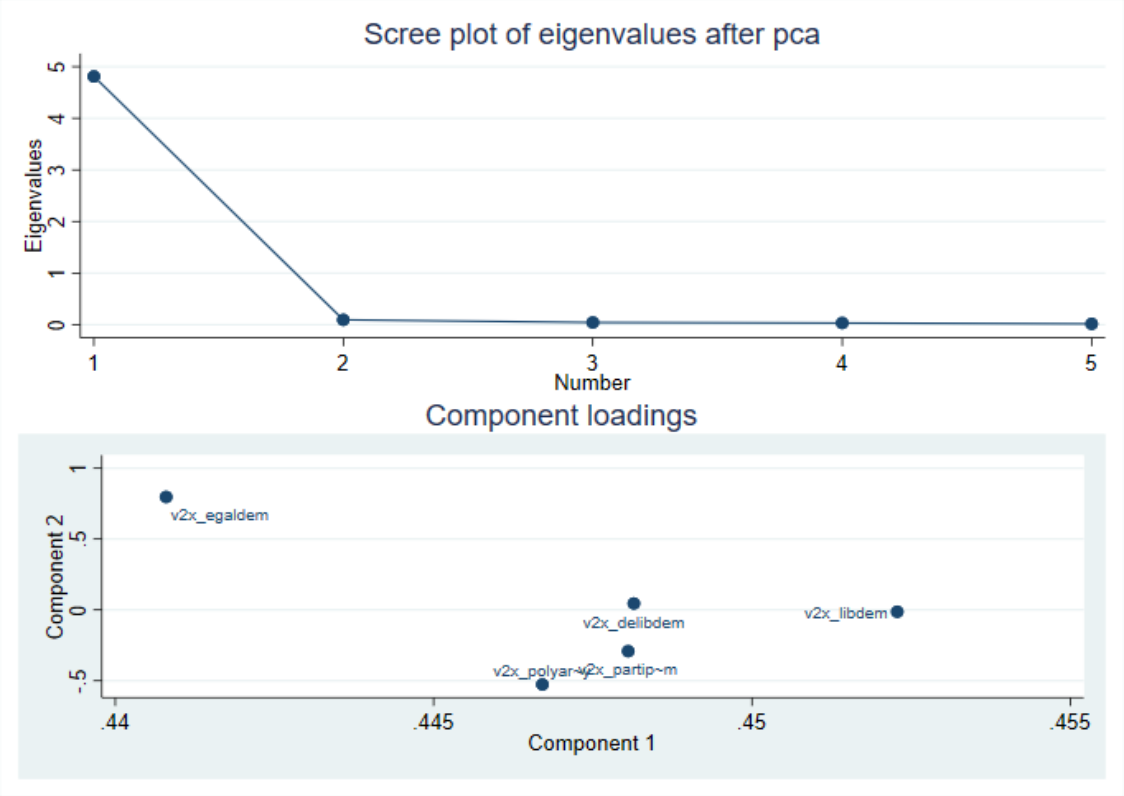

Figure B.3 Results of principal component analysis of High-level V-Dem Democracy indices

Note: v2x_polyarchy= Electoral democracy index; v2x_libdem= Liberal democracy index; v2x_partipdem= Participatory democracy index; v2x_delibdem= Deliberative democracy index, and v2x_egaldem= Egalitarian democracy index.

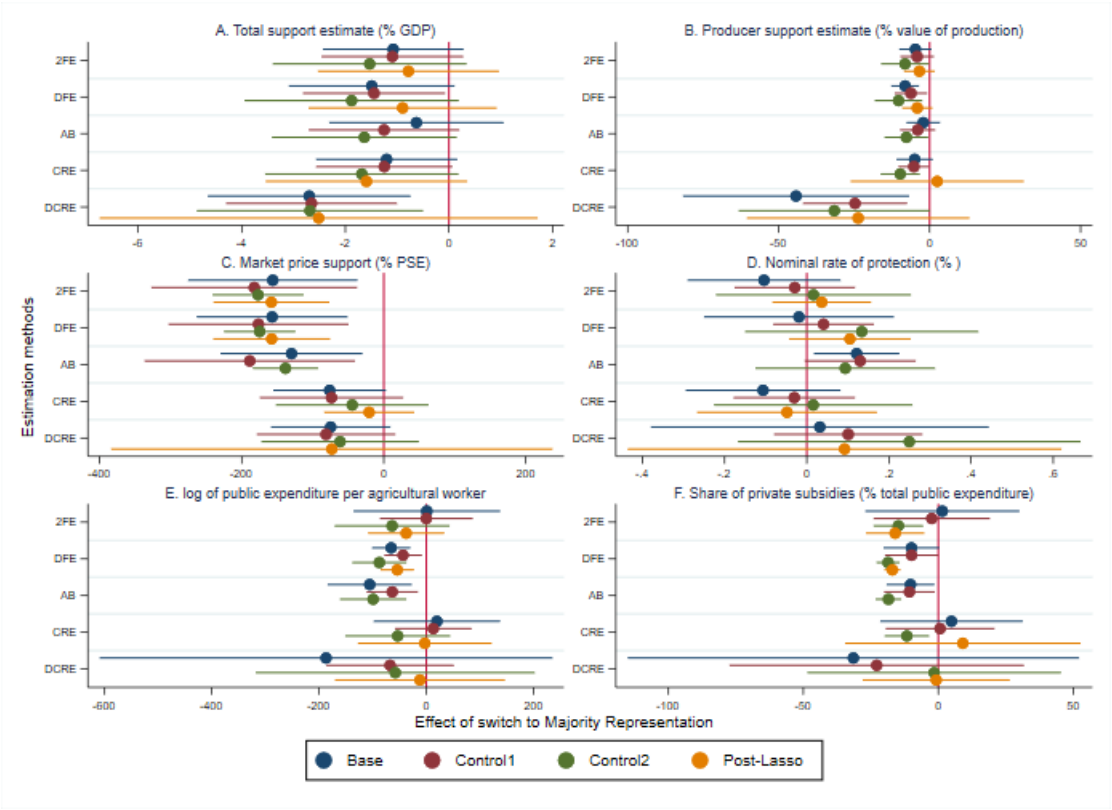

Figure B.4 Effect of Majority representation on some indicators of Agricultural Support Policy. Using different estimation methods and controls variables.

Note. This figure plots summary the effects of switch to "Majority representation" (from Proportional representation) on some agricultural support policy. The original estimates are rescaled by 100 in panel E. The horizontal bars are 95% confidence intervals. The y-axes show different estimation methods: 2FE= two-way fixed effects; DFE= dynamic 2FE; AB= Arellano-Bond estimator (difference GMM); CRE= correlated random effects, and DCRE= dynamic CRE. The legend shows different controls variables: Base=without controls; Control1= lagged of government-industry interaction indicators (institutional and net agricultural trade status); Control2 = lagged of some structural socio-economic conditions (Gini index, share of agricultural labor, and the labor productivity gap between the agricultural and non-agricultural sectors; Post-Lasso=lagged controls selection with Post-LASSO method (Belloni and Chernozhukov, 2013; Belloni et al., 2016).

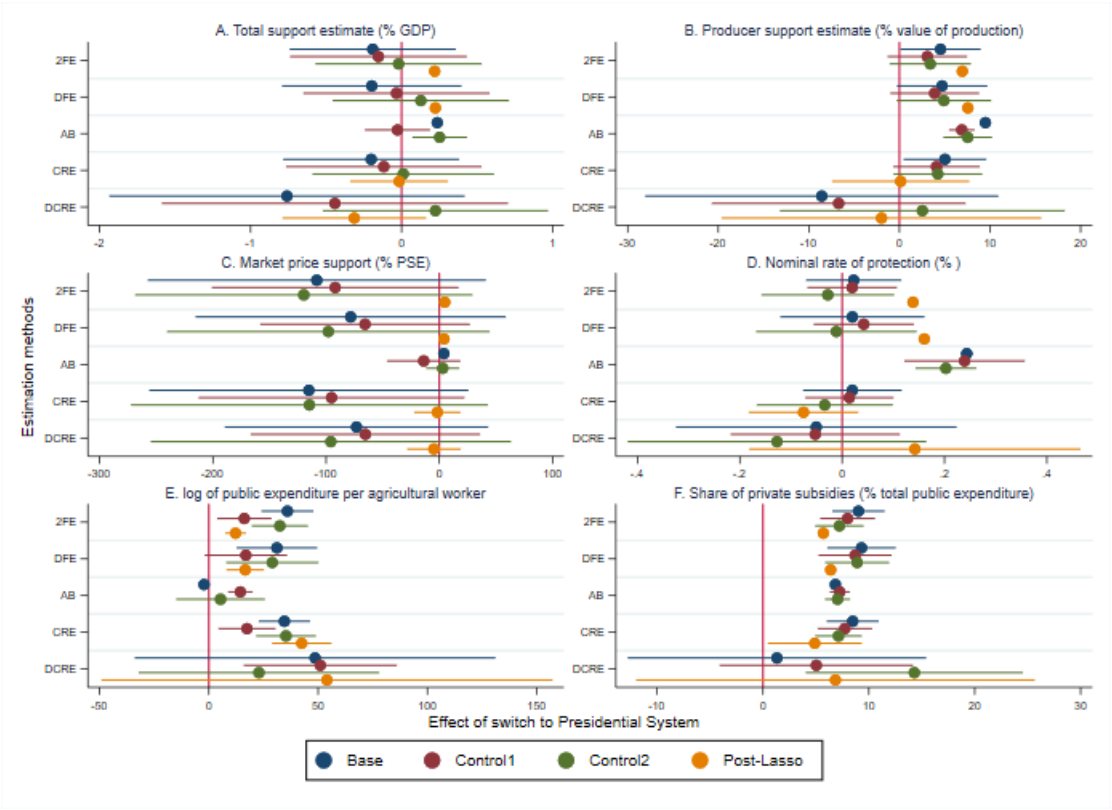

Figure B.5 Effect of Presidential system on some indicators of Agricultural Support Policy. Used different estimation methods and controls variables.

Note. This figure plots summary the effects of switch to "Presidential system" (from Parliamentary system) on some agricultural support policy. The original estimates are rescaled by 100 in panel E. The horizontal bars are 95% confidence intervals. The y-axes show different estimation methods: 2FE= two-way fixed effects; DFE= dynamic 2FE; AB= Arellano-Bond estimator (difference GMM); CRE= correlated random effects, and DCRE= dynamic CRE. The legend shows different controls variables: Base=without controls; Control1= lagged of government-industry interaction indicators (institutional and net agricultural trade status); Control2 = lagged of some structural socio-economic conditions (Gini index, share of agricultural labor, and the labor productivity gap between the agricultural and non-agricultural sectors; Post-Lasso=lagged controls selection with Post-LASSO method (Belloni and Chernozhukov, 2013; Belloni et al., 2016).

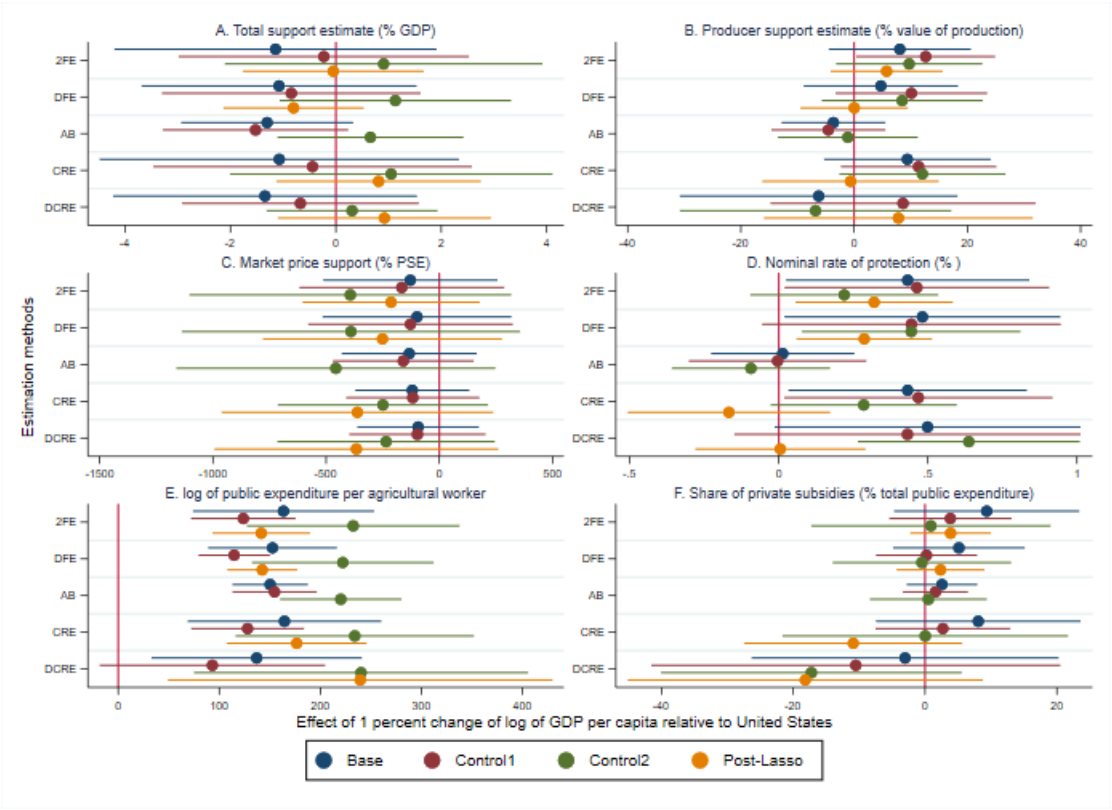

Figure B.6 Effect of Institutional Development on some indicators of Agricultural Support Policy. Used different estimation methods and controls variables.

Note. This figure plots summary the effects of change "Institutional Development", measured as log of GDP per capita relative to United States in the 1960s and 1970s, on some agricultural support policy. The original estimates are rescaled by 100 in panel E. The horizontal bars are 95% confidence intervals. The y-axes show different estimation methods: 2FE= two-way fixed effects; DFE= dynamic 2FE; AB= Arellano-Bond estimator (difference GMM); CRE= correlated random effects, and DCRE= dynamic CRE. The legend shows different controls variables: Base=without controls; Control1= lagged of political institutions indicators (electoral rules and forms of government); Control2 = lagged of some structural socio-economic conditions (Gini index, share of agricultural labor, and the labor productivity gap between the agricultural and non-agricultural sectors; Post-Lasso=lagged controls selection with Post-LASSO method (Belloni and Chernozhukov, 2013; Belloni et al., 2016).

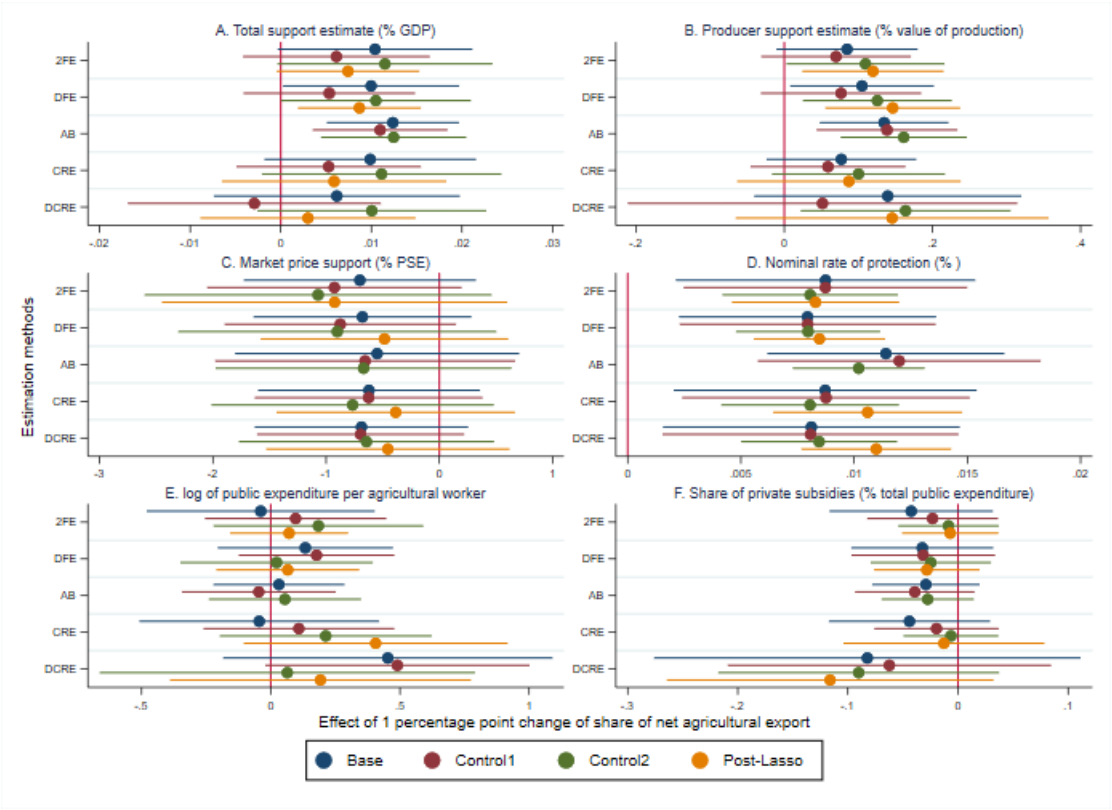

Figure B.7 Effect of net Agricultural export status on some indicators of Agricultural Support Policy. Used different estimation methods and controls variables.

Note. This figure plots summary the effects of change "net Agricultural export status", measured as share of net agricultural export (% agricultural production), on some agricultural support policy. The original estimates are rescaled by 100 in panel E. The horizontal bars are 95% confidence intervals. The y-axes show different estimation methods: 2FE= two-way fixed effects; DFE= dynamic 2FE; AB= Arellano-Bond estimator (difference GMM); CRE= correlated random effects, and DCRE= dynamic CRE. The legend shows different controls variables: Base=without controls; Control1= lagged of political institutions indicators (electoral rules and forms of government); Control2 = lagged of some structural socio-economic conditions (Gini index, share of agricultural labor, and the labor productivity gap between the agricultural and non-agricultural sectors; Post-Lasso=lagged controls selection with Post-LASSO method (Belloni and Chernozhukov, 2013; Belloni et al., 2016).

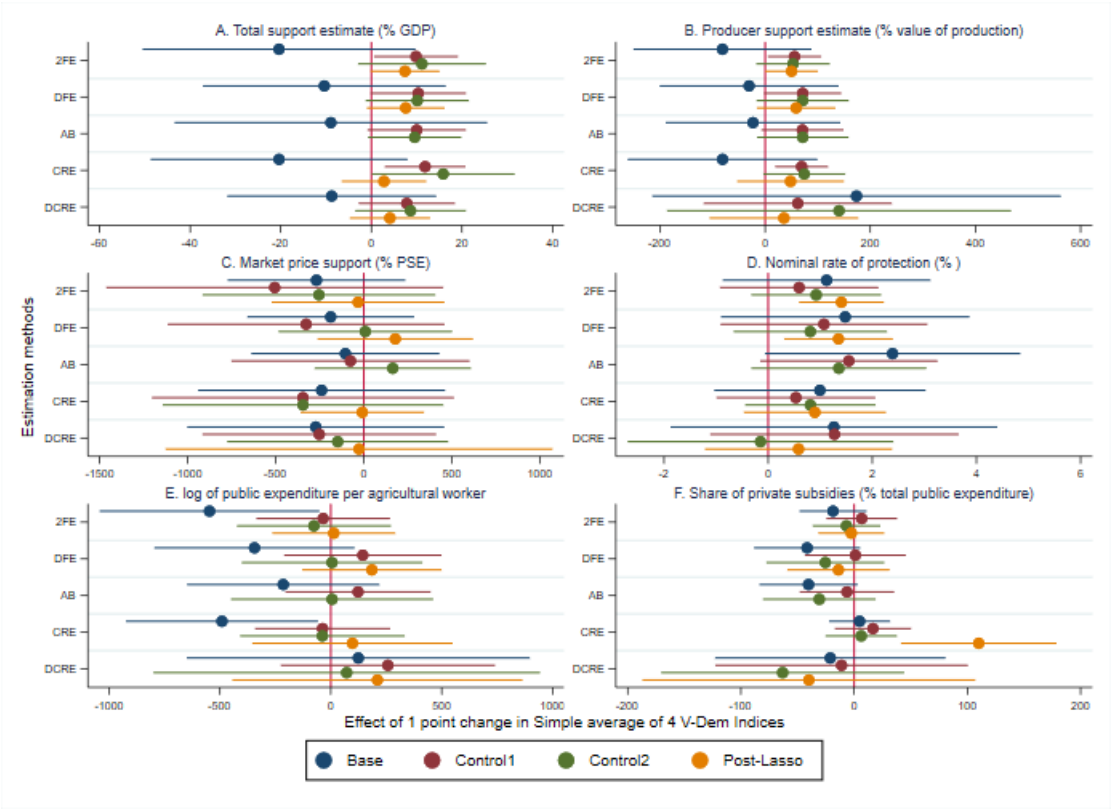

Figure B.8 Effect of single average of 4 V-Dem Indices on some indicators of Agricultural Support Policy

Note. This figure plots summary the effects of change of "single average of 4 V-Dem Indices" (single average of Electoral democracy index, Liberal democracy index, Participatory democracy index, and Deliberative democracy index) on some agricultural support policy. The original estimates are rescaled by 100 in panel E. The horizontal bars are 95% confidence intervals. The y-axes show different estimation methods: 2FE= two-way fixed effects; DFE= dynamic 2FE; AB= Arellano-Bond estimator (difference GMM); CRE= correlated random effects, and DCRE= dynamic CRE. The legend shows different controls variables: Base=without controls; Control1= lagged of government-industry interaction indicators (institutional and net agricultural trade status); Control2 = lagged of some structural socio-economic conditions (Gini index, share of agricultural labor, and the labor productivity gap between the agricultural and non-agricultural sectors; Post-Lasso=lagged controls selection with Post-LASSO method (Belloni and Chernozhukov, 2013; Belloni et al., 2016).

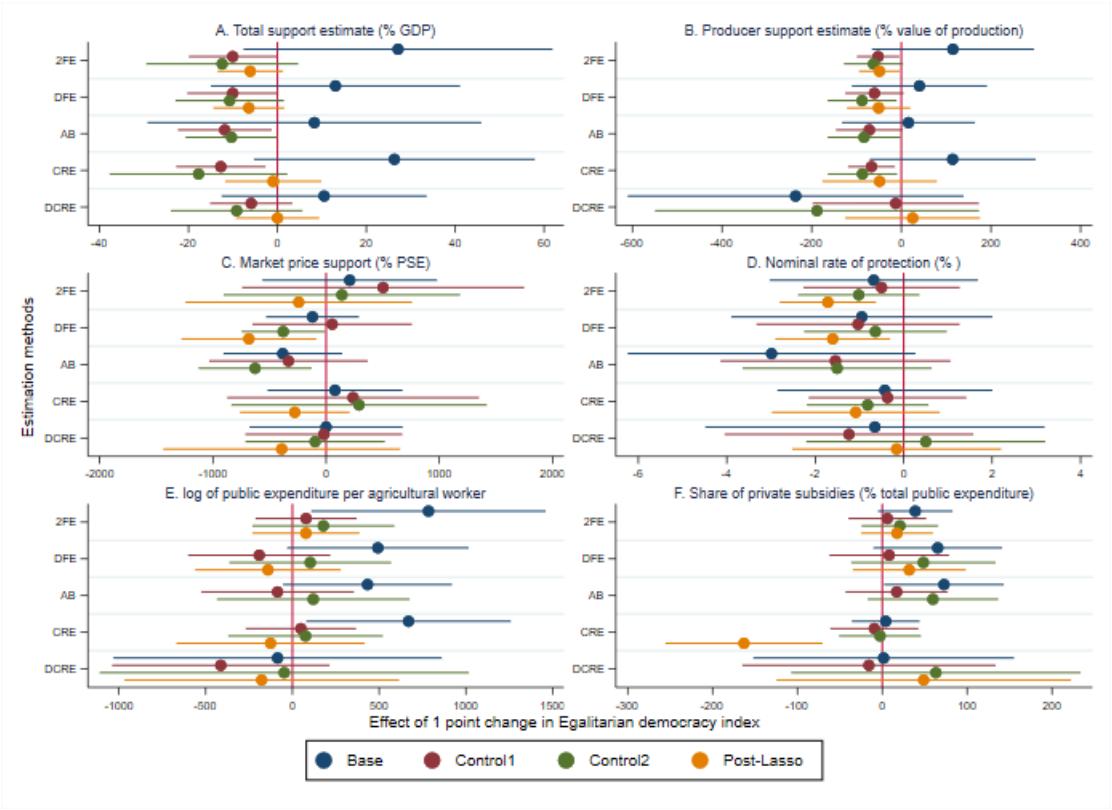

Figure B.9 Effect of Egalitarian democracy index on some indicators of Agricultural Support Policy

Note. This figure plots summary the effects of change of "Egalitarian democracy index" on some agricultural support policy. The original estimates are rescaled by 100 in panel E. The horizontal bars are 95% confidence intervals. The y-axes show different estimation methods: 2FE= two-way fixed effects; DFE= dynamic 2FE; AB= Arellano-Bond estimator (difference GMM); CRE= correlated random effects, and DCRE= dynamic CRE. The legend shows different controls variables: Base=without controls; Control1= lagged of government-industry interaction indicators (institutional and net agricultural trade status); Control2 = lagged of some structural socio-economic conditions (Gini index, share of agricultural labor, and the labor productivity gap between the agricultural and non-agricultural sectors; Post-Lasso=lagged controls selection with Post-LASSO method (Belloni and Chernozhukov, 2013; Belloni et al., 2016).