EXPLAINING THE CHANGES OF AGRICULTURE LAND PRICES IN LITHUANIA

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Abstract. *This article investigates the recent changes of agricultural land prices in Lithuania and quantitively assesses the most important factors affecting it. Land is one of the main scarce resources and it distinguishes itself among others by the inelasticity of price change to quantity, meaning that the changes in land prices are affected by demand and in very limited extend by supply. Taking this into account, it is important – from the practical as well as the theoretical points of view – to know these factors and, if needed, take regulatory measures. As the case of Lithuania suggests, the recent rapid growth of land prices is mainly driven by general economic performance (GDP), EU and national financial support provided to the Lithuanian agriculture sector and the regulation of agriculture food prices (the setting of purchase prices).*

Keywords: *agriculture land prices, financial support, regulatory prices, error correction model, Engle-Granger.*

1. Introduction

Agriculture land prices experienced a rapid increase in Lithuania after the economic downturn, exceeding the number of other assets' classes price performance. This raises practical and theoretical questions of whether such movements are sustainable; are they driven by fundamental factors in agriculture activities? Or this is a result of speculative or regulative actions? The experience of researchers in this field suggest that both could be expected: direct as well as indirect factors that affect the agriculture land prices. This question in Lithuania is not yet fully covered; thus, the *main aim* of this paper is to quantitively assess agricultural land price developments in Lithuania over the last two decades.

To understand the factors behind agriculture land price changes, we investigate recent academic literature pieces and find uneven explanations and no better results. Notwithstanding this, we empirically describe main factors behind recent change in agriculture

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land price in Lithuania. Moreover, we employ quantitative analysis methods and present an original model that is capable of explaining agricultural land price movements for almost two decades. The model suggests that without a macroeconomic factor like the GDP, agricultural land price changes in Lithuania, to a great extent, could be explained by regulatory factors like national and supranational financial support (EU funding) or the regulated purchase prices of agriculture production.

Without the introduction and the conclusions, this paper is constituted of four main sections. The second section reveals the theoretical background of changes in agriculture prices. The third section deals with recent changes in agricultural land prices in Lithuania. In the fourth section, methodological issues of quantitative assessment have been presented. In the fifth section of this paper, the results of a quantitative assessment are presented. The authors are thankful to their colleagues Milda Šeškutė and Dmitrij Celov for their valuable comments and suggestions provided during the preparation of this article.

2. Factors behind Changes in Agricultural Land Prices: The Theoretical Background

Factors affecting agricultural land price changes are, in general terms, divided into two main categories: the first one relates to the income opportunities of the land use, and second one – to the alternatives of land use. In the first case, the price (or rent price; however, in this article, rent prices have not been assessed) of land is determined by the value of economic goods created by working the land itself. The theory of capitalization suggests that the value of an asset depends on its ability to earn revenues. The same is with the price of agricultural land as it should be closely linked to the potential of this land to earn revenue. The current value of the land calculated by applying the discounted cash flows method for the agricultural production depends on several factors: the characteristics of the agricultural land (e.g., fertility, the use of fertilizers), prevailing agricultural structures (e.g., small farms or agricultural companies), distance to populated areas (logistics costs) etc. Moreover, the agriculture land price assessed in the abovementioned way would be also affected by the return rate on agricultural activity, inflation and interest rates.

As for the second category, agriculture land sales and rental prices may be influenced by non-agricultural factors, such as the possibilities to use land for the alternative activities (e.g., building residential or commercial buildings, creating recreational areas, use land as an alternative investment object etc.). This case is referred to the Hedonic Price Model. According to this model, land sales and rental prices are determined by the flow of income from alternatives to agricultural activities and usually depends on the location, population density, infrastructure etc.

Traditional methods do not always explain the reasons behind agriculture land price changes. The experience of the United States shows that the net present value of the land was both significantly higher and lower than the nominal price in the market. This suggests that there are other factors affecting the price of agriculture land (Gardner and Nucton 1979). As the land area alone has different agrarian characteristics, their prices can be caused by various features: external economic factors and government policies (unequal demand for different agriculture products, taxation policies of agriculture activities etc.), future expectations, needs and priorities of the buyer and seller, crop and animal prices, the potential of population growth, limited investment opportunities.

Land is often seen as a safe investment: it could be used for the protection against inflation, which means that demand and value of land may increase in the course of faster economic growth. Investors can use land as a hedging instrument against unfavorable changes in the prices of other classes of assets; therefore, agriculture land price changes are also influenced by speculative activities. Due to the limited supply of other profitable investments (current relatively low returns in the low interest environment) demand and price of land are increasing. Given the fact that land is one of the scarce resources, it receives a lot of attention from the authorities in implementing additional regulation: land plots have been planned; sale contracts are additionally regulated; land and agricultural products are taxed at preferential rates or subsidized. Feichtinger and Salhofer (2011) summed up the variables that influence the price of land (see Figure 1).
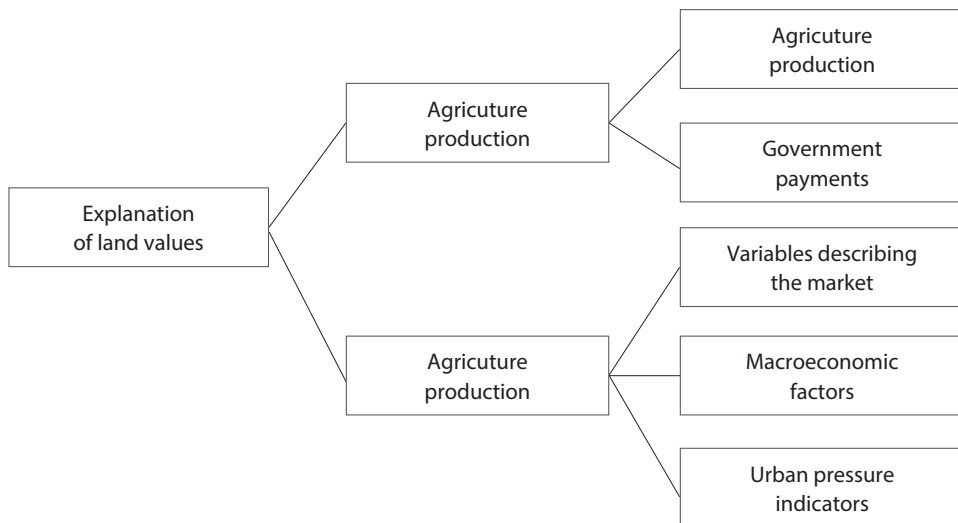

FIGURE 1. **Factors affecting the land prices.**

Source: Feichtinger, P., Salhofer, K. 2011. "The Valuation of Agricultural Land and the Influence of Government Payments." *Factor Markets Working Papers, No. 10.*

Financial aid provided by the state or other institutions (e.g., by the EU) to the agriculture sector contributes to the growth of land prices. The government's desire to support food production through local resources contributes to rising land prices: agricultural subsidy programs and direct financial support contributes to faster land sales and rent prices growth. Subsidies granted to agricultural activities or land holders tend to capitalize on the price of land sales or rent (even if these subsidies are primarily intended to create jobs or increase productivity in agriculture sector). Various studies confirm the direct impact of general government support on the growth of land or rental prices (see Swinnen and Knops 2013).

A study by Feichtinger and Salhofer (2013) shows that 10% decrease of agriculture funding by the state leads to a fall in land prices by 3.3–5.0%. The growth of payments to the agriculture sector by 1% resulted in a 0.6% rise of land prices in Sweden (Ciaian, Kanc & Swinnen 2012). Studies by the aforementioned authors also show that the 1-euro supplementary support capitalizes on a 6–94 cents increase in land rent prices. Direct agricultural support represents a significant price "add-on": Kilian et al. (2012) revealed that 44–94% of the support capitalizes on the rental land price (EU-wide studies present an approx. 40% share). According to Herck, Swinnen and Vranken (2013), direct agricultural payments are capitalizing up-to 25% of the increase in the land rent price. Moreover, the abovementioned capitalization is higher in those countries where access to the credit markets is more restricted and less where large farms predominate (mainly due to the greater bargaining power in the market).

Nevertheless, some studies show a minor impact of general support for the agriculture activities to the land prices. Ciaian, Kanc and Swinnen (2012) surveyed 15 EU countries and found that only 6% of the support from 2004 to 2007 was capitalized in the price of land (although the results in the regions are very uneven).

3. The Recent Developments of Agricultural Land Prices in Lithuania

Currently, agricultural land prices are at the highest level in Lithuania for the last 18 years. At the first quarter of 2018, one hectare of agricultural land (with an exception of gardens and gardeners' associations) price constituted an average 3.1 thousand euros (see Figure 2.). After the economic downturn, agriculture land prices fell (solely in 2009 by nearly 25%) but then started to recover rapidly over the years of 2011–2017 and reached on average of 15.7% annual growth rate. During the aforementioned period, the growth of agriculture land prices significantly exceeded the increase of the general price level in the country and were at a higher level if compared to other assets classes like housing, stock exchange or debt securities. In this part of the article, some descriptive statistics are provided to explain the recent changes of agricultural land prices in Lithuania.
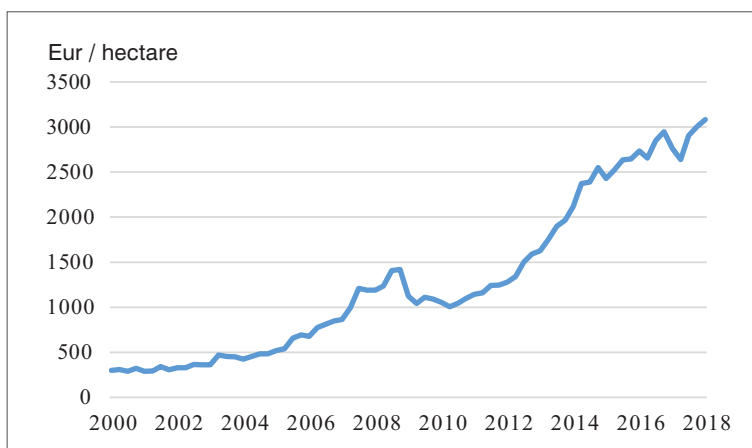
FIGURE 2. **The price of agricultural land (with an exception of gardens and gardeners' associations).**
Source: The Centre of Registers.

The efficiency of agricultural activity in Lithuania and the income generated by this activity are increasing. The utilization area in agriculture is growing slowly and the income from one hectare is growing at an even faster pace. This indicates the increasing efficiency of agricultural activity: for example, the productivity of cereal crops in Lithuania is growing quite rapidly, the relative decline in the number of workers employed in agriculture is observed; however, investments in buildings, vehicles and machinery are increasing and the farms become bigger on average. As a result, revenue from one hectare is increasing, and this pushes demand for land – and the price at the same time – as the total supply of land does not change substantially.

The growth of agriculture land prices may receive positive impact from the financial support to agriculture activities provided by the EU and the national authorities. Row estimates suggest that during the period from 2004 to 2017, the support for the agriculture activities amounted to 10 billion euros. The Ministry of Agriculture of the Republic of Lithuania currently provides about 20 different types of assistance measures (for example, insurance premiums, compensations of credit interest etc.) for agricultural entities. Moreover, in addition to the aforementioned support, the agricultural sector in Lithuania also benefits from exceptional tax incentives. A study by the National Audit Office of Lithuania showed that 25 tax exemptions are applied solely to the agriculture sector in Lithuania. An annual survey of the "Farm Performance Results," carried out by the Lithuanian Institute of Agrarian Economics, shows that the end result of the agricultural activities of farms has been noticeable improved by the support provided (see Figure No. 3.). Against this background, it can be argued that agricultural support contributes to increasing competition related to land acquisition, as a growing demand for land
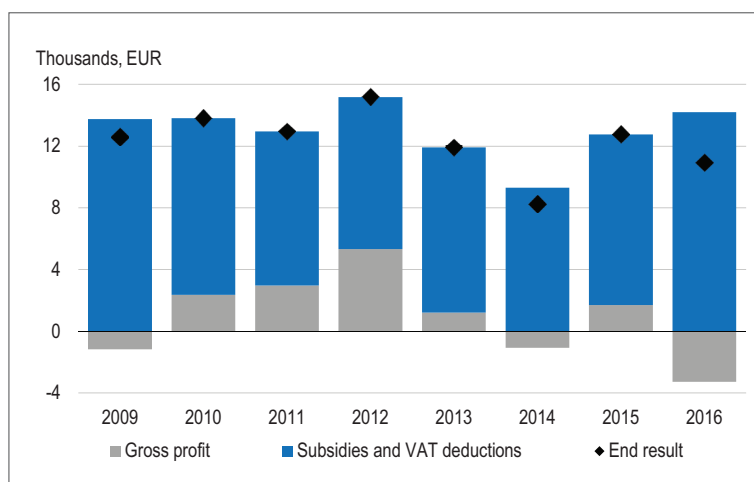
FIGURE 3. **Farmer's farm's weighted average of the end result.**

Source: Lithuanian Institute of Agrarian Economics.

materializes in significant increase of investment in land. As mentioned above, at least part of the support for agricultural activities could be capitalized in the price of land.

Growth in productivity and increase of financial support contributes to the growth of agriculture land prices in Lithuania. The technical capacity of agricultural activity in Lithuania is increasing. This is reflected in the rising investment in technology, growth fertility and a drop in the number of workers working in agriculture sector. The impact that financial support can have on the price of agricultural equipment or machinery should be insignificant, as the supply of such production factors is basically unlimited in highly competitive market. However, the situation with land is totally different, as supply is inelastic to price and this leads to an increase in land price as demand starts to pick up.

Land price growth has recently sprouted in comparison with other alternative investments. Since 2010, agriculture land prices in Lithuania have grown the most if compared to residential real estate prices, changes in stock exchange or government debt securities value of governments from the euro area. Given that the increase in land prices has been several times faster than other key asset classes in recent years, this could have additionally contributed to a higher demand for land and further pressure to price growth not only from agricultural subjects but also from other investors (e.g., for speculative purposes).

The loans granted by banks for the land purchase have very limited impact on the general activities in the land market. The participation of banks by providing funding for land acquisition is very limited and counts for up to 6% in the period from 2009 to 2015. Agriculture land transactions financed by banks are also limited; however, they began to increase recently and, along with the growth of production capacity or alternative land use factors, may contribute to the faster growth of agricultural land prices. However,

this impact is unlikely to be significant: for example, the source of funding for tangible investment in crop and livestock farming, hunting and related sports activities shows that around four fifths of these activities are funded by companies from their own sources.

4. The Methodology of Agriculture Land Price Estimation in Lithuania

The quantitative analysis in this article is based on time-series methods. This section begins with the stationarity of the data under consideration, which is checked by means of the augmented Dickey-Fuller tests (Dickey and Fuller 1979; 1981) and the Phillips Perron test (Phillips and Perron 1988). The null hypothesis of these tests is the existence of a unit root. Unit root/stationarity tests are utilized to check whether the data are integrated of first-order. The justification of this way of proceeding is because in some cases, for example, if the variable displays structural breaks, the unit root/stationarity tests could identify unit roots instead of stationarity with structural changes. In this case, these tests suggest the presence of unit roots, which is the precondition in the application of the co-integration analysis.

This article adopts the Engle and Granger (EG) (1987) co-integration test. This procedure is carried out in two steps. The first step in the analysis tests for the order of integration of the variables. The order of integration refers to the number of times a variable is differenced before becoming stationary. A condition applicable to the above tests is that the variables entering the co-integrating equation should be integrated of the same order. According to Engle and Granger (1987), if the two variables are co-integrated, there exists a long-run equilibrium relationship between them. In the EG method, co-integration is tested by regressing some variables on the other one and testing whether the residuals of the estimated regression equation are stationary. In this paper, the ADF test is used to test the stationarity of the residuals obtained from the bivariate co-integration equations.

Engle and Granger proposed the co-integration theory and the two steeps method, provided another way for non-stationary time series modeling. The co-integration method has been applied in prices analysis many times. Given that agricultural land prices have often been characterized as following a nonstationary process, co-integration is likeable because it allows us to test a model a long-run path consistent with a short run. Using the differentiation for the variables to be stationary, we have only a short-run relationship. More specifically, in order to derive the long-run relationship between real land prices (y) and explanatory variables (x) for the period ($t = 1, \dots , T$), consider the following dynamic equation:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \beta_0 x_t + \beta_1 x_{t-1} + u_t \qquad (1)$$

where the residual u_t is normally distributed ($u_t \sim N(0; \sigma^2)$). Both x and y are in natural logarithmic form and are assumed to exhibit preservation, in line with many economical

and financial variables (e.g. Nelson and Plosser (1982)) (x, y ~ $I(1)$). Then, following Banerjee et al. (1993), we can rewrite Eq. (1) as follows:

$$\Delta y_t = \alpha_0 + \beta_0 \Delta x_t + (\alpha_1 - 1)\left(y_{t-1} + \frac{\beta_1 + \beta_0}{\alpha_1 - 1} x_{t-1}\right) + u_t \tag{2}$$

or simply

$$\Delta y_t = a + b\Delta x_t + c(y_{t-1} + dx_{t-1}) + u_t \tag{3}$$

The Δ is the difference parameter, thus Δy_t represents land price difference. We need to estimate parameters a, b, c and d; the short-term sensitivity of y to x is captured by the parameter b. The parameter c measures the speed of adjustment to return to the long-run path ($y_t - 1 + dx_t - 1$), which is called the error correction term (ECM). The parameter d is the vector of co-integrating parameters that summarize the long-run relationship between x and y.

In the presence of a long-run relationship between *y* and *x*, d is super-consistent and the ECM is stationary $I(0)$, standard hypothesis testing using *t*-ratios and diagnostic testing of the error term is appropriate. Then, the adjustment parameter *c* should be $-1 < c < 0$ (Engle and Granger (1987)). A parameter c value that is close to -1 indicates fast adjustment to return to the long-run path, and a parameter c value that is close to 0 indicates slow adjustment to return to the long-run path. In contrast, when there is no long-run relationship between *x* and *y*, c will not lie within this theoretical range.

5. Data Sources and Empirical Findings

There are various factors on the fluctuation of agricultural land prices, including external as well as internal/agricultural variables. This analysis is mainly focused on the explanation of price increase and the internal and external variables of Lithuanian agricultural land prices. The primary data source for dependent variable is the database of the Centre of Registers,[1] with Lithuanian agricultural land transaction prices recorded between 2004 and 2018.

To estimate an ECM model, the first task consists of choosing the economic variables that can explain better agricultural land price movements. This choice of variables is in line with empirical work by Paul Feichtinger & Klaus Salhofer (2011) and theoretical examples used to explain land prices by other researchers shown in Table 1. To choose the relevant system of variables, a general to specific method was followed. In this way, while testing for the existence of co-integration, only significant repressors with an economic expected sign were kept. Regarding the internal/agricultural variables – the

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[1] Access to the Centre of Registers database is free of charge for academics; it includes transaction details for the Real Property Register and the Cadaster, the Register of Legal Entities, the Address Register, the Population Register and the Mortgage Register. We use Lithuanian agricultural land prices that are bigger than 1 hectare.

TABLE 1. **The examples for variables used to explain land values.**

VARIABLE	REFERENCE
Agricultural returns - Monetary variables	– Market revenues (Carlberg 2002; Barnard et al. 1997; Folland & Hough 1991; Gardner 2002; etc.) – Returns to land (Goodwin et al. 2005 & 2010; Weerahewa et al. 2008) – Net income (Devadoss & Manchu 2007) – Producer price of wheat (Goodwin & Ortalo-Magné 1992)
Agricultural returns – Non-monetary variables	– Yield (Pyykkönen 2005; Devadoss & Manchu 2007; Latruffe et al. 2008) – Soil quality (Barnard et al. 1997; Kilian 2010) – Temperature and precipitation (Barnard et al. 1997) – Dummy for: o Irrigation (Barnard et al. 1997) o Presence of intensive crops (Barnard et al. 1997) o Special crops (Pyykkönen 2005) – Fraction of cropland (Gardner 2002) – Proximity of a port (Folland & Hough 1991)
Government payments	– Total government payments (Devadoss & Manchu 2007; Vyn 2006; Henderson & Gloy 2008; Shaik et al. 2005) – One or multiple categories of government support (Goodwin et al. 2003 & 2005; Pyykkönen 2005)
Variables describing the market	– Pig density (Duvivier et al. 2005) – Manure density (Pyykkönen 2005) – Farm density (Pyykkönen 2005) – Average farm size (Folland & Hough 1991) – Size of the agricultural land market (in the case of Duvivier et al. 2005, e.g., the fraction of arable farmland exchanged in a particular district in a particular year) – Dummy for a specific region
Macroeconomic factors	– Interest rate (Weerahewa et al. 2008; Devadoss & Manchu 2007) – Inflation rate (Alston 1986) – Property tax rate (Gardner 2002; Devadoss & Manchu 2007) – Multifactor productivity growth (Gardner 2002) – Debt to asset ratio (Devadoss & Manchu 2007) – Credit availability (Devadoss & Manchu 2007) – Unemployment rate (Pyykkönen 2005)
Urban pressure indicators	– Total population (Devadoss & Manchu 2007) – Population density per square kilometre – Population growth (Gardner 2002) – Ratio of population to farm acres (Goodwin et al. 2010) – Urbanisation categories (Goodwin et al. 2010 & 2005, defined through proximity to an urban center) – Rurality – fraction of the population living on farms (Gardner 2002) – Dummy variables for metropolitan areas (Henderson & Gloy 2008) – Proportion of the labour employed in agriculture (Pyykkönen 2005)

Source: Feichtinger, P., Salhofer, K. 2011. "The Valuation of Agricultural Land and the Influence of Government Payments." *Factor Markets Working Papers, No. 10.*

purchase prices of agricultural production, investments in technology (tractor, harvester etc.), profits from agricultural activities and support from the government and the European Union have meaningful impact on prices. Regarding the external variables, only one macroeconomic variable (GDP) played significant role. The ECM, in both settings, will be estimated using quarterly data in period from 2004 to 2018. In this article, the calculation process is all completed by using R.

The unit root was tested using the Augmented Dickey Fuller (ADF). The test was applied to each variable over the period of 2004–2018. Variables are nonstationary at levels and any attempts to use them will lead to a spurious regression as suggested by Mesike, Okoh and Inoni (2010). In addition, Yusuf and Falusi (1999) observed that it is not ideal for policymaking and cannot be used for predictions in the long run. The variables were all stationary at their first difference at 1% level of significance and integrated of same order, i.e., the $I(1)$ level. The H_0 of unit root for all the time series were rejected at their first difference, since their ADF result test statistic was greater than the critical values at 1% level of significance.

The PP test produces results similar to those of ADF test. The level of significance of the PP statistics is 1% for all indicators. These results again confirm the earlier results of the ADF test, indicating that the land prices and other exogenous variables behave as non-stationary. The result of the co-integration test (EG) shows that there is a stable equilibrium relationship between land price and exogenous variables. The ADF test statistics to test for the stationarity of residuals from regression shows that equation have white-noise residuals. Residuals are stationary, i.e., $I(0)$ – this means that there is a long-run (co-integration) relationship.

The existence of co-integration among prices gave rise to the estimation of the Error Correction Model (ECM). Table 2 showed the result of the long run corrected estimates, so that standard tests, such as t-test, can be applied (Engle and Yoo (1991), Cuthbertson et al. (1992)). From the result, the model fit the observed data precisely well as indicated by the adjusted R^2 (0.978) and DW statistics.

TABLE 2. **The result of the Error Correction Model.**

Lithuanian agricultural land price		
	β	p - value
Intercept	-12.58	<0.001
GDP	2.53	<0.001
Investment / Profit	0.13	<0.001
Support	0.42	<0.001
Purchase prices	0.86	<0.001
Observations	50	
R^2 / adj.R^2	0.979 / 0.978	

Source: calculated by the authors.

The model log-log can be evaluated as elasticity, explaining internal/agriculture indicators, such as the investment to technology (tractors, harvesters and farm equipment) ratio between income from agricultural activities – if it increased by 1 percent, land prices will increase by 0.13 percent. The support from the European Union or the national budget has a strong influence on land prices: per a 1 percent increase in support, there will be a 0.41 percent increase agricultural land price. Agricultural production prices rise 1 percent – if so, then a 0.86 percent rise will occur agricultural land prices. The external variable GDP has by far the strongest impact on agricultural land prices: an increase in 1 percent causes a 2.53 percent increase in land price.

The results of the co-integration tests and the error-correction model estimate analysis indicate that the movement in land price can be predicted using such exogenous variables as GDP, investment, profit, support and purchase prices.

Conclusion

Agricultural land prices in Lithuania have grown exceptionally over the last two decades. The rapid price growth exceeded movements in other main investment directions, like residential real estate, exchange or the sovereign debt market. Theoretical and practical investigation suggests that fundamental factors of agriculture land price movements are not always capable of providing comprehensive explanations. Moreover, land, as a scarce resource, distinguishes itself among the other resources by supply inelasticity to price changes, meaning that basically only the demand-side factors make any impact on land prices.

The changes in agriculture land prices could be explained by the internal and external variables. Internal variables are direct ones and linked to the agriculture production process and government support. External variables are indirect ones and linked to the market, macroeconomic and urban pressure variables. In the article, we develop a co-integration method for explaining the long-run relationship in Lithuanian agricultural land prices in the short-run with the traditional ECM model. We find that Lithuanian agriculture land data support a linear functional form with co-integrating variables. They indicate that the movement of agricultural land price can be predicted from the movements of the exogenous variables.

GDP in Lithuania is a largely dependent variable affecting agricultural land price. Also, investments into technology will lead to significant increase in land price. Technology helps to increase productivity, have less workforce in the farms and receive bigger profits. Moreover, the bigger regulated purchase prices of agricultural products are, the more attractive agricultural activity is. Support from the EU and the national government also plays a substantial role by explaining agriculture land price movements in Lithuania. The last two factors may be affected by the authorities; thus, agricultural production price regulations and support to this sector should be performed with caution, as they have a direct, strong impact on the changes in land prices.

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