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Factors Influencing Farm-Land Value in the Czech Republic

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Abstract: Czech farm-land had enjoyed considerable growth in value from 2008 to 2019. This paper identifies the main determinants of agricultural land prices variations and how these variations are influenced by urbanization, lease payments, and subsidies. These three factors were thoroughly examined for the existence of a unit root using the Augmented Dickey Fuller Test. The long-run relationship between farm-land value and these elements was estimated using the co-integration approach, specifically the Johansen procedure. The estimation confirms the existence of this long-run relationship. Short-run fluctuation in agricultural land prices is explained using the Error Correction Model. As the most important variable in the short-run performance of Czech agricultural land prices, the authors identified the influence of urbanization. This information could be used to help regulators avoid potential agricultural land value instabilities and volatility in the market and hence would contribute to sustainable land use.

Keywords: land; value; agriculture; factors; Czech Republic; cointegration

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1. Introduction

There are numerous factors that influence agricultural land value and thus, its price [1]. One of these factors is the proximity to large urban centers [2,3]. The pricing of built-up land is often thought to have pricing similarities to that of agricultural land. Changing land purpose from agricultural to built-up happens more frequently in areas with a close proximity to urban areas, and hence is attributed more to population density. Due to increased urbanization, speculators may purchase agricultural land on the outskirts of urban areas with the expectation and intention of converting that land to built-up land. This may cause an increase in agricultural land prices that may not be sustainable from the long-term perspective [2,3].

The analyzed region of the Czech Republic lies in Central Europe with an area of 78,871 square kilometers and population of 10.51 million [4]. In terms of land use, the Czech Republic has 4.2 million hectares of agricultural land with various ownership structures—76.5% is owned by individual persons, 13.8% by legal entities, 5.5% by municipalities and regions, and 4.2% by the state [4]. According to data from the State Administration of Land Surveying and Cadaster, there has been a drop of 25 hectares of arable land per day [3]. Decreases are higher in places surrounding large metropolitan areas that were historically built on the most fertile lands of the plains. Furthermore, prices are rising due to current changes to climate and geo-political issues. Soil is a major natural resource not only for food production but also for its retention function. This function is starting to draw more attention given the emergence of more and more extreme hydrological effects—floods and drought. The soil sealing in urban areas is perceived as a driver of flood risks in many contexts [5–8]. Czech land ownership is a very sensitive issue due to the recent processes of privatization and restitution. In addition, the price of land is most likely influenced by the availability of mortgages; low or zero interest rates from banks and possibly subsidies on hectares of agricultural land. Recently, with the quantitative easing by the ECB and the large amount of liquidity in the Czech financial market, the prices of agricultural land have started to increase considerably beyond previous expectations and seem to be less and less sustainable [9]. Globally, agriculture is the main utilizer of land, which is also ostensible in the Czech Republic as agricultural land totals are approximately 55%. At the same time, agriculture employs 100.9 thousand people and accounts for 0.89% of GDP [4]. Generally, agriculture has been losing its significance in the economy, but in light of rising food prices and calls for sustainability, agriculture has to be seen as a key element of the Czech economy [5–8].

Agricultural land is generally a very valuable input for agricultural production. Land is one of the main components of the landscape and a basic component of the environment, but also one of the most important natural resources. During the COVID-19 pandemic and especially at the start of it, thanks to the restrictions on transport and trade and the closing of borders, the question of individual states' self-sufficiency in food production was reopened. It should be possible to subsidize basic nutrients for the livelihood of the population from their own geographical resources in the event of various disasters of a natural or anthropogenic nature. An example from history is England during World War II. During the Second World War, when Great Britain was in a state of siege, it was necessary to cover food production from its own resources [10]. The former Czechoslovakia was also almost self-sufficient in basic food production during World War II. On average, the current Czech population consumes 90 g of protein per day per capita [11]. This protein source may come either from animal or plant sources. If we look to the future of land use for agriculture, plant cultures will be sustainable in the first place and will help to replace animal protein, which in European conditions seems to be a serious threat to the environment. Plants such as legumes, oats, and buckwheat as well as more non-traditional species like chickpea and amaranth can be produced in the conditions of the Czech Republic. These crops are more gentle on agricultural land, reduce the risk of erosion, and some improve soil properties through a natural process.

Whereas other investment opportunities offer relatively low returns, investing in land shows potentially lucrative returns both in form of capital gains and rent [4,12]. This is obvious from Figure 1, which represents the evolution of land prices in the Czech Republic between 2008 and 2018 [4].

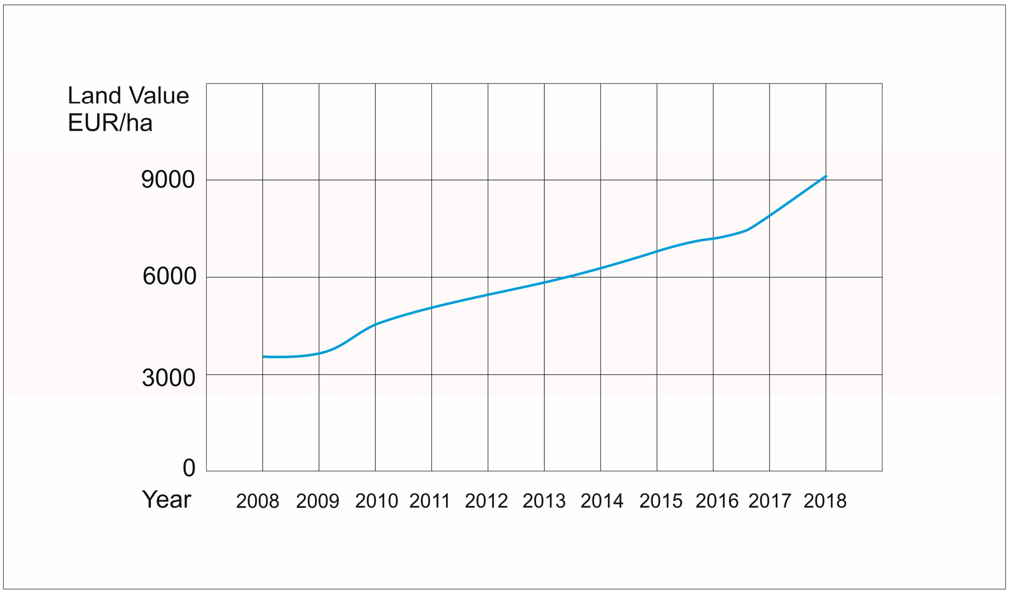

Figure 1. Agricultural land prices development.

In 2018, the average market price of agricultural land increased by 15.2%, from 8163 EUR per hectare in 2016 to 9510 EUR per hectare in 2018. Compared with previous years, the rate of growth of prices has slightly decreased. For 2019, the price grew at a similar pace and thus exceeded 10,000 EUR per hectare. From the point of view of the size of the trade, in 2017, the highest demand was for medium-sized areas of 5 to 50 hectares. Regionally, the highest market prices were achieved mainly in the vicinity of Prague (up to EUR 20,000 per hectare), where the vicinity of the capital city influenced the market prices of land intended solely for agricultural production [1,12,13].

With the onset of speculators and threats to the increasing cost of production, the increasing prices of agricultural land need to be better understood and analyzed. It is necessary to rigorously examine factors that are believed to stand behind the increasing agricultural land prices in the Czech Republic. It is also important to determine the extent of the effects that the identified factors have. The development of prices that is studied and analyzed in this paper may provide important insight into its nature. The results from this analysis can be important for policy makers, as the cost related to land ownership creates a large share of the overall cost of agricultural production [14,15]. Moreover, based on these findings, policy makers may regulate the factors that contribute to increasing farmland prices. Finally, the increasing prices of agricultural land have a direct effect on the profit margins of agricultural producers [14]. This means that increasing land prices in the Czech Republic may lead to a lower performance of agricultural producers and a reduction in the profit margins of farmers in the Czech Republic [16].

Although the study of the impacts of the studied factors on land value in the Czech Republic is limited, these have been studied extensively on the international level. For example, Han, Zhang, and Zheng [17] studied the impact of urban sprawl on Chinese land prices. They studied various government policies and how they influence land prices in China. Another study by Hosseini and Hajilou deals with urbanization pressure on the property prices in Iran [18]. They claim that population growth has a positive effect upon land value. Urbanization impact on agricultural land was reviewed by Ayele and Tarakegn [19] for Ethiopia. The authors claim that urbanization leads to higher demand for agricultural land in the peri-urban areas of Ethiopia. This leads to a limitation of land available for agricultural production and thus threatens the livelihood of farmers and food security in Ethopia. Furthermore, parcel size may play an important role in the determination of the average price of agricultural land [19].

Based on the literature review, it is obvious that agricultural land is particularly influenced by urbanization. This paper evaluates whether or not land value in the Czech Republic is influenced by urbanization and the extent of this influence. The limited supply of agricultural land due to conversion or due to high prices may threaten the agri-food sector in the Czech Republic; therefore, a study on urbanization pressure is important.

2. Materials and Methods

In this paper, land prices are analyzed using a general framework that is given by the following Equation (1):

$$Lt = f(Rt, St, Ut) \tag{1}$$

where Lt means value of land, Rt stands for rent from agricultural land, St for agricultural subsidies, and Ut for urban influence. This is based on several papers. For example, Feichtinger and Salhofer examine in their paper the influence of government payment on land value at the European level [12]. This approach has never been applied for the Czech Republic.

All variables provided in the equation above were thoroughly examined for the existence of a unit root(s) using the appropriate unit root examination methods such as the Augmented Dickey Fuller Test. The long-run relationship between farm-land value and other variables was estimated using the cointegration method, specifically the Johansen procedure. Each variable from Equation (1) is properly identified and expressed below.

2.1. Agricultural Rent

Farm-land value in the Czech Republic, as introduced in Figure 1, is influenced by several factors. One of the most important factors is receiving rent from the land. Rents of agricultural land between 2008 and 2018 are presented in Figure 2. Rents are presented for both firms and individuals [4].

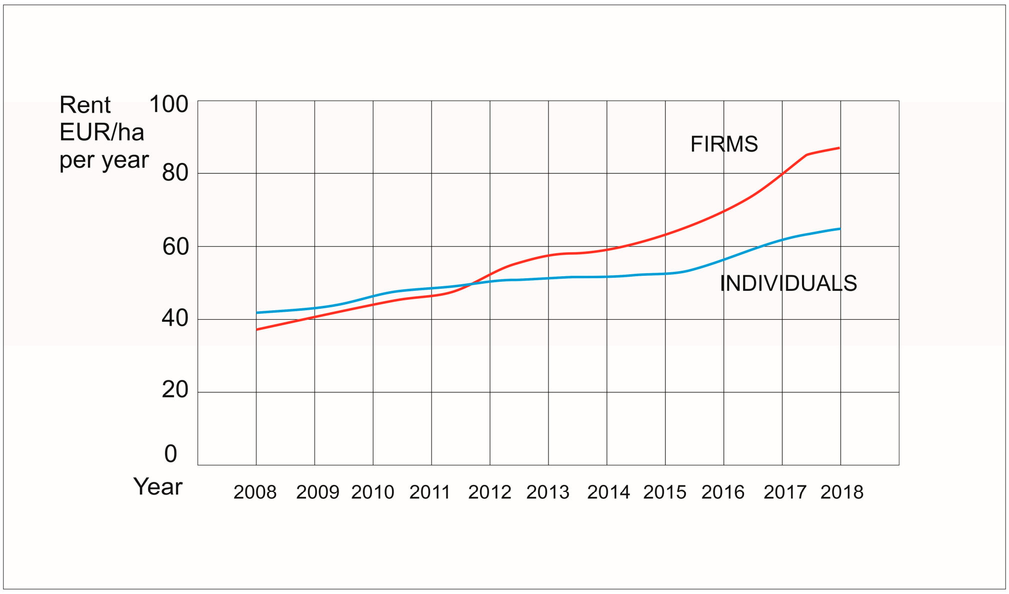

Figure 2. Rent of farm land in the Czech Republic (2008–2018) for firms and individuals.

The incorporation of rent into the model is based on the elementary notion of present value calculations. The present value model (PVM) is a model that tries to find a relationship between stock and its expected future returns discounted to the present using an appropriate discount rate that may be constant or vary with time. The present value model is described in detail in the following section.

The authors of this paper expected stock returns to vary over time, meaning that the relationship between prices and returns is not linear. This leads to the definition of the gross real rate of return on one hectare of land (Ret) for the period between t and t + 1 as this (2):

$$Rett = \log(Lt + 1 - Lt + Rt + 1) - \log(Lt) \quad (2)$$

where Rt stands for rent from agricultural land and Lt stands for the value of agricultural land. This expression is further processed by the first order Taylor expansion into a linear expression. From this, rent-value ratio is defined so that given rational behavior of economic agents, it is assumed that farm-land price Lt and rent of agricultural land Rt cannot drift apart too much. This expression can be tested using time-series analysis [20].

2.2. Urban Influence

As already discussed, in the Czech Republic, the pressure of urbanization upon farm-land prices cannot be underestimated. The geography and population of the Czech Republic is influenced to a large extent by possible land use. Much of the agricultural land lies in the vicinity of both larger and smaller cities and villages [12,15,20].

This land was developed for commercial and residential uses and is subject to Environmental Impact Assessment. As a proxy for this urban pressure, population density was selected to represent competing demand for agricultural land. This is in line with numerous studies that use population density as a proxy for the variable of urban pressure; population density (people per square km) in The Czech Republic was last measured at 136.62 in 2015, according to the World Bank [21]. Population density used in this study is simply population divided by land area in square kilometers. Population consists of all residents regardless of legal status or citizenship. Land area is a country's total area, excluding areas under inland bodies of water [21]. Population density in the Czech Republic is represented by Figure 3 [21].

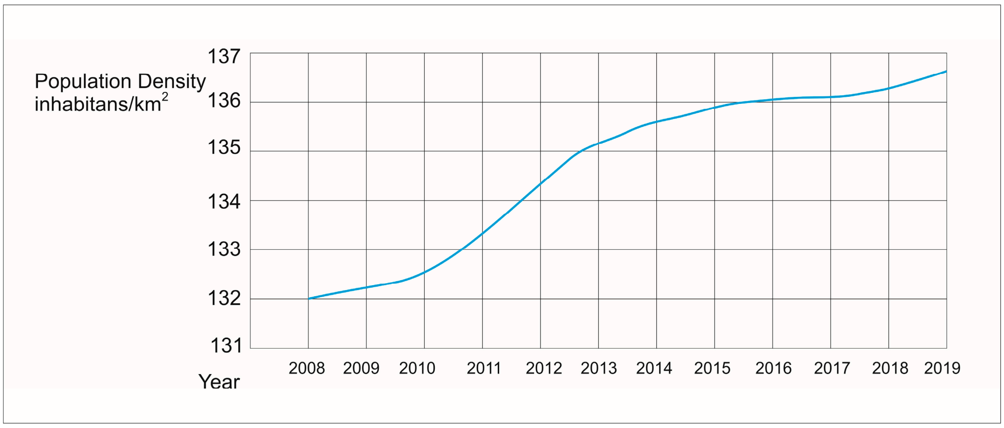

Figure 3. Population density in the Czech Republic (2004–2019).

2.3. Subsidies

Government payments should also be considered as a rent source, although a basic distinction must be made about which type of subsidy is analyzed [12]. For the purpose of this study, Single Area Payment Scheme was selected, as it is the most significant source of payments provided to Czech farmers. Czech Republic is among the 10 countries that have SAPS as the most significant source of subsidies [22]. Subsidies are depicted in Figure 4 [1]. Currently, subsidies in the European Union are slowly shifting from livestock to alternative products [23]. This will enable Europe to produce a sufficient amount of protein from plant-based resources using subsidies schemes.

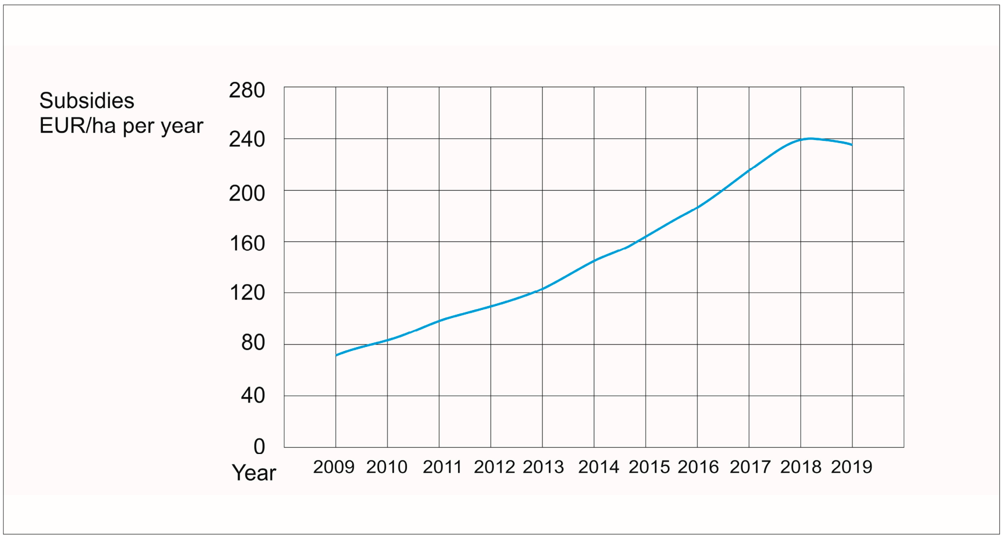

Figure 4. Subsidies in the Czech Republic (2009–2019).

2.4. Parcel Size

Unfortunately, data for average parcel size realized in the transaction is not available for the analyzed time framework.

2.5. Model and Data

The above-mentioned variables were put into a model so that the authors of this research can try to determine the key drivers and factors influencing land price development in the Czech Republic and their pattern of action. In the model, agricultural land is perceived as a productive factor or asset, whereas the agricultural land price is sensitive to the return, which is demonstrated by rents Rt and subsidies St. Furthermore, based on the previous analysis, farm-land prices in the Czech Republic are assumed to be sensitive to urbanization effects that are represented by population density Dt. Rt represents net cash rent per hectare of cropland. [24,25]. Furthermore, St represents level of subsidies, i.e., agricultural support programs that may also capitalize on land value [26,27]. These direct payments were provided by SZIF [28]. All monetary variables are presented in real terms (base year 2000), and, thereby, inflation was incorporated into the model.

Density data was provided by World Bank (2017) [21] and was calculated according to the methodology presented above. The variables were modified by taking their logs in order to reduce a multiplicative relationship to an additive one. Before the model can be estimated, all variables must be tested for the existence of unit roots. This unit root test was conducted using the Augmented Dickey Fuller test. The Augmented Dickey-Fuller (ADF) test was proposed by Dickey and Fuller (1981) [29] in order to test time series for the presence of unit roots or non-stationarity. The most general regression form of the ADF test is presented below (3):

$$\Delta Yt = \mu + \gamma Yt - 1 + j - 1pjYt - j + \beta t + et \quad (3)$$

where Yt represents the tested variable, μ is the drift term, t denotes the time trend, and p is the largest lag length used. The unit root tests that are presented in Tables 1–5 for all analyzed variables show that all variables are non-stationary. They require differencing in order to become stationary.

They are all integrated of order I (1). In Table 2, direct payments are tested for the presence of unit root. Next, the analyzed variables were examined for the existence of a long-run relationship. This was done using the Johansen procedure. The Johansen procedure is a multivariate version of the univariate augmented Dickey Fuller test. The Johansen procedure can be used to determine the number of existing cointegrating (i.e., long-run) relationships among the variables in hand. It is commonly acknowledged that the statistical properties of the Johansen procedure are better than the Engel Granger test [30].

Let us take a reduced form vector autoregression of order p (4):

$$\text{yt} = \text{A1yt} - 1 ++ \text{Apyt} - \text{p} + \text{Bxt} + \text{ut} \quad (4)$$

where yt is a k-vector of I(1) variables, xt is a n-vector of deterministic trends, and ut is a vector of shocks. This VAR can be rewritten as Equations (5) and (6):

$$\text{yt} = \Pi\text{yt} - 1 + \text{i} - 1\text{p} - 1\text{iyt} - \text{i} + \text{Bxt} + \text{ut} \quad (5)$$

where:

$$\Pi = \text{i} - 1\text{pAi} - 1, \text{i} = -\text{j} - \text{t} + 1\text{pAj} \quad (6)$$

Johansen's procedure helps us to estimate the Π matrix from an unrestricted vector autoregression and tests whether the restrictions implied by the reduced rank of Π can be rejected.

This test relies on the relationships between the rank of the analyzed matrix and its characteristic roots. The rank of Π equals the number of its characteristic roots that differ from zero. This, in turn, corresponds with the number of cointegrating vectors. The Johansen procedure is done using two tests (trace and maximum likelihood test). The results of the Johansen procedure are presented below in Table 5 for both the trace test and maximum eigenvalue test. Since variables are cointegrated, it is necessary to run the error correction model to explain some of the short-run fluctuations in the model. It is also necessary since the Johansen procedure does not distinguish between dependent and independent variables.

Information about the number of cointegrating relationships are incorporated into the model. The general form of the model can be written as (7):

$$\Delta\text{yt} = 1\Delta\text{xt} - 1 - \alpha\text{yt} - 1 - \theta\text{xt} - 1 + \text{et} \quad (7)$$

where xt represents a vector of exogeneous variables (in our case Rt, Dt, and St) and yt represents agricultural land value Lt. The model also shows that land prices (yt) react in the short-run to changes in xt and also any changes in the LR equilibrium, which is represented by (yt − 1 − θxt − 1).

3. Results

The model estimation was performed and the results of the estimation are provided in the following sections. First, it was necessary to evaluate the nature of the time series, which determined the next steps for analyzing interdependence among analyzed variables.

3.1. Nature of the Time Series

In this section, the nature of the time-series is evaluated using Augmented Dickey Fuller (ADF) in order to determine possible (non)stationarity.

Results from the ADF model estimation are presented below in Table 1 for subsidies *St.*

Table 1. Statistical properties of variables (ADF test) for S_t including one lag of $(1 - L)\, S_t$.

sample size 10
unit-root null hypothesis: $a = 1$
with constant and trend
model: $(1 - L)\, y = b0 + b1{*}t + (a - 1){*}y(-1) + \ldots + e$
1st-order autocorrelation coeff. for e: −0.291
estimated value of $(a - 1)$: −1.05215
test statistic: $tau\_ct\ (1) = -2.2155$
asymptotic *p-value* 0.601

The results show that we do not reject the null hypothesis, and it cannot be concluded that the time series of subsidies is stationary.

In Table 2, land value *Lt* is tested for the existence of the unit roots.

Table 2. Statistical properties of variables (ADF test) for L_t including 2 lags of $(1 - L)\ L_t$.

sample size 10
unit-root null hypothesis: $a = 1$
with constant and trend
model: $(1 - L)y = b0 + b1{*}t + (a - 1){*}y(-1) + \ldots + e$
1st-order autocorrelation coeff. for e: −0.454
estimated value of $(a - 1)$: −1.27922
test statistic: $tau\_ct(1) = -2.18944$
asymptotic *p-value* 0.4968

The results show that we do not reject the null hypothesis, and it cannot be concluded that the time series is stationary.

In the following Table 3, the same test is done for the rent *Rt*; in this case, rent for firms renting land from the owners.

Table 3. Statistical properties of variables (ADF test) for R_t including one lag of $(1 - L)\ R_t$.

sample size 10
unit-root null hypothesis: a = 1
with constant and trend
model: $(1 - L)y = b0 + b1{*}t + (a - 1){*}y(-1) + \ldots + e$
1st-order autocorrelation coeff. for e: 0.031
lagged differences: $F(2, 4) = 0.109$ [0.8745]
estimated value of $(a - 1)$: −0.392363
test statistic: $tau\_ct(1) = -0.274254$
asymptotic *p-value* 0.993

The results clearly suggest that we do not reject the null hypothesis, and it cannot be concluded that the time series is stationary.

Finally, in Table 4, population density *Dt* is tested for the existence of a unit root.

Table 4. Statistical properties of variables (ADF test) for D_t including one lag of $(1 - L)\ D_t$.

sample size 10
unit-root null hypothesis: $a = 1$
with constant and trend
model: $(1 - L)y = b0 + b1{*}t + (a - 1){*}y(-1) + \ldots + e$
1st-order autocorrelation coeff. for e: −0.218
estimated value of $(a - 1)$: −0.387556
test statistic: $tau\_ct(1) = -3.15871$
asymptotic *p-value* 0.09282

While population density shows the closest resemblance to stationarity, it is also non-stationary.

The results shown in this section indicate that all analyzed variables are non-stationary, and thus, it is possible to examine their long-run relationship.

3.2. Analysis of Relationship among the Analyzed Variables

As all analyzed variables are non-stationary, in other words, they all exhibit unit root, we could proceed with cointegration analysis. The cointegration results are presented in Table 5.

Table 5. Johansen procedure test results for P_t, D_t, S_t and R_t.

Rank	Eigenvalue	Trace Test *p*-Value	Lmax Test *p*-Value
0	0.97682	87.132 [0.0000]	64.312 [0.0000]
1	0.83554	24.912 [0.1778]	19.362 [0.0978]
2	0.34456	5.6458 [0.7252]	4.4596 [0.8245]
3	0.11112	1.2683 [0.2734]	1.2678 [0.2734]

The results from the trace test show that although we can reject a null hypothesis of no cointegration relationship, we cannot reject a null hypothesis of maximum of one long-run relationship. The results of the maximum likelihood test confirm the same results as the trace test. This means that all four variables of *Pt, Rt, St,* and *Dt* are cointegrated. Both tests confirm the same story, which means that there is a cointegrating relationship among the variables.

As all analyzed time series have a long-run relationship, in other words, they are cointegrated, it was possible to proceed with the error correction model to analyze short-term dynamics among the analyzed time series.

3.3. Short-Run Dynamics of the Analyzed Variables

The results of the estimation using the error correction model are presented in Table 6 below. The results show which variable drives the movement in the short-run framework and the extent to which it does so.

Table 6. Results of error correction model.

VAR system, lag order 1				
OLS estimates, observations 2008-2019 (T = 11)				
Log-likelihood = 4.96219				
Determinant of covariance matrix = 0.025341856				
AIC = −0.1650				
BIC = −0.0111				
HQC = −0.2573				
Portmanteau test: *LB(2)* = 3.52115, *df* = 1 [0.0655]				
Equation (1): l_landvalue				
Heteroskedasticity-robust standard errors, variant HC1				
	Coefficient	Std.Error	*t*-ratio	*p*-value
l_landvalue_1	−0.0604364	0.187576	−0.3222	0.75671
l_SAPSpay_1	0.426601	0.516146	0.8265	0.43578
l_landrent_1	0.402036	0.542568	0.7410	0.48281
l_popdens_1	1.18623	0.170053	6.9756	0.00022
Mean dependent var	11.48056	S.D. dependent var		0.358540
Sum squared resid	0.266549	S.E. of regression		0.195137
R-squared	0.999816	Adjusted *R*-squared		0.999738

The results of the error correction model in Table 6 provide interesting insights into the model, and the statistical significance exists only with one variable. This is population density, where the coefficient takes a positive value and, at the same time, the probability values are less than 0.01, making it a strong candidate to explain the short-run fluctuations. This means that we can conclude that land prices in the Czech Republic in the short-run are influenced by population density. According to our results, out of all variables introduced, urban influence, as presented by the population density proxy, plays an important, quantifiable role. This means that any policies related to changes in population density will lead to a price effect on land value. For example, an increase in population due to immigration will influence the prices of land in the Czech Republic. It can be expected that the population density pressure will continue in the coming decades, and hence, it will continue to influence the short-run dynamics of land prices in the Czech Republic.

4. Discussion

Agricultural land prices have been analyzed by several researchers, including [14,20,31,32]. Several studies examine agricultural land prices using the framework of the present value model [20,33–35]. Land value should be theoretically equal to the discounted present value of all future financial streams. This means that researchers evaluate a stream of rent payments that are capitalized into the farm-land, which is considered as a capital asset. This approach of PVM has been validated by several studies [20,32,33], and it has been further developed by incorporating other variables that may explain land value, such as urbanization influences or subsidies related to land ownership [27,36]. Urbanization plays a dominant role in the value of land in built-up areas in peri-urban locations of countries such as China [37]. The government tries to limit the supply of land available for conversion by various policies such as floor-to-area ratio (FAR), whose impact has been found to be significant and positive [38].

Furthermore, other researchers have tried to explain the rising prices by looking at, for example, some macroeconomic variables such as GDP per capita inflation, farm size, farm debt, or value of agricultural production [9,39,40]. Regarding the estimation technique, Hamilton (1994) [41] in his work claims that asset prices usually follow a random walk i.e., they are non-stationary. Economic theory tells us that agricultural land prices as well as other economic variables will drift apart [20]. This leads to the notion that these series are naturally non-stationary, which means that cointegration and error correction approaches can be used. The concept of cointegration has been brought up in econometrics literature [24,25,34,35].

Urbanization plays an important role in the overall area of the Czech Republic. This primarily applies to the surrounding areas of larger urban centers. This is also confirmed by a study conducted by Ayele and Tarekegn [19], who claim that peri-urban land in Ethiopia is fragmented and sold for development purposes. According to Hosseini and Hajilow, urban sprawl is driven primarily by population growth—17% for Iran [18].

Furthermore, a field having a large number of owners or smaller tracks of land will lower the price of the land in marginal countryside localities (disadvantageous renting contracts, etc.). Land ownership in the Czech Republic is scattered among many individuals and firms. Although the ownership structure is quite heterogeneous, recently, major agricultural producers have started to acquire large pieces of land, which may lead to imbalances and disparities [42].

In their study, Satterthwaite, Mc Granahan, and Tacoli state the contradiction between the expansion of the urbanized areas at the expense of agricultural land and the consequent declining ratio of food producers to consumers. A key issue is the ability to sustain the increasing demand for food [43]. It concerns developing countries the most, because providing food security is a larger problem for them. However, even in developed countries such as the Czech Republic, we observed a significant trend of degradation and loss of agricultural land. This is compounded by climate change, which threatens ubiquitous drought and thus endangers agricultural production [43,44]. Szturc and Hybler state that during individual periods from the past to the present, the quantity and quality of agricultural land has decreased. In most cases, agricultural land is urbanized in favor of urban development [45]. Kocur-Bera and Psenna's study in neighboring Poland aimed to analyze the conversion of land used for agricultural purposes to build-up land in the suburban zone of cities [46]. The authors point to the consequences of uncontrolled urbanization, which we are currently also dealing with in the Czech Republic. These aspects generate long-term social and economic losses, difficulties on the labor market, and rising prices of suburban land, which can become an obstacle to development.

In addition, suburban land parcels can be far from existing developed areas and especially technical infrastructure. In his work, Radvan [47] mentions urbanization as the cause of higher management costs for cities, as they are responsible for local infrastructure and services. The legal regulation of local taxes and, in particular, the fee for local roads and paths is not sufficient in the Czech Republic. Ultimately, this leads to the intensification of the negative pressure on the agriculturally used areas. Despite the impact on society, the economy, and the environment, the chaotic development of suburban areas continues. The process of dividing parcels and converting agricultural land into build-up land contributes to the problems to a large extent. Not only is it legally approved, but as research has confirmed, it is also economically viable and therefore attractive to agricultural landowners [46,47].

According to the study by Klusáček et al. [48], in recent decades, various aspects of deagrarianization have been clearly visible on the outskirts of large cities of Central Europe. This is manifested by the cessation or significant reduction in agricultural activity. Key factors in this process include increased pressures to cover suburban agricultural land with new development, insufficient protection of agricultural land, inefficient urban planning, and low status of agriculture. Urbanization pressures are among the factors intensifying an overall deagrarianization, as more suburban farmers are usually unable to compete with other urban functions as well as withstanding the high land prices in suburban areas [48].

5. Conclusions

The Czech agricultural land market has experienced rapid price growth in the last several years. This is a pressing issue, as farm-land is one of the most expensive inputs of agricultural production. Therefore, it was necessary to evaluate the origins of this growth. Higher land prices can have many unintended consequences. The most pressing one can be an increase in food prices, as acquisition of agricultural land is one of the largest investments for agricultural producers.

Based on the literature review, the authors identified three key variables that should explain the long-run behavior of land prices in the Czech Republic. These key factors were determined to be rent, agricultural subsidies, and the influence of urban sprawl represented by population density. The existence of this long-run relationship was tested by the Johansen procedure using both trace and max eigenvalue tests, after which each time series was examined for the existence of the unit root. Results show that there is a long-run relationship between land price in the Czech Republic on one hand, and subsidies, rent, and population density on the other. This means that all time series tend to hold long-run equilibrium. Short-run fluctuations in the land prices were tested using the error correction model and showed that one of the identified variables, namely population density, is significant. According to the model, in the short-run, the most important factor that influences value of land is population density.

The study results indicate a need to control the variables that are causing growth in farm-land prices by appropriate policy responses if applicable. For example, urban sprawl can be controlled by strict land use policies that lead to sustainable land use. Urban sprawl uses areas of valuable farm and wild land. It leaves people with less green areas. Therefore, if urban sprawl is slowed down by appropriate policies, quality of life can be improved. Currently, sustainable development in the Czech Republic is threatened by the increasing prices of land that lead to increased investments into land and related demands for land use changes. With the war in Ukraine, population pressure may increase and the onset of the energy crisis may slow down this development.

Another factor that influences the price of land in the Czech Republic according to the results are subsidies. Subsidies are directly controlled by the government (both at the local and EU level). This means that the proper placement of subsidy programs is necessary in order to prevent the rise in agricultural land prices. Subsidy programs, for the most part, are well known to lead to soil degradation or groundwater depletion due to the overuse of available resources. The presented results in this paper show that agricultural subsidies may also lead to increasing land prices with all of the associated negative aspects that were already mentioned. It is also important to mention that degradation and resource depletion is related primarily to animal-based protein production through livestock industry. Authors recommend incorporating this notion into new subsidy negotiations for future national and European Union's subsidy programs.

Finally, rent can also be controlled by appropriate policy tools such as income tax. Proper policy response in this case is harder to recommend. Rent of agricultural land is also reflected directly in the price of agricultural production. Therefore, any policies aiming at increasing income tax would lead to higher rent, and hence, to lower land price, and could have an adverse impact.

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