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APPLICATION OF PERPETUAL RENT MODEL TO VALORISATION OF AGRICULTURAL LAND*

Abstract

The concept of creating public goods by land factor is often considered in literature, but its theoretical foundations are quite debatable. The theories of land rent in mainstream economics stand at the position that land factor alone does not create any utility, which means that it does not have any "intrinsic utility". Only by changing this assumption, it is possible to reconsider a theoretical model for provision of public goods by agriculture. The authors wonder which model of value can be applied to valuate agricultural land so as to make it reflect its intrinsic utility. They propose to adopt the neoclassical Gordon's model of perpetual rent. The theoretical aim of the article is to interpret the relationships described in this model for the market of agricultural land. The empirical goal is to assess the long-term growth rate of land rent from the Gordon's model in the 16 regions (voivodeships) of Poland and in the cross-section of different acreages. Paradoxically, it turns out that the neoclassical model is well-fitted to the market of agricultural land in the long term, despite the far-reaching institutional regulation of this market and it provides a basis for quantification of the intrinsic land utility.

Keywords: perpetual rent, rental fee, agricultural land, sustainable agriculture.

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Introduction

The paradigm of sustainable agriculture assumes that agriculture and the land factor provide public goods (such as natural values, landscape, rural culture, biodiversity, traditional food production techniques), which is why production intensification should be sustainable at the environmental, social and economic level to keep durability of these goods. The concept of public goods creation by land factor, although present in the economic reality, is pretheoretical because the mainstream land rent theories argue that land – as a production factor – cannot create any utilities, i.e. it does not have the so-called "intrinsic utility" (Czyżewski and Brelik, 2015; Czyżewski and Matuszczak, 2016). Only a change in this assumption, theoretically, justifies the process of provision of such goods. In this context a question comes up: what model should be used to describe the value of agricultural land to make it take account of its intrinsic utility as regards public goods creation? The authors suggest to adapt the neoclassical model of perpetual rent, termed in the financial regime as the Gordon's model (Brigham and Gapenski, 1990). The panel research conducted on quarterly data for all regions (voivodeships) in Poland, paradoxically proves that the model discounting the perpetual rent well-described the land market in Poland in the long term (2003-2014), despite the objections concerning regulation of the market and determining rental rates under tenders by the Agricultural Property Agency (*Agencja Nieruchomości Rolnych, ANR*). In practical sense, it means that the agricultural land market regulations made to date were good because they did not interfere too much in the information efficiency of the market[1]. If yes, then the use of the Gordon's model to valorise agricultural land and measure the intrinsic utility of land seems to be justified. Based on the model, it is possible to estimate the so-called "expected constant growth rate of perpetual rent". The authors assumed that for agricultural land it has a residual character (i.e. it is formed in specific conditions of rental fee, land prices and interest rates) and reflects changes in the intrinsic utility of agricultural land. A theoretical aim of the paper is interpretation of relations described in the model of perpetual rent for the agricultural land market based on author's deduction and literature review. The empirical goal of the research is to assess the "long-term growth rate of land rent" from the Gordon's model in the voivodeships of Poland and in the cross-section of different acreages. If the rate is positive, it means that macroeconomic conditions are met and the land rent not only was perpetual but also grew by a constant rate in a given time unit. This constant rate is a measure of the growing rarity of land and intrinsic utilities of land are a function of the rarity – the lesser rural landscapes there are and the smaller the area of high natural values, the more valuable they become to consumers.

[1] It may be said that the institutional solutions used so far were complementary to the agricultural land market and as of May 2016 these solutions are substitutable.

Valorisation of agricultural land – input, income and hedonic approach

In the neoclassical economics, the land rent constitutes the residual income of a farm, which in the conditions of efficient allocation should be equal to perpetual rent discounted in prices of owned land, because the land resource is not subject to depreciation and is renewable. Lower residual income undermines the economic rationality of a farm, because theoretically land sales or lease would be a better solution. The statement that the market value of agricultural land corresponds under conditions of rational expectations to the discounted stream of perpetual rent is not a novelty, but has always been subject to controversy (more in: Czyżewski, 2013). Woś, as one of the first in Poland after 1990, compared land rent to perpetual rent. He noted that the value of agricultural land "is a capitalised fund that over time encompasses land, buildings, water bodies, irrigation facilities, permanent plantations, structures permanently attached to the ground, and other rare (unique) farming structures. (…) Annual payments are made from the fund (…); if it is indestructible (which is the case for land), it is a perpetual rent", which was calculated by the quoted author according to the formula for perpetual rent value at a given discount rate and land value (Woś, 2006). Woś, when writing about annual "payments", probably meant the farm income stream. The above reasoning shows also the impact of the input approach, because the capitalised stream of inputs translates into the value of the aforementioned "fund", i.e. land.

The input (cost) method of land valuation was criticised already in the 1960s. It was argued that it is not possible to thus value a resource which is not determined by amount of human labour. Chołaj wrote that because there are no market methods of its valuation, land should be termed as "fictional capital" (Chołaj, 1966). In another study Woś and Gruda emphasised the role of individual preferences in forming the value of resources stating that "the resource is worth as much as someone is ready to pay for it (…). This theory dismisses all attempts at finding an objective price basis, assuming that it is conductive to cost prices" (Gruda and Woś, 2008).

Input and transaction methods are still applied to value forests, though. Podstawka and Konieczny estimated the value of a forest planted on land not used for agricultural purposes as a sum of costs of setting up a plantation and the value of land not used for agricultural purposes, multiplying the sum by the quality coefficient of the forest stand (considering afforestation density, quality of trees in a habitat, etc.) (Podstawka and Konieczny, 2002).

In foreign literature, it is assumed that the only theoretically justified method of determining the current value of agricultural land consists in discounting the expectations of purchaser as regards the future land rents. Ciaian – researching the impact of the Single Payment Scheme (SPS) in the countries of the "old" EU-15 on the prices of agricultural land – writes that "if sales prices fully incorporate the discounted sum of future rental values, then the effect of the SPS

on sales prices is equal to the effect of the SPS on rents" (Ciaian, Kancs and Swinnen, 2010). Borchers quotes several dozen papers which use the perpetual rent model with varied modifications to determine the factors of agricultural land value, simultaneously using the same approach (Borchers, Ifft and Kuethe, 2014). To conclude, income approach is one of the most often used methods to model land prices.

At the microeconomic level, hedonic method is an alternative to income models. It comes down to the assumption that the price of a heterogeneous good can be described using its properties. In other words, this method may be used to determine the worth of respective properties of a given good, including also agricultural land. To determine the impact of individual properties on the value of a given good, econometric models are constructed, where the price of a given good is the dependent variable and its key quality properties are the independent variables (Coulson and McMillen, 2008). Theoretical grounds of the hedonic method were extended by Lancaster (1966) and Rosen (1974).

In the described approaches, the basic models of land prices are, in general, developed with variables illustrating the impact of agricultural policy, structural aspects (agrarian structure) and macroeconomic aspects. For example, Kuźmiński estimated agricultural land prices in the European Union countries, considering the impact of agrarian policy of the state expressed in Lorenz quantitative land concentration ratio. It also considered the share of UAA in the total country area (%), the share of arable land in the UAA (%) and productivity per 1 ha of arable land (Kuźmiński, 2015). In the discussed model the achieved significance of all of the above-listed variables was at α=0.05, and the coefficient of determination at R_2=0.905.

Whereas research conducted by Pietrzykowski (2011) on the spatial correlations between agricultural land price and its quality, and other factors determining productivity and economic value, point out that the prices of good quality soils are affected by the prices of average and poor quality soils, single direct payments and the area of soils of class V and VI. These research failed to confirm that supplementary payments and subsidies to LFA, and the level of mineral fertilisation treated as an indicator of production intensity, have any impact on the price of agricultural land.

Whereas different authors in the hedonic approach indicate that the value of an agricultural real estate is determined also by agricultural suitability of land, organisational values of the real estate, its location and technical condition and usefulness of buildings (Kozioł and Parlińska, 2009). Identification of properties influencing the agricultural land prices in Turkey showed that, with the use of a similar modelling, distance from the farm, organic matter, potassium, water saturation, pH, salinity, phosphate, easement values are statistically significant (Vural and Fidan, 2009). Newer research, implemented by Czyżewski and Trojanek (2016), assigned key significance to the location factor termed "functional

type of a rural area" and observation of a trial broken down by the criterion, and the research showed that the type of rural area not only changes the location and inclination of the regression function but also signs of some regressors. It is the type of an area that decides whether and how utility values (e.g. surface area, shape coefficient and agricultural complex) or non-agricultural values (e.g. build-up possibilities, distance from a metropolis, intrinsic value, speculation) influence the land price. The quoted authors also stated that the payments for public goods (SPS, LFA and AEP) largely influence the formation of the agricultural land value, compared to other attributes of real estate at a plot level.

The literature also indicates that the impact of agricultural policy is expressed in capitalisation of subsidies in rental fees. This is evidenced by a sharp growth in rental fees from the moment of obtaining the status of beneficiaries of Common Agricultural Policy of the European Union by the Polish farmers. Góral and Kulawik (2015) argue that this distorts the idea of support, because it was presupposed that direct payments were to improve and stabilise the professional situation of "professionally active farmers", while they largely go to landowners, who are not professionally active farmers and leased their land, as increased land rent. The described phenomenon is sometimes termed as "outflow of budgetary support". This is common not only in the EU but also all across the world. It is estimated that only 20% of all the support for agriculture in the OECD countries creates net margin in agriculture and the rest flows to the surrounding of the agricultural sector. This process has wider implications for the model of agricultural land market. On the one hand, it increases the share of speculations in the market and, on the other, it "reveals prices" increasing information efficiency on the land market, as is the case of futures contracts for agricultural raw materials. According to the authors, taking over of land rent by non-agricultural sectors causes that models of value from capital markets, such as e.g. perpetual rent model, are paradoxically well-suited to the land market. However, it needs to be remembered that land rent outflows from agriculture not only because of subsidies. This process is also the result of the so-called technological treadmill or land market treadmill described for the first time by Cochrane in the 1950s (Cochrane, 1958; Levins and Cochrane, 1996). To increase the efficiency of agricultural production its scale must grow. Thus, demand for land increases, its prices and rental rates grow, consequently, absorbing the income margin for productivity growth. It should be noted that the problem of taking over land rent goes beyond political systems, because it was present also in the Marxist economy, which blamed it on the sectoral differences in the so-called rates of exploitation (Lewandowski, 1960).

Perpetual rent model versus agricultural land market

The use of the perpetual rent model, the so-called Gordon's model, popular on the capital markets to valorise agricultural land seems to be debatable. What

is problematic are the institutional solutions regulating the trade in land and determination of rental rates, which can distort the market mechanism operation. But then, the above-described process of taking over the land rent paradoxically streamlines the market.

From the theoretical perspective, the Gordon's model has interesting properties matching the specifics of agricultural land, especially reflecting the essence of the thesis on intrinsic utility of the resource which was elaborated on in other publications (Czyżewski and Matuszczak, 2016). This is illustrated by (1a) model version which assumed that the perpetual rent grows by a constant rate:

$$L_0 = \frac{R_0}{S} \tag{1}$$

$$L_0 = \frac{R_0(1+k)}{S-k}\ ,\ \ k < s \tag{1a}$$

where:
R_0 – annual value of market land rent,
S – discount rate (rate of return on alternative assets, e.g., long-term interest rate),
L_0 – land price in baseline period,
k – expected constant growth rate of perpetual rent.

What should be noted in the above is the long-term growth rate k which can reflect the constant and secular process of growing rarity of land as a resource of limited supply. Growth in rarity of agricultural land inevitability involves growing utility or in other words "worth" of its environmental and ecological values (known as amenities) which are intrinsic as per the previously adopted concept. As a result, it can be assumed that k rate reflects the dynamics of intrinsic land utility. Upon transformation of (1a) it is clear that:

$$k = \frac{s - \dfrac{R_0}{L_0}}{1 + \dfrac{R_0}{L_0}} \tag{2}$$

This means that the long-term growth rate of land rent is directly proportional to its opportunity cost (discount rate) and inversely proportional to the relation of rental fee / land price. The value of rental fee reflects the residual income on agricultural production. Whereas land price is the discounted stream of the incomes and other non-economic utilities, including speculative motive and the-

saurisation. If the share of rental fee in the agricultural land price grows it may be interpreted as a growth in profitability of agricultural production linked to its intensification and scale. It is clear that it is a competitive process to amenities of land. Therefore, the inversely proportional correlations described with the model are correct from the theoretical perspective. The directly proportional correlation between the discount rate and long-term growth rate of land rent is also justified. From the neoclassical perspective land is a type of capital – burdened with a relatively low risk, but rather immobile. If the cost of capital in the national economy grows, the expected land rent growth rate goes in the same direction and vice versa.

To conclude, the authors suggest to use a neoclassical approach, in which the non-market values are assigned to the residual variable *k*, i.e. long-term (constant) growth rate in the land rent value. But does this constant growth (as far as k is positive) follow only from the growing rarity and worth of land as natural resource? It is debatable and it can even be the effect of speculations. This question will be partly answered in the further analysis in regional terms and across different acreages. If *k* rate had been the effect of speculations, it should concern transactions in larger parcels. Whereas if it concerns intrinsic utility of land and its non-production values it should be higher for small parcels and regions covering areas of high natural values. Higher long-term growth rate of land rent, referring to formula 2, is mostly the effect of lower relation of rental fee to land price. The rent determined in tenders of the Agricultural Property Agency is much higher for lands of better soil valuation classes and for large parcels characterised by good layout. In case of small parcels, the rental fee is much lower but what is interesting – it does not translate into proportionally lower price of agricultural land, thus the relation of rent / land price drops and the long-term land rent growth rate increases. Why smaller parcels "keep their price" despite lower and sometimes even minute production values? According to the authors, this is preconditioned by non-production values, known in English literature as amenities, i.e. tourism, recreational, habitat and residential potential, sometimes thesaurisation motives that make the expected rent growth rate relatively high. This potential can be included to intrinsic utilities of land created without additional capital inputs or even due to their reduction. A drop in agricultural production intensity at the microeconomic level is necessary to release specific utilities at higher level of aggregation – local, regional, national and global (these are positive externalities), although it conflicts with the microeconomic optimisation criteria. The concept of intrinsic land utility can be illustrated with a parabola from Fig. 1. It follows from the above that from a certain moment growth in capital inputs in agriculture causes a drop in net production, considering positive and negative externalities related thereto.

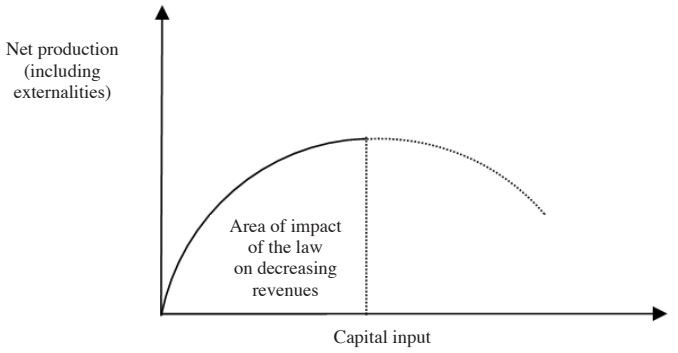


Fig. 1. Concept of intrinsic utility of agricultural land.
Source: own study.

Valorisation of intrinsic utilities of land factor is problematic, though. It largely takes place via institutional mechanisms, e.g. subsidies under the CAP but of course the mechanism is not perfect. It is emphasised increasingly more often that the above-mentioned utilities are capitalised in agricultural land prices, which is quite convincingly showed by hedonic analyses and observations of relations of discounted rental fees to land prices (Czyżewski and Polcyn, 2016). They prove that land price discounts much more utilities than it would result from its agricultural functions (Barnard, 2000; Flanders, White and Escalante, 2004; Delbecq, Kuethe and Borchers, 2014). To confirm the thesis in dynamic terms (hedonic analyses usually have a static character), the expected constant growth rate of perpetual rent from the Gordon's model can be used according to the authors. If it is positive, it means that intrinsic land utilities exist.

Yet, it needs to be added that the fact that it cannot be used when the discount rate is smaller than the long-term growth rate, is a shortcoming of the Gordon's model (Goźliński, 2016). This was not the case in the conducted research. Nonetheless, the use of the Gordon's model would be unjustified if it was impossible to estimate statistically significant parameters for the land rent and discount rate in the econometric model of land prices for a given year. Therefore, representativeness of the perpetual rent model for the researched land market is a premise to calculate a constant growth rate. In case of Poland, the condition has been met.

The authors estimated the following regression coefficients for (1) (linearisation with the use of logarithmic function); they are all statistically significant at the level of $\alpha = 0.05$, and the functional form of the perpetual rent model no. 1 (signs by regressors) was maintained:

small UAA (1-9 ha)

$$\log L_{it} = 0.021 \log R_{it} - 2.36 \log S_{it} + \beta' x_{it} + 12.28 \quad (3)$$

where:
i – voivodeship,
t – period (quarter),
β – vector of significant parameters of zero-one variables for the period (quarter); other signs as in 1.

Panel estimation method with the use of "fixed effects", 694 observations, quarterly data from Central Statistical Office of Poland (*Główny Urząd Statystyczny, GUS*) and Agricultural Property Agency across 16 voivodeships in 2003--2014; LSDV $R_2 = 0.941162$; WITHIN (i.e. intra-group) $R_2 = 0.931167$.

medium-sized UAA (10-99 ha)

$$\log L_{it} = 0.030 \log R_{it} - 1.04 \log S_{it} + \beta' x_{it} + 9.29 \quad (3a)$$

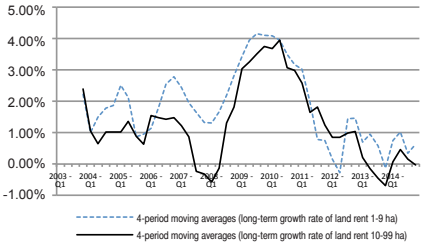
Panel estimation method with the use of "random effects" (GLS), 615 observations, from GUS and Agricultural Property Agency across 16 voivodeships, in 2003-2014; both formulas adopted a fixed effect for the variable grouping the "periods" because of non-linear trend of rents and land prices after entry into the EU (different effects over time, fixed in space). Randomness may thus concern only the variable groups "voivodeships".

What should be noted, the regression coefficient at land rent for small UAA is much lower than for large UAA (growth in R rent by 1%, causes a growth in land prices by 0.021% in case of larger areas by 0.3%). The reaction to a change in the interest rate is converse – in case of small areas it is much stronger (growth of S by 1% causes a drop in land prices by 2.36%). This confirms the conclusion that the value of small parcels is preconditioned more by non-production factors and that of large parcels mainly by incomes from agricultural production, which are reflected on the market in the price of rental rate. Details of the estimation procedure and in-depth analysis of results of the modelling are descried in another study of the authors (Kułyk and Czyżewski, 2016).

Results of observation of constant growth rate of land rent

Statistical data indicated in the explanations to (3) and (3a) were used in the calculations. First, cold facts are presented and later an attempt at their interpretation (see: Fig. 2):

DOLNOŚLĄSKIE



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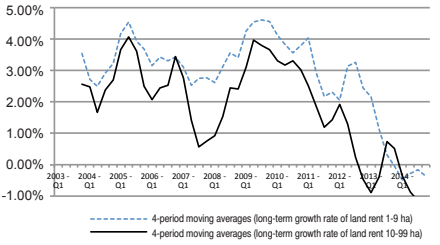

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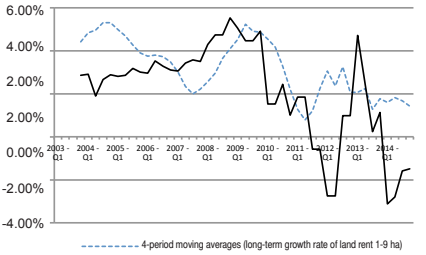

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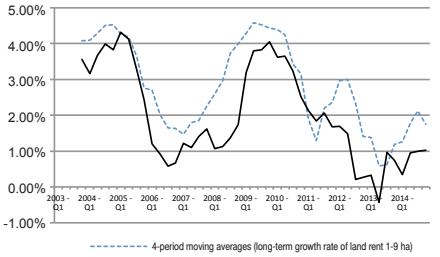
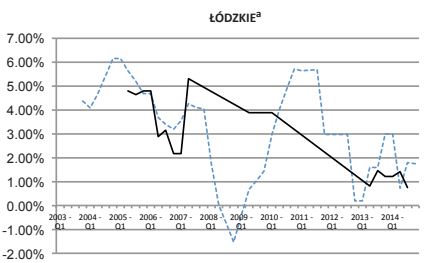
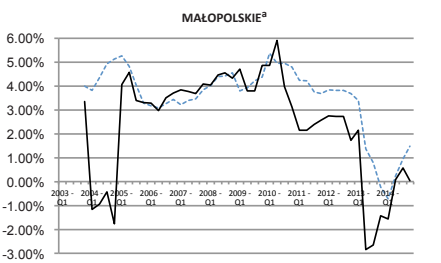


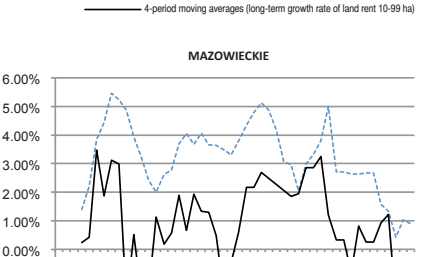
ŁÓDZKIE[a]



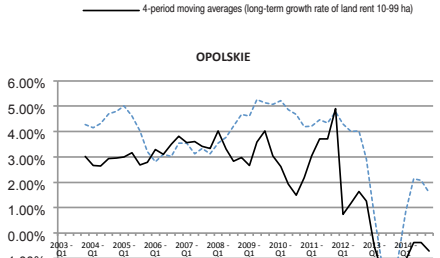
MAŁOPOLSKIE[a]

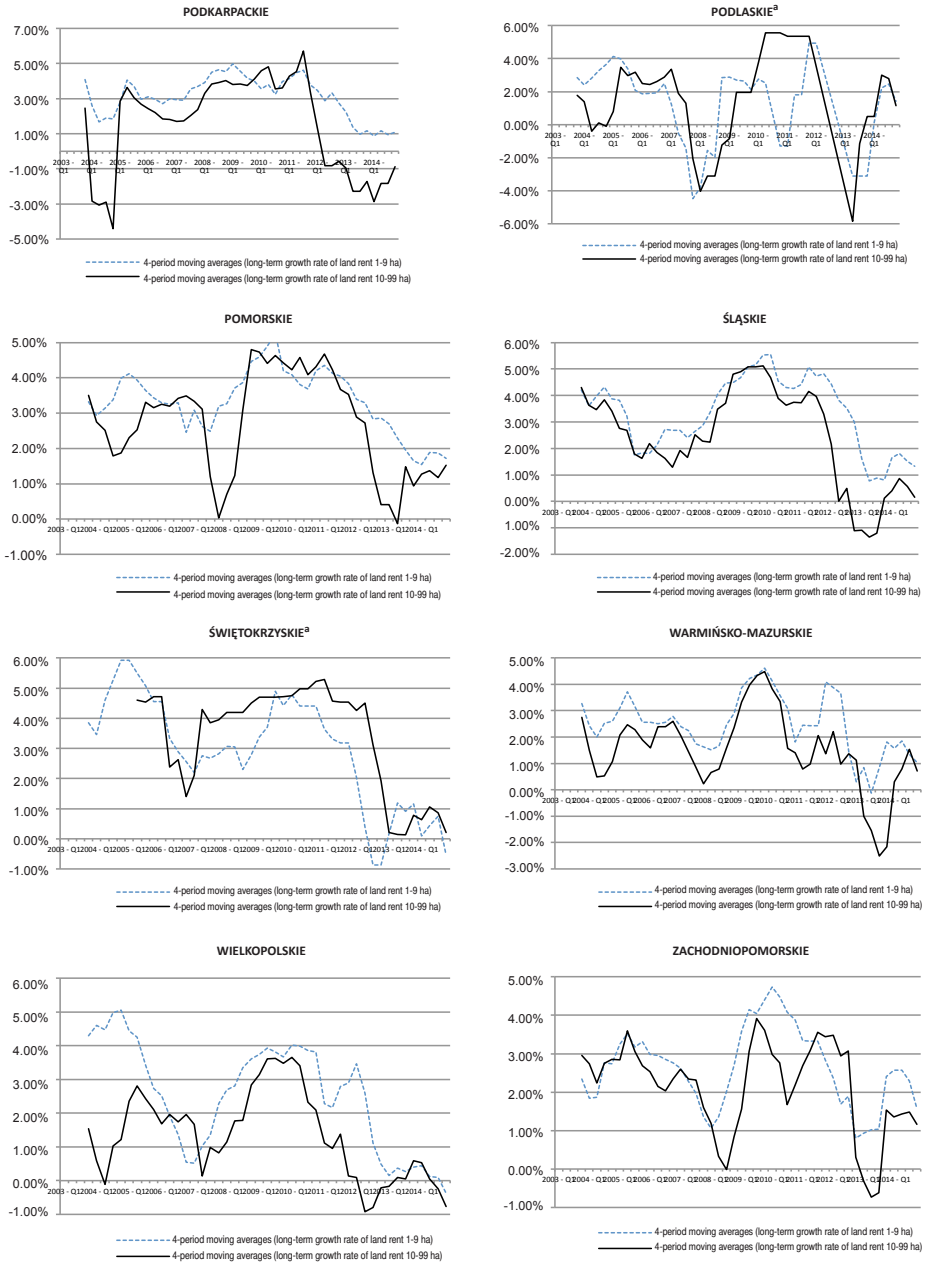


MAZOWIECKIE



OPOLSKIE





[a] Limited reliability of results due to many data gaps on rental fee (gaps in at least 10 cases per 40 quarters), which can distort the moving averages.

Fig. 2. Constant (long-term) growth rate of land rent in the Gordon's model.

Source: own study based on data from the Agricultural Property Agency and GUS.

1) Growth rate for land rent in over 90% of the observations (voivodeships and quarters) is positive.
2) For most of, observations it is higher for small acreages (dotted line).
3) In the long term, downward trends are noted in all voivodeships primarily because of the growing relation of rental rates to land prices; but this overlapped with a dropping cost of capital (after 2009).
4) In 2014, the land rent growth rate for small areas (the last observation) was the highest in Podlaskie, Lubuskie, Lubelskie and Pomorskie voivodeships (ca. 2%) and the lowest and negative in Wielkopolskie, Kujawsko-Pomorskie and Świętokrzyskie voivodeships (in the latter the results are less reliable given gaps in data on rents). In the remaining voivodeships it fluctuated around 1%.
5) In 2014, the land rent growth rate for large areas was negative or close to 0 in 12 per 16 voivodeships; it remained positive and higher than 1%, e.g. in the aforementioned Lubuskie, Podlaskie and Pomorskie voivodeships.
6) The advantage of rent growth rate for small areas over the large ones is especially clear and fixed in the Wielkopolskie, Warmińsko-Mazurskie, Kujawsko-Pomorskie, Mazowieckie, Dolnośląskie and Lubuskie voivodeships.

Interpretation of the results will be inherently debatable since these are one of the first attempts at measurements of thus defined land rent growth rate. A general assumption comes to mind: the more productive is agriculture, the lower constant land rent growth rate – which complies with the expectations. Therefore, e.g., in the Wielkopolskie voivodeship the rate for larger acreages drops below zero and for small – used in agriculture to a limited degree – it is constantly higher. The more non-production uses of agricultural land, the higher constant growth rate of land rent. It is evident mainly with small acreages and in voivodeships characterised by large potential of natural resources (tourism, recreation or habitat).

Conclusions

To conclude, the above-presented results confirm the usability of the perpetual rent model to assessment of the so-called intrinsic utility of agricultural land. Paradoxically this neoclassical model is in the long term well-suited to the agricultural land markets in Poland, despite far-fetched institutional regulation of the market. This contributes to the thesis that the former model of land market regulation was correct from the perspective of the criterion of complementarity of institutions and the market. It is not possible to refer in this paper to the new model of regulation applicable since May 1, 2016 (Act on formation of the agricultural system, 2015) since it has functioned for too short time. There are, however, reasons to believe that from the perspective of the aforementioned criterion it is much worse. Intrinsic utility of land reflects its potential to non-agricultural applications (e.g. environmental, recreational, tourism, residential, habitat) and it can be expressed with the use of a constant land rent growth rate,

which is residual, i.e. it is formed in specific conditions of relations between the rental fee to the land price and interest rates. The concept of intrinsic utility of the resources is a necessary element of the sustainable agriculture paradigm because without it the thesis on creation of public goods by the land factor is theoretically groundless.

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ZASTOSOWANIE MODELU RENTY WIECZYSTEJ DO WALORYZACJI ZIEMI ROLNEJ

Abstrakt

Koncepcja tworzenia dóbr publicznych przez czynnik ziemi jest często rozpatrywana w literaturze tematu, ale jej podstawy teoretyczne są dosyć dyskusyjne. W teoriach renty gruntowej głównego nurtu ekonomii czynnik ziemi nie tworzy samodzielnie żadnych użyteczności, czyli nie posiada tzw. „samoistnej użyteczności". Dopiero zmiana tego założenia legitymuje w sensie teoretycznym proces dostarczania dóbr publicznych przez rolnictwo. Autorzy zastanawiają się, jakim modelem opisać wartość ziemi rolnej tak, żeby uwzględniał on jej samoistną użyteczność? Proponują adaptację neoklasycznego modelu renty wieczystej Gordona. Teoretycznym celem artykułu jest interpretacja relacji opisanych w tym modelu dla rynku ziemi rolnej. Celem empirycznym jest ocena dynamiki „długookresowej stopy wzrostu renty gruntowej" z modelu Gordona w układzie województw w Polsce i w przekroju różnej wielkości areałów. Paradoksalnie, okazuje się, że ten neoklasyczny model jest w długim okresie dobrze dopasowany do rynku ziemi rolnej w Polsce, mimo daleko idącej regulacji instytucjonalnej na tym rynku i daje podstawy do kwantyfikacji samoistnej użyteczności ziemi.

Słowa kluczowe: renta wieczysta, czynsz dzierżawny, ziemia rolna, rolnictwo zrównoważone.

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