p-ISSN 0044-1600
e-ISSN 2392-3458

Zagadnienia Ekonomiki Rolnej

www.zer.waw.pl

4(349) 2016, 39-67

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DOI: 10.5604/00441600.1225663

SELECTED PROBLEMS OF FARMLAND VALUATION AND SETTING RENTS FOR ITS LEASE

Abstract

Farmland is a specific economic good of almost fundamental importance for the current societies and their development and prosperity perspectives. It underlies the traditional agricultural activity and this process will continue in the foreseeable future, but in the conditions of incessantly growing number of people on Earth, most of which still experiencing various quantitative and qualitative food shortages. Their basic needs will be satisfied in the conditions of progressing climate change, water problems and shrinking land acreage suitable for agricultural use. The above circumstances highlight the second aspect of farmland, i.e. its role as the source of diverse ecosystem and agri-environmental services provision. The fact that land meets many functions at the same time poses a serious challenge for land valuation. Precision in this field largely predetermines the amount of rents for the factor of production. In this context the key aim of the paper is to present the evolution of formal concepts and empirical models used to determine farmland value and rents for the possibility to benefit from its use.

Keywords: rents for farmland lease, capitalisation of agricultural subsidies, farmland value.

Microeconomic basics

A natural starting point for discussions initiated in the paper is the category of economic rent. The term has different definitions. Hence, some of the most representative ones should be presented. D. Begg et al. place the term under transfer income, which stands for a minimum payment for the use of a factor of production (Begg, Fisher and Dornbush, 2007). In this context economic rent is an additional payment for a given factor for it to start provide for a given use. W.J. Baumol and A.S. Blinder understand economic rent as a part of income per a given factor of production which exceeds the minimum amount needed to make it available for a given profit-making purpose (Baumol and Blinder, 2015). According to E. Czarny, economic rent is the price for use of resources offered in fixed quantity (Czarny, 2006). For B. Czyżewski, economic rent is the surplus income, above the income which in the given market conditions inclines factors of production to provide services (Czyżewski, 2013). But then, D. Kamerschen et al. treat as economic rent all and any long-term payment obtained for using a given resource of a factor of production, exceeding its opportunity cost (Kamerschen, Mckenzie and Nardinelli, 1992). Finally, H.R. Varian defines the rent as a difference between the revenue on a given factor of production and the minimum payment necessary for its purchase (Varian, 2002).

Initially, economic rent originated from the fact that some factors of production exist in almost fixed quantity, regardless of price. This means that the curve of their supply is almost perpendicular to the x-axis. However, there appear failures on the market of factors of production, mainly their monopolisation and state measures administratively reducing payment rates, also termed as rental rates or rental fees. The above list needs to be supplemented with the issues of market valuation of services provided by the factor of production, e.g. environmental or agri-environmental services. In general, it is assumed that the factors of production of unique quality or difficult or straight out impossible to be replaced can bring relatively high economic rents due to their rarity. These rents are, at the same time, less elastic than supply of the given factor of production. Conversely, factors of production that are easy to produce at a fixed cost and offered by many suppliers, are characterised by low economic rents or they fail to bring them at all (Baumol and Blinder, 2015; Krugman and Wells, 2012; Mankiw and Taylor, 2009; Samuelson and Nordhaus, 2012). In the long term, in a well-functioning market economy, in purely theoretical terms, economic rents should be disappearing.

At the level of enterprises, a category close to the economic rent and according to D. Kamerschen et al. almost the same, is economic profit. Baumol and Blinder show it as a difference between the accounting net financial result and opportunity costs of capital and other inputs supplied by the organisation owners. It comes from the monopolistic position, the fact of incurring risk by owners and success in implementing innovation. But then, according to Krugman and Wells, and Mankiw and Taylor economic profit is generated by deducting total costs (i.e. their explicit and implicit headings) from total revenues, also known as takings. The functioning of the competition mechanism should, as for economic rent, result in disappearance of the economic profit in the long term.

Land rent is the prototype for economic rent. In most general terms, it can be defined as the surplus of agricultural product value over their social production prices (see Fig. 1) (*Encyklopedia agrobiznesu*..., 1998).

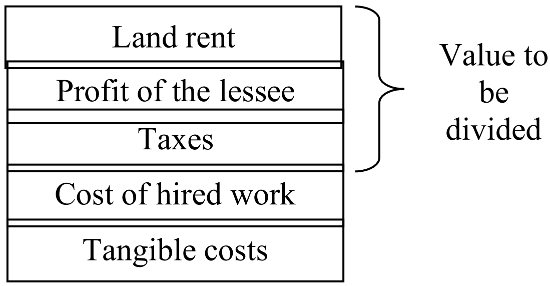

Fig. 1. Social components of the price of an agricultural product.

Source: own compilation on the basis of: *Encyklopedia agrobiznesu* (1998), ed. A. Woś. Wydanie pierwsze, Warszawa: Fundacja Innowacja.

According to B. Czyżewski and J. Staniszewski, agriculture of some highly-developed countries witnesses a phenomenon of regression of land rent, i.e. relative decrease in its input into the national capital as compared to profits and wages (Czyżewski and Staniszewski, 2015). This is to result, primarily, from permanent slowdown of the economic growth worldwide, i.e. the so-called secular stagnation, which results from surplus savings in rich countries. Because of this, capital becomes relatively cheaper and the most extreme consequence thereof is the use of negative interest rates by some central banks, led by ECB and Bank of Japan. As discussed below, interest rates translate into discount rates and these are used to determine the land prices and amount of land rents and rental rates. Then it will be straightforwardly shown that low interest and discount rates lead straight to lower land rents and rental fees. Secondly, only some part of the budget support allocated to agriculture is capitalised because a lot of direct payments and other subsidies is taken over by the surrounding of agriculture in the form of the so-called outflow. Poland has not yet seen the aforementioned contraction. It is moreover interesting that the contraction was also not reported in the researched highly-developed countries in the period of economic slowdown.

Land rent is the consequence of limited land resources and monopolisation of its ownership. It is a component of the full, i.e. economic cost and an instrument of breakdown of incomes generated in agriculture. Thus the rent exists in two forms:

(1) land price, when the factor is being sold,
(2) rental fee, when its form of use is lease.

H.R. Varian presents also a different view on the valuation of the economic land rent. In formal terms, though, the rent amounts to:

$$rent = p^* y^* - c_v(y^*) \quad (1)$$

where:
c_v – average total costs less rent for production in a state of equilibrium,
p^* – price of product in conditions of equilibrium,
(y^*) – production in a state of equilibrium.

In purely theoretical microeconomic terms, both price and rental fee should be formed by derived demand for farmland (i.e. generated by demand for agricultural products manufactured due to its use and reflecting its marginal productivity) and its supply. The national demand for food in Poland is and rather will continue to be stable, while foreign demand is still at a high level which is evidenced by constant, but slowing down, growth in our agri-food export. Still, demand for land is standardly treated almost as a fixed resource, thus it should not react to a change in price or rent. These correlations are presented in Figure 2. In line with the above, *SS* demand is vertical. In some countries, the amount of land can increase, then supply can move slightly to the right; remaining at an angle of 90° against the x-axis or the angle will decrease slightly to below 90°. However, in most of the countries the amount/supply of land drops in the long term and the *SS* line moves left. Under different conditions, this should result in a growth in land price and/or rental rates. In practice, one can try to counteract this by intensification of land use, thus using, first of all, inputs increasing its productivity.

In Figure 2, the input demand for land is marked with *DD* line. Its intersection with *SS* supply determines the land price and/or rental fee at market equilibrium. It is the R_0 point. If demand for land grows – as a result of, e.g., good prices for agricultural products against the prices of acquired means of production or as a result of increased budget support, which will be subject to at least partial capitalisation in the value of fixed assets – the demand moves to *D'D'* line. In the conditions of almost constant *SS* supply of land, this will result in a growth in land prices and rental rates. This is showed by the new point of equilibrium R_1. Of course, it is possible to move the demand line downward against the *DD* input demand, when economic slump consolidates in agriculture or when the scale of its subsidisation will actually drop. This will be followed by a drop in land prices and rental rates below the R_0 level.

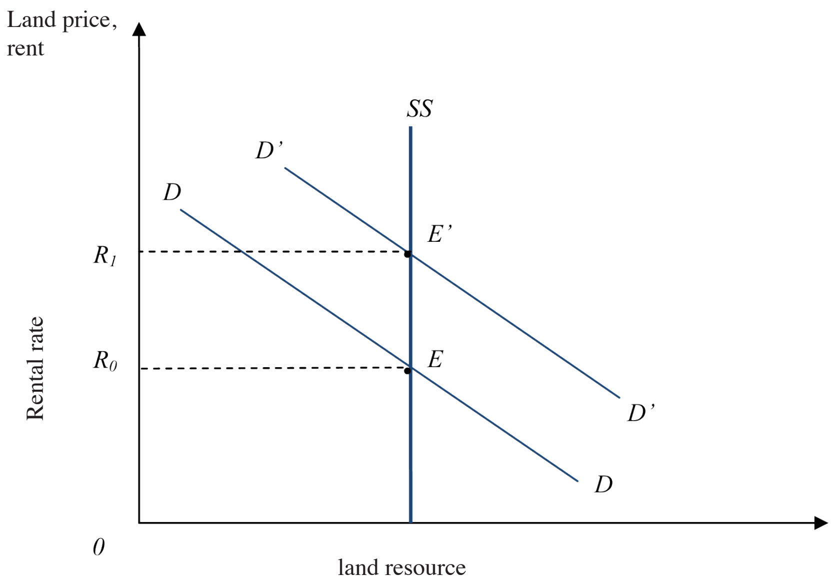

Fig. 2. Functioning of the farmland market.

Source: own compilation based on: D. Begg, S. Fischer, R. Dornbusch (2007). *Mikroekonomia*. Warszawa: PWE.

Traditional models of land value appraisal

In formal terms, land price is most often determined with the use of the model of capitalisation of assets. The oldest and most general manner of its presentation is as follows:

$$P_t = \int_{t=0}^{\infty} A_i(t) e^{-rt} dt \qquad (2)$$

where:

A_i – annual net income / land rent / net cash surplus,
e – basis for the natural logarithm,
P_t – land price at t,
r – discount rate (*Land Economics...*, 2014).

But the above is not too convenient for operationalisation. A much better solution is reference to the term of perpetual rent. The price of capitalised equilibrium at the beginning of the considered period of L_t land will then amount to:

$$L_t = \sum_{i=0}^{\infty} \frac{E(R_{t+i})}{(1+r_{t+1})(1+r_{t+2})\ldots(1+r_{t+i})} \qquad (3)$$

where:
E – the expected net income / land rent / cash surplus depends on information at t,
R_t – net income / land rent /net cash surplus at t,
r_t – discount rate at t (*Agricultural Support...,* 2008).

Of course, the result of calculations can be presented in nominal or real terms, but most often in the latter.

Assuming that discount rate is constant throughout the analysed period and economic agents are characterised by risk aversion, and the issues of taxation of capital gains and rental fees are omitted, land value calculation becomes much easier which is expressed by the following:

$$L_t = (1 + r)^{-i} \sum_{i=0}^{\infty} \frac{E(R_{t+i})}{(1+r)^i} \tag{4}$$

Now, assuming that the term R will be constant over the entire capitalisation period, i.e. it will be marked as R^*, it gives a universally known term of land value as a capitalised rental fee:

$$L_t = \frac{R^*}{r} \tag{5}$$

Thus:

$$R^* = L_t r \tag{6}$$

Land rent, i.e. rent, will grow when the land price or discount rate rises. It needs to be noted as well that land price should reflect the future efficiency and profitability of agricultural activity, while discount rate becomes a sort of generalisation of the expected macroeconomic location of a given national economy and resources, including capital and risk level.

In practice, also non-agricultural branches, mainly residential housing and infrastructural construction compete for the rather constant farmland resource. Non-agricultural activity is often subsidies, as well. Figure 3 approximates implications therefrom for the level of land prices and rental fees. Demand for farmland was marked here as D_FD_F, while reported demand for building land – D_HD_H. In the long term, farmers divide the land at their disposal between the two competitive uses to equalise rental fees for them. But short-term adjustments are also interesting. At the starting point, the rental rate balancing the total demand for land (in both uses) with its supply is set at R_0. If at this point government subsidies are introduced, e.g. for residential housing, new demand curve will appear – $D'_H D'_H$, reflecting the rate of unit subsidy, which can be taken over in whole by the owners of such plots since rent grows to R_1. This encourages the well-known phenomenon of "deagrarisation" of farmland, because in short-term farmland prices and rental rates for it still amount to only R_0. After some time, new long-term equilibrium is established and land prices and rental rates equate in the two uses, amounting to R_2. These adjustments and governmental subsidies provide an opportunity to earn some income to non-agricultural households.

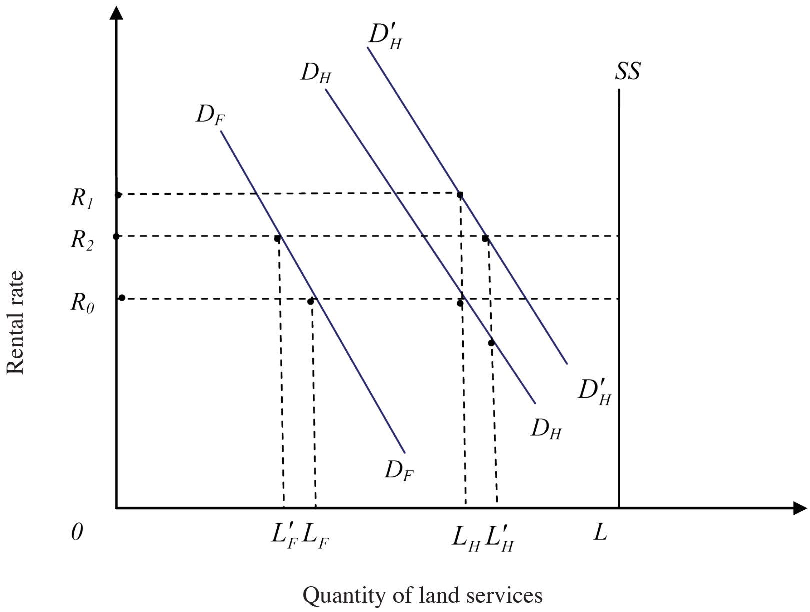

Fig. 3. Effects of intersectoral competition for farmland.
Source: D. Begg, S. Fischer, R. Dornbusch (2007). *Mikroekonomia*. Warszawa: PWN.

Formal implications for land prices, land rents and rental fees because of the possibility to allocate farmland to non-agricultural purposes are expressed by the following:

$$P_t = \int_{t=0}^{\infty} A_i(t) e^{-rt} dt + R_i(x_i, u) e^{-ru} \qquad (7)$$

where:
A_i, e, P_t, r – as in (2),
R_i – one-off income from conversion of farmland in optimum period u,
x_i – vector of exogenous characteristics of converted land.

American economists and agricultural financiers strongly highlight the need for consideration in short-term (e.g. to ten years) net income capitalisation formulas, land rents and/or rental fees, of the potential for growth in land value on account of its growing productivity over time and the overall price movement. For instance, K.O. Olson uses the following expression of capitalisation:

$$PV = \sum_{t=1}^{n} \left[R_t (1+i)^t \right] + AP / (1+i)^n \tag{8}$$

where:
AP – anticipated land value in the final moment of its use n,
i – discount rate determined as weighted average cost of total capital,
PV – discounted/updated land value,
R_t – net income expected value in t year (Olson, 2011).

P.J. Barry and P.N. Ellinger suggest even more developed approach to short-term capitalisation (Barry and Ellinger, 2012). In the first place, they consider the possibility of growth in the real value of the asset on account of improvement in its productivity over time. Thus, the following:

$$V_0 = \frac{P_0 (1+g)}{(i_t - g)} \tag{9}$$

where:
g – growth rate of real net income on land,
i_t – real capitalisation/discount rate,
P_0 – real constant net income on land,
V_0 – updated/discounted value of land.

Apart from the i_t rate the overall price changes marked as i_f should be also considered. By adding them we get the general capitalisation rate i. Consequently, it is possible to set the general return on/profitability of land as follows:

$$i = \frac{P_0 (1+g)}{V_0} + g + i_f \tag{10}$$

It is clear that it is the sum of real current income (first component), real capital gain (g) and inflation capital gain or deflation capital loss, which is, recently, the case for Poland.

Consequently, updated land value can be now determined as follows:

$$V_0 = \frac{P_0 (1+g)}{i - g - i_f} \tag{11}$$

Land value can be, of course, also determined with the use of market prices (Kay, Edwards and Duffy, 2012; Olson, 2011). The key challenge is finding already sold plots that can be adequately compared. Moreover, the financial conditions of sales, relations between the buyer and seller and the time of transaction need to be accurately analysed. It is recommended to divide the entire process into two phases: in the first one, we try to determine the value of land only and, in the second, we estimate the value of buildings and structures related thereto. Summing up the two values we get the input value of the entire real estate. Next in line are numerous corrections considering, e.g., the size of the plot, its layout, location in relation to communication routes and key markets, but primarily its actual product production potential.

Farmland prices, land rents and rental fees are actually determined by many other factors than those included in the previously presented formal and graphic approaches. The above-mentioned J.M. Duke and J. Wu illustrate the problem very comprehensively stressing the variables listed below:

1. Macroeconomic ones of national, supranational or even global character. This refers to: inflation/deflation, interest rates, economic growth rate, savings, public debt, consumption, intensification of speculative behaviours.
2. Pertaining to intra-agricultural business cycle and scale and form of budget support for the agricultural sector, complexity of agricultural and rural policy and their cohesion, development of technologies, sector of biofuels and effects of climate change, intensification of fiscal and interregional external costs.
3. Having the character of the dominant paradigm of rural and agricultural development and referring to the pace of urbanisation and growth in population density.
4. Describes only the land sales contracts or land lease contracts. These include: treatment of land as production factor or a consumer good (used for recreation and hobby purposes), level of farmland protection, duration of lease period, natural and environmental values of plots, sociological characteristics of purchasers or lessees, and their relations with the sellers or lessors, transaction costs, attitudes of parties to risk and formation of expectations regarding prices, costs and rents.

Duke and Wu also draw attention to make a very careful differentiation between short-, medium- and long-term correlations, certainty, risk and uncertainty situations, static and dynamic approach, use of aggregated or disaggregated data. Moreover, they recommend being very careful and prudent when making conclusions because farmland sales and lease markets are, actually, very shallow markets, hence very susceptible to changes and omnidirectional fluctuations. The phenomenon of long-term convergence to prices and rents in the EU-15 needs to be added in countries that joined the EU in 2004 and later.

Hedonic models

This is a tool to reveal demand for specific goods, including also not having direct market prices, which can be divided into some attributed, properties or characteristics and their groups (Boardman et al., 2011; Gruber, 2015). In case of agriculture, these models are usually termed as Ricardian analysis (Kolstad, 2011; Perman et al., 2011; Principles of Environmental..., 2000; Tietenberg and Lewis, 2015). They are extensively used mainly in the market of residential housing, in calculations of the consumer price index (CPI) and in valuation of environmental goods and services. They allow us to determine, e.g., the degree of capitalisation of attributes (properties or characteristics) in the value of land and real estate, rental rates, but also in regional differentiation of payments resulting, e.g., from environmental advantages and disadvantages of specific localisations. First more precise proposals from the area appeared already in the 1960s, but by the end of 1920s the idea had been indirectly referred to by F. Wargh. Varied types of regression accounts are used to estimate the above models.

A starting point in the simplest hedonic model is construction of hedonic price via a relevant function regression. For example, assuming that the price of a house (h) depends on its characteristics (e.g. environmental ones): $q_1, q_2,\ldots,q_n$. Then the above function will be as follows:

$$h = h(q_1, q_2, \ldots, q_n) + \varepsilon \qquad (12)$$

where:
ε – random component of the model (Perman et al., 2011).

In the second phase the implicit price is determined:

$$p_j = \frac{\partial h(q_1, q_2, \ldots q_n)}{\partial q_j} \qquad (13)$$

As visible, the above price informs on the “input” of j-th characteristics in the change of total price.

Going to the form of a hedonic model that has a practical usefulness requires consideration of consumption of a bundle of goods (x) and budget limit for a representative household in the form of disposable income (y). Then, its total utility can be expressed via the following Lagrange function:

$$L = u(x, q_1, q_2, \ldots, q_n) + \lambda(y - x - h(q_1, q_2, \ldots q_n)) \qquad (14)$$

The existence of its minimum results from the first order condition which simultaneously is the marginal willingness-to-pay for the *j*-th characteristic (MWTP):

$$\frac{\partial u / \partial q_j}{\lambda} = \frac{\partial h(q_1, q_2, \ldots, q_n)}{\partial q_j} = p_j \qquad (15)$$

It equals the implicit price p_j. Knowing that the MWTP curve is also the demand for the *j*-th characteristic, the point of its intersection with the p_j curve marks the level of the latter in equilibrium.

The considerations can be continued focusing, for example, on the price of real estate following from a total impact of all characteristics and their interaction with consumption of other goods. The problem then complicates, because these characteristics can have different implicit prices at respective markets. What can also change is the course of the hedonic price function. Although using integral calculus it is possible to establish quite accurately the growth in benefits for a representative farm on account of improvement of a definite characteristic, but it is much more difficult to estimate the changes in overall social welfare. It also needs to be considered that the growth in the price of real estate resulting from more favourable characteristics of its localisation usually translates into higher rental fees, as far as their level is not administratively regulated. Thus, it favours the owner at the expense of the lessee. Another already signalled problem is growth in wages, which at other constant conditions can reduce the investment attractiveness of a given location.

Mendelson, Nordhaus and Shaw constructed a hedonic model which they used to analyse the impact of global warming on agriculture (Mendelson et al., 1994). It assumed that a representative farmer will maximise net income π as a difference between revenues on crops and costs omitting the land factor. Whereas the production function (x), whose arguments include non-land inputs (to simplify, only labour was considered herein) and environmental advantages of land (q), will be the limitation. The parameters p, w and n designate the prices of products, wage rates and quantities of involved labour. With the above assumptions the maximisation problem of a farmer is expressed by the following Lagrange function:

$$\pi = (px - wn) + \lambda(x - x(n, q)) \qquad (16)$$

Solving this function against n and replacing x, the net income function can be expressed per 1 ha and thus identified with net land rent. Thus, the following:

$$\pi = \pi(p, w, q) \qquad (17)$$

Completion of the maximisation procedure requires to reduce the value of π with rental fee h per 1 ha, which is, e.g., the function of environmental values of a given plot. Then, in formal terms equalisation of the derivative of the difference with a derivative of the hedonic price function is the first order condition for the maximum existence. Consequently the following becomes true:

$$\frac{\partial \pi}{\partial q} = \frac{\partial h(q)}{\partial q} \quad (18)$$

Wasson et al. constructed a much expanded hedonic model (Wasson et al., 2013). It included characteristics for the entire agricultural sector of the US but also those referring to the researched plots in Wyoming. Upon model estimation it turned out that environmental values of the land increased on average its price for 1 acre by ca. USD 31 in the US. In Wyoming, in turn, it was from USD 8.2 to USD 56.2 depending on the region of the state (western, central and eastern). Wasson et al. presented in a highly disaggregated manner also the impact of environmental disadvantages on the price of 1 acre, distinguishing vegetation coverage of the area, its location and condition of wildlife. Throughout the US, plot prices dropped the most due to an unfavourable location (on average by nearly USD 72) and the least due to the characteristics “wildlife” (little over USD 15). All in all, “location” also reduced the prices the most in Wyoming (from USD 44 to USD 115), followed by “vegetation coverage of the area” (from USD 21 to USD 58), and the drop caused by “wildlife” was once again the least severe (from USD 5 to USD 29).

Designing lease contracts

Microeconomics in the part concerning designing mechanisms and contracts offers, e.g., proposals to negotiate interests and motivations between parties to the lease contract. The already mentioned Varian, for instance, suggests in this context the following formula to determine the amount of rental fee:

$$R = f(x^*) - c(x^*) - \bar{u}, \quad (19)$$

where:

c(x)* – generalisation of total costs (efforts) incurred by the lessee optimising both its goal function, and owner of land or other assets; this optimum will be achieved when the marginal product *MP* (*x**) equals marginal cost (x*),

f(x)* – production volume for optimum lessee effort (*x**),

R – rental fee,

ū – total utility (gain) achieved by a lessee from other gainful activities, but also from possible free time.

Varian line of thought is also a good opportunity to address the controversial issue of resignation from charging rent for use of the poorest quality soils by the Agricultural Property Agency. After all, they give farmers the entitlements to apply for direct payments and support from the second pillar of CAP. Hence the popular among individual farmers lease contracts for "subsidies and possible agricultural tax". Assuming that these will be only direct payments, they could constitute a starting point for application of even the most symbolic rents, of course upon deduction of transaction costs of obtaining them and production costs of meeting the cross-compliance requirements. No doubt, it would be a challenge to estimate the $\bar{u}$ utility. To this, costs of monitoring contracts on such areas by the Agricultural Property Agency should be added. But if we introduce redistributive premises and purposefulness of keeping poor soils as a specific strategic reserve of the state and if we consider their potential to provide environmental services, resignation from charging rents can be a rational measure. However, rents could constitute a reasonable lower limit of the interval of their variance.

The problem of not charging rents by the Agricultural Property Agency on the poorest soils touches upon a more fundamental issue, i.e. marginal areas, which do not bring land rents in statistical terms (Baumol and Blinder, 2015). But if demand for food grows significantly in a given country, firstly, because of growing population figures areas so far considered as marginal can be included into production. Another factor decreasing the share of former marginal areas is growth in farming intensity in agriculture. Such UAA start to bring marginal products and thus land rent, thereby giving real reasons for charging even symbolic rental fees.

Resignation from charging rents is also the case in the agriculture of highly-developed countries. As shown by J. Bryan et al., in Canada for ca. 3% of lease contracts there is no such payment (Bryan, Deaton and Veersink, 2015). This results from low profitability of conducted agricultural production, concerns about overgrowth of UAA with shrubs and bushes and the fact that agricultural real estates are taxed at a four-time lower rate than residential housing, as far as the former are actually used for agricultural purposes.

In microeconomic literature, it is strongly emphasised that lease can lead to a more efficient, in social terms, allocation of land than sales, especially if loan and property insurance markets in agriculture are incomplete and imperfect (*Handbook of Agricultural Economics*..., 2001). This is evidenced by a rather simple formal method. It is accepted that the following production function has constant economies of scale:

$$Q = \theta F(e, h), \tag{20}$$

where:

Q – production,

e – effort, cost of obtaining production,

h – lessee number or a representative lessee,

θ – stochastic segment.

The income of the lessor is:

$$y = h\left[(1-\alpha)Q - \beta\right] \tag{21}$$

where:
β – function describing the selection of the lessor of the level of lessee effort α.

Whereas the income of a representative lessee can be determined as follows:

$$Y = \alpha\, Q + \beta \tag{22}$$

where:
β – minimum additional utility of the lessee on non-agricultural activity or free time.

Depending on the share of α and β it is possible to conclude three types of contracts between the landowner and lessee:
1. constant cash rent when $\alpha = 1, \beta < 0$,
2. typical work contract if $\alpha = 0, \beta > 0$,
3. sharing benefits, costs and risk when $0 < \alpha < 1$.

The former usually brings the highest productivity.

In practice, modelling of lease contracts is far more complicated than what has already been presented. Authors dealing with the issue are faced with the challenges of precise differentiation between the cases of certainty, risk and uncertainty, and formulation of expectations of the parties and converting uncertainty into certainty equivalent related thereto (Barry et al., 2000; Besly et al., 2016; Bryan, Deaton and Weersink, 2015; Ito, Bao and Ni, 2016; Qui, Goodwin and Gervais, 2011; Sotomayor, Ellinger and Barry, 2000). Another problem is the selection of the utility functions and methods of their optimisation. Moreover very complex issue is adequate reflection of the depth and type of subsidies and their capitalisation in the land value and rental rates. In case of contracts it is also necessary to tackle the problem of information asymmetry and its derivatives in the form of negative selection and moral hazard. Next, empirical research as usual need to minimise threats on the part of endogeneity, omission of some important independent variables and the manner of selection of the research sample.

Lease contracts, because of the need for continuous payment in the form of rent, create a financial and operational risk for a farm benefiting from external assets. Thus it requires professional management. Classical risk management instruments in agriculture include primarily diversification (differentiation) of the production programme and purchases of insurances and conclusion of contracts in derivatives market. Much rarer are "innovative" instruments, such as mainly the so-called weather derivatives. For some time there are attempts at using the latter to reduce financial risk linked to lease of assets in the form of the so-called rental fee adjustment clauses (*klauzule dostosowujące czynsze dzierżawne, KDCD*) (Hotopp and Musshoff, 2012; Langemeier, 1997; Muβhoff and Hirschauer, 2013).

In general, this instrument consists in acceptable equalisation/smoothing over time the costs following from paying rental fees, i.e. their reduction when times are worse and increase when they are better against the average value for several or several dozen years. Thus, it is also the intention to equalise profits and income over time. Thinking theoretically, it would seem that farmers should be rather interested in using the instruments of rental fee adjustment clauses. Yet, in practice their use is not yet widespread. This mainly follows from low level of knowledge about them and not much empirical research which would unanimously prove their efficiency in risk reduction.

Capitalisation of subsidies in rental fees

Agricultural policy each time has its redistributive dimension. By analogy to public finance in this context, the above dimension is termed as incidence, which on the grounds of this discipline in economics is translated as scope, range, frequency of and burden with e.g. taxes. In general, the scope of a fiscal instrument, i.e. agricultural subsidies, is understood as entities which on account of applying it benefit or have to incur costs (Blankart, 2011; Brümmerhoff, 2011; Zimmermann et al., 2012). In the narrow meaning, these effects are limited to changes in the division of income. The absolute scope, termed also as specific, is a method of researching the results of fiscal tools of spending and income. Efficient or economical or actual scope is a hypothetical final point of fiscal impact, i.e. after considering all adjustments thereto. The scope of the payment obligation refers only to taxes. Along with the scope of addressing the fiscal instrument, established on the grounds of a relevant law and reference theory, it creates the formal scope.

In case of agricultural subsidies the theoretical model assumes that those among them which are linked to land should be marked by higher rate of capitalisation – which is the expression of their scope – because supply of the factor of production is, as a rule, distinguished by very low elasticity to its price or it is even constant in the short term (Ciaian, d'Artis and Pokrivčák, 2013; Ciaian and Swinnen, 2006; Ciaian and d'Artis, 2012). In reality it turns out that the capitalisation rate of subsidies more loosely linked to land or even independent from it, does not have to be lower than for area payments. Of course, agricultural subsidies can be capitalised also in rental rates. Regardless of whether the value of farmland and other tangible assets grows or higher rents are auctioned as a result of budget support for agriculture, the problem is how benefits on that account are distributed between landowners and its user. In the short term, this influences differences in agricultural income, and in the long term – also the status of wealth. In practice, a lot depends on taxation of agriculture, though. For instance, it may happen that taxation of income on rent fully burdens the owners of land and tangible assets. This equals the so-called negative capitalisation. But other farms have to consider that in such circumstances the taxes will become their additional cost, i.e. they will be transferred to them by primary taxpayers to a lesser or greater extent.

In 2012, P. Ciaian and K. d'Artis published a paper in which they presented the capitalisation level of direct payments under SAPS in the new EU Member States in rental fees. Formally this capitalisation is expressed by the following total derivative:

$$\frac{dr}{ds} = \frac{1}{1 - \left[pf_{AA} + p\frac{f_A^2}{f_\varsigma} \right] \varepsilon \frac{A}{r}} \tag{23}$$

where:

A – area to which SAPS was granted,
ε – price elasticity of land supply,
$f_i\, f_{ii}$ – first and second partial derivative to relevant arguments (area and price elasticity of demand for agricultural products),
p – prices of agricultural products,
r – rental fee rate per land unit,
s – SAPS amount,
ς – price elasticity of demand for agricultural products.

From the definition it follows that capitalisation rate should fall into the closed interval between zero and one. A key issue at this point is forming the elasticity of demand for land. If the ε parameter equals zero, i.e. supply is absolutely inelastic, total SAPS can be – in strictly theoretical terms – fully taken over by the landowner.

Figure 4 supplements (23). The x-axis shows the quantity of land, while the y-axis shows the formation of rental rates and subsidies. The starting demand for land is illustrated by L curve, while its supply by two curves: S_0 – when the elasticity $\varepsilon = 0$, and S_1, if elasticity is positive ($\varepsilon > 0$). In case of no SAPS, equilibrium at the land market is determined by points A^* and r*. After introduction of the SAPS payments the demand for land moves to the L_S curve, but the equilibrium continues to depend on the elasticity of its supply. When $\varepsilon = 0$, A^* and r_S0^* are the equilibrium coordinates. Consequently, the total subsidy amount is capitalised in the rental fee and in accounting terms – the capitalisation rate (s) is the difference between r_S0^* and r^*. For $\varepsilon > 0$ the capitalisation rate drops because then equilibrium is determined by points A_S1^* and r_S1^*. Of course, higher supply of land decreases the pressure on growth in rental rates, but it is necessary to always remember that in reality there are much more determinants thereof.

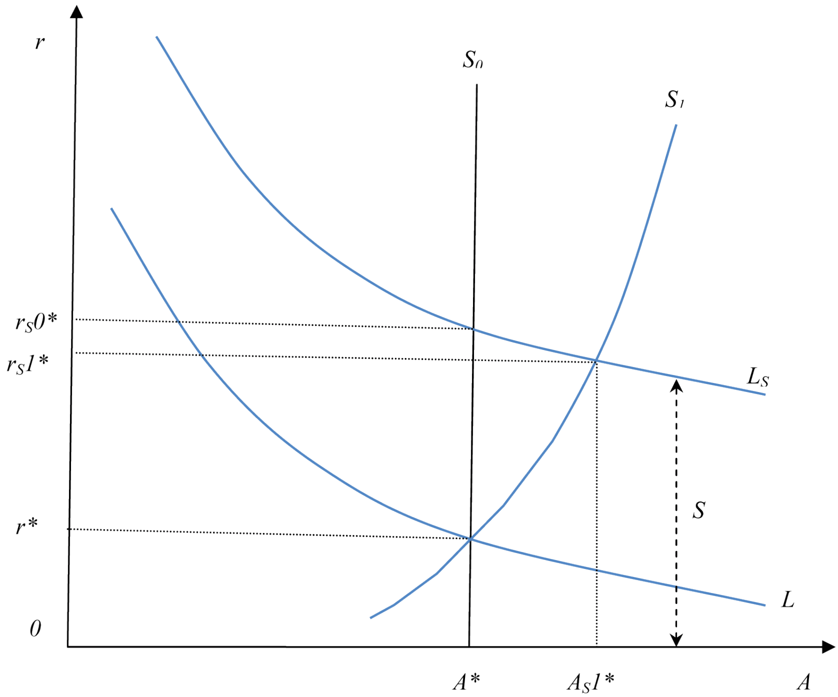

Fig. 4. SAPS and the land market.

Source: own compilation based on: P. Ciaian, K. d'Artis (2012). The capitalization of area payments into farmland rents: micro evidence from the New EU Member States. *Canadian Journal of Agricultural Economics*, vol. 60, no. 4.

For instance, Ciaian and d'Artis, in their regression model used as independent variables: market profitability (production per 1 ha of UAA), other subsidies per 1 ha of UAA, changes in the future agricultural policy, farm size (ESU), share of family labour in total labour inputs and the relation of long-term tan-gible assets to their amount increased by the sum of short and long-term loans. In total, the two researchers analyse seven countries, including Poland. Source data came from FADN and concerned events registered in 2004 and 2005. In total 20 930 observations were processed. Four estimated regression models showed that the partial regression coefficient between SAPS in EUR per 1 ha of UAA and rental rates in EUR per 1 ha of UAA was in the interval of 0.183-0.196. The analysis of estimation resilience conducted later, extended the interval to 0.178-0.202. This means that at least ca. 0.2% of SAPS was accumulated in rent growth by 1%.

To put it differently, each EUR paid as SAPS increased rental rate by ca. EUR 0.20. This is a rather low capitalisation rate. From the above it further follows that only ca. 10% of the SAPS was taken over by owners in the seven researched countries. In Poland, the thus measured "outflow" of subsidies is even lower by ca. 5%; this was due to domination of family farms in our country which own a large part of land in Poland. From the above, it should be concluded that SAPS was an efficient instrument to improve the income and quality of life of farmers – its beneficiaries.

The generally low SAPS capitalisation rate, obtained by Ciaian and d'Artis, at the background of other research results, can seem to be contrary to the assumptions of the neoclassical model. This may follow from different types of restrictions in elastic adjustment of rental rates. This primarily refers to imperfect operation of the land and lease markets, administrative restrictions in land mobility and conclusion of leases, differentiated share of informal leases and payment of rents also in the form of share in harvest, underdevelopment of the market of loans and wealth insurance (Ciaian and Swinnen, 2006).

Determinants of future rental fees in Poland

Based on the current considerations and referring to the results of analyses of some other researchers and using the own experiences of the author of this study, Comparison 1 presents factors affecting, directly or indirectly, profitability of agriculture, thus the value of land and rental fees for land belonging to the State Treasury. This list is very extensive and covers projections concerning the years 2016/7-2020, which means they are burdened with significant uncertainty. The selected period directly corresponds to the present budget perspective of the EU and CAP, which by subsidisation of our agriculture has major significance for its financial condition. What is natural, rent determinants show a major differentiation if it comes to the direction of impacts. After all, it seems that they do not give grounds to base rent projections mechanically on, e.g., simple extrapolation of the current trends.

Comparison 1

Probable formation of factors influencing the rental rates for land owned by the State Treasury offered by the Agricultural Property Agency in 2016-2020

Factor	Probable behaviour of a factor	Probable impact of a factor on rents	Remarks
World			
- changes in GDP	↔, ↑	↔, ↑	growth will be low and average, but fragile
- FAO agricultural price index			its behaviour will imitate the markets of non-agricultural resources, in particular the oil market
a) nominal	↓	↓	
b) real	↓	↓	
Euro area			
- changes in GDP	↔, ↑	↔, ↑	growth will be low (1-2%) and variable
- inflation	↔, ↑	↔	certain deflation pressure will continue
- interest rates	↔, ↑	↔	
- fiscal situation	↔, ↓	↔, ↓	it has already been deteriorating in some countries
- PLN/EUR exchange rate	↑, ↔	↑, ↔	a lot depends on budget situation and economic growth rate in Poland
Poland – macroeconomics			
- changes in GDP	↔, ↓	↔, ↓	a drop in the dynamics may occur as of 2018
- consumer demand	↑, ↔	↑, ↔	
- inflation	↔, ↑	↔, ↑	it can start to grow slightly by the end of 2016
- interest rates of the National Bank of Poland	↔, ↑	↔, ↑	growth may occur only in 2017
- fiscal situation	↔, ↓	↔, ↓	problems can start in 2017
- tax on retail trade	↑	↓	we do not know when it will be introduced, though
- unemployment	↓↔↓	↑↔↑	

Comparison 1 cont.

Factor	Probable behaviour of a factor	Probable impact of a factor on rents	Remarks
Polish agricultural sector			
- foreign agri-food demand (export)	↑, ↔	↑, ↔	export rate will fall without structural reforms
- national agri-food demand	↔	↔	
- prices obtained by farmers	↓, ↔, ↑	↓, ↔, ↑	
- prices paid by farmers	↔, ↑	↔, ↓	
- utilised agricultural area	↔, ↓	↔, ↑	
- land productivity	↔	↔	
- total factor productivity (TFP)	↔, ↓	↔, ↓	without structural changes it can drop
- working in agriculture	↔, ↓	↔, ↑	
- budget support system	↔	↔	possible Brexit and Poland's fiscal situation will have a major impact
- farmland prices	↓, ↔	↓, ↔	
- severity of regulation of farmland sales	↑	↓	however, it is not possible to exclude growth in demand in the lease market, thus also a growth in rents
- severity of regulation of farmland lease	↔	↔	
- treatment of farmland as investment asset	↓	↓	

Comparison 1 cont.

Factor	Probable behaviour of a factor	Probable impact of a factor on rents	Remarks
Lease of land owned by the State Treasury			
- pace of convergence of land prices and rental rates in Poland with those in the EU-15	↔	↔	
- supply of land offered by the Agricultural Property Agency	↑	↓	changes will be minor, though
- quality of land offered by the Agricultural Property Agency	↔	↔	it is the key determinant of rents
- productivity of land offered by the Agricultural Property Agency	↔, ↑	↔, ↑	this property is closely linked to the land quality; the potential of UAA is used rationally
- variability of yields	↑	↓	it is also a very important determinant of rental rates
- risk aversion among lessees	↑	↓	
- social capital, i.e. proximity of relations between parties to the contract	↔	↔	it has only minor importance
- lease renewal level	↔	↔	as above
- population density around leased land	↔	↔	it has no major importance because most of the leases take place in poorly urbanised areas
- frequency of moral hazard attitudes among lessees in the form of, e.g., excessive land exploitation	↔	↑, ↔, ↓	this determinant in Poland has a marginal significance; results of empirical research are not clear, but it will be more prudent not to force too high rental rates

Key: ↑ – increased intensity of a property; ↔ – situation without clear changes; ↓ – decreased impact of the factor. The order of symbols is compliant with the time elapsed between 2016 and 2020.

Source: own study.

New directions of research on rental fees

The simplest regression function to empirical analysis of determinants of rental rates is the following:

$$r = x\beta + \varepsilon \tag{24}$$

where:
β – estimated parameters,
r – rate of cash rent per 1 ha,
x – size of the matrix n x k, and k means determinants of rates and control variables,
ε – random error (Breustedt and Habermann, 2011).

An interesting extension of the above regression model can be the addition of spatial delays, which allows for tracking the process of transmission of rental rate in space. Such a model is described by the following reaction function termed as spatial model with delay:

$$r = pW_1 r + x\beta + \varepsilon \tag{25}$$

where:
pW_1r – spatial delay, where W_1 means spatial weights matrix with the size of n x n, and p is a spatial autoregressive parameter.

Next, after application of the optimisation procedure concerning rental rates Breustedt and Habermann (2011) derive a general formula for the reaction function (R):

$$r_i = R(r_{-i}, x_i) \tag{26}$$

As clear, it shows the degree of dependence of the rent paid by the i-th farmer on the set of exogenous determinants (x_i) and on the rents paid by other farmers in the neighbourhood (r^{-i}). Continuing their deliberations Breustedt and Habermann, finally, arrive at the issue of establishing the marginal effects of impact of rental rate determinants. This is expressed as follows:

$$\frac{\delta_r}{\delta_{x_k}} = (I - pW)^{-1}\beta_k \tag{27}$$

where:
$(I-pW)^{-1}$ – spatial multiplier matrix,
x_k – marginal effect of k-th determinant.

Upon making relevant calculations and testing the obtained estimations in various regression models, Breustedt and Haberman determined, for instance, the spatial effect of transmission of 2001 rental rates in Lower Saxony in a group of 4376 farms at 0.57. This means that a growth in the rates by one cash unit at farms surrounding a given farm increased rents on the farm by 0.57 of cash unit. The conclusion that the marginal effect of subsides to commercial crops exceeded 1 may be considered as counterintuitive. From the above it would follow that the payments were capitalised to a higher degree than 100 per cent in rental fees. The above researchers explain such a result with a convergence in time of changes in intervention payments and prices, and inflexibility (tardiness) of rent adjustments and also with a different time of signing relevant lease contracts.

Even the hedonic models, universally used from the 1970s to model the determinants of the process of establishing the land prices and rental rates for their lease, have a number of weaknesses. As shown by März et al., they are highly sensitive to erroneous specification of the functional form because they assume the presence of linear correlations between the dependent variable (land price and rental fee rate) and independent variables (März et al., 2016). Thus, only average values of variables and the same marginal effects are used for them. Consequently, there can even appear a spurious regression, especially when the researchers fail to correctly present in the model the spatial correlations between variables and time lapse.

Bayesian semiparametric geoadditive quantile regression can provide a response to the above-noted shortcomings of the standard hedonic models (März et al., 2016). This method overrides the assumption on the linearity between the researched phenomena focusing on the different impact of the independent variables on the land prices and rental rates at various points of their full distribution. Thus, econometric modelling tries to more precisely show the process of information generation by determinants of land prices and rental rates and the simple fact that a different set of them can form values located in the lower part of the statistical distribution and a completely different one in its upper part. The correlations are not monotonic, i.e. different threshold values appear, which when exceeded reverse their direction. Such regression reflects also the preferences and future expectations of sellers and purchasers of land and its owners and lessees in a much more correct fashion. It is much better also to measure the impact of various aspects of diversity (in time and space), including also omitted variables and variables not observed directly. Finally, it needs to be added that the parametric approach is satisfactory to model the impact of various terms of concluding lease contracts for rental rates.

Determinants of rental rates for leased UAA cover a term structure. By analogy to the financial market and hedging transactions on commodity markets, including also the agricultural market, which uses a term structure of interest rates, specialists dealing with rents on the housing market noticed that they also change depending on the term of a relevant contract. Formally, these relations are established using rather advanced mathematical tools (e.g. Brownian motion and Wiener process and partial differential equations). These works inspired S. Hüttel et al. to construct relevant tools to analyse rents paid for UAA (Hüttel et al., 2016). The following hedonic model was used as a starting point:

$$R(T) = e^{f_1(T)} \cdot e^{f_2(A_j)} \tag{28}$$

where:
R(T) – rate of cash rent per 1 ha depending on the term of a relevant contract,
$f_1(T)$ – non-linear function of the term of the lease contract,
$f_2(A_j)$ – function of attributes j=1, …, k of the leased plot of farmland.

It was further assumed that the term structure of rental rates can be threefold:
(a) upwards – indicating that in the future there will be a growth in the prices of agricultural products which will ultimately translate into higher rents;
(b) downwards – suggesting that although presently the lease market is “hot”, in the future rents will rather drop, because the profitability of agricultural activities will deteriorate or the supply of land suitable for lease will grow;
(c) flat – when the *status quo* holds.

The empirical model of Hüttel et al. comprised a number of independent variables, thus characterised with quality of plots and their size, the share of leased land in all UAA at the disposal, location in space (artificial variable “poviat”), rents from the previous year (variable delayed by a year), time (artificial variable) and term structure of a lease contract (interactive element composed of time variable and lease contract term). The above-model was estimated with the use of a normal method of the least squares, based on 2123 observations between 2002 and 2010 made in Saxony-Anhalt.

The results were as follows:
1. The quality of leased land had a major positive and statistically significant impact on rental rates. Whereas the size of leased plot and the share of leased land in all UAA at the disposal showed a differentiated statistically minor and non-uniform relation with rents.
2. The location of plots in four out of ten cases was significantly correlated with rents, which is reflected by differentiation of unobserved characteristics of the setting of farms, linked to the condition of technical infrastructure, population density and intensity of urbanisation processes. Although the rental rates from the previous year positively affected their current level but in a statistically insignificant manner. Consequently, one needs to be extremely cautious when using simple extrapolation approaches.
3. In the researched nine-year period there were all three of the above-noted term structures of rental rates as a response to the changes in the business

cycle in agriculture and the direction of CAP. It is a clear evidence that extrapolation of time series should precisely consider also these structures. Caution in conclusions and generalisations on past events and events from distant future is also preconditioned by the fact that rents in the second case can include also the risk premium. Another challenge is additionally the shallowness of the market of land lease and sales.

Conclusions

The microeconomic mechanism explaining the formation of land prices and rental rates is apparently simple. All that needs to be done is to refer to the determinants of supply of the production factor and demand for it. However, the latter has a derivative character, i.e. it results from demand for agricultural products and marginal productivity of land itself. But to this the expectations of farmers regarding realisation of capital gains and increase in land value on account of inflation need to be added. Supply of land is rather constant. Accordingly, a growth in the demand for land automatically has to lead to a growth in its prices and a growth in rental rates. To get a relatively complete image, now the discount rate has to be introduced as it also has a macroeconomic aspect because it should reflect the growth potential of a given economy and its capital resources. Consequently, it is at this point possible to formally link the price of land, rental rates and discount rate, thus having any two of the categories it is possible to precisely determine the value of the third one. The case becomes more complicated when it is moved to a small open economy, such as Poland, which strongly reacts to shocks coming from abroad, e.g. to movements of financial capital having both a purely speculative and investment character. This can even lead to speculative bubbles on the agricultural land market. Nevertheless, the greatest methodological and calculation challenge consists in the fact that the determination of land prices, rental rates and discount rates should consider their future values. But today even the strongest forecast centres worldwide make projections for only 2-3 coming years. This mainly results from the universally significant instability of the key macroregions and markets.

Cash rental rates are formed also by variables characterising the entire agricultural sector and directly referring to the relation between the lessor and lessee. At the sector level, the attention is focused mainly on the future market profitability of agricultural activity, subsidies and fiscal burdens, trends in the field of total and land productivity, regulations concerning the market of land and leases. Whereas in the case of specific lease contracts, the rental rates are the strongest determined by the product-making potential of a given plot and its actual use. In the future, it can be expected that also other advantages of the plots will start to become more significant, allowing them to provide various ecological services. A noticeable global trend as regards rental rates is the drive at their elasticity, i.e. levelling the position and risk of the lessor and lessee.

The mechanism applied in Poland for lease of land belonging to the State Treasury, which consists in coupling the rental rates with the prices of wheat or rye seems to be a rational formula in the context, but it is not free from shortcomings (imprecise reflection of the financial situation of farms having a low share of wheat in sowing).

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WYBRANE PROBLEMY WYCENY WARTOŚCI ZIEMI ROLNICZEJ I USTALANIA CZYNSZÓW ZA JEJ DZIERŻAWĘ

Abstrakt

Ziemia rolnicza jest specyficznym dobrem ekonomicznym, o fundamentalnym wręcz znaczeniu dla współczesnych społeczeństw i perspektyw ich rozwoju oraz dobrobytu. Stanowi ona podstawę prowadzenia tradycyjnej działalności rolniczej i tak będzie nadal w dającej się przewidzieć przyszłości, jednak w warunkach stale rosnącej liczby ludności, której większość ma nadal rozmaite niedobory ilościowe i jakościowe w zakresie wyżywienia. Zaspokajanie tych potrzeb odbywać się będzie przy postępującej zmianie klimatu, problemach z wodą i kurczącym się areale gruntów nadających się do rolniczego użytkowania. Okoliczności te zwracają naszą uwagę na drugi wymiar ziemi rolniczej jako źródła świadczenia rozmaitych usług ekosystemowych i agrośrodowiskowych. To spełnianie jednocześnie wielu funkcji stanowi poważne wyzwanie przy pomiarze wartości ziemi. Od precyzji w jej ustalaniu w dużym stopniu zależy także wysokość stawek czynszów za wynajem tego czynnika produkcji. Podstawowym celem artykułu jest przedstawienie ewolucji koncepcji formalnych i modeli empirycznych wykorzystywanych do określania wartości ziemi rolniczej i czynszów dzierżawnych za możliwość czerpania pożytków z jej użytkowania.

Słowa kluczowe: czynsze dzierżawne za ziemię rolniczą, kapitalizacja subsydiów rolnych, wartość ziemi rolniczej.

Accepted for print: 02.12.2016.