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Jean-Sauveur Ay and Laure Latruffe



The Empirical Content of the Present Value Model: A survey of the instrumental uses of farmland prices

ABSTRACT

After reviewing the Present Value Model (PVM), in its basic form and with its major extensions, the authors carried out a literature review on the instrumental uses of farm land prices; namely what land prices may reveal in the framework of the PVM. Urban influence, non-market goods and climate change are topics where the PVM used with applied data may reveal farmers' or landowners' beliefs or subjective values, which are discussed in this paper. There is also extensive discussion of the topic of public regulations, and how they may affect land price directly, or through its present value.

FACTOR MARKETS Working Papers present work being conducted within the FACTOR MARKETS research project, which analyses and compares the functioning of factor markets for agriculture in the member states, candidate countries and the EU as a whole, with a view to stimulating reactions from other experts in the field. See the back cover for more information on the project. Unless otherwise indicated, the views expressed are attributable only to the authors in a personal capacity and not to any institution with which they are associated.

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The Empirical Content of the Present Value Model: A survey of the instrumental uses of farmland prices

Jean-Sauveur Ay and Laure Latruffe*

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1. Introduction

Because aggregate land supply is fixed, land market outcomes (land price in particular) are almost always studied through their demand side. *A priori* exceptions could exist when supply and demand in terms of land are considered specific to the different uses of the resource (Wiltshaw, 1985; Hertel, 2011). As such, a supply from farming to an alternative use (or inversely) could be of interest. Nevertheless, the determinants of land supply for a particular use remain totally dependent on the demands for the other uses. Thus, in almost all cases, land market outcomes could be fully described by the interactions of competing and exclusive demands for the same, limited, resource.

This general statement helps understanding the primacy of the Present Value Model (PVM) in land economics. The PVM is a key model as it provides a structural basis for empirical estimation of farmland price determinants, removing the need to take into account the classical simultaneity of supply and demand shifts. Assuming that farmland is an income-generating asset like any other, the PVM relates its current price to the infinite streams of future returns that holding the asset allows to earn. Accordingly, the only or, at least, major, driver of farmland price is the returns to land.

In the light of the classical rent theory, land rent is the payment that returns to the landowner “for the use [by himself or someone else] of the original and indestructible powers of the soil” (Ricardo, 1817). As the net present value of the future rents that a landowner has planned to earn, current land price reflects the landowner’s subjective willingness to pay to own the land: it is a demand. According to the PVM, observed land prices capitalise numerous heterogeneous, but economic-relevant information, that will be surveyed and discussed in this paper. As such, the PVM could be compared to the trophic cascade theory in ecology, which often justifies a focus on high trophic levels because they capitalise the global (and complex) health of the ecosystems.

In terms of empirical content, what is sometimes presented as a refutable theory (Campbell and Shiller, 1987; Falk, 1991; Hallam et al., 1992; Zhao et al., 2011) does not induce clearly falsifiable predictions. In effect, the net present value of land gathers numerous unobserved subjective values as well as idiosyncratic beliefs, discount schemes and bargaining positions that are almost impossible to measure accurately (Goodwin et al., 2003; Roberts et al., 2003). By contrast, the PVM is a powerful tool to study the performance of the land market and the Right Hand Side (RHS) components of the capitalization formula. This is what we call here the instrumental use of land prices.

* Laure Latruffe is a Researcher at INRA (French National Institute for Agricultural Research). Jean-Sauveur Ay is a post doctoral researcher in CNRS (French National Centre for Scientific Research).

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In this paper, we present a survey of the abundant literature that reverses the logic of the PVM by studying RHS components through land prices or land rents. This literature is grounded both explicitly in the PVM and in the hedonic frameworks (Rosen, 1972, for the hedonic theory, and Palmquist, 1989, for the application on farmland) that are often empirically similar (Feichtinger and Salhofer, 2011). Hedonic framework is generally qualified as a revealed preference method of valuation. This means that the object of research is not the land prices in themselves but the information they contain about the preferences of the population.

The following section 2 presents the basic formulation of the PVM and its main extensions (with alternative land use; with uncertainty in rents), as well as the existing most unified framework. Section 3 discusses the empirical use of PVM to study public policies. Section 4 surveys the other main empirical applications of PVM, namely urban influence, public goods and climate change. Section 5 concludes.

2. The Present Value Model

2.1 The basic model

The PVM explains the price of an income-earning asset as the discounted sum of the expected future net returns to this asset. In the case of land, the returns are land rents. Accounting for the expectations and discounting, the price at period t (p_t) can be written as:

$$p_t = \sum_{i=0}^{\infty} \frac{E(R_{t+i})}{(1+r_{t+1})(1+r_{t+2})\dots(1+r_{t+i})} \quad (1)$$

where R_t is the net return of the asset at period t , r_t is the time varying discount rate for period t , and E is the expectation regarding the future asset returns. For the moment, we do not enter into the details of R_t and define it as a monetary equivalent of the earnings generated from holding the land. It is not necessary a physical payment in money as it could include a stewardship value of land (Lichtenberg, 2002) or any other amenity value that impacts the utility of the landowner without it needs to pay for it.

Let us assume that the growth rates (g) of land returns are the same in each period, as the discount rates (r), and that agents are risk neutral. In the benchmark case that there is no tax on asset income, equation (1) becomes:

$$p_t = \frac{R_{t+1}}{(r-g)} \quad (2)$$

Equation (2) is the simplest expression of the PVM applied to land price, also called the capitalisation formula. It describes a relation of proportionality between current land price and the expected land rent of the next period. This expression contains the main insights of modern theory about the formation of farmland prices. It presents the land price as depending on time preferences, beliefs about growth and future earning, all of these parameters being specific to the landowner under consideration.

As such, equation (2) also provides a convenient and well-used way to study more aggregate and more objective market outcomes such as the demand for groundwater, the value of climate, etc. These extensions of the instrumental uses of land price are justified by an implicit sorting process of buyers. Potential landowners, who express their preferences and beliefs in land prices, are not randomly selected in the population. In a competitive land market, the buyer of land is the one who has expressed the highest bid. Therefore, observed land prices are the discounted value of the agent with the highest willingness to pay for owning the land. With hedonic terms, the market price of land is the upper envelop of individual bid functions. In the case of farmers, these individual bid functions depend on

incomes, production specialisation, liquidity constraints, or information about prices and opportunities.

For many researchers this simple capitalisation formula is sufficient, in the sense that their instrumental use of PVM is about the explicit parameters of equation (2), and/or the equation fits their data well. Thus, most of the researchers in applied studies have not felt the need to extend the basic formula. Nevertheless, several authors have introduced other determinants within or outside the land rent and other specifications in their land price model in order to explore new research questions and/or fit their data on land prices better.

2.2 Extension to alternative land uses

The possibility for land to be used by alternative activities (such as housing, transport infrastructures) has been considered in the PVM in the form of potential land returns from other uses by, for example, Arnott and Lewis (1979), Robison et al. (1985), Plantinga and Miller (2001) and Plantinga et al. (2002). As summarised by Guiling et al. (2009), in the presence of multiple land uses the PVM is as follows:

$$p_t = \sum_k \sum_{i=0}^{\infty} \frac{E(R_{kt+i})}{(1+r_{kt+1})(1+r_{kt+2})\dots(1+r_{kt+i})} \quad (3)$$

where k is the type of use.

In a presence of an alternative use, the price of land implicitly contains an additional major piece of information, the period T when the landowner decides to change the use of the land. As equation (3) is derived from optimal stopping problems, the underlying dynamic programming logic implies a discrete shift in land use when the returns from the alternative use are higher than those of the current use. The higher the interest rates and the rents of the alternative use, and the lower the growth rate of the alternative use, the later is the conversion period T . With a constant growth rate of expected returns, the choice of changing land use at T is never reverted in the future. But the case is different when uncertainty about future returns is present, as we will see in the subsection 2.3.

When land use is freely chosen by rational agents, current land price describes an upper envelop of the net present values from the different potential uses of land. As a process of potential land use sorting, it is the intertemporal equivalent of the sorting process of potential landowners in the static, hedonic case. Therefore, land price schedule implicitly contains the optimal use of the resource and anticipated shifts of land use (i.e., adaptation). This feature of PVM is extensively used in the literature, as we will see later.

In reality, free choice of land use is more the exception than the rule. In developed as in developing countries, numerous policy rules constrain the choices of landowner in many different ways: zoning, taxes, density threshold, compulsory environmental compensation, etc. Such external constraints modify the intertemporal path of returns from land and, according to the PVM, are capitalised (positively or negatively) into current land prices. Consequently, observed land price could be used to infer in monetary terms the internalisation by landowners of the policy rule. This allows researchers to evaluate, for example, the private costs of a policy relatively to its social benefits.

2.3 Extension to uncertainty

Agricultural land price may be modelled as including an uncertainty or irreversibility term, which is the difference between the planned returns with and without uncertainty. Uncertainty about future rents is also capitalised in land prices, in an additive form. Land prices also contain the internalisation, by landowners, of uncertainty, and this uncertainty modifies the optimal time of land use change.

The price of agricultural land includes an option value as well, the counterpart of the irreversibility premium in the price of urban land. The option value comes from the fact that

keeping the farmland in its current use allows the owner to benefit from potential opportunity in the future. The presence of an option value capitalised in land prices is conditioned by an increasing trend of the rents of the alternative use and random drifts around this trend. This option value decreases as the distance from the boundary of the urban area increases, and, consequently, the time of changing land use moves further in the future. Moreover, the growth premium in the price of agricultural land decays more quickly when the future is uncertain.

2.4 Toward an unified framework

Extensions to alternative land use and uncertainty are the most structural improvements of the capitalisation formula of the PVM. They provide the skeleton of multiple applications that are closer to the local conditions of the area of interest for the researchers. One can mention the extensions including preferential tax treatment (Feldstein, 1980), capital gains taxation (Alston, 1986; Burt, 1986; Baker et al., 1991), credit market constraints (Shalit and Schmitz, 1982) and transaction cost (Just and Miranowski, 1993). The structure of the model and the assumptions about the land market functioning are constant in these models. But a general feature of these partial approaches is that the elements of interest in each study are integrated separately in the PVM without a cumulative trend of increasing complexity.

Attempts to propose a unified framework accounting for all hypothesised determinants are rare, with the exception of Just and Miranowski (1993). The authors developed a comprehensive model specifying various expectation schemes and considering the role of inflation, risk aversion, taxes on capital gains, transaction costs during selling and credit market imperfections. The authors considered that land was not only an asset generating returns from farming, but that it was also an instrument of wealth accumulation. Assuming that land price and returns to land from farming are normally distributed, and that farmers' utility follows constant absolute risk aversion (CARA), the complex equation of land price formation proposed by Just and Miranowski (1993) is as follows (their equation (20)):

$$p_t = f_t \frac{\rho(1 - \tau_t \psi_t \Psi_v) \bar{P}_t + (1 - \tau_t) \bar{R}_t - \beta \phi^2 A_t \Sigma_t}{(1 - \tau_t \psi_t \Psi_v) + \gamma_t (1 - \tau_t) + \Psi_s Z_t + \psi_t - \Psi_d f_t (1 - \Delta) Z_t} \quad (4)$$

where

p_t is the real price of land at the beginning of period t ;

\bar{P}_t is the expectation of the real price of land at the end of period t ;

\bar{R}_t is the expectation of then net returns to land per acre from farming including government payments;

f_t is 1 plus the current rate of inflation;

ρ is the share of gross proceeds on sale of land left after sales commissions and transaction costs;

τ_t is the current tax rate on income;

ψ_t is the proportion of capital gains taxed;

β, ϕ are parameters from the farmer's CARA utility function;

γ_t is the real rate of return on savings and other investments;

ψ_t is the property tax rate on real estate;

Ψ_v is the proportion of current land value attributable to capital gain;

Ψ_s is the proportion of farmland in farms with a binding minimal savings constraint;

Ψ_d is the proportion of farmland value financed by debt;

Δ is the rate of finance charges and other transaction costs on new debt;

A_t is current land holdings after purchases/sales;

Σ_t is the perceived variance of end-of-year wealth per acre, which is a function of τ_t , V_t , Ψ_v , ρ , the respective variance of land price and returns to land from farming, and their covariance;

Z_t is the effective cost of debt, which is a function of γ_t , τ_t , Ψ_d , Δ and the real rate of interest on land debt r_t .

This complex equation is an extended PVM formula, where the numerator and the denominator have the same meaning as in the simple capitalisation formula. The numerator shows the value of owning a unit (here, one acre) of land, comprising three terms: i) the expected value of land after appreciation reduced by transaction costs during land sale and by capital gains taxes; ii) the value of land attributable to farming reduced by income tax; iii) a discount term due to risk present in farming and holding land, which depends on farm size. The denominator indicates the opportunity cost of transforming one unit of wealth (here, one dollar) into land, and include five terms: i) the opportunity cost of one unit of wealth used for investment reduced by the tax, reflecting the tax break until land is sold; ii) the opportunity cost from savings reduced by the income tax; iii) a higher borrowing cost for purchasers who do not have sufficient savings to cover the land purchase; iv) the property tax on real estate which increases the cost of land investment; v) the opportunity cost increase arising from credit constraints. If several simplification assumptions are made, such as no inflation ($f_t = 1$), no taxes ($\tau_t = 0$ and $\psi_t = 0$), no credit imperfections ($\gamma_t = r_t$), no transaction costs ($\Delta = 0$ and $\rho = 1$) and no risk aversion ($\beta = 0$), then equation (4) reduces to the basic capitalisation formula with γ_t as the discount rate in the denominator.

This Euler type equation does not permit to implement comparative static analyses and to draw theoretical conclusion on the relative impact of each determinant. The authors tested empirically their relative importance for the United States (US) using state data between 1963 and 1986. They found that their model fit their data relatively well, and that inflation and changes in capital returns explained mainly the land price changes during the period. The authors also concluded from their sensitivity analysis to various expectation specifications, that the choice of expectation scheme did not influence the model statistical fit.

Just and Miranowski's (1993) model is a cornerstone in the farmland price formation literature. Their model includes all determinants that were suggested by the literature at their time of analysis. It does not explicitly specify policy support, although the authors underline that their farming returns variable (\bar{R}_t) include government payments. Also, their model does not explicitly specify the alternative uses of land (urban pressure in particular). However, land conversion possibilities are implicitly included in their model through expectations that agents form on the future price of land at the end of the period (\bar{P}_t).

3. Using PVM to study public policies

Translating the previous theoretical insights in empirically tractable models is often more easily said than done. Even if the different capitalised components of land prices appear linearly in previous formulas, obtaining the necessary statistical conditions to identify parameters with an economic interest is proven more difficult. In particular, these conditions are heterogeneous between studies, and this heterogeneity can be understood only in relation to the public policies of interest.

Policy regulations that may affect the land market can take several forms, such as cash support, constraints or restrictions relating to the use of land. Here we categorise public

policies that affects farmland price into three groups: i) agricultural policies; ii) land use regulations; and iii) land institutional and transaction regulations.

3.1 Agricultural policies

Agricultural policies mainly aim at supporting farm income. This can take the form of agricultural subsidies (provided per unit of output or of input; under constraints or free of constraints), of production restrictions (production quotas) or of quality regulations (e.g. requirements to obtain the organic production label).

How quality regulations may influence farmland prices has not been much investigated. By contrast, the role of public subsidies on agricultural land prices has largely been documented in the literature. Studies emphasise the significant impact of subsidies in the way that part of the subsidies are capitalised in the farmland price. The existence of differentiated capitalisation rates can inform about the economic distortions generated by agricultural policies. The main issue discussed in the literature relates to the distributional effects between landowners and tenants, which is crucial as a large amount of farmland is tenanted in modern agricultures. But other effects are also important. The capitalisation of agricultural policies may imply, according to OECD (2007), a loss in terms of economic efficiency in other (than land) factor allocation, entry costs for agents not in the agricultural sphere, and the difficulty of time optimisation for farmers.

The capitalisation, or the incidence (Roberts et al., 2003, Kirwan, 2009), of subsidies in land price is a standard empirical finding (Latruffe and Le Mouël, 2009; Feichtinger and Salhofer, 2011; Ciaian et al., 2012b), but it is more difficult to understand what theory predicts. Latruffe and Le Mouël (2009) provide a graphical demonstration of the effect of output price support and land subsidy on farmland price, as well as a review of empirical findings on the effect of several types of agricultural support. The latter have in general a positive effect on farmland price.

Latruffe and Le Mouël (2009) note that most of the studies investigating the effect of agricultural support on farmland price have used the PVM, although a few studies used hedonic price regressions. In the PVM agricultural subsidies are incorporated in a form of a component of the agricultural revenue generated by the land, as proposed originally by Goodwin and Ortalo-Magné (1992) and Clark et al. (1993). More precisely, the agricultural return to land is assumed to have two components: one market-based component (M_t), that is to say returns generated from producing food and fibre on the land; and one government-based component (G_t), that is to say returns in the form of agricultural support. Formally, the PVM is written as follows:

$$p_t = \sum_{i=0}^{\infty} \frac{E(M_{t+i} + G_{t+i})}{(1+r_{t+1})(1+r_{t+2})\dots(1+r_{t+i})} \quad (5)$$

Weersink et al. (1999) have proposed that the two sources of agricultural returns, M_t and G_t , may not have the same discount rate r . The authors found that, in Ontario between 1947 and 1993, government payments were discounted less heavily than market-based returns, implying that the former were considered as more certain than the latter. Their article presents an instrumental usage of land prices, to estimate subjective beliefs of farmers. Land price may reveal farmers' beliefs regarding the stability in time of agricultural payments (Goodwin et al., 2003).

3.2 Land-use regulations

Land-use regulations prohibit certain uses on specific agricultural parcels. They include development controls in order to limit urban sprawl and regulatory programs constraining farmers' practices. Land-use regulations often have an environmental aim. State controls have long been applied to agricultural land in order to preserve its supply of public goods such as environmental benefits (e.g. wildlife habitat), storage for ground water and amenities

associated with open space (Plantinga and Miller, 2001; Guiling et al., 2009; Vyn, 2012; Uematsu et al., 2013). They can take the form of zoning (such as greenbelts), tax abatements or exemptions, farmland preservation programmes or conservation easements. In the European Union (EU) restrictions that may affect agricultural land use are for example the Natura 2000 zoning and the 1991 EU Nitrate Directive.

The effects of land-use regulations on agricultural land price are threefold, as explained by Jaeger et al. (2012), and therefore result in a net effect that may be positive or negative. Firstly, restriction effects are neutral or negative, in the way that the regulations may prevent the parcel to be used in its “best use” and therefore would decrease its price. Secondly, scarcity effects are positive, but they do not apply to the parcel regulated. It is the price of unregulated parcels that is increased through scarcity effects, since parcels where a specific use is still permitted become scarcer and may be more demanded. Finally, the price of a regulated parcel may be increased due to amenity effects. The regulations aim at promoting the supply of amenity on the parcel, and, when they succeed, increase its value.

Jaeger and Plantinga (2007) provide a literature review on studies analysing the influence of land-use regulations on land price. No general conclusion can be drawn since, as underlined by the authors, it is not possible to expect *a priori* the direction of the net effect of land-use regulations and the issue has to be investigated empirically.

In general studies investigating the influence of land-use restrictions have not used the PVM. Most of them relied on the hedonic pricing approaches (Grout et al., 2011), where the regulatory variables are considered as explanatory variables of land prices. Le Goffe and Salanié (2005) have for example used this approach to investigate the influence of livestock manure limits in France. Another existing approach is the inverse agricultural land demand model applied by Vukina and Wossink (2000) to investigate the same issue but in the Netherlands.

3.3 Land institutional and transaction regulations

The agricultural land's market activity may be influenced by land institutional and transaction regulations. Transaction regulations aim at regulating the type of participant in the market, or the type or quantity of land exchanged on the market. More precisely, land ownership may be prohibited for specific entities, or there may exist restrictions regarding the size of the plot exchanged, or the government may impose some price regulations. For example, foreigners were not authorised to buy agricultural land in the EU New Member States during a transition period, and foreigners need a special authorisation to purchase land in the border area in Greece (Ciaian et al., 2012a). Restrictions regarding the size of the plot exchanged exist for example in Estonia, where the minimum size of the exchanged plot is 30 square meters, and in Lithuania where the maximum size is 500 hectares (Ciaian et al., 2012a). Sale prices are partly regulated in France and in Germany. In France, this may occur through the public service missions of the private regional bodies SAFERs (“Sociétés d'aménagement foncier et d'établissement rural”). SAFERs have the right to intervene in the farmland market if certain transactions may hinder farmers' settlement, favour farm fragmentation or enlargement of very large farms, or encourage price speculation. In particular, the SAFERs have a pre-emption right on the parcel exchanged, in the way that they purchase the parcel at a lower price than the one proposed, and can re-sell it later at a lower price or at the same price but to another buyer of their choice (Latruffe and Le Mouél, 2006). In Germany specific price regulations are applied in the frame of the Compensation and Indemnity Act and the Regulation on the Acquisition of Agricultural Areas, that aims at supporting the purchase of land in the former German Democratic Republic by former landowners through maximum sale prices (Ciaian et al., 2012a). Transaction regulations also relate to the transaction costs that sellers and buyers have to bear. These include registration costs, notary fees, and tax on the capital gains from selling the land. In addition, in former communist countries specifically, transaction costs stem from demarcating boundaries and providing physical access to the plot (Latruffe and Davidova, 2007).

Institutional regulations that may affect farmland market include pre-emptive rights for specific buyers, taxes on land ownership (real estate tax), and inheritance rules. The latter are not regulations directly targeted to the farmland market but may affect its activity. Inheritance can be made via two schemes, namely full testamentary freedom (where the owners are allowed to design their heirs) or mandatory transfer to rightful heirs, e.g. spouses and children, with specific bequest share for each heir (Latruffe and Le Mouël, 2006). Another aspect of inheritance regulations lies within the inheritance taxes. Regarding pre-emptive rights, the state often has the right to pre-empt land in a view of urban development or land preservation, and private entities may have priority in the purchase of the land parcel, such as neighbouring farmers, current tenant farmers or current co-owners (Latruffe and Le Mouël, 2006).

Institutional and transaction regulations are rarely considered in the PVM. The notable exceptions are taxes on capital gains and transaction costs, for example in Baker et al. (1991), Just and Miranowski (1993), or Lence and Miller (1999).

3.4 Integrating the three types of regulations in the PVM framework

There is no single way of including regulations in the land pricing framework based on the PVM. Regulations may influence land price through two different channels. The first channel is an influence on land (present) value, which is given by the PVM. Within the present value formula, the influence is through the returns to land. The second channel is a direct influence on land price. In this case, the present value formula is unchanged, and an additional term may be added to or subtracted from the present value. Formally, it can be written as follows:

$$p_t = \sum_{i=0}^{\infty} \frac{E(f(R_{t+i}))}{(1+r_{t+1})(1+r_{t+2})\dots(1+r_{t+i})} + g \quad (6)$$

where f is a function of the land returns (first channel) and g is a function which does not depend on land returns (second channel).

Agricultural policies influence land price through the present value formula. As explained above, there is a consensus on how agricultural support is incorporated in the PVM: the agricultural return to land is separated into a market-based component, M , and a government-based component, G (equation (5)).

Regarding quality regulations, which are in general voluntary, not all of them may influence farmland values but only those that relate to land use. This is the case of organic production labelling. Farmers willing to sell their production under the organic production label have to comply with specific rules, in particular relating to the use of pesticides and fertilisers for crop cultivation. But before being authorised to sell their production under the certified organic label production, farmers have to apply the requirements during a few years' transitory period. During this period, farmers are not authorised to sell their production at the organic price which is higher than the conventional price. To compensate for the decrease in yield resulting from the switch to organic farming, which cannot be balanced by the higher organic price, EU farmers receive organic conversion subsidies which are area payments. Such payments may be capitalised in the price of land as they are part of the government-based source of land returns G .

In addition, there is another channel through which the value of land may be increased in the case of organic production labelling. Indeed, a change in ownership of a piece of land which is currently used to produce crops sold under the certified organic label production does not imply that a new transitory period has to be applied. The new owner can sell his/her production under the certified organic label production as soon as he/she owns the land. This means that the new owner would not face the loss in revenue incurred by selling the production at the (lower) conventional price. Hence, such land parcel would present a higher value than a similar parcel used for conventional production, due to the higher expected future market-based agricultural returns M . In summary, agricultural policies may be

modelled within the PVM either as an additive component to the market-based agricultural return, or as a function influencing the market-based agricultural return.

Land-use regulations are generally specified econometrically using the hedonic pricing approach, but not modelled theoretically with the PVM. As explained above, three effects can be hypothesised. Restriction effects are expected to decrease the price of land as the latter cannot be used in its “best use”. This implies that, from the PVM point of view, the revenue generated by the piece of land is not at its “best”, or maximal, level. For example, urban development controls imply that land cannot be converted to housing, and therefore the returns to land are the continued stream of earnings from farming (Nickerson and Lynch, 2001). In the case of the EU Nitrate Directive, farmers may be constrained in the number of livestock heads and therefore in their production level. By contrast, amenity effects, which increase the supply of ecological benefits, may generate additional returns to land. For example agricultural earnings may be improved by a regulation aiming at protecting soil erosion. Tourism attracted by open space may generate extra-farming revenues for farmers. As for scarcity effects, they imply that revenue generated by the use of a parcel which is not subjected to an existing regulation is higher than if the regulation was not existing. In summary, land-use regulations would play a role on the land value, through the returns to land in the PVM. They would not be modelled as an additive component of R , but as a function influencing the non-government-based (i.e. market-based) component M .

In opposition to agricultural policies and land-use restrictions, institutional and transaction regulations do not influence the present value of land, as they do not affect the land incomes. They would directly affect the price of land (function g in equation (6)). Transaction costs and taxation act as a price increase, while price regulations act as a price decrease. Restrictions regarding the participation to the land market for specific entities, inheritance laws and pre-emptive rights may restrict the number and type of potential buyers, and may therefore reduce the competition. A consequence may be the increase in the price of land.

4. Other instrumental uses of PVM

4.1 Urban influence

For agricultural activities, the proximity to urban areas is both an opportunity and a threat (Livanis et al. 2006; Wu et al., 2011). It is an opportunity in the sense that local markets (both for inputs and outputs) are closer, and this enables farmers to survive as high-quality local producer of goods that are costly to move (Livanis et al., 2006). But it is also a threat due to the induced competition for the use of land resources, the speculation of landowners about land use changes and the difficulty to manage the negative externalities that farmers generate and affecting the population (odours, machinery noise and pollution, etc.; see Ready and Abdalla, 2005). Using land prices gradients as the capitalised net values (opportunities minus threats) of urban proximity allows Livanis et al. (2006) to classify, according to their importance, the various influences of urban areas on agriculture. Urban impacts on farmland prices are high and the global effect on agricultural returns is found to be positive (as in Wu et al., 2011). The existing literature suggests that proximity to cities appears more as an opportunity than a threat to agriculture. One can note here the originality of the empirical strategy of Livanis et al. (2006), as it takes into account the spatial simultaneity of the different dimensions of urban influences on farmland values.

The recent study of Guiling et al. (2009) suggests that the determinants of the capitalisation of urban proximity in farmland price are population, real incomes and time. The effect of urban proximity on land prices is generally recognised as high. But in absolute terms, Salois et al. (2012) found that changes in farmland values are more strongly associated with changes in the distribution of agricultural returns than urban proximity. Nevertheless, this result is not true for every region of the US and for the whole period studied. In addition to urban influences, urban growth policies play an important role in determining the anticipations about land use change. According to the PVM, one can reverse the

capitalisation formula and study the determinants of the spatial variations of urban influence on farmland values. With a stochastic framework about the future of urban policies and land use restrictions, Géniaux et al. (2011) use farmland prices to reveal the credibility of urban policies from the landowner point of view. The fine spatial resolution of farmland sales allows the authors to map these effects. They show that some municipalities present low capitalisation rates of urban influences on land prices (revealing a credible policy of the limitation of urban development) and some municipalities show the opposite.

Some recent studies aim at providing an empirical quantification of the real options and option values of the future of urban extension. For the US as a whole, Plantinga et al. (2002) evaluate the share of farmland prices that the option value represents relatively to agricultural returns. They find a distribution of option-value shares with a high heterogeneity, between 0% and 80% with a median of about 10%, but the authors do not study precisely the spatial variations of the shares. With a local application (the city of Seattle), Cunningham (2006) includes in addition an analysis of the timing of development and found evidences of both implications of the PVM model: a greater uncertainty of urban rents both increase the price of farmland and delay the moment of land use change.

4.2 Non market goods

The paper by Lind (1973) is a cornerstone work about the recognition that benefit measurement for (fixed or produced) public goods could be deducted from the variations in private land value. Interestingly, this paper, uniquely concerned with the value of land, is published before the seminal paper by Rosen (1979) about the hedonic framework that regards all types of goods (including produced goods). This is an indication that the hedonic intuition was firstly discovered for the case of land, without naming it as such.

To our knowledge, the first hedonic paper applied to farmland price is Miranowski and Hammes (1984). It presents an estimation of the marginal values of soil characteristics for agriculture production. The underlying economic model presents simply the soil characteristics as determining land productivity and consequently agricultural returns. Peterson (1986) uses the same intuition of the capitalisation of the biophysical attributes of land (natural fertility, water holding capacity, etc.) and provides an interesting US national picture of the relative value of biophysical attributes of land as revealed by aggregate land prices. Another contribution of this paper was to provide at a state level a land quality index as revealed by land price, once all the non-agricultural determinants are controlled for. This paper has been followed by other articles that use the same methodology and the same results about the importance of biophysical determinants of land prices (see Xu et al., 1993).

Farmland areas are often considered as providing general public goods such as open space, typical landscapes or environmental conservation. Protecting these social functions may alter the future uses of farmland and therefore, may influence land prices. In the example of greenbelts around cities, Deaton and Vyn (2010) find some evidence that constraints on land conversion effectively alter land development patterns and influence land values. However, the evidence of an effect is limited to a small region within the countryside. With a similar hedonic framework, Bastian et al. (2002) measure recreational and scenic activities associated with rural land to estimate their effects on farmland prices. With the biophysical attributes controlled for, the environmental amenities are found to influence positively farmland prices.

Water availability is crucial for the agricultural use of land. According to the PVM, as this availability strongly modifies the expected returns, the value of water is capitalized in land prices. In irrigated regions, the presence of groundwater usable for irrigation increases land price and, more important, by reverting the capitalisation formula we can use observed land prices to infer the value of water availability (Koundouri and Pashardes, 2003). Where water availability is a public good, the same insights could be obtained for a public disamenity, such as erosion risk that decreases land values (Palmquist and Danielson, 1989), potential for environmental contamination (Boivert et al., 1997) or

aquatic invasive species (Horsch and Lewis, 2009). Other examples of water valuation through land prices are Miranowski and Hammes (1984), Gardner and Barrows (1985), Caswell and Zilberman (1986), and Faux and Perry (1999). The presence of water is found to impact positively land prices. This provides an estimation of the subjective value that farmers give to water in order to help policy-makers to make better trade-offs.

Still relating to the “biological conservation” side of land values, under the PVM assumption that land price contains the opportunity cost in terms of agricultural activities, Ando et al. (1998) are in the position to present land conservation priorities at the US scale for the conservation of endangered species. This is particularly important because there is a high heterogeneity in terms of agricultural productions, farms’ structure and local markets. Then, numerous papers have followed this approach, for example Naidoo et al. (2006) and Bode et al. (2008).

Suitable habitats for biodiversity constitute a global public good that allows maintain some endangered species. Providing such natural areas that are threatened by conversion to intensive agricultural production, implies some opportunity costs for landowners, that are at the interplay between the necessity to provide natural habitat at least cost and the necessity to sufficiently compensate landowners. For wetland easement, Shultz and Taff (2004) regress farmland sale prices on land’s physical and institutional characteristics. Even if the authors do not find a significant effect of easement on prices, they provide evidence that each additional acre of permanent wetland under easement decreases average prices by 79%. For the case of perpetual conservation easements, that permanently remove the option to convert existing habitat to more intensive agricultural production, Lawley and Towe (2013) infer the marginal opportunity cost of such constraints. Here again, the capitalisation formula is reversed to answer the question of the adequate compensation of landowners by conservation agencies.

4.3 Climate change

The seminal paper of the instrumental use of land price for climate change is Mendelsohn et al. (1994). The authors use land prices available for the US as a whole to infer the capitalised value of climate in land price. The appealing of the methods is that, the land price schedule is the upper envelop of rents from different uses and thus contains the adaptations. Another major point is that, contrary to the predictions of more mechanistic models that do not allow well land use to respond to climate, they find a positive effect of climate change for the US agriculture. Numerous works followed, certain being very critical of the methodology used, but many others inspired (Schlenker and Roberts, 2009).

Darwin (1999a) compares the hedonic approach to other modelling techniques. The author emphasises that “changes in agricultural land rents reflect exactly the annual value of climatic change to agriculture if output and other input prices remain constant,” but are inappropriate if there are endogenous price changes.

Several authors have questioned the particular implementation in Mendelsohn et al.’s (1994) paper, for example Cline (1996), Kaufmann (1998), Darwin (1999b), and Quiggin and Horowitz (1999). Specifically, they suggest that (a) the hedonic approach cannot be used to estimate dynamic adjustment costs; (b) the results are not robust across different weighting schemes; and (c) the inadequate treatment of irrigation in the analysis might bias the results. The first criticism alludes to the fact that some farmers might not find it profitable to switch to new cropping patterns given their existing crop-specific fixed capital. Climate change will occur only gradually, however, and most costs can thus be seen as variable.

5. Conclusion

Land is a production factor, a wealth asset and an activity place in the sense that many activities compete for its use. This implies that studying farmland price formation is complex, and cannot be restricted to the simple case of income-generating asset.

The literature about the determinants of farmland price is very large. A large body of the literature relies on the PVM for the basis of their empirical estimation of the determinants. The basic formulation of the PVM, i.e. the capitalisation formula, is frequently used as it provides in general consistent results. Some authors have extended the formula by including one or several determinants other than the land rent. They usually restricted their methodological improvement to one or two additional determinants, as their interest was to focus on such determinants. Attempts to develop a unified formula accounting for all determinants have rarely been made so far, not only due to the complexity of the exercise but also due to the absence of need. Just and Miranowski's (1993) is an important paper in the sense that it provides a framework that accounts for most of the determinants. Empirically, the existing studies differ by the computation of rents but also the necessary assumptions about land market performance. Econometric technical differences also distinguish the existing papers, e.g. collinearity, endogeneity (Livanis et al., 2006) and simultaneity (Shaik et al., 2005).

We provided here a survey of instrumental uses of farm land prices, that is to say what land prices may reveal in the framework of the PVM. Urban influence, non market goods and climate change are topics where the PVM used with applied data may reveal farmers' or landowners' beliefs or subjective values.

We also discussed extensively the topic of public regulations, and how they may affect land price directly, or through its present value. In the literature, agricultural policies have been modelled within the PVM, while land-use regulations have been specified econometrically only. As for land institutional and transaction regulations, there are numerous and various, and have not been really considered in the present value framework except for transaction costs and capital gains taxation. We provided a discussion on how three types of regulations may affect land price in the present value framework.

Two additional points are worth noting regarding the regulations. Firstly, theoretically, agents' anticipations may change the effect of regulations. As suggested by Grout (2010), if agents anticipate that a compensation scheme or waiver for a land-use restriction policy will be implemented in the future, then the negative restriction effect that decreases land returns may be offset by the positive increase in land revenues even prior to the implementation of the regulation. Nickerson and Lynch (2001) also noted that land prices may not be affected by land-use restrictions if market participants expect that such restrictions will not be binding.

The second point to note is that there may be inverse relationship between regulatory policies and farmland prices. In the case of agricultural subsidies, for example, Shaik et al. (2005) hypothesised a two-way causality between government payments and land revenue. Therefore, they specified two equations, one for the PVM and one where the dependent variable was the government subsidies and land returns are within the determinants. In the case of land-use restrictions, Grout et al. (2011) underline that zoning may be decided based upon land characteristics (e.g. soil quality) and therefore specific econometric methods must be used, such as instrumental approaches or matching techniques.

Our final concluding point would be that further research is needed to understand the functioning of farmland market so that the PVM can be used efficiently. In particular, using different levels of observations together (e.g. plot level, farm level) can shed new light on existing and well-known results.

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Comparative Analysis of Factor Markets for Agriculture across the Member States

245123-FP7-KBBE-2009-3

The Factor Markets project in a nutshell

Title Comparative Analysis of Factor Markets for Agriculture across the Member States

Funding scheme Collaborative Project (CP) / Small or medium scale focused research project

Coordinator CEPS, Prof. Johan F.M. Swinnen

Duration 01/09/2010 – 31/08/2013 (36 months)

Short description Well functioning factor markets are a crucial condition for the competitiveness and growth of agriculture and for rural development. At the same time, the functioning of the factor markets themselves are influenced by changes in agriculture and the rural economy, and in EU policies. Member state regulations and institutions affecting land, labour, and capital markets may cause important heterogeneity in the factor markets, which may have important effects on the functioning of the factor markets and on the interactions between factor markets and EU policies.

The general objective of the FACTOR MARKETS project is to analyse the functioning of factor markets for agriculture in the EU-27, including the Candidate Countries. The FACTOR MARKETS project will compare the different markets, their institutional framework and their impact on agricultural development and structural change, as well as their impact on rural economies, for the Member States, Candidate Countries and the EU as a whole. The FACTOR MARKETS project will focus on capital, labour and land markets. The results of this study will contribute to a better understanding of the fundamental economic factors affecting EU agriculture, thus allowing better targeting of policies to improve the competitiveness of the sector.

Contact e-mail info@factormarkets.eu

Website www.factormarkets.eu

Partners 17 (13 countries)

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EC Scientific officer Dr. Hans-Jörg Lutzeyer

