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The pure market allocation of land between forestry and agriculture

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ABSTRACT

Presented in the paper is an analysis of the pure land allocation when a land use change affects the prices paid for goods and production factors in different ways. Three different models are presented: a fully open economy, a closed economy and an economy where selected prices are exogenously determined. The reaction in terms of land allocation occurs in an intuitive manner only in the case of certain market conditions. In more complex situations, no general prediction of the land use change is possible. The introduction of policy programmes to boost forestry has different effects in open and partially open economies. Therefore, the different channels by which the prices of goods and factors determine the allocation of land are identified. This approach allows for the formulation of specifications permitting a grouping of economies with different market structures into classes with equal land allocation patterns.

1. The problem of pure market allocation of land

Forestry competes with other land uses such as agriculture or infrastructure development for land. If agriculture or any other land use wins then forestry losses. Amongst other, this land use change is a main reason of deforestation and stands in the critical focus of the world public (e.g. European Union, 2018). Therefore governments, UN organizations and numerous non-government organizations fight against this kind of land use change.

They design policies, such as regulations, taxations and subsidy programmes, to affect the actions of the individuals in direction to overcome the problem of deforestation. All these policies affect the prices of production factors and goods in many direct and indirect ways and induce intended as well as unintended effects to the various markets. Concerning the complexity of the market structure the overall results of these policies are not straightforward to understand intuitively.

Furthermore the many organizations above do not only fight against deforestation as a consequence of land use change. They also fight against hunger and support projects for more agriculture and for better infrastructure development. Thus, policy seeking to slow deforestation, food policy, development policy, climate change policy and other policies affect the allocation of land. Isolated policy programmes might lead only to random outcomes.

Both the qualified design of specific deforestation policies and the matching of the different policies need economic analyses.

Fortunately, the effects of market exchange to the allocation of land between forestry and agriculture are now fairly well understood in the cases of land quality, distance to the market, security of property rights, and the influence of political regimes. This will be referred in the second section of this paper. However there is a gap concerning the study of the pure market allocation of land. Therefore, in this paper a contribution to fill out this gap is attempted.

For studying this pure allocation problem we exclude the effects of different land qualities and the problems of property rights which are analyzed elsewhere and to which we refer in Section 2. Thus we assume land of the same quality where all property rights are defined and secured and where no distance problems exist. This land can be allocated either to forestry (L_F) or to agriculture (L_A), where the available land is also the supplied land L_S, which is assumed as completely price inelastic:

$$L_S = L_F + L_A \tag{01a}$$

Precisely this land use alternative characterizes the pure problem of the allocation of land.

To exclude the analysis for cases where land is not scarce, i.e. idle land exists, we additionally assume.

$$V_F \geq 0, \quad V_A \geq 0, \tag{01b}$$

where V is the value of one hectare of land.

This problem demands an optimal allocation of the resources which is analyzed in the third section of this paper.

The pure allocation of land differs from country to country induced by numerous structures of markets. These can include the size of the

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area in question, the proportion of factor demands in forestry and agriculture relative to other branches of the economy, and the market constitutions.

Often the size of the area in question is not identical to the size of the markets served. For instance, if we study the timber market at the global level, the timber prices depend on the amount of forestland. On the other hand, when we select a particular area without any important contribution to the global timber market, we will find that any shift in the amount of forest land in this area has no effect on the prices paid for timber products globally.

A second reason for the effect of the amount of forestland on a price is the proportion of forestry and agriculture relative to all other branches of an economy. While wage and interest rates in a purely industrial state are mainly determined in the urban places, in a purely agrarian state wage and interest rates are determined in the forestry and agricultural sectors. Whereas in the first case the amount of forestland does not affect wage and interest rates, in the latter the amount of forestland will affect these factors.

The market constitution is a third reason; whether prices depend on or are independent of the amount of land allocated forestry. Different sets of institutions exist for markets in different parts of the world, such as the definition of property, the conditions of market competition, liability rules, rules for building contracts, etc. For instance, in the case of a market in which imports and exports of agricultural commodities are very limited, the prices of these agricultural commodities will depend on the amount of agricultural land. In contrast, the prices paid for agricultural products within a national agriculture commodity market with no export and import regulations will not be affected by the amount of land allocated to agriculture.

Clearly all of these reasons affect the allocation of land between forestry and agriculture. Independent of the specific reasons where the amount of forest land affects prices, in this paper the numerous market configurations are stylized as fully open, fully closed and partial open economies. In the fully open economy the prices of factors and goods are determined exogenously. In the fully closed economy all these prices are determined endogenously by the amount of land allocated to forestry. In the partial open economy only selected prices are determined exogenously while all other prices are determined endogenously by the amount of land allocated to forestry.

From the analytical perspective the fully open and the fully closed economies are the two extremes of a continuum. The partial open economies represent market structures within these two extremes.

In particular, in this paper the allocation of land of the three stylized economies are analyzed. We will find that in these three economies the optimal land allocations evolve differently. This is caused by the different channels by which the prices of factors and goods affect the land values and become visible in the different models. Especially the channels in the partial open economy are more complex interwoven with a lot of interdependencies. These will be visible in “bulky” structure of the related models in sub-section 3.3. Oftentimes these various interdependencies in the partial open economy lead to effects which are not intuitively expected. Paradoxical effects to the allocation of land are possible.

With the help of these stylized examples a valid approximation to the main features of pure land allocation with respect to the various market configurations is possible. This merely analytical perspective provides the basis, from which a discussion of the implications to various policies which affect the allocation of land is possible. Some final remarks on these findings close the paper.

2. Related literature

Two main lines of theory exist for the study of land allocation. One line bases on Ricardo (2004), the second on von Thünen (1990). Whereas the Ricardian model focuses on different land qualities, the Thünen model studies the location of different land uses in respect of the weight and storage life of the different commodities derived from agriculture, forestry and the town economy. Randall and Castle (1985) and Parks et al. (1998) explained, summarized and compared these two lines.

Forest land related analyses of land allocation are based on these two lines of theories and address additional questions. Samuelson (1976: 480–482) derived, based on a Faustmann model, a three-variable factor-price frontier of the land rent. He showed that the higher the interest rate and the real wage rate, the lower the rents for forest land.

Strand (1969: 246) studied the land allocation between forestry and agriculture based on the Faustmann model in a graphical way. He modelled the land values of these two land uses as functions of labour costs and interest rates. He also considered conversion costs, albeit conversion costs were assumed only from forestry to agriculture. The change from agriculture to forest was modelled on the basis of a gradual regrowth of forests without regeneration costs but with income losses due to the revenue lag caused by regrowth (cp. also Hyde, 1980: 48).

Salo and Tahvonen (2004) presented a dynamic forest land allocation model giving special consideration to forest age-classes at which the prices of timber and agricultural commodities are determined endogenously. They found that some fraction of agricultural land will be used for adjustments to fluctuations in the supply of timber caused by non-normal age class structures. Furthermore, the two authors revealed that land conversion costs affect the optimal allocation of land with the initial land use (forestry or agriculture) affecting the optimal allocation of land. The model by Salo and Tahvonen (2004) is similar to the model developed by Stavins [1990]: 146, eq. (1)] but Stavins (1990) did not work with age classes.

Amacher et al. (2009: 171–183) presented an analysis of land allocation between agriculture, plantation forestry, illegal logging in native forests and non-timber benefits. They considered land quality as a variable. Their analysis of timber prices revealed that the higher the timber price, the higher the minimum level of land quality for the purposes of agriculture. They also revealed that different land qualities lead to an allocation of land where forestry and agriculture exist simultaneously, even where all prices are driven exogenously.

Halbritter and Deegen (2011) published a model of the land expectation value (LEV) in which the land quality is determined endogenously by the land use and the land use intensity. Applying their perspective, agriculture and forestry can be seen as the production period (agriculture) and as a recovery period (forestry) within a global land use programme. Thus, forestry and agriculture become mere parts in an overall system of land use and no longer land use alternatives.

Hyde (2012: 13–53) applied a more developed model to study the pattern of forestry in the course of economic development. He expanded the ideas of Thünen by including a gradient of property rights security. Thus, land allocation is affected not only by the values of the different land uses but also by the level of security of property rights. Hyde's expansion showed how the costs incurred in securing property rights can be incorporated in future analyses of land allocation.

Mendelsohn (1994) combined a property rights analysis with declining quality of land for agriculture as an endogenous variable. The costs of securing property rights were considered as protection costs or as a probability that land users (squatters) would be evicted from the land. A main result of the analysis was that the higher the probability of eviction the more squatters accept land use types which faster decline land quality.

A further extension in the direction of the incorporation of political variables into market models was provided by Kuusela and Amacher (2016). They modelled agriculture and forest land rents depending on the political effort, which included the probability of the political regime staying in power. The overall result concerning the change to the relative land rents was generally ambiguous so that Kuusela and Amacher (2016) expanded upon their analytical finding by means of an econometric study.

All of the analyses cited above provide instructive and important