FARM CONSOLIDATION AS AN EXAMPLE OF INTERNALIZING EXTERNALITIES IN AGRICULTURE

Key words: externalities, agriculture, internalization, Edgeworth’s box, social costs and benefits

ABSTRACT. The paper deals with the issue of internalising external effects arising during agricultural production. An example was the account of an agritourism farm and a swine farm. Using the Edgeworth box concept, difficulties in establishing a market equilibrium without precisely established property rights are presented. The aim of the study was to indicate a possible solution to the problem of negative external effects. It was indicated that the internalization of unfavorable phenomena resulting from agricultural production may take place across farms. The rationality of such a solution was documented using the profit maximization functions of separate and post-merger farms. In a newly established entity, in order to maximize the benefits of pig production and the offered accommodation places, the factors increasing the emission of odor to the atmosphere should be limited to a socially acceptable level. The theoretical nature of the presented possibilities of limiting the adverse effects of agricultural production for society may take on real shape. The currently observed direction of changes in agriculture towards the creation of farms with an increasing area allows to suppose that a certain amount of negative externalities will be limited, and therefore the social costs of production will partially be reduced. It is difficult to indicate specific values, e.g. reduced social costs, but it is important that the direction of changes is socially desirable.

INTRODUCTION

Considerations about externalities among economists date back to the times of Alfred Marshall (late 19th century) [Marshall 1980]. Currently, after more than a hundred years, the occurrence of this phenomenon is more and more often noticed by economists. The described cases of various types of external impacts of enterprises operating in many industries allow for a better and more accurate estimation of the full costs/benefits of the functioning of economic operators [Pajewski, Gołębiewska 2018]. Also, among economists in the agricultural sector, there is increasing interest in relations: farm (farmer) – environment (others), especially in the context of environmental public goods, which this kind of economic activity significantly affects [Gołębiewska, Pajewski 2018].

The study presents the problem of internalizing external effects on the example of the relationship between an agritourism farm and neighboring swine farm. The study
aimed to indicate the possibilities of solving the problem of emerging external costs of agricultural production in the context of unused production potential of agritourism farms. The legitimacy of consolidating farms with different activity profiles to limit excessive social costs of agricultural production was indicated.

METHODS OF RESEARCH

The paper presents the relation of two entities that exert an external influence - outside the market. The hypothetical relation of closely located farms: agritourism farms and swine farms were analyzed. The Edgeworth model (box) was used to illustrate the relationship between these entities and the difficulties in finding a consensus on the level of influence of one on the other.

The method of internalizing negative technological externalities in the described relation was justified by using the profit maximization function of the company.

As justification for seeking restrictions affecting the operation of the entities in the agricultural sector indicated the untapped potential of accommodation of Polish tourist farms. Information from the Local Data Bank of the Central Statistical Office (GUS) was used to present the accommodation potential. The time scope of the research covered the period 2015-2019.

AGRITOURISM FARMS

An interesting example of using available resources in rural areas is an agritourism farm because it is not a “typical” agricultural activity aimed at maximizing the surplus/profit per hectare by producing plant and animal products [Schilling et al. 2012]. It is essential to interest customers in recreation “in the country-style”. Ewelina Surdacka points out that additional value for this type of farm is the location in naturally valuable areas, such as landscape parks and their buffer zones, the so-called agro-ecotourism farms [Surdacka 2017]. The values and specific features of such farms are described, among others, by Bogusław Sawicki and Anna Mazurek-Kusiak [2010], Krystyna Młynarczyk [2002], Adam Wasilewski [2013], Katarzyna Gralak and Marzena Kacprzak [2018], Agata Balańska and Jan Zawadka [2013].

Both the demand and the supply side of the market of agritourism services have changed significantly. The differences in the “old” and “new” approaches were presented by Ohe Yasuo and Adriano Ciani [Ohe, Ciani 2012]. Originally, the domain of agritourism was the use of free resources (capital and labor) on farms, the quality of services offered was low (compared to the current standards) and the management skills of the owners should be assessed as low. The demand for this type of service was described as derivative and the demand (needs) of consumers for the services of the agritourism sector was assessed as low. The market for this type of services was associated with cheap recreation for clients without affluent wallets.

The modern type of agritourism farm is based on non-productive aspects of agricultural activity, which fall within the concept of multi-functionality of rural areas [Wilkin 2011].
The high quality of services is ensured by the farm’s management, which notices the need for managing its own business. Customers are defined as aware of the services offered by agritourism farms, which means that the demand for them should be defined as primary – customers are not on the farm by accident. Their needs and (agro) tourism requirements should be defined as high, therefore consumers in such a market are defined as wealthy.

In Poland, there is a noticeable increase in the number of agritourism facilities, which include both guest rooms and year-round accommodation, in 2019 it was 3,160 facilities (by 473 more than in 2015 – 17.6%). This translated into a greater number of available beds 73,268 (more by 29.3% than in 2015). The potential of these facilities should be indicated, defined as being taken up fully (100%). In 2015, it was over 20.6 million overnight stays, and in 2019 over 26.7 million overnight stays. A noticeable change in these values proves the great potential of Polish agritourism facilities, which is not fully used (approx. 12% in 2015 and approx. 15% in 2019).

Among the entities interested in the agritourism offer, domestic tourists still dominate (over 90% throughout the entire period), the rest of the consumers are foreigners. The unused accommodation potential in Polish agritourism facilities may have many reasons [Zawadka 2010]. One of the possibilities may be a lack of consumer interest as a result of unfavorable phenomena in the surroundings of the farm (guesthouse). An example will be the relationship between two objects, i.e. an agritourism farm and a swine farm, and an unpleasant smell. The effects of such a relationship can be explained by the economic theory of externalities. In this case, it is a negative technological external effect of production, which, according to Jerzy Śleszyński, does not occur directly between the perpetrator and the aggrieved party, but due to the impact of a specific effect directly on the natural environment, there are losses or benefits to economic operators [Śleszyński 2010]. The Edgeworth box concept was used to illustrate the relationship between the entities.

The present case presents two entities – $A$ and $B$ with different preferences as to the amount of “held i.e. consumed” unpleasant smell and the same for its money resources. The length of the abscissa (the long side of the rectangle) describes the total sum of money owned by entities $A$ and $B$. The money of entity $A$ grows left to right on the bottom axis, and entity $B$’s money resources increase from right to left on the top axis. The ordinate

### Table 1. The traditional and modern approach to agritourism

<table>
<thead>
<tr>
<th>Type of agritourism farm</th>
<th>Supply</th>
<th>Demand</th>
<th>Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional</td>
<td>Use of free farm resources (labor, capital)</td>
<td>Derivative</td>
<td>Cheap leisure</td>
</tr>
<tr>
<td></td>
<td>Poor quality of services</td>
<td>Low level of tourist needs</td>
<td>Low income</td>
</tr>
<tr>
<td></td>
<td>Low level of management skills</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modern</td>
<td>Taking advantage of the multifunctionality</td>
<td>Primary</td>
<td>High income</td>
</tr>
<tr>
<td></td>
<td>of the countryside</td>
<td>High level of tourist needs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High quality of services</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High level of management skills</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: [Ohe, Ciani 2012, p. 283]
(short side of the rectangle) represents the total amount of malodor (odor) produced. This value should be limited, so it is assumed that the level of unpleasant odor can be estimated in the range <0.1>, where 0 means no unpleasant smell and 1 such a large amount that not a single client will decide to stay overnight at an agritourism farm.

Subject $A$’s preferences are growing in terms of both money resources and odor. It should be assumed that the amount of smell produced by a pork producer is positively correlated with the increase in the level of his welfare as a result of increasing production – increasing profits from the activity. Subject $A$’s preferences are expressed in the chart by the indifference curves $UA_1-UA_4$ – rising towards the upper right corner of the box. Entity $B$ – the owner of an agritourism farm (guesthouse) – also shows growing preferences as to the number of money resources, but is not so optimistic about the amount of odor. Its level of prosperity depends on the number of accommodation places sold to agritourists, and the unpleasant smell from a nearby piggery may limit interest in this form of recreation. Its preferences are represented by the $UB_1-UB_4$ indifference curves – rising from the upper right corner towards the starting point of subject $A$ (lower-left corner).

<table>
<thead>
<tr>
<th>Category</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilities in total</td>
<td>2,687</td>
<td>2,798</td>
<td>2,829</td>
<td>3,050</td>
<td>3,160</td>
</tr>
<tr>
<td>Year-round facilities</td>
<td>1,345</td>
<td>1,409</td>
<td>1,452</td>
<td>1,650</td>
<td>1,724</td>
</tr>
<tr>
<td>Total accommodation</td>
<td>56,682</td>
<td>60,302</td>
<td>63,239</td>
<td>69,008</td>
<td>73,268</td>
</tr>
<tr>
<td>Year-round accommodation</td>
<td>28,978</td>
<td>31,368</td>
<td>33,150</td>
<td>37,808</td>
<td>40,472</td>
</tr>
<tr>
<td>Total tourists</td>
<td>685,139</td>
<td>809,785</td>
<td>903,514</td>
<td>1,067,121</td>
<td>1,169,236</td>
</tr>
<tr>
<td>Foreign tourists (visitors) non-residents</td>
<td>46,535</td>
<td>64,747</td>
<td>81,552</td>
<td>94,481</td>
<td>111,853</td>
</tr>
<tr>
<td>Total accommodation provided</td>
<td>2,446,246</td>
<td>2,885,265</td>
<td>3,278,783</td>
<td>3,687,155</td>
<td>4,108,236</td>
</tr>
<tr>
<td>Accommodation granted to foreign tourists (non-residents)</td>
<td>147,644</td>
<td>209,359</td>
<td>304,348</td>
<td>347,533</td>
<td>439,066</td>
</tr>
<tr>
<td>Annual potential of the facilities*</td>
<td>20,688,930</td>
<td>22,010,230</td>
<td>23,082,235</td>
<td>25,187,920</td>
<td>26,742,820</td>
</tr>
<tr>
<td>Utilization of the potential of year-round facilities [%]</td>
<td>11.82</td>
<td>13.11</td>
<td>14.20</td>
<td>14.64</td>
<td>15.36</td>
</tr>
<tr>
<td>Share of foreign tourists [%]</td>
<td>6.79</td>
<td>8.00</td>
<td>9.03</td>
<td>8.85</td>
<td>9.57</td>
</tr>
<tr>
<td>Share of foreign tourists in provided accommodation [%]</td>
<td>6.04</td>
<td>7.26</td>
<td>9.28</td>
<td>9.43</td>
<td>10.69</td>
</tr>
<tr>
<td>Share of foreign tourists [%]</td>
<td>6.8</td>
<td>8.0</td>
<td>9.0</td>
<td>8.9</td>
<td>9.6</td>
</tr>
<tr>
<td>Share of domestic tourists [%]</td>
<td>93.2</td>
<td>92.0</td>
<td>91.0</td>
<td>91.1</td>
<td>90.4</td>
</tr>
</tbody>
</table>

* the annual potential of tourist facilities was calculated as the product of total bed places and the number of days in a year

Source: own study based on Local Data Bank of the Polish Central Statistical Office data
The vertical line running through the center of the figure shows the initial money resources of the entities. Hal R. Varian points out that determining the “initial resources” in this case of odor should depend on the legal system. Property rights should be established in such a way that there is no doubt as to whom and to what proportion a given asset belongs. Only in this case can the possibility of having to dispose of the odor or fresh air in such a way as to achieve the equilibrium level of Pareto be discussed. The points \( E \) and \( E' \) represent just such Pareto-effective solutions appearing at the points of contact between the indifference curves of two subjects. Point \( E \) presents a situation in which entity \( B \) (the owner of an agritourism farm) decides to sell entity \( A \) a part of the clean air right in exchange for appropriate financial compensation. The compensation should be at least equal to the loss of benefits resulting from the resignation of some vacationers from arrival because reselling the rights to this type of resource signifies, at the same time, consent to its pollution within certain limits. The possible equilibrium in point \( E \) expresses an exchange between entities, where entity \( B \) would be willing to pay a certain amount of money to entity \( A \) in return for reducing odor emissions – it would buy more fresh air from \( A \), provided, of course, that it would be justified by the potential benefits resulting from greater interest in the farm’s offer.

The above analysis shows that, in conditions of well-established property rights that give owners the ability to decide about all the resources they have access to, it is possible to achieve a Pareto equilibrium. However, defining property rights at such a detailed level is not easy, and possibly not feasible. Therefore, as Hall R. Varian notes, practical problems with externalities arise mainly because of poorly defined property rights [Varian 2013].
In the analyzed relationship between a pig breeder and the owner of an agritourism farm, there will also be claims to certain resources from both sides. Because, can we say that an agritourism farm needs more fresh air and, therefore, may its owner impose restrictions related to the emission of unpleasant odors on the neighbor? On the other hand, can a swine farmer reduce, without any consequences, the welfare of a neighbor by increasing odor emissions by increasing production? The problem of external effects of production appears here, which can be solved in several ways, e.g. by so-called internalization [Stiglitz 2004]. A significant element of this concept is to emphasize the market ineffectiveness associated in this case with a lack of market for unpleasant odors, and thus the inability to achieve a Pareto equilibrium achieved by transferring/reselling the rights to part of the fragrance between entities. Edgeworth’s concept of equilibrium would only be effective if, as already mentioned, property rights were precisely defined.

The internalization of the external effect could, in the analyzed case, take place through the consolidation of market entities. Let us stay with the markings describing the entities – A and B. Let entity A be a producer of pigs – the number of pigs marked as \( t \), sold at a price of \( p_t \). In addition to basic production, there is also a side effect, i.e. an unpleasant smell – \( z \). The cost function of this entity takes the form \( c_i(t,z) \).

Entity B – the “agritourism” host is located in the neighborhood. It offers agritourism services – at a price of \( p_{sa} \), but its “production” is burdened with the external factor \( z \) – an unpleasant smell. Its cost function takes the form \( c_a(a,z) \).

It should be assumed that the emerging unpleasant smell affects both entities in different ways. For the pork producer, the greater emission of unpleasant odors in the environment contributes to a reduction of production costs\(^1\) – it can be assumed that \( \frac{\Delta c_t}{\Delta z} > 0 \).

For subject B, the ingestion of the unpleasant odor increases production costs\(^2\), in the way that \( \frac{\Delta c_a}{\Delta z} > 0 \).

Considering the above, the formula for maximizing profit for a pork producer can take the form of:

\[
\max_{t,z} [p_t s - c_i(t,z)]
\]

It should be remembered that at the point of profit maximization, the price of both the pig and the odor should equal its marginal cost. In this case, pollution has a price of zero. These conditions can be described as follows:

\[
p_t = \frac{\Delta c_t(t^*,z^*)}{\Delta t}
\]

\[
0 = \frac{\Delta c_t(t^*,z^*)}{\Delta z}
\]

\(^1\) The emission of odor outside the piggery contributes to the animals’ well-being – improves their welfare.

\(^2\) Costs are lost profits as a result of avoiding the pen due to an unpleasant smell in the immediate environment.
The formula for maximizing profit for an agritourism farm has the form:

$$\max_a [p_a a - c_a(a, z)]$$

Assuming that the price of the agritourism service is equal to its marginal cost:

$$p_a = \frac{\Delta c_a(a^*, z^*)}{\Delta a}$$

The presented conditions of profit maximization for two entities show the discrepancy between private and social costs of production of a good accompanied by a negative external production effect. The issuer’s lack of propensity to reduce odor emissions is due to the assumption of a zero pollutant price. It shows that the level of pollution resulting from the size of profit-maximizing production will tend to the point where the cost of an additional unit of pollution will be zero. In other words, the production of pollutants will be increased until it turns into a reduction in the cost of pig production. It can, therefore, be expected that the growing level of odor in the surroundings of an agritourism farm will effectively reduce the demand for the services offered. The emerging discrepancy between the private costs of entity $A$ and social costs, the beneficiary of which is entity $B$, does not allow for achieving a Pareto equilibrium. Therefore, it is necessary to look for solutions conducive to limiting the formation of the “surplus” of social costs resulting from production/consumption.

Internalization is one of the ways of reducing the phenomenon of externalities. Alfred Marshall, in the Principles of Economics, has already mentioned such a way of dealing with too high social costs of production using the terms “internal economics” and “external economics” [Marshall 1890]. The idea of internalization is to close the external effect within an enterprise/group of enterprises/group of entities – in such a way that the entity/entities bear the total costs resulting from the phenomenon. In such a configuration, the goal of the individual is to reduce social costs to such an extent that direct production costs and the resulting social costs enable the maximization of benefits. The problem of internalising externalities in agriculture is raised by authors on a global scale, e.g. Lv Yao and Yushu Zhang [2007], Frederick Buttel [2003] and Tomasz Pajewski et al. [2020].

The internalization of an unpleasant odor could take place by merging two entities into one – a pig producer (Entity $A$) and a provider of agritourism services (entity $B$). The resulting organization would maximize the benefits of total production only on the condition of optimal use of all resources (combined in one farm). The formula for maximizing profit for such a company would therefore be:

$$\max_{t, a, z} [p_t t + p_a a - c_t(t, z) - c_a(a, z)]$$

Where optimality conditions regarding the equality of prices with the marginal costs of both entities are as follows:

$$p_t = \frac{\Delta c_t(\hat{t}, \hat{z})}{\Delta t} \quad p_a = \frac{\Delta c_a(\hat{a}, \hat{z})}{\Delta a}$$
There remains an optimality condition for the externality for which, as mentioned, the price is equal to zero. In this case, this condition would take the form:

\[
0 = \frac{\Delta c_t(\hat{t}, \hat{z})}{\Delta z} + \frac{\Delta c_a(\hat{a}, \hat{z})}{\Delta z}
\]

This means that a newly established company maximizing profit by determining the optimal level of production (pigs and agritourism services) takes the social costs of pig production into account. So, the sum of the marginal costs of the fattening house and the guesthouse is zero. This is a very important expression, especially when it comes to the production of pollutants. Initially, the independently operating farms did not take the social effect of their activities in the calculations into account. A swine producer produced so much pollution at which the marginal cost of production was zero. As a result of the merger, pollution-odor production will be such that the total marginal costs of the fattening house and guesthouse will be zero. This relation can be presented as follows:

\[
-MC_t(\hat{t}, \hat{z}) = MC_a(\hat{a}, \hat{z})
\]

Considering the above formula, it can be stated that the newly established farm will produce less air pollution than the fattening house before the merger. This is because the marginal costs of the guesthouse \(MC_a\) are positive, which directly results from the increasing costs of acquiring customers – agritourists as a result of the presence of odors in the air.

Therefore, in the entity internalizing externalities, the issuer will be inclined to keep the marginal costs at a positive level (previously it tried to equate them with zero), so that it is possible to achieve a Pareto equilibrium, which leads to a socially acceptable amount of negative externalities.

CONCLUSIONS

Economic reality is far from ideal, for example in terms of the efficient allocation of resources. Producing goods and offering services in an imperfect market often means that some goods are insufficient and others are abundant. The emergence of this type of phenomenon is particularly important for entities that base their actions (some part) on resources for which they do not have exclusivity (property rights). The success of the organization depends on its quality. This type of relation will always work to the disadvantage of the entity that, in the calculation of its potential benefits from the business, includes elements to which it does not have exclusive property rights. Basing the company’s operating strategy, e.g. on the quality of public goods, the consumption of which, in addition to the basic offer, e.g. accommodation, is also of interest to customers, might be problematic.

The analyzed example presents the relation and possibility of solving emerging problems of external effects. It was pointed out that the lack of precisely defined property rights concerning public goods may cause unfavorable consequences for some entities, in this case, agritourism farms. The limitations discussed in the article are only a part of a set of factors that reduce interest in resting in agritourism farms, the unused potential of
which remains at a very high level. Combining farms can be a solution to the problem of the emerging social costs of agricultural production and better use of the potential of the agritourism industry. As a result of merging two different entities, interacting externally while maintaining the economic assumptions of profit maximization, both private and social benefits can be obtained from total production.

BIBLIOGRAPHY


ŁĄCZENIE GOSPODARSTW JAKO PRZYKŁAD INTERNALIZACJI
EFEKTÓW ZEWNĘTRZNYCH W ROLNICTWIE

Słowa kluczowe: efekty zewnętrzne, rolnictwo, internalizacja, skrzynka Edgewortha, koszty i korzyści społeczne

ABSTRAKT


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