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DETERMINING THE ACCEPTABLE PRICE LEVEL FOR AGRI-FOOD PRODUCTS AND THE CHOICE OF THE PROCESSOR

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Abstract

The purpose of the analysis presented in this paper is to answer why a specific price level of agri-food products is determined and accepted by both the consumer and processor, as well as by the agricultural producer and processor. An answer to this question requires presenting a number of equations and functional relationships based on specific assumptions, which is a formal and analytical method of analysis. This method is based on the assumption that the acceptance involves maximizing the goal function of the processor and the goal function of the consumer and agricultural producer simultaneously, as well as that there are conditions for competitive equilibrium on these markets. The essence of this method is the choice of the processor in terms ofprices on the agri-food market. The importance of the procurement price level forthe choice of the processor is presented in an unusual and new manner by conducting an advanced analysis. The basic result of the analysis is a mechanism to determine the acceptable price level for these entities on the agri-food market. This is determined by introducing the admitting inequalities, which specify the ratio of expectations of these entities to the market equilibrium price. The conclusion is that the price level is mutually acceptable because the goal functions of the entities have been carried out. The analysis is analytical and formal and has a theoretical and cognitive value. It may contribute to the theory of prices in the agri-food sector and the conditions for the choice of the processor.

Keywords: acceptable price level, agricultural product, food product, benefits for processor, benefits for agricultural producer, benefits for consumer, choice of processor.

JEL codes: Q13, L11, D01, D21.

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Introduction

Using control-related terms, the paper describes the issue of price formation at the input and output of an agri-food processor. In terms of microeconomics and agricultural economics this means the mechanism of price formation on the two markets where the processor operates. These include the market of final products of the processor, i.e., the food products, and the input market, i.e., the agricultural products. The latter determines the specificity of the processor. The value added of this paper is the determination of the mechanism of price formation of both products, the acceptable price level for the processor and its market partners, i.e., the consumer on the food market and the agricultural producer on the agricultural market. The statement that the level of these prices is determined as a result of the intersection of the supply and demand curves on both markets and the interactions between the supply, demand, and prices, is insufficient. Firstly, the point is to determine the reason for which the processor accepts a given price level for its food product and the price level of a purchased agricultural product. Secondly, it should be determined why this price level is also acceptable to its market partners. We believe that the basis of this acceptance lies in the processor's benefits. However, transactions at a given price level require the acceptance of the other parties, i.e., the consumer and agricultural producer, which involves the presence of mutual benefits of the consumer and processor on the final product market. Similarly, mutual benefits for the processor and agricultural producer must be available on the agricultural product market.

The baseline for the analysis is the processor and maximizing their goal function. We assume that the processor operates within the two levels of prices, which on the one hand affect their revenues and on the other hand determine their production costs. The price of a final food product is a variable of its revenues, while the procurement price is a variable of its production costs. As demonstrated in the paper, the price levels of agri-food products, maximum levels for the processor and its market partners, i.e., the consumers and agricultural producers, are formed on both markets. The price level for all these market partners is a market value. The partners act as price-takers. The activities of neither the consumer, nor the agricultural producer or processor have an impact on the level of the actual equilibrium price – both of the food product and of agricultural product. In order to reflect the conditions for the maximization of the goal function, we adopt the assumptions of the neoclassical theory of producer behavior, as relevant to the actual conditions of the processor's choice. However, we refer to the production factors in the production functions rather than to the processor's choice. Such an approach derives from the invested capital and creates a production technique underlying the applied technologies and use of inputs. In this paper, we adopt it as a baseline condition following the ceteris paribus principle. According to the purpose of this paper, we refer to the processor's choice with consideration to the two types of direct inputs. These include a resource input (agricultural product) and processing inputs. This creates a production function in relation to inputs, which can be understood as a technological function of the processor. Revenues from the produced and sold volume of the final food products limit the volume of input use, which is understood as a hard budget constraint. The price incurred by these two influences affects the processor's choice, the subject of this paper. The second selection criterion, albeit of secondary importance, is the "productivity"[1] of both inputs. This second criterion refers in particular to the processor-specific conditions on the agri-food market, including the agricultural product market, which is not the area of interest of this paper. Our analysis focuses on the mechanism of price formation at a level acceptable to the market partners. The thesis we present and prove on the basis of an analytical and formal deduction is that there is a mechanism behind the formation of an acceptable price level of a product, both for the processor and consumer on the food market. The same applies to the presence of a mechanism behind the formation of a procurement price level acceptable for both the processor and agricultural producer on the agricultural market. Taking the level of generality into consideration, the reasoning falls within the margins of academic agricultural economics and microeconomics. The paper is of a theoretical and cognitive nature.

Reference to literature

The approach presented in this paper fills a specific research gap. In practice, the literature includes no references to the formation of a price level which is mutually acceptable to the parties, i.e., the consumer and processor, or the processor or producer on both markets mentioned above. The approach of Jovens, followed by Marshal, differentiating between the cost economics (on the part of the producer – supply) and utility economics (on the part of the consumer – demand)[2] may serve as a theoretical prerequisite. Also the Hurwicz's mechanism design theory, in which the parties pursue the maximization of the expected mutual benefits and compatible actions[3] may be a point of reference. When referring to the prices affecting the agri-food processor, the literature describes primarily the issue of price gap between the price level of a final food product and the procurement price level of an agricultural product. The theoretical foundations of price gap formation were developed in Gardner's study (1990). Gardner associated the price gap with the processor's goal function and the method of its maximization with considera-

[1] Productivity can be defined as, e.g., the yield of a final product from agricultural product understood as resource input and processing input.

[2] Jovens referred to the value (price) linking it with utility rather than costs. The manufactured product is a cost, while the purchased product is utility (becomes a good), thus not all incurred costs create a value. Jovens used the equations and deduction (Skousen, 2012), which reflects the approach presented in this paper.

[3] The mechanism designing consists in the game of the parties to obtain maximum benefits, subject to certain assumptions derived by Hurwicz. In particular, there is no mechanism for decreasing the utility of one of the parties to the transaction, which at the same time leads to optimum in terms of Pareto (Jasiński, 2009). This paper does not discuss these issues, however, it determines the conditions for mutual benefits resulting from the parties' utility function, i.e., admitting inequalities for the consumer and processor and the processor and agricultural producer, who derive their benefits and their levels without reducing the benefits of the other party. The above may be also referred to the individual utility functions in relation to the social welfare function (Kot, 2012) and decisions in the theory of games (Kiryluk-Dryjska, 2014).

tion to the resource and processing inputs. This approach is indirectly referred to in this paper. The gap between the price of an agri-food product and the mechanism of its formation has been continued without significant additions in the studies by Tomek and Kaiser (Tomek and Kaiser, 2014), and Hudson (2007), as well as Rembisz (2008), Hamulczuk (2018). There are many papers describing this phenomenon in an evidence-based manner, including journalistic ones, which refer to, among others, the share of a farmer in USD (PLN) spent on food. It is even hard to list them. The differentiating papers include a study by Wough (1990) identifying the integrated two functions of prices of agri- food products, which was used in our paper to a certain extent. The papers referred to above fail to describe how these prices are formed. Some issues regarding the mutual relations between the agricultural producer and processor in the supply chain, with a view to the contract terms, which implicitly and indirectly includes the prices, were discussed by Fałkowski (2015). Similar relations, including price relations between the entities, such as producer and processor in the value chain, based on a reasonable assessment of capacity, were presented by Wieland and Walbenberg (2013). These studies contain only a few references to the mechanism of price formation at the processor's input and output. Such references are presented in this paper. Using a formal and analytical method in a deduction-based approach, we derive the conditions that allow the formation of a mutually acceptable price of a final processed food product and the procurement price level of an agricultural product. The mutually acceptable level means the level acceptable by the consumer and processor on the food market and by the agricultural producer and processor on the agricultural market. According to our hypothesis, such conditions may be formally determined with consideration to the maximization of the goal function of these entities, provided that the processor is the focus of interest.

Two prices in the goalfunction of the processor

The processor can be described in terms of microeconomics with a view to two inputs, i.e. agricultural product and processing inputs, as well as the final product of the processor, in the following manner[4]:

$$\dot{z}_{max} = f(y, n)$$

with the following constraint:

$$\dot{z} \cdot p_{\dot{z}} = y \cdot p_y + n \cdot p_n$$

where:
$\dot{z}$ – food product; y – agricultural product; n – input for processing the agricultural product; $p_{\dot{z}}$ – price of the food product; p_y – procurement price of the agricultural product; p_n – processing input price; all variables are positive, i.e., the price levels and volumes of production and inputs in a given period of time, the time variable (t)

[4] After the approximation and estimation of its parameters, it may be take the following form:

$$\dot{z} = a + b \cdot y(t) + c \cdot n(t) \mp u(t)$$

is excluded. The expression on the left in the constraint is the processor's revenue expressed as the product of the price level and production volume, equal to the sold volume: ($\dot{z} \cdot p_{\dot{z}}$), while the expression on the right side of the constraint is the costs of use of processing input: ($y \cdot p_y$) and processing input: ($n \cdot p_n$). No costs other than inputs are included.

The baseline of this description of the processor is the following production function[5]:

$$\dot{Z} = f(K, L, \xi) .$$

where: $\dot{z}$ – production volume; K – capital factor (machines and equipment); L – labor factor (number of workers; ξ – residual.

The production function determines the relations in the above description of the processor expressed as a certain technological (input) function. The basic function also affects the manner, in which the productivity coefficients of the two direct inputs are derived from this technological function. The technological function of the processor includes the variables from the two markets of interest: final agri-food market, including in particular the prices of food products: $p_{\dot{z}}$ and from the agricultural market, namely the procurement prices and their level: p_y, as well as purchase volume: y.

We assume that the processor is the price-taker on both markets. In addition, it can be assumed that the processor somehow affects the agricultural market, including the procurement prices. This depends mostly on the structure of this market. It needs to be noted that the processor, in a certain period of time, affects the revenues of agricultural producers: $y(t) \cdot p_y(t)$. This is determined by the processor's revenues from sales of its products: $\dot{z}(t) \cdot p_{\dot{z}}(t)$ and costs of processing inputs: $n(t) \cdot p_n(t)$. This defines the available options to pay for agricultural products used as inputs. Thus, the dependencies are simple. The revenues of an agricultural producer are determined or, more generally, affected by the financial capacity of the processor, i.e.:

$$\left(\dot{z}(t) \cdot p_{\dot{z}}(t) - n(t) \cdot p_n(t)\right) \Rightarrow y(t) \cdot p_y(t)$$

This may clearly suggest that the processor has some capacity to form the conditions on the agricultural product market. This capacity results also from the function of the processor's demand for agricultural products, which may be derived from the constraint of the processor's revenues, i.e.:

$$y(t) \approx \dot{z}(t) \cdot \frac{p_{\dot{z}}}{p_y}(t) - n(t) \cdot \frac{p_n}{p_y}(t)$$

Thus, the demand for agricultural products depends on the food production volume in relation to processing inputs and the ratio of final product prices to procurement prices (which is known as the price gap), and the ratio of procurement prices to prices of processing inputs (alternate relationship). These demand variables are somehow independent from the processor in a certain period of time, although

[5] This function and the parameters were approximated and estimated by Firlej (2017).

they depend on the market condition and the applied production technology determined by the basic function (changes are observed over a long-term perspective). The above should be taken into account when referring to the impact of the processor on the procurement price in a given period. The processor's impact on the procurement price for a given period, upon the transformation of the above formula, is determined by the following dependencies:

$$p_y(t) \approx \frac{\dot{z}}{y}(t) \cdot p_{\dot{z}}(t) - \frac{n}{y}(t) \cdot p_n(t)$$

The dependencies are simple[6]. The level of the procurement price is determined by the ratio of the final product price to the price of the resource input needed to produce such a product. The procurement price also primarily depends on the processing efficiency, which is understood in terms of a food product obtained from an agricultural product for a given price level of a final food product, which is reflected by the following formula:

$$\gamma = \frac{\dot{z}}{y} \cdot p_{\dot{z}}$$

The procurement price level also depends on the alternate relationship of processing input to resource input for a given level of a processing input price:

$$\varepsilon = \frac{n}{y} \cdot p_n$$

These processor's functions and associated conditions result in a specific demand on agricultural products of this agri-food processor. This may affect the formation of the procurement price: p_y, which in this paper takes a form of a reverse demand function[7]:

$$p_y = f(y^d, \dot{Z}) \quad \text{for} \quad (t)$$

where:
y^d – processors' demand on agricultural products as inputs (resources) for production; $\dot{Z} = \dot{z} \cdot p_{\dot{z}}$ – processor's revenues as a product of the production volume and sales of final food products: $\dot{z}$ and their prices: $p_{\dot{z}}$, here as a constraint for the purchase volume and procurement price level.

[6] These values are identifiable and constituted the subject of empirical analyses. The estimated price relation of a retail food product to resource input ranges from 0.3 to 0.5, from 30 to 50%. The statistical data on the share of farmer in USD spent for food or the share of farmer in PLN spent for food, are a frequent example. In the past, these indicators decreased, while currently they have stabilized in the range defined above. This process reflects the structure of actual consumer demand with a higher share of services related to processing, trading, and delivery of a product, as well as catering services. All these processes are reflected in the indicators presented in this formula.

[7] The introduction of a procurement price formula which includes the cost $k(n)$, final product price $p_{\dot{z}}$, and the purchase volume as:

$$p_y = \frac{p_{\dot{z}} - k(n)}{y_t}$$

where the procurement prices are inversely proportional to the purchase volume at a given ratio of food product price to processing costs, and proportional to this difference.

The procurement price level is the function of processor's demand for this product and depends on the processor's revenues from sales of final food products, which were processed with the use of the agricultural product.

In the competitive equilibrium conditions, the situation on the final food product market is as follows:

$$\dot{z}(t) \cdot p_{\dot{z}}(\mathrm{t}) \Rightarrow y(t) \cdot p_y(t) + n(t) \cdot p_n(t)$$

The induction symbol used in this formula suggests that the revenue amount is given independently from the processor, since the processor acts as the price-taker. Thus, the processor must adjust the production (processing) costs to the level of food product prices, which are formed on the market in the competitive equilibrium conditions, rather than vice versa. This bears the consequences for the above mentioned formula determining the procurement price level.

The ratio of processor's revenue amount to resource costs is of the key importance for the analyzed issue and takes the following form:

$$\frac{\dot{z}(t) \cdot p_{\dot{z}}(t)}{p_y(t) \cdot y(t)} = \mu$$

This ratio forms a basis to derive a simple formula determining the procurement price level for the processor's revenues, i.e.:

$$p_y(t) = \frac{p_{\dot{z}}(t) \cdot \dot{z}(t)}{y(t)}$$

The interpretation of this formula is obvious. The procurement price level is inversely dependent on the purchasevolume for the given processor's revenues.

The same principle applies to deriving a formula for the price level of the food product:

$$p_{\dot{z}}(t) = \frac{p_y(t) \cdot y(t)}{\dot{z}(t)}$$

The price of this product is inversely proportional to the production volume of final food products and incurred costs of resource purchase.

The final food product price – the consumer perspective

The final food product market operates under certain conditions of competitive equilibrium, including the product price. This is acceptable both for the buyer (consumer) and seller (agri-food processor)[8] . This price is admittable or mutually acceptable, because a transaction – i.e. product purchase – takes place. The research focuses on how this mutually acceptable or admittable price level is formed. It is assumed that it results from certain references to the price level, which is visible (like the market price level) to both parties. Each party has its own perspective or

[8] Given that the reasoning in this paper is general, the role of wholesale and retail sales is omitted.

basis of reference to the market price level, and has different expectations in terms of price. The basis of reference to the price is its impact on the opportunity to exercise the individual goal functions in the sufficient value. The consumer's objective function is the maximization of utility from income. In this case, the main role is played by the price of products whose purchase is associated with the maximization of the utility function. The solution maximizing the utility function requires an equality of the marginal utility of the purchased good with its price level. It may be assumed that the basis of reference to the price of a given final food product for the consumer is its utility[9]:

$$p_{ż}(t) = f\big(u_{ż}(t)\big)$$

It may be pointed out that this utility – i.e. food product utility – is a component of a general utility function. If it referred to two products (goods) – i.e. the food product and other products (industrial products and services), that is to say non-food products, we receive the following equation:

$$u_{max} = f(ż, nż)$$

where:
$nż(t)$ – the consumption of non-food products in a given time period; $u_{ż}(t)$ – food product utility; $u_{max(t)}$ – maximized total consumer utility; other symbols as above.

The impact of the consumption of each of these products on total utility as the consumer's goal function may be assessed by differentiating this function. As a result (skipping the transformations)[10], the following equation can be derived:

$$du = (\partial u/\partial ż) \cdot \Delta ż + (\partial u/\partial nż) \cdot \Delta nż \qquad \text{for a given } (t)$$

where:
the first expression of the above equation on the left expresses the impact of changes in consumption on the consumer's utility, where: $\frac{\partial u}{\partial ż}\frac{1}{t} > 0$ is a marginal utility of a food product for a given time period (t).

We know that the consumer maximizes its utility function where the marginal utility of a product equalizes with its price:

$$\frac{\partial u}{\partial ż}\frac{1}{t} = u`_{ż}(t) = p_{ż}(t)$$

We also know that both marginal and average utility decrease along with an increase in consumption, which affects the acceptable price of a food product. When analyzing the implemented conditions, it should be noted that food and non-food products compete for income or expenditure of the consumers within the given constrains. This results in the following equations:

[9] Determination in time (t) is omitted.

[10] For a general case in Rembisz and Sielska (2015).

$$m(t) = \dot{z}(t) \cdot p_{\dot{z}}(t) + n\dot{z}(t) \cdot p_{n\dot{z}}(t)$$

and:

$$\pm\Delta\dot{z} \cdot p_{\dot{z}}(t) = \mp\Delta n\dot{z} \cdot p_{n\dot{z}}(t)$$

where: $p_{n\dot{z}}$ is the price of non-food products.

With regard to the hypothesis on the decreasing utility of food products, such a situation affects the competitiveness of expenditure on food products compared with other expenditures. This translates into a demand for food products, which constitutes one of the key variables for the processor. Accordingly, demand is related to the food product price and other variables, including the prices of non-food products and consumer income. This demand can be determined using the penultimate equation:

$$\dot{Z}(t) = \frac{m}{p_{\dot{z}}}(t) + \frac{p_{n\dot{z}}}{p_{\dot{z}}}(t) \cdot n\dot{z}(t)$$

which means that the demand for agri-food products, de facto assumed or given in advance, depends on the level of relative food price, i.e. the ratio of the price of these products to the consumer income, i.e.: $\frac{m}{p_{\dot{z}}}(t)$ [11]. This is associated with Engel's law, which *de facto* means a relatively decreasing demand for these products. The other important variables also include the alternate demand and price competition, which occurs in a given time from non-food products: $\frac{p_{n\dot{z}}}{p_{\dot{z}}}(t)$ and the value of actual demand for the latter products: $n\dot{z}(t)$. All these variables can be included in the projections.

The essential issue for analysis in context of this paper's objective – that is, the formation of food prices – is the basis of reference of the purchaser (the consumer) to the price of this product, which gives[12]:

$$p_{\dot{z}}(t) = f\left(u_{\dot{z}}(t)\right)$$

It is assumed that this basis is an average utility rather than marginal. The reason is that, according to the analysis of the utility function, the equalization of marginal and average utility determines the reasonable level and inflection point in the hyperplane of total utility function.

[11] Some elements of the ratio of income to food prices analysis (Lee, Schulter, O'Roak, 2000).

[12] This analysis will be performed without distinguishing whether the food product is domestically produced or imported. We consider only the utility in relation to the product price. Import definitely affects these relations and creates conditions for competitiveness and food consumption sensitivity (Gorzałczyński and Przybyliński, 2018).

The price level of food product for the processor

A question arises as to what is the point or basis of reference of the processor for the price level of food product, which is determined on the market and independently from the market. We must remember that the processor is the price-taker and operates on the market with competitive equilibrium, as agreed above. In order to answer this question, we performed the analysis in the same way as previously. We assume that the processor's objective function is to maximize profit. This is achieved by the processor, like each processor in the microeconomic environment, when it equalizes the cost of production (marginal and average) with the price of its product, which is the exogenous variable. As already mentioned, this statement is important and obvious on the final food product market operating in full competitive equilibrium. Thus, the processor must always compare the market price of its products with the unit (average) costs of its production:

$$p_{\dot{z}}(t) = f\big(c_{\dot{z}}(t)\big)$$

where:
$c_{\dot{z}}$ – average unit costs of production of the final product by the processor.

These unit costs: are specified as follows:

$$c_{\dot{z}}(t) = \frac{y(t) \cdot p_y(t) + n(t) \cdot p_n(t)}{\dot{z}(t)}$$

As we can see, the level of these costs depends on the scale of production $\dot{z}(t)$, as well as other variables, including the procurement price level $p_y(t)$ and purchase volume $y(t)$ in a given time. The processor only affects the production volume. Its increase, which facilitates among others the process of concentration and specialization[13], affects the processor's reference to the market level of agri-food product price. From this perspective, the processor should pursue the following relation:

$$p_{\dot{z}}(t) \geq c_{\dot{z}}(t) = \frac{y(t) \cdot p_y(t) + n(t) \cdot p_n(t)}{\dot{z}(t)}$$

In other words, in the existing competitive market conditions, the processor is forced to adapt its costs to the price level rather than vice versa[14]. The basic way

[13] In practice, such increase in scale is required and ensured by the recipients, i.e. the retailers, including large retailers and discount stores, which prefer the processors ensuring a large scale of production. This attitude results from, among others, the discussed formula and is sometimes contested by some socio-political stands, including in particular populist addresses.

[14] In monopolistic conditions of the processor, it is the processor who adapts the production volume to the price level of food products (determined by the processor) in relation to the production costs. The price level will be expressed in the following way:

$$p_{\dot{z}} = p_{\dot{z}}(\dot{z})$$

This reverse demand function demonstrates that the processor sets the production volume adequately to the above mentioned price level (to sell all products), thus affecting this price level, which is derived from the following formula: $\frac{\partial p_{\dot{z}}}{\partial k_p} > 0$ (see Tokarski, 2011).

to do this is to reduce the average costs, in most cases, by increasing the production. Such activities also improve the input use efficiency indicators: agricultural products: $(\frac{n}{\dot{z}}\downarrow)$ and other products: $(\frac{y}{\dot{z}}\downarrow)$ included in the formula. In most cases, this process is accompanied by increasing the share of the processor's products on the market, which gradually affects the price: $p_{\dot{z}}(t)$ in a given time period. The other issue is increasing the utility of the produced agri-food products[15], which should be reflected by a price increase $p_{\dot{z}}(t)$. The formula includes the procurement prices as our field of interest: $p_y(t)$. We assumed that the formation of their level is independent from the processor, although the processor's impact on their level, as indicated above, is more probable in terms of the processor's impact on the prices of food products. This results directly from the cost formula. The processor, increasing the scale of production, also needs to increase the purchase, which affects the procurement price level. These are the natural market processes.

These conditions comply with the term of the economic optimum of the producer, in this case the agri-food processor, which specifies the basis of reference of the producer in more detail in terms of the market price of its product. The formula reflecting the economic optimum is as follows:

$$p_{\dot{z}}(t) = c_{\dot{z}}(t) = c`_{\dot{z}}(t)$$

This indicates the equality of the levels of final product price with average costs, and the equality of average costs with the level of marginal costs. The same can be derived from the zero-profit assumption, which refers to the market in a competitive equilibrium state (as the sine qua non condition). This assumption is usually valid in the conditions of the final food product market and affects the basis of reference of the processor to the price level of a final product, which should be reflected by the following formula:

$$p_{\dot{z}}(t) = f\left(c`_{\dot{z}}(t)\right) = f\left(c_{\dot{z}}(t)\right)$$

The latter component of these functions will be included in further analysis.

Consumer and processor with reference to the price level of food product

The market level of food product price is a common reference for the consumer (buyer) and processor (seller)[16]. We assumed that this price is the equilibrium price, which is equally visible on the market to the consumer and the producer, and equally independent from them. However, the latter part of the assumption may be questionable. We will consider it valid, since the competition related to supply – i.e. to the processors – seems to be quite obvious. According to these assump-

[15] This is usually associated with improved quality, compliance with H&S requirements and utility requirements.

[16] There are also wholesalers, retailers, transport, marketing, etc., costs which are covered by the margin on the price actually earned by the processor. The same applies to VAT. At this level of generality, we recognize this value as a given value in a market price paid by the consumer and received by the processor, including this margin. The above derives from the reductionism method necessary for theoretical and cognitive reasoning.

tions, both entities are the price-takers. We established the basis of reference of both analyzed entities to the equilibrium price, i.e. to its level. We did not find why the consumer and the processor accept, or agree on this market price level of a food product, and, as a result, whether they conduct the purchase and sales transactions according to this level.

It is obvious, that the above must be associated with benefits from sales and purchase of the same product at this price level. The benefit for the consumer is where the level of market price is below its utility assessment of this product. The equality of price and utility determines its optimum choice. This means that this equality is the limit of the profits[17]. The same applies to the processor's benefits. If the level of market price exceeds the cost basis referred to above, i.e. average cost, this may lead to extraordinary profits, i.e. the processor's benefits. The limit of benefits is the optimum state, in which the average cost (equal to marginal cost) is equal to the price. This situation is called a zero-profit situation, in which there is a return on the invested capital at the level of its productivity and the costs of use of resources and other inputs with applicable margins are covered. Both parties – i.e. the consumer and the processor – have adequate expectations with respect to the value of benefits from the ratio of price to utility and costs. This affects their market behaviors. Both parties somehow design these behaviors with a view to gains, which, in a simplified form, may be perceived as an example of the Hurwicz's mechanism design.

Thus, a question about the consumer's gains arises. We may assume that the consumer expectations refer to inequalities[18]:

$$(p_{ż}^{*}(t) \leq u_{ż}(t)) \succ (p_{ż}^{*}(t) = u_{ż}(t))$$

The consumer expects that the market equilibrium price: will be lower than its subjective assessment of the product's utility (for specific income and preferences), which prioritizes this inequality over an optimum choice[19]. The relationship determined by inequality is the consumer's benefit. This can be also expressed as the consumer's surplus, although these terms are not exactly the same. The benefit is a positive value:

$$(u_{ż} - p_{ż}^{*}) > 0 \qquad \text{or} \qquad \frac{u_{ż}}{p_{ż}^{*}} > 0$$

Analogically, another question about the processor's benefits arises. Following the same logic, we may determine the expectations of the processor with respect to a potential benefit for a given market price level (equilibrium). The processor expects, or hypothetically projects, that the market price level could be higher than the level of its average production costs, which are a subjective and completely dependent on the processor variable. The processor expects that the following condition will be met:

[17] When this situation occurs in the basket of food products and non-food products, i.e. the prices are equal to the utility of these two goods, we may also speak of the optimum in terms of Pareto.

[18] We ignore the symbols of the expected value: and focus only on the essence of this issue.

[19] The equality of price and utility of the product.

$$p_{ż}^{*}(t) \geq c_{ż}(t)$$

The processor prefers this solution over the condition of optimum choice, because the first option guarantees extraordinary profits, which is reflected by the following equation:

$$\left(p_{ż}^{*}(t) \geq c_{ż}(t)\right) \succ \left(p_{ż}^{*}(t) = c_{ż}(t)\right)$$

The benefit must be a positive value:

$$\frac{p_{ż}^{*}}{c_{ż}}(t) > 0 \quad \text{and} \quad \left(p_{ż}^{*}(t) - c_{ż}(t)\right) > 0$$

These conditions are obvious to each processor and implemented in each favorable situation.

The above expectations are not always met. What is more, when these benefits occur, they may relatively quickly decrease or disappear. They encourage both entities to behave in a specific manner. These behaviors of both entities change the situation and the ratio of the level of equilibrium price to utility and average costs as the reference points. Such benefit encourages the processor to increase production and sales, which may lead to a decreased price of the final product and therefore to reduced inequality understood as the benefit resulting from the new lower price level of food product. The processor will behave in such a manner in the competitive conditions, because they want to obtain the most benefits. Although they are aware that such an approach may lead to a decrease in the equilibrium price and in this benefit, they continue doing so. The processor does not know how the competitors – who are also focused on their profits – will behave. This approach is known from the theory of benefits as the prisoner's dilemma. Only when the processor is in a quasi-monopolistic situation can they control the price level and value of benefit. Similarly, the consumer's benefit may encourage the increase of purchases of a given food product. This increases the demand, because the gains are similar for the vast majority of the consumers. As a result, the price level of this product may increase, which means a decrease in the favorable inequality between the market price level and its assessment in terms of product utility. From the perspective of the consumers, the demand for the final food products fully meets the conditions of perfect competition. Therefore, it is hard to concert these behaviors, the more so that no consumer can influence the location and slope of the demand curve. Herd behaviors prevail. In the case of the vast majority of final agri-food products as the basic goods, all fundamental rights and principles are observed (Woś, Rachocka, Kasoerek-Hoppe 2011). The sustainability of demand for these products objectivizes and standardizes mass behaviors. These are the components of the basic behavioral mechanisms of market entities (Rembisz and Sielska, 2015; Morgan, Katz, and Rosen, 2009).

One may assume that the purchase and sales transactions take place, i.e. the food products are sold by the processors and purchased by the consumers, when there are benefits defined as above. They may be present in an adequate ratio. These mutual gains are the essence of reasoning and mechanism of accepting the equilibrium price level by the consumer and processor understood as the formation of a mutually acceptable price level of food product. It may be assumed, for example, that mutual benefits are relatively equal, though this condition is not necessary. It may also be assumed that the presence of a transaction, i.e. the transformation of a food product into a good (purchase), the following condition should be met:

$$\left(u_{ż}(t) \geq p_{ż}^{*}(t)\right) \approx \left(p_{ż}^{*}(t) \geq c_{ż}(t)\right)$$

This is of key importance, because it means that the consumer accepts the processor's product offered at a given price, and therefore accepts the costs of its production. This is also of importance due to the presence of competitive equilibrium condition – the consumer may de facto choose between many processors, and may also withhold the purchase. This condition is equivalent to:

$$\left(u_{ż}(t) - p_{ż}^{*}(t)\right) \approx \left(p_{ż}^{*}(t) - c_{ż}(t)\right)$$

Both components of this formula (in order to emphasize the approximate values a symbol of a lesser strength than equality was adopted) have positive values, which means mutual benefits. In accordance with the above, the equilibrium price (its level) is a common price for the consumer and the producer in terms of their expectations and projections of their behaviors – following the thesis that at the beginning, this price is too high (consumer), and too low for the other one (processor). Their behavior mechanisms lead to a consensus which can be expressed as follows:

$$p_{żk}(t) > p_{ż}^{*}(t) > p_{żp}(t)$$

and finally as:

$$p_{żk}(t) = p_{ż}^{*}(t) = p_{żp}(t)$$

where:

$p_{żk}$ – the price of a food product projected by the consumer;

$p_{żp}$ – the price of a food product projected by the processor.

These relationships resulting from the consumer and processor behaviors and affecting the projection of their expectations with respect to the price level of food product are of key importance. They form the demand conditions for the supplier, including in particular in terms of the price level of its final product. This undoubtedly affects the processor's approach to the procurement price level of the agricultural product.

Procurement price level in choosing the agri-food processor

For the processor, the procurement price level of the agricultural product is the basic and crucial component determining the value of the production costs of the food product. In the assumed conditions of competitive equilibrium[20], these costs of processor (price-taker), for a given price level of a final product in time (*t*), are usually minimized. This takes place in particular when the processor is unable to transfer the cost effect of the increase in the procurement price level on the price level paid by the final recipient, i.e. consumer, in the conditions of competitive equilibrium. It seems that such a situation is relatively typical for the processor in the existing market conditions in Poland and the vast majority of the EU Member States. Thus, for this situation, we will solve the issue of maximizing the processor's goal function as the basis of its reference to the procurement price level. With regard to the above, the basis of reference will be the reverse output function of the processor with the minimization of costs as the goal rather than the output function of the processor. In the processor's function, the procurement price is a component of cost constraint, the so-called isocosts. This is a line, on which the purchased agricultural products (as resource inputs): y and their prices: p_y, as well as inputs for resource processing: n and prices of these inputs p_n are recognized. The isocost line expresses the amount of costs incurred for the processor's production. This value is therefore a subject of minimization at a given production volume as a constraint. Thus, for a given (*t*), the output function of the processor is as follows:

$$kp_{min} = y \cdot p_y + n \cdot p_n$$

for a given processor's goal function:

$$\dot{z}^x = f(y, n)$$

where:
kp_{min} – minimized production costs of the processor; other symbols as above, i.e.: $n \cdot p_n$ – processing costs as a product of processing inputs and their prices; $y \cdot p_y$ – costs of purchase of agricultural product at the procurement price – costs of resource inputs, $\dot{z}^x$ – the assumed production volume; all variables for a given time (*t*).

For the processor's function expressed in this way, subject to the above-mentioned conditions of the final food product market, the processor's objective function – i.e. profit – can be maximized by means of the minimization of costs of used inputs necessary to achieve a given production volume, at the given final prices of food products. This takes place in the ratio of: ($\frac{\dot{z}}{y,n}$), which is *de facto* a given productivity from these outputs, which is associated with the used technique and

[20] The assumption on the conditions of competitive equilibrium on the retail food market, although disputable, is usually fulfilled. There may be also other market structures, for example of certain competitive advantages or monopolistic position of the processor, which would allow for the impact on the price level of final food product.

technology of production applied by the processor and expressed, as already mentioned, by the production function: $\dot{z} = f(K, L, \xi)$.

This issue is solved with the use of the Lagrangian conditional function:

$$\mathrm{H} = kp - \lambda(f(y,n) - \dot{z}^x$$

and:

$$\mathrm{H} = y \cdot p_y + n \cdot p_n - \lambda(f(y,n) - \dot{z}^x$$
$$\mathrm{H} = y \cdot p_y + n \cdot p_n - \lambda(f(y,n) + \lambda\dot{z}^x$$

Thus, upon calculating the first derivatives (the second derivatives are assumed to be negative) of variables, i.e. the inputs: agricultural product: y, processing inputs: n, and an undetermined multiplier: λ for the given prices of these inputs, we compare them with zero as the extremum condition:

$$\frac{\partial \mathrm{H}}{\partial y} = p_y - \lambda\left(\frac{\partial \dot{z}}{\partial y}\right) = 0$$
$$\frac{\partial \mathrm{H}}{\partial n} = p_n - \lambda\left(\frac{\partial \dot{z}}{\partial n}\right) = 0$$
$$\frac{\partial \mathrm{H}}{\partial \lambda} = \dot{z} - f(y,n) = 0$$

These extremum conditions determine the minimization of the input costs incurred for the production of a given volume of food products for the processor's function referred to above. The Langrange multipliers and their economic interpretation are of importance at this point. When solving the first two conditions[21] with the use of this multiplier, we receive:

$$\lambda = \frac{p_y}{\partial \dot{z}/\partial y} \quad \text{and} \quad \lambda = \frac{p_n}{\partial \dot{z}/\partial n}$$

which may be interpreted as profit in terms of marginal productivity from a monetary unit spent by the processor on an agricultural product or input for its processing. Needless to say that the greater the productivity, the lower the production costs of a food product incurred by the processor. From the perspective of the analyzed issue, i.e. the reference of the processor to the acceptable procurement price level, this is a clear indication. The processor refers to the procurement price level considering the productivity of inputs in a given time, that is:

$$p_y(t) = \frac{\partial \dot{z}}{\partial y}(t)$$

This formula acts as a basis of productivity, which the processor may refer to the procurement price level and which is associated with the maximization of the goal function in the conditions of a competitive market for final food products in a given time period. It is obvious that the greater the input productivity, the lower the costs

[21] The third condition is of balance nature.

of the final product. Thus, the processor, in accordance with λ, may be willing to pay for a given input, including accept a higher procurement price level (its higher level will be acceptable to the processor). In most cases, the way to achieve a higher input productivity leads to a more intensive processing of agricultural resources. The dependencies are mutual. The increase in the procurement price level forces the need for its more intensive processing to achieve higher productivity, while improved productivity allows for the acceptance of the higher procurement price:

$$p_y \Leftrightarrow \frac{\partial \dot{z}}{\partial y}$$

When considering the ratio of processing input productivity to its price, i.e.:

$$p_n(t) = \frac{\partial \dot{z}}{\partial n}(t)$$

the issue of substitution between these inputs, i.e. agricultural product and inputs for its processing seems to be obvious. This is determined by the relations of their productivity (understood as utility for the processor from the perspective of minimizing the costs for production of a final food product unit) and the relations of the price levels. This also determines the basis of reference of the processor to the procurement price level. This may be proved in terms of the productivity and substitutability of processing inputs to achieve (constrained in advance) the production volume of the final food products, resulting from the demand on a competitive market, for a given time (t). We receive:

$$d\dot{z} = \left(\frac{\partial \dot{z}}{\partial y}\right) \cdot \Delta y + \left(\frac{\partial \dot{z}}{\partial n}\right) \cdot \Delta n$$

Both expressions on the right side of the equation demonstrate the impact of changes in the use of both inputs, including the resource input (agricultural product) on the processor's production volume. This specific change of using the input: $\Delta y(t)$ and $\Delta n(t)$ is weighted by the above-mentioned marginal productivity of resource input: $(\frac{\partial \dot{z}}{\partial y}\frac{1}{t})$ and processing input: $(\frac{\partial \dot{z}}{\partial n}\frac{1}{t})$ in a given period of time. Following the theory of production function, these marginal productivities, may have positive values, approximating zero, or negative values for a given input. According to the right of decreasing productivity revenue for a given production function, they usually follow a decreasing course, yet demonstrate positive values. This may be adjusted upwards (moving the function curve up) only by technological progress and innovation. This means a dislocation of the input function and productivity (Tokarski, 2011), and is achievable by investments made by the processor. These investments change the factor relations in the basic function[22], i.e.: $\dot{Z} = f(K, L, \xi)$ and, as a result, change the technological input function and input use efficiency, as indicated above.

[22] The basic function may have different estimable analytical forms, for example, the most common:

$$\dot{z} = A \cdot K^a \cdot L^b \cdot e^{ut}$$

When assuming that the basic function and its location is given in advance[23], i.e. when we refer to a given production volume using a given production technique in a given period of time, the total production growth is equal to zero. In such case, the exact differential is equal to zero, i.e.: $d\dot{z} = 0$ to: y and n. Thus, the maximization of the processor's goal function involves a substitution between these inputs (resource and its processing) in terms of their marginal productivities in a given time (t), which may be linearly expressed as:

$$s_{\frac{n}{y}} = \frac{\frac{\partial \dot{z}}{\partial y}}{\frac{\partial \dot{z}}{\partial n}} < 0$$

Considering the equation of income constraint for the processor and the relations of input prices, we determine the substitution of these inputs. In most cases, the substitution of resource input for its processing (or reversely) due to the relation of prices of both inputs in a given time (t), in which the product price increases more rapidly than the price of processing input can be expressed as follows:

$$s_{\frac{y}{n}} = \frac{\Delta y}{\Delta n} = -\frac{p_y}{p_n} \qquad \text{for} \qquad \frac{\Delta p_y}{\Delta p_n} > 0$$

The substitution of resource input by processing input, i.e. more intensive processing of an agricultural product, depends on the relations of prices of these inputs. Increased procurement prices must lead to more intensive processing of an agricultural resource, in particular when it is higher than the increase in the processing input prices, which is very common (Szczepaniak and Firlej, 2015). This results directly from the processor's goal function and the assumption determined by the exact differential equal to zero. The comparison of these marginal rates of substitution for agricultural product input by the processing input determines the conditions acceptable for the processor in terms of the price level of both these inputs. After minor transformations for a given (t), we receive:

$$s_{\frac{y}{n}} = \frac{\Delta y}{\Delta n} = -\frac{p_y}{p_n} = \frac{\frac{\partial \dot{z}}{\partial y}}{\frac{\partial \dot{z}}{\partial n}}$$

which determines the optimum structure of inputs for production of a food product at a given market price (established as in the first part of the paper) and the conditions for increasing the use and acceptable input price level with regard to its productivity for an agricultural product:

$$\frac{\partial \dot{z}}{\partial y}\frac{1}{t} \cdot \Delta y(t) = p_y(t)$$

and for processing input:

$$\frac{\partial \dot{z}}{\partial n}\frac{1}{t} \cdot \Delta n(t) = p_n(t)$$

[23] This may be related to a demand constraint resulting from a competitive equilibrium on the food product market, which seems to match the reality.

When referring to the first formula, it is seen that the acceptable procurement price level for the processor is determined by the marginal efficiency of agricultural product processing and the capacity to use the increased resource input. The same applies to the resource inputs for processing. The marginal productivities, including: $\frac{\partial \dot{z}}{\partial y}$ and the capacity to use the increased resource input: $+\Delta y$, are mostly determined by the basic function of the processor: $\dot{z} = f(K, L, \xi)$. These dependencies determine the point or basis of reference of the processor to the procurement price level. To simplify, this results from the utility of input, i.e. the agricultural product for exercising the processor's goal function. It is therefore difficult to expect that the processor would accept a higher procurement price than determined on the basis of these dependencies. This has implications for the agricultural market and value chain, including the hypothesis on value extraction or transfer of surplus value (Czyżewski, 2017).

Procurement price level for the agricultural producer

In contrast to the processor, the procurement price level for the agricultural producer is a variable being a revenue component. The value of revenue is expressed as: R, revenue is a product of volume[24] of the sold product: and its price level: p_y:

$$R(t) = y(t) \cdot p_y(t)$$

It should be assumed that the value of revenue should cover the costs of the involvement of the production factors by the producer according to their actual inputs and remunerations[25]:

$$y(t) \cdot p_y(t) = R(t) \geq K(t) \cdot p_K(t) + L(t) \cdot p_L(t) + Z(t) \cdot p_Z(t)$$

where:
$K \cdot p_K + L \cdot p_L + Z \cdot p_Z$ – the costs of the involvement of production factors, the costs of production excluding the costs other than inputs; individual variables; – approximate inputs of the production factor of capital, labor factor, and land factor; variables: are the costs of the involvement of these factors, and at the same time their remunerations, which are financed from the producer's revenue; the products on the right are mostly the costs of inputs of the individual production factors[26].

[24] The measure of this volume is usually quintal or ton.

[25] See the approach by Kleinanss (2014) derived from the theory by J.B. Clark (Binswanger, 2011), where the involvement or engagement of a given factor is weighted by its remuneration, which affects market conditions, e.g. interest rate, market wages and land rent. Also, the understanding of the production factors follows Woś andTomczak (1983), and Smędzik-Ambroży (2018).

[26] In strict economic terms, according to the alternative uses of inputs of these factors or market prices of these inputs, or remunerations in these alternative uses, as presented by the authors and vast majority of recommended handbooks on microeconomics.

The importance of the procurement price level is obvious. It acts as a variable forming the agricultural producer's revenue and should cover the average costs of the use of inputs of the production factors[27]. Using the above-mentioned formula, we receive:

$$p_y(t) \geq \frac{K(t) \cdot p_K(t) + L(t) \cdot p_L(t) + Z(t) \cdot p_Z(t)}{y(t)}$$

Another issue is whether the product price adjusts to the production costs, or whether it is the opposite, i.e. the costs, as a subjective category, are adjusted by the producer to the market procurement price level. We adopt the latter approach as binding, which is associated with the assumption on the presence of conditions similar to competitive equilibrium on the purchase market, where both the producer and processor are the price-takers[28].

Acceptable price level for the processor and agricultural producer

For both parties, i.e. the agricultural producer and agri-food processor, the market procurement price (equilibrium price), determined as: is an exogenous market point of reference and is independent from each of them. Each of these entities is de facto a price-taker, and the market operations of neither the producer nor the processor change, at least essentially, the procurement price level[29]. In the case of the producer, this price affects the actual revenue:

$$R`(t) = y(t) \cdot p_y^*(t)$$

In the case of the processor, this procurement price as the equilibrium price affects the actual costs:

$$kp_{ż}(t) = y(t) \cdot p_y^*(t) + N(t)$$

where: $N = n \cdot p_n$ costs of other processing inputs.

The procurement price as the equilibrium price is located on the two opposite sides in the goal functions of both entities, which confirms the previous comments and remarks. For the processor, it is located on the side of the costs, in contrary to the price of the final agri-food product (revenues) which was analyzed above.

[27] The costs other than inputs, e.g. taxes, contributions to the Agricultural Social Insurance Fund or the Social Insurance Institute, etc. are not included.

[28] This assumption actually reflects the reality and has no visible competitive advantages. There is also no price intervention, the sectoral intervention programs are not based on the procurement price. The core instrument of the agricultural policy is the direct payments made outside the market scheme, which does not disturb the mechanism of procurement price formation.

[29] It is the opposite in the case of the operations of a certain group of producers and processors. Usually the group of agricultural producers is larger or significantly larger than the group of processors. Thus, the potential impact of the processor's operations on the procurement price level is greater. This is a separate issue associated with the (agricultural) market structure and the arising conditions of competitive or monopolistic advantages. The impact of these operations on the formation of conditions allowing the mutually acceptable procurement price level may somehow change the perspective of analysis and requires a separate paper. A competitive advantage of a buying processor is usually pointed out (Czyżewski, 2017; Firlej, 2017).

These obvious issues are emphasized due to their impact on the mechanism of the procurement price formation from the perspective of the processor. Both parties, i.e. the producer and processor, have their own, different expectations with respect to the procurement price level as the equilibrium price. The basis of such expectations are their own maximized goal functions, i.e. income (agricultural producer) and profit (agri-food processor).

For the agri-food processor, the procurementprice is not only the component of processing costs. Its level results from or is the function of the price level of final food product , in a given technology, established on the market in a given period of time (t):

$$p_y^* = f(p_{ż}^*)$$

This is the basic perspective of the processor, when they refer to the procurement price level as the equilibrium price, i.e. a variable given in advance. The processor must see the procurement price level from the perspective of the final food product price, the production of which requires buying the agricultural product at this price. We can also present it in analytical terms. The procurement price level, as seen by the processor, is derived from the final food product price as follows:

$$p_y^*(t) \Leftarrow p_{ż}^*(t)$$

This takes place, as we frequently emphasize, when certain conditions of competitive equilibrium on the market of final agri-food products are met. However, there can be an opposite situation, in which the procurement prices affect the final prices of food products. This may happen in the case of deficiency of agricultural product or control of their supply in effect of, for example, institutional and intervention activities, as well as in the case of disturbed competitive equilibrium in a given time period (including insufficient supply) on the final product market. In such a case:

$$p_y^*(t) \Rightarrow p_{ż}(t)$$

In this situation, the processor would establish their prices (received for food products) with regard to the procurement prices (paid prices). This issue is frequently brought up in the media and results from price transmission indicators (Rembeza, 2010; Olipra, 2020). In the conditions of strong competition on the final product market, this situation cannot take place. We will ignore this issue in further analysis, but it should be noted that it is associated with a price gap:

$$a = \frac{p_{ż}(t)}{p_y(t)} \qquad \text{for} \quad a > 1.$$

The greater the price gap, i.e. the higher quotient, the weaker the impact of change in the procurement price on retail price and vice versa.

Considering the discussed procurement price as the equilibrium price and the processor's perspective, it is assumed that the following condition is or should be met:

$$p_y^*(t) < p_{ż}(t)$$

Thus, the final price of a food product is higher than the procurement price, *implicite* considering the technological conversion factors of processing the resources in a final product. In the context of *willingness to pay* (WTP)[30], the processor would be willing to pay for an agricultural product (as an input) at the procurement price: p_y, where it achieves a benefit in the form of reduced production costs. This is met when, instead of the acceptable price level: $p_y(t)$, it will pay less: $p_y^*(t)$ that is when the following condition is met:

$$p_y(t) > p_y^*(t)$$

In such a case, the processor achieves a surplus, i.e. a reduction of costs to the planned level, for example, which forms a basis of extra profit. In the production costs of the final food product at the price: $p_ż^*(t)$, the processor planned the price level: $p_y(t)$, while they actually paid: $p_y^*(t)$ that is, according to the above-mentioned formula, less than planned. In such an event, the processor will increase purchases. As a result, the market level of the procurement price: p_y^* may grow to the level of $p_y(t)$, i.e.:

$$p_y(t) = p_y^*(t)$$

This mechanism is known from the price cobweb model.

The agricultural producer will expect the procurement price level as the equilibrium price to cover the production costs at a given production volume. The processor will expect the procurement price level on the market to allow the minimization of the costs of processed agricultural product as a resource for production of a final food product at the retail (wholesale) price established on the market. In formal terms, we may assume that the procurement price level for the agricultural producer is the unit (average) cost function:

$$p_y^* = f(k_p) \qquad \text{for a given } (t)$$

The agricultural producer may adjust to the procurement price or expect that the procurement price will adjust to the average costs: $k_p(t)$. However, the mechanism of price formation on the market is unclear. According to Jovens, the production costs – as a subjective and individual category – should be adjusted to the price as an objective (market) category and not the reverse. However, the impact of the organizations and political force of the agricultural producers on the agricultural policy and intervention programs may invert and frequently inverted these principles.

An inverse procurement price formation system, based on a theoretical assumption, the so-called production and cost formula, has operated in the public intervention purchase scheme within a centrally planned economy. This cost and production basis for the procurement price is also one of the prerequisites of the so-called price intervention, i.e. maintaining the price in order to adjust it to the production costs calculated as the average costs. This is also how the costs in the agricultural sector and

[30] Trendy terms in literature: *willing to pay* (WTP), and, previously in the text, *willing to supply* (WTS).

its components are calculated. This is a separate issue, which refers to the market and intervention, as well as understanding the production costs, and affects the mechanisms governing the choices made by the agricultural producers (Rembisz, 2010).

The key point from the perspective of this analysis is that in the eyes of the producer, as indicated above, the procurement price formed on the market should meet the following condition:

$$p_y^*(t) \geq k_p(t)$$

This is regardless of whether the producer adjusted their costs as an exogenous and subjective category to the procurement price of the product acting as a "price-taker" or reversely – as a "price-maker". The latter situation frequently takes place, where the price intervention adjusts the procurement prices to the average production costs, although – as mentioned above – this is a separate issue. The procurement price level established by a market mechanism is an objective reference for the agricultural producer. From the standpoint of the agricultural producer for a given demand: $d_y(t)$, it is a function of agricultural product supply on a given market. The producer participates in the formation of supply on the basis of its earlier production decision concerning the price. When implementing the results of this decision, the producer adopts a given procurement price level (of the product) as a specific variable – exogenous and market-based (the producer may also withhold the decision, although its action will not affect the market condition). The procurement price level (of the product) is as follows:

$$p_y^*(t) = f\left(\frac{d_{y(t)}}{y(t)}\right) \quad \text{for } y > 0$$

or in analytical terms:

$$p_y^*(t) \approx \frac{d_y(t)}{y(t)} \qquad \text{for } y > 0$$

It is obvious that the greater the supply of agricultural products for a given demand, the lower the procurement price. This triggers the attempts of interventional impact on the formation of the procurement price. These attempts were focused, according to the above-mentioned formula, on decreasing the supply (e.g. the scheme of warehouse receipts or state reserves) in order to maintain or increase the price level.

The procurement price level: p_y^* may also be a determiner or rather result from the production costs generated by the least efficient agricultural producers (the highest production costs). In such case, the producer surpluses do not occur. The surplus is used by the producers, who would be willing to supply products on the market at the prices below the procurement price, i.e. for:

$$p_y^*(t) > p_y(t)$$

because their price: is equal to the average costs generated by the more efficient producers:

$$p_y(t) = k_p(t)$$

All producers using the surplus will reduce the costs to the level falling within the price: p_y. This reflects the efficiency-based market regulation.

The above derivations of the formulas and related comments lead to the subsequent formulas determining the bases of favorable relations between the expectations of an agricultural producer and agri-food processor with respect to the procurement price level. The point is to achieve equal gains by both entities. As mentioned above, the procurement price is a common and exogenous variable for both the agricultural producer and processor. Considering the fact that the conditions of competitive equilibrium are met, which does not differ from the reality, it is also assumed that both these entities are price-takers[31].

The above reasoning may form a basis to determine certain admitting inequalities, which somehow refers to the Hurwicz's ideas (Rembisz, 2020). It may be assumed that a state of equilibrium or equality between the expectations as to the economic benefits of both the producer and processor takes place, when the following equation is met:

$$p_y^*(t) \geq k_p(t) \quad \text{and} \quad p_y^*(t) < p_{ż}(t)$$

that is:

$$p_{ż}(t) > p_y^*(t) \geq k_p(t)$$

This in fact describes the essence of market regulation. Generally speaking, it is about the satisfaction of both parties to the transaction. In formal terms, this is a scheme of specific equilibrium between the expectations of the agricultural producer and the food processor (in the food chain) with respect to the procurement price level. Mutual expectations on the level or amount of the procurement price must be admitting. In other words, these expectations should be compatible to make a transaction. This means that the procurement price level of the product should be, on the one hand, lower than the price level of the final food product, while on the other hand the price level should be higher than the level of subjective average costs of the agricultural product that is the subject of purchase.

Both the producer and processor must receive an economic benefit from the potential purchase and sales transaction. The agricultural producer receives specific benefits, i.e. revenue from a given procurement price level (comparing to the producer's average costs), which allows for repeating production and potential individual profits to be obtained. At this procurement price level, the processor assumes a specific price gap enabling production to be repeated and profit to be earned, which translates into the value added. This takes place providing that, as already mentioned, the price level of the final food product is given[32] implicite on the competitive equilibrium market. Without this assumption, the situation of a "pass it on" in relation to the costs would occur, which means transferring the effects of

[31] This assumption basically or fundamentally shapes or may shape the relations between the agricultural sector and processing sector, as well as the commercial sectors in the agri-food economy as a whole. It may be criticized in practice, because it is not always met at the local level. This issue requires, however, a separate analysis. The microeconomic approach does not always allow for aggregation and drawing conclusions at the sectoral level.

[32] In more advanced approach, the logarithmic derivatives of these variables are in this case equal to zero.

accepting the higher procurement price level than admittable one on the final food product, which can be illustrated as:

$$\uparrow p_{ż}(t) \Longrightarrow \uparrow p_{y}^{*}(t) \Leftarrow k_{p}(t) \uparrow$$

This scenario is not favorable for the consumers and acts as one of the essential sources of inflation for the economy as a whole. This condition is provided only to illustrate the importance and additional aspects of the discussed issue, i.e. how the equilibrium between the expectations of and benefits for the agricultural producer and processor for a given procurement price level is established.

We can also deviate from the market formation of a price, where the procurement price level is established by the administration authorities, for example as an intervention or minimum price. In such a case, in order to ensure sustainable management, the admitting inequality referred to above must be maintained. If this is impossible, for example when the procurement price level is lower than the production costs of the product, to which the procurement price refers: $p_{y}^{*} < k_{p}$ or when the procurement price is higher than the price of the final food product: $p_{ż} < p_{y}^{*}$, which should be regarded not only as a hypothetical situation. Since such cases have occurred in the economic practice[33], interventions and specific subsidies are usually needed. These are necessary to restore the admitting inequality: $p_{ż} > p_{y}^{*} \geq k_{p}$, which contrasts with the selective market scheme and leads to improved efficiency and social benefits.

It may be assumed that this distribution of benefits in the form of admitting inequalities and their formation mechanism is of an iterative nature. The mechanism is similar to the Walrasian scheme, where it is described using the example of an auctioneer and equilibrium price established by means of a trial-and-error method. In reality, each short- or medium-term equilibrium (for a given purchase campaign in different locations and in the market scale) is established by means of a trial-and-error method. As a result, the subsequent iterations lead to equilibrium in terms of admitting inequalities, in particular on the real agricultural market, which determine the benefits of the parties, i.e. the agricultural producer and agri-food processor as:

[33] Both situations have frequently taken place in the centrally planned economy in the People's Republic of Poland and in some cases, primarily the first one, in market interventions in the 1990s. At the times of central planning and in order to implement the specific socio-food policy, the prices of final agri-food products have been frequently controlled, i.e. maintained below the actual costs, which resulted in permanent deficiencies. The similar situation was observed in market intervention conditions, when the prices are adjusted to the higher average costs and production is intervention-based. This creates problems for the processor, in particular when the price level of the processed final goods is controlled administratively or formed in effect of competition with imported goods. In central planning and intervention, the prices do not lead to the conditions determined by the admitting inequalities, which are the equilibrium system per se.

$$p_{ż}(t) > p_y^*(t) = p_y^*(t) \geq k_p(t)$$

and in more economic and empirical terms as:

$$p_{ż}(t) - p_y^*(t) = p_y^*(t) - k_p(t)$$

where:

$$\left(p_{ż}(t) - p_y^*(t)\right) > 0 \quad \text{and} \quad \left(p_y^*(t) - k_p(t)\right) > 0$$

This is the essence of mutual benefits (or surpluses) for the agricultural producer and processor. The benefits refer to a procurement price level acceptable for both parties. The nature of benefits is relative – benefits understood as positive values are assessed subjectively by each of the parties. Thus, a subjective assessment may mean that despite a formal equality, the gains may be perceived as unequal. However, this is a separate issue pertaining to the effects of market regulations.

Conclusions

The deductive and formal analysis enabled the determination of the conditions in which the mutual acceptance of a specific price level on the two markets occurs. These conditions include the benefits for both parties to a given transaction on a given market, referred to as the admitting inequalities. The two markets are the market of food products with a consumer and processor and the market of agricultural products with an agricultural producer and processor. The food market establishes the acceptable price level of food product which is mutually beneficial for the consumer and processor, and favorable from the perspective of their goal functions. This is determined by the conditions of the admitting inequalities derived in the paper. The same applies to the agricultural product market with reference to the procurement price. Its level is acceptable for the agricultural producer and agri-food processor, because it is mutually beneficial from the perspective of their goal functions. An appropriate equilibrium between the prices on both markets is created. This affects the behavior and choices made by these entities on the food and agricultural markets, and in effect the price relations. The analysis is performed under the assumption that the conditions of competitive equilibrium on both markets is met, i.e. no entity affects the price level – all entities are price-takers[34] . The reasoning is performed from the perspective of an agri-food processor and the conditions of their choice determined by the acceptable price level of the food product and agricultural product as an input. The formal basis of the analysis is the input (technological) function of the processor and the assumption of profit maximization

[34] We do not analyze the case, in which the processor affects the formation of the price level of a food product and agricultural product. This creates the new admitting conditions for acceptance of this price level forced by one party. This is of the utmost importance for the procurement price. Perhaps there is also another mechanism. Some clues may be derived from the theory of choice of the producer – monopolist (oligopolist), price discrimination, the issue of the so-called competitive advantages, and the asymmetry of information. This is a new scientific challenge to which we should refer in near future.

as the goal function. We assumed that this is the processor's production function determining its production technique. This forms the basis of effectiveness of resource (agricultural product) processing into the final food product, which is included in the technological function. The processor's choices within this function, focused on the minimization of costs in order to achieve the final food product, are made within the relations of acceptable price levels on the food and agricultural markets.

The scientific contribution of the analysis presented in this paper is the formal description of the comprehensive correlations of price relations on both markets and their impact on the choices made by the agri-food producer. The main contribution of this paper is deriving the conditions of admitting inequalities for acceptance of a given price level, mutually acceptable for the entities operating on both markets, i.e. the consumer and processor on the food market, and the producer and processor on the agricultural market. This may shed new light on the transfer of surpluses and competitive advantages within the value chain, as well as the on the bases of the formation of a price gap between food and agricultural products.

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KSZTAŁTOWANIE DOPUSZCZALNEGO POZIOMU CEN PRODUKTU ŻYWNOSCIOWEGO I ROLNEGO A WYBÓR PRZETWÓRCY

Abstrakt

Celem analizy w artykule jest odpowiedź na pytanie, dlaczego ustala się określony poziom ceny produktu żywnościowego i rolnego obustronnie akceptowany przez konsumenta i przetwórcę oraz producenta rolnego i przetwórcę. Dla uzyskania odpowiedzi na to pytanie wyprowadzamy szereg równań i zależności funkcyjnych przy określonych założeniach, co jest formalno-analityczną metodą analizy. W metodzie tej ważne jest założenie, że akceptacja wiąże się z jednoczesną maksymalizacją funkcji celu przetwórcy oraz maksymalizacji funkcji celu konsumenta i producenta rolnego, a także występują na rynkach warunki równowagi konkurencyjnej. Centralnym punktem rozumowania w tej metodzie jest jednak wybór przetwórcy w ramach cen na dwóch rynkach, żywnościowym i rolnym. Zwłaszcza znaczenie poziomu ceny skupu w wyborze przetwórcy jest ukazane oryginalnie w nowy sposób i w zaawansowanej analizie. Najważniejszym jednak wynikiem analizy jest pokazany mechanizm ustalania się dopuszczalnego poziomu cen dla podmiotów na dwóch rynkach. Określają to wyprowadzone nierówności dopuszczające, w których określony jest stosunek oczekiwań tych podmiotów do ceny równowagi rynkowej. Wniosek z nich jest taki, że poziom cen jest obustronnie dopuszczalny, bo następuje realizacja własnych funkcji celu podmiotów. Analiza ma charakter analityczno-formalny i ma znaczenie teoretyczno-poznawcze. Może być wkładem do teorii cen w sektorze rolno-żywnościowym i warunków wyboru przetwórcy.

Słowa kluczowe: dopuszczalny poziom cen, produkt żywnościowy i rolny, korzyści przetwórcy, producenta rolnego, konsumenta, wybór przetwórcy.

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