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Method of Constructing Evaluation Criteria of Economic Efficiency of Innovative Projects with Regards to Quality Adjustment

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***Abstract*—A methodology has been developed for constructing criteria for evaluating the economic efficiency of innovative projects, considering the price adjustment for quality with regards to new and existing industries. The proposed performance indicators in real prices were calculated on the basis of real cash flows and the real discount rate, which showed that price unevenness, has a strong influence on project performance, therefore it is necessary to use quality adjustment methods (hedonic price indices) to estimate them more accurately.**

Keywords—economic efficiency; innovative projects; quality adjustment methods; hedonic price indices

I. Introduction

There are several methods for accounting for inflation in investment project efficiency indicators: deflating the final indicator with inflation, deflating by converting cash flow into a "hard" currency, forming a discount rate with inflation. However, these methods are less accurate and do not always allow to take into account the heterogeneity of price changes, which is observed, including when adjusting prices for quality. The most accurate method of accounting for inflation in assessing the economic efficiency of projects is to make cash flow calculations at real prices. Therefore, we will build a methodology for assessing the economic efficiency of projects taking into account the quality adjustment.

The method of hedonic quality adjustment was first proposed by J. Triplett and R. Macdonald [1]. The idea was to use the hedonic method only in situations where the conventional methodology is unable to correctly take into account the quality and appearance of new products. This method was implemented in the US Producer Price Index (then it was called the wholesale price index) for refrigerators. It is also worth noting the contribution of Jack Triplett to the development of hedonic methods. The result of his many years of work can be considered the hedonic index guide [2], which formed the basis of the official international guide on the consumer price index [3].

Since the methods for evaluating innovative projects for revolutionary and evolutionary products are different, it is proposed to develop a methodology for assessing the economic efficiency of projects, taking into account the quality adjustment, in two directions. For revolutionary products, new enterprises are created, or at least separate divisions in the enterprise. Therefore, the evaluation of such a project can be carried out independently of the main activity of the enterprise. Here, any project can be considered "from scratch", taking into account all gross revenues and expenses. Difficulties in such projects may arise in determining the initial price of a revolutionary product, as well as in predicting the dynamics of product prices during the course of a project.

However, a significant part of innovation projects is carried out at existing enterprises and they are difficult to separate from existing production. Such projects include projects aimed at modernization, reconstruction of enterprises, as well as projects aimed at improving the quality of the product. Such a product is called evolutionary. In the case of evolutionary products, projects are usually aimed at "improvement", that is, they are implemented within the framework of existing production. Therefore, it is more difficult to evaluate such project. Improvement may not concern the entire product, but its individual options. In this regard, it is proposed to evaluate the project with respect to individual options.

II. Algorithm of Building a Methodology for Evaluating the Economic Efficiency of Innovative Projects

It is proposed to build a methodology for evaluating the economic efficiency of innovative projects, taking into account the quality adjustment for newly created production, based on the following algorithm. The following algorithm is proposed:

- Determination of the price of an innovative product in the zero period.
- Determination of investment costs and current project costs.
- Determination of projected prices, both for the income and for the expenditure side of the project.
- Determination of gross cash flows for each period in projected prices.
- Recalculation of cash flows into real prices by deflating to the general inflation index.
- Calculation of performance indicators in real prices based on real cash flows and real discount rate.

Let us consider each of these stages in more detail.

The determination of the price of an innovative product in the zero period should be based primarily on marketing research. However, it is not always possible to compare with comparable products of competitors [4], which is especially true for innovative and, in particular, revolutionary products. In this regard, it is necessary to use other methods. Obviously, the price of a new product can be set subjectively, based, for example, on expert evaluations. Also price for product can based on the cost of production and the desired margin of the manufacturer [5]. However, in the case when a product can be presented as a set of some options, its price can be set on the basis of hedonic regression, which is the most objective method.

Hedonic regression is described by a regression equation, in which the price of the product, *p*, refers to the quantities of the characteristics given by the vector, where the product is determined based on the variable values of its characteristics: $z=(z_i, z_2,\ldots,z_n)$, i.e.:

$$p(z)=p(z_i, z_2,\ldots,z_n). \quad (1)$$

In practice, for each product (or its modification) its price, characteristics, and possibly the quantity, and therefore the cost of the products sold, must be recorded.

As a rule, a semi-log representation should be used for hedonic regressions. Here, the (natural) logarithm of the price is used as the dependent variable, and for the variables on the right side of the equation, the usual notation is preserved. This approach has the advantage of allowing the inclusion of conditional variables in the right-hand side of the equation indicating the presence or absence of some characteristic. Such conditional variables take the value 1 if the product has this characteristic, and a zero value otherwise.

When using the logarithmic form, there are some difficulties. Thus, the variables z_i on the right side of the equation should also be represented as logarithms, and if any of these variables z_i are conditional, taking a zero value in some cases, the logarithmic representation becomes impossible, since you cannot take the logarithm of zero. Thus, the basic is the semi-log form. So, the usual hedonic regression has the following form:

$$p = \beta_0 \beta_1^{z_1} \beta_2^{z_2} \beta_3^{z_3} \ldots \beta_n^{z_n} \varepsilon. \quad (2)$$

This approach is particularly productive in cases where the market does not allow to identify the price of quality characteristics necessary for making amendments. Markets allow you to identify the prices of products, rather than quality characteristics, so products should be considered as related groups of characteristics. A sufficiently large set of data on products with their characteristics and sufficient variability of the set of characteristics for different products make it possible to obtain estimates for the implicit prices of these characteristics using hedonic regression.

In addition, for the subsequent forecasting of prices for a new product, it is necessary to base on objective estimates of its current price. Having determined which options “enter” into a product and how they affect the final price, it is easy to forecast the price of such a product using hedonic price indices.

Determination of investment costs and current project costs in this case is a standard procedure and does not differ in any way from ordinary investment projects. In this regard, we will not dwell on it.

Determination of projected prices, both in terms of revenue and expenditure of the project, is an important step in the analysis of any investment project. In its simplest form, the project can be calculated in current, that is, in stable, constant prices. This is the most common assumption in the preparation of investment projects. In essence, it means that the uniformity of price changes for all articles of the project is accepted and current prices are equal to real ones. However, in practice, the homogeneity of price movements is too crude an assumption that can distort project performance. Therefore, there is a need to determine target prices for the entire period of the project.

It is possible to determine projected prices by calculating independent projected price indices for all products and resources. Of course, this in itself is a time consuming task. Therefore, in a simpler version, it is possible to calculate only those price indices, which, according to experts, can significantly deviate from the general inflation rate. However, in either case, price indices for innovative products should be calculated taking into account the quality adjustment. Therefore, by default, we assume that for the articles of the income part of the innovative project, hedonic price indices are applied, taking into account the quality change.

As a result, the forecast value of prices for products and resources will be equal to the product of the current price by the forecast price index for this article:

$$\hat{p}_i^t = p_i^0 \cdot H_i^{t/0} = p_i^0 \cdot H_i^1 \cdot H_i^2 \cdot \ldots \cdot H_i^{t-1} \cdot H_i^t = p_i^0 \cdot \prod_{k=1}^{t} H_i^k \quad (3)$$

$$\hat{p}_j^t = p_j^0 \cdot I_j^{t/0} = p_j^0 \cdot I_j^1 \cdot I_j^2 \cdot \ldots \cdot I_j^{t-1} \cdot I_j^t = p_j^0 \cdot I_j^1 \cdot I_j^2 \cdot \ldots \cdot I_j^{t-1} \cdot I_j^t = p_j^0 \cdot \prod_{k=1}^{t} I_j^k \quad (4)$$

where $\hat{p}_i^t$ – the forecast price for the *i*-th article of the income part of the project in period t; $\hat{p}_j^t$ is the estimated price for the *j*-th article of the expenditure part of the project in period t; p_i^0 is the current price for the *i*-th article of the income part of the project; p_j^0 is the current price for the *j*-th article of the expenditure part of the project; $H_i^{t/0}$ is the basic hedonic price index for the *i*-th article of the project revenue part in the period t; $I_j^{t/0}$ is the base price index for the *j*-th article of the expenditure part of the project in period t; $H_i^1 \cdot H_i^2 \cdot \ldots \cdot H_i^{t-1} \cdot H_i^t$ – chain hedonic price indices for the article of the income part of the project in periods 1 ... t; $I_j^1 \cdot I_j^2 \cdot \ldots \cdot I_j^{t-1} \cdot I_j^t$ –chain price indices for the j-th article of the expenditure part of the project in periods 1 ... t.

Thereafter, nominal net cash flows are determined for each period in forecast prices. The nominal net cash flow (NCF) is the difference between the nominal cash inflow and the nominal cash outflow of the project in the relevant period:

$$\text{NCF}_{\text{nom}}^t = Income^t - \text{Expense}^t \quad (5)$$

$$\text{Income}^t = \sum_{i=1}^{m} \hat{p}_i^t \cdot q_i^t = \sum_{i=1}^{m} p_i^0 \cdot H_i^{t/0} \cdot q_i^t \quad (6)$$

$$\text{Expense}^t = \sum_{j=1}^{n} \hat{p}_j^t \cdot c_j^t = \sum_{j=1}^{n} p_j^0 \cdot I_j^{t/0} \cdot c_j^t \quad (7)$$

where $\text{NCF}_{\text{nom}}^t$ – nominal net cash flow of the project in period t; q_i^t – the quantity in physical units of the product according to the i-th article of the income part of the project in period t; c_j^t– quantity in natural units of resources according to the j-th article of the expenditure part of the project in the period t; m – is the number of types of income items (products); n – the number of types of expenditure items (resources).

At the next stage, cash flows are recalculated into real prices by deflating to the general inflation index:

$$\text{NCF}^t = \frac{\text{NCF}_{nom}^t}{I_{\text{gen}}^{t/0}} = \frac{\text{Income}^t - \text{Expense}^t}{I_{\text{gen}}^{t/0}} = \frac{\sum_{i=1}^{m} p_i^0 \cdot H_i^{t/0} \cdot q_i^t}{I_{\text{gen}}^{t/0}} - \frac{\sum_{j=1}^{n} p_j^0 \cdot I_j^{t/0} \cdot c_j^t}{I_{\text{gen}}^{t/0}} \quad (8)$$

This is equivalent to asking not the price indices themselves, but the ratio of the growth rate of the price of each product to the rate of General inflation:

$$\text{NCF}^t = \sum_{i=1}^{m} p_i^0 \cdot \frac{H_i^{t/0}}{I_{\text{gen}}^{t/0}} \cdot q_i^t - \sum_{j=1}^{n} p_j^0 \cdot \frac{I_j^{t/0}}{I_{\text{gen}}^{t/0}} \cdot c_j^t \quad (9)$$

where $\text{NCF}_{\text{nom}}^t$ – real net cash flow of the project in period *t*; $I_{\text{gen}}^{t/0}$– the underlying (basic) General inflation rate in period *t*.

Deflating the General inflation index also applies to interest rates, which are converted from nominal to real.

Calculation of performance indicators in real prices based on real cash flows and real discount rate. In this case, static performance indicators will be calculated in the same way as for standard projects. Consider dynamic indicators that take into account the change in the value of money over time.

The investment profitability index (PI) is calculated as the ratio of the amount of discounted income to the amount of discounted project costs:

$$PI = \sum_{t=0}^{T} \text{Income}^t \cdot \frac{1}{(1+r)^t} \div \sum_{t=0}^{T} \text{Expenses}^t \cdot \frac{1}{(1+r)^t} = \sum_{t=0}^{T} \frac{1}{(1+r)^t} \sum_{i=1}^{m} p_i^0 \cdot \frac{H_i^{t/0}}{I_{\text{gen}}^{t/0}} \cdot q_i^t \div \sum_{t=0}^{T} \frac{1}{(1+r)^t} \sum_{j=1}^{n} p_j^0 \cdot \frac{I_j^{t/0}}{I_{\text{gen}}^{t/0}} \cdot c_j^t \times$$
$$\times \sum_{t=0}^{T} \frac{1}{(1+r)^t} \sum_{j=1}^{n} p_j^0 \cdot \frac{I_j^{t/0}}{I_{\text{gen}}^{t/0}} \cdot c_j^t = \sum_{t=0}^{T} \sum_{i=1}^{m} p_i^0 \cdot \frac{H_i^{t/0}}{I_{\text{gen}}^{t/0} \cdot (1+r)^t} \cdot q_i^t \div$$
$$\div \sum_{t=0}^{T} \sum_{j=1}^{n} p_j^0 \cdot \frac{I_j^{t/0}}{I_{\text{gen}}^{t/0} \cdot (1+r)^t} \cdot c_j^t \quad (10)$$

where T – i the duration of the project; r – the real discount rate.

Net present value (NPV):

$$\text{NPV} = \sum_{t=0}^{T} \text{Income}^t \cdot \frac{1}{(1+r)^t} - \sum_{t=0}^{T} \text{Expenses} \times \frac{1}{(1+r)^t} = \sum_{t=0}^{T} \frac{1}{(1+r)^t} \sum_{i=1}^{m} p_i^0 \cdot \frac{H_i^{t/0}}{I_{\text{gen}}^{t/0}} \cdot q_i^t -$$
$$- \sum_{t=0}^{T} \frac{1}{(1+r)^t} \sum_{j=1}^{n} p_j^0 \cdot \frac{I_j^{t/0}}{I_{\text{gen}}^{t/0}} \cdot c_j^t = \sum_{t=0}^{T} \sum_{i=1}^{m} p_i^0 \cdot \frac{H_i^{t/0}}{I_{\text{gen}}^{t/0} \cdot (1+r)^t} \cdot q_i^t -$$
$$- \sum_{t=0}^{T} \sum_{j=1}^{n} p_j^0 \cdot \frac{I_j^{t/0}}{I_{\text{gen}}^{t/0} \cdot (1+r)^t} \cdot c_j^t. \quad (11)$$

Internal rate of return – IRR is defined as IRR=r, where:

$$0 = \sum_{t=0}^{T} \text{Income}^t \cdot \frac{1}{(1+r)^t} - \sum_{t=0}^{T} \text{Expenses}^t \times \frac{1}{(1+r)^t} = \sum_{t=0}^{T} \frac{1}{(1+r)^t} \sum_{i=1}^{m} p_i^0 \cdot \frac{H_i^{t/0}}{I_{\text{gen}}^{t/0}} \cdot q_i^t -$$
$$- \sum_{t=0}^{T} \frac{1}{(1+r)^t} \sum_{j=1}^{n} p_j^0 \cdot \frac{I_j^{t/0}}{I_{\text{gen}}^{t/0}} \cdot c_j^t = \sum_{t=0}^{T} \sum_{i=1}^{m} p_i^0 \cdot \frac{H_i^{t/0}}{I_{\text{gen}}^{t/0} \cdot (1+r)^t} \cdot q_i^t -$$

$$-\sum_{t=0}^{T}\sum_{j=1}^{n} p_j^0 \cdot \frac{I_j^{t/0}}{I_{gen}^{t/0}\cdot(1+r)^t} \cdot c_j^t . \quad (12)$$

Simple payback period (PP) - PP = min k, at which:

$$\sum_{t=0}^{k}\sum_{i=1}^{m} p_i^0 \cdot \frac{H_i^{t/0}}{I_{gen}^{t/0}} \cdot q_i^t \geq \sum_{t=0}^{k}\sum_{j=1}^{n} p_j^0 \cdot \frac{I_j^{t/0}}{I_{gen}^{t/0}} \cdot c_j^t . \quad (13)$$

Discounted payback period (DPP) - DPP = min k, at which:

$$\sum_{t=0}^{k}\sum_{i=1}^{m} p_i^0 \cdot \frac{H_i^{t/0}}{I_{gen}^{t/0}\cdot(1+r)^t} \cdot q_i^t \geq$$
$$\sum_{t=0}^{k}\sum_{j=1}^{n} p_j^0 \cdot \frac{I_j^{t/0}}{I_{gen}^{t/0}\cdot(1+r)^t} \cdot c_j^t . \quad (14)$$

From the presented formulas, it is possible to reveal the influence of indices of changes in prices for products and resources on the results of the evaluation of an innovative project. Hedonic price indices that take into account quality adjustments are usually lower than general inflation, moreover, they can even be negative. Thus, price indices for innovative products with a quality adjustment are also lower than price indices for ordinary resources in the expenditure part:

$$H_i^{t/0} < I_j^{t/0}. \quad (15)$$

In this case, the forecast prices for innovative products will ‘lag behind’ from the general price level.

First of all, this effect will be observed in the revenue part of the project, where revenue from product sales is formed. With this in mind, the net cash flows for the project at forecast prices can both increase and decrease, but they will always lag behind the general price increase.

III. The Adjustment of Project Performance Indicators in the Case of the Use of Hedonic Price Indices

The following algorithm is proposed:

- Definition of the price of "improvement", that is, additional options or their improvement in the zero period.
- Determination of investment costs and current marginal costs associated with improving the product.
- Determination of projected prices, both for the income and for the expenditure side of the project.
- Determination of marginal cash flows for each period in projected prices.
- Recalculation of cash flows into real prices by deflating to the general inflation index.
- Calculation of performance indicators in real prices based on real cash flows and real discount rate.

The determination of the price of "improvement", that is, additional options or their improvement in the zero period involves the presentation of the product as a set of characteristics, despite the fact that each characteristic has its own implicit (not observed in the market in an explicit form) price. This, in turn, requires the specification of the market for these characteristics, since prices are the result of market mechanisms. Hedonic regressions can also be used to quantify the improvement of the product, to determine the price of such improvement, that is, the price of the option. But unlike the previous situation, when hedonic regression was used to predict the price of a new product, in this case hedonic regression is based on data on available products in the market, and the result of the evaluation is the definition of one or more parameters of the model responsible for the corresponding options.

For example, by constructing a hedonic regression on the improved product:

$$\ln p = \ln\beta_0 + z_1 \ln\beta_1 + z_2 \ln\beta_2 +$$
$$+ z_3 \ln\beta_3 + \cdots + z_n \ln\beta_n + \ln\varepsilon \quad (16)$$

where p is the price of the improved product.

It is possible to calculate the unit price of the option being improved (let it be z_1), which will be expressed in the parameter β_1. Thus, it is possible to objectively calculate the increase in the price of the product due to the improvement of certain options. Note that there may be several improved options. In this case, the increase in the price of the product being improved is calculated on the basis of hedonic regression in the same way.

It is easy to show that the increase in price as a result of changing one option z_1 will be equal, ceteris paribus:

$$\partial \ln p = \partial z_1 \ln\beta_1 \quad \rightarrow$$
$$\ln\left(1 + \frac{\partial p}{p}\right) = \partial z_1 \ln\beta_1 \quad \rightarrow$$
$$\frac{\partial p}{p} = \beta_1^{\partial z_1} - 1 (17).$$

If the changes concern several options $(z_i, z_2, \dots, z_n)$, then the price increase can be calculated by the formula:

$$\frac{\partial p}{p} = \beta_1^{\partial z_1} \cdot \beta_2^{\partial z_2} \cdot \ldots \cdot \beta_n^{\partial z_n} - 1. \quad (18)$$

And in absolute terms, the price increase due to the improvement of the product will be equal to:

$$\partial p = p(\beta_1^{\partial z_1} \cdot \beta_2^{\partial z_2} \cdot \ldots \cdot \beta_n^{\partial z_n} - 1). \quad (19)$$

This price (which we will further call the price of “improvements”) will increase for the product in the zero period due to the improvement of options in the framework of an innovative project in any existing production.

The definition of investment costs and current project costs in this case means the calculation of marginal costs, as well as the amount of capital investment costs that are associated with the improvement of products. That is, for the purposes of analyzing the project, it is not the cost price itself that is taken, but the cost change (which, by the way, may decrease if new technologies are introduced). As for capital investments, they are fully included in the expenditure side of the project. Thus, it is necessary to determine the increase in costs relative to the existing production. In real terms, the change in resource costs for the *j*-th article is denoted as ∂c_j. Then the change in costs for the *j*-th article will be equal to $p_j \partial c_j$, and the change in costs for the entire project will be $\sum_{j=1}^{n} p_j \partial c_j$.

Determination of projected prices is both for the income and for the expenditure part of the project. The price of the "improvements" defined by us above corresponds to the zero period of the project. However, during the course of a project, the cost of options may vary significantly. According to hedonic regression, the price of options is related to the cost of the product through the coefficients *β*. Therefore, it is sufficient to calculate the hedonic price indices for the product as a whole. After this, the predicted value of the price of "improvements" is calculated as follows:

$$\partial\hat{p}^t = \hat{p}^t(\beta_1^{\partial z_1} \cdot \beta_2^{\partial z_2} \cdot \ldots \cdot \beta_n^{\partial z_n} - 1) = $$
$$= p^0 \cdot H^{t/0} \cdot (\beta_1^{\partial z_1} \cdot \beta_2^{\partial z_2} \cdot \ldots \cdot \beta_n^{\partial z_n} - 1) = $$
$$= p^0 \cdot H^1 \cdot H^2 \cdot \ldots \cdot H^{t-1} \cdot H^t \times$$
$$\times (\beta_1^{\partial z_1} \cdot \beta_2^{\partial z_2} \cdot \ldots \cdot \beta_n^{\partial z_n} - 1) \quad (20)$$

where $\partial\hat{p}^t$ is the forecast change in price as a result of "improvements" in period t relative to the current price of the product; $\hat{p}^t$- forecast value of the product price in period *t*.

In this case, a priori, the invariability of the hedonic regression for future periods is assumed. Obviously, it can change, but it can be adjusted only on the basis of actual data, but not before the start of the project, when it is evaluated.

For costs, projected prices for resources are also calculated using formula (5).

The definition of marginal cash flows for each period in the forecast prices, as the difference in marginal revenues and expenses from the project:

$$\partial \mathrm{NCF}_{\mathrm{nom}}^t = \partial \mathrm{Income}^t - \partial \mathrm{Expesnse}^t \quad (21)$$
$$\partial \mathrm{Income}^t = \partial\hat{p}^t \cdot q^t =$$
$$= p^0 \cdot H^{t/0} \cdot (\beta_1^{\partial z_1} \cdot \beta_2^{\partial z_2} \cdot \ldots \cdot \beta_n^{\partial z_n} - 1) \cdot q^t \quad (22)$$
$$\partial \mathrm{Expense}^t = \sum_{j=1}^{n} \hat{p}_j^t \cdot \partial c_j^t = \sum_{j=1}^{n} p_j^0 \cdot I_j^{t/0} \cdot \partial c_j^t$$
$$\partial \mathrm{Expense}^t = \sum_{j=1}^{n} \hat{p}_j^t \cdot \partial c_j^t = \sum_{j=1}^{n} p_j^0 \cdot I_j^{t/0} \cdot \partial c_j^t \quad (23)$$

where q^t is the quantity in natural units of the product produced in period *t*; ∂c_j^t – change in resource consumption in physical terms relative to current production for the *j*-th article in period *t*

Recalculation of cash flows into real prices is by deflating to the general inflation index:

$$\partial \mathrm{NCF}^t = \frac{\partial \mathrm{NCF}_{\mathrm{HOM}}^t}{I_{\mathrm{gen}}^{t/0}} = \frac{\partial \mathrm{Income}^t - \partial \mathrm{Expense}^t}{I_{\mathrm{gen}}^{t/0}} =$$
$$= \frac{p^0 \cdot H^{t/0} \cdot (\beta_1^{\partial z_1} \cdot \beta_2^{\partial z_2} \cdot \ldots \cdot \beta_n^{\partial z_n} - 1) \cdot q^t}{I_{\mathrm{gen}}^{t/0}} -$$
$$- \frac{\sum_{j=1}^{n} p_j^0 \cdot I_j^{t/0} \cdot \partial c_j^t}{I_{\mathrm{gen}}^{t/0}} \quad (24)$$

or

$$\partial \mathrm{NCF}^t = p^0 \cdot \frac{H^{t/0}}{I_{\mathrm{gen}}^{t/0}} \cdot (\beta_1^{\partial z_1} \cdot \beta_2^{\partial z_2} \cdot \ldots \cdot \beta_n^{\partial z_n} - 1) \times$$
$$\times q^t - \sum_{j=1}^{n} p_j^0 \cdot \frac{I_j^{t/0}}{I_{\mathrm{gen}}^{t/0}} \cdot \partial c_j^t. \quad (25)$$

Calculation of performance indicators in real prices is based on real cash flows and real discount rate. The investment profitability index (PI) is calculated as the ratio of the amount of discounted income to the amount of discounted project costs:

$$PI = \sum_{t=0}^{T} \partial Income^t \cdot \frac{1}{(1+r)^t} \div \sum_{t=0}^{T} \partial \mathrm{Expense}^t \cdot \frac{1}{(1+r)^t} =$$
$$= \sum_{t=0}^{T} \frac{1}{(1+r)^t} \cdot p^0 \cdot \frac{H^{t/0}}{I_{\mathrm{gen}}^{t/0}} \cdot (\beta_1^{\partial z_1} \cdot \beta_2^{\partial z_2} \cdot \ldots \cdot \beta_n^{\partial z_n} - 1) \cdot q^t \div \times$$
$$\sum_{t=0}^{T} q^t \div \sum_{t=0}^{T} \frac{1}{(1+r)^t} \sum_{j=1}^{n} p_j^0 \cdot \frac{I_j^{t/0}}{I_{\mathrm{gen}}^{t/0}} \cdot \partial c_j^t$$
$$= \sum_{t=0}^{T} \cdot p^0 \cdot \frac{H^{t/0}}{I_{\mathrm{gen}}^{t/0} \cdot (1+r)^t} \cdot (\beta_1^{\partial z_1} \cdot \beta_2^{\partial z_2} \cdot \ldots \cdot \beta_n^{\partial z_n} - 1) \cdot q^t$$
$$= \sum_{t=0}^{T} \cdot p^0 \cdot \frac{H^{t/0}}{I_{\mathrm{gen}}^{t/0} \cdot (1+r)^t} \cdot (\beta_1^{\partial z_1} \cdot \beta_2^{\partial z_2} \cdot \ldots \cdot \beta_n^{\partial z_n} - 1) \cdot q^t$$
$$\div \sum_{t=0}^{T} \sum_{j=1}^{n} p_j^0 \cdot \frac{I_j^{t/0}}{I_{\mathrm{gen}}^{t/0} \cdot (1+r)^t} \cdot \partial c_j^t. \quad (26)(26)$$

Net present value (NPV):

$$\mathrm{NPV} = \sum_{t=0}^{T} \cdot p^0 \cdot \frac{H^{t/0}}{I_{\mathrm{gen}}^{t/0} \cdot (1+r)^t} \cdot (\beta_1^{\partial z_1} \cdot \beta_2^{\partial z_2} \cdot \ldots \cdot \beta_n^{\partial z_n} - 1) \cdot q^t -$$
$$\mathrm{NPV} = \sum_{t=0}^{T} \cdot p^0 \cdot \frac{H^{t/0}}{I_{\mathrm{gen}}^{t/0} \cdot (1+r)^t} \cdot (\beta_1^{\partial z_1} \cdot \beta_2^{\partial z_2} \cdot \ldots \cdot \beta_n^{\partial z_n} - 1) \cdot q^t -$$
$$- \sum_{t=0}^{T} \sum_{j=1}^{n} p_j^0 \cdot \frac{I_j^{t/0}}{I_{\mathrm{gen}}^{t/0} \cdot (1+r)^t} \cdot \partial c_j^t \ . \quad (27)$$

Internal rate of return (IRR) is defined as IRR = *r*, at which:

$$0 = \sum_{t=0}^{T} \cdot p^0 \cdot \frac{H^{t/0}}{I_{\mathrm{gen}}^{t/0} \cdot (1+r)^t} \cdot (\beta_1^{\partial z_1} \cdot \beta_2^{\partial z_2} \cdot \ldots \cdot \beta_n^{\partial z_n} - 1) \cdot q^t$$
$$0 = \sum_{t=0}^{T} \cdot p^0 \cdot \frac{H^{t/0}}{I_{\mathrm{gen}}^{t/0} \cdot (1+r)^t} \cdot (\beta_1^{\partial z_1} \cdot \beta_2^{\partial z_2} \cdot \ldots \cdot \beta_n^{\partial z_n} - 1) \cdot q^t$$
$$- \sum_{t=0}^{T} \sum_{j=1}^{n} p_j^0 \cdot \frac{I_j^{t/0}}{I_{\mathrm{gen}}^{t/0} \cdot (1+r)^t} \cdot \partial c_j^t . \quad (28)$$

Simple payback period (PP) is PP = *min k*, at which:

$$\sum_{t=0}^{k} \cdot p^0 \cdot \frac{H^{t/_0}}{I_{gen}^{t/_0}} \cdot (\beta_1^{\partial z_1} \cdot \beta_2^{\partial z_2} \cdot \ldots \cdot \beta_n^{\partial z_n} - 1) \cdot q^t \geq \sum_{t=0}^{k} \sum_{j=1}^{n} p_j^0 \cdot \frac{I_j^{t/_0}}{I_{gen}^{t/_0}} \cdot \partial c_j^t . \quad (29)$$

Discounted payback period (DPP) is DPP = *min k*, at which:

$$\sum_{t=0}^{k} \cdot p^0 \cdot \frac{H^{t/_0}}{I_{gen}^{t/_0} \cdot (1+r)^t} \cdot (\beta_1^{\partial z_1} \cdot \beta_2^{\partial z_2} \cdot \ldots \cdot \beta_n^{\partial z_n} - 1) \cdot q^t \geq \sum_{t=0}^{k} \sum_{j=1}^{n} p_j^0 \cdot \frac{I_j^{t/_0}}{I_{gen}^{t/_0} \cdot (1+r)^t} \cdot \partial c_j^t . \quad (30)$$

The presented formulas allow you to establish the relationship of changes in the cost of various options with the project performance indicators aimed at improving the product.

IV. Conclusion

Hedonic methods are implemented in the calculation of performance indicators in two ways. Firstly, when determining the current price of the product or “improvements” in the initial period of the project, which is carried out with the help of hedonic regression. Secondly, when forecasting prices for an innovative product or its individual options, when hedonic price indices are used instead of normal ones.

Heterogeneous price dynamics for various goods must necessarily be taken into account in the evaluation of investment projects. This is especially true of innovative products, the adjusted prices for which can significantly lag behind the general price level.

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