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FACTOR MODELING OF REUSEABLE GOODS MARKET IN THE CONTEXT OF DEMATERIALIZATION OF CONSUMPTION

MODELOWANIE CZYNNIKOWE RYNKÓW TOWARÓW WIELOKROTNEGO UŻYTKU W KONTEKŚCIE DEMATERIALIZACJI

ФАКТОРНОЕ МОДЕЛИРОВАНИЕ РЫНКА ТОВАРОВ ПОВТОРНОГО ИСПОЛЬЗОВАНИЯ В КОНТЕКСТЕ ДЕМАТЕРИАЛИЗАЦИИ

Abstracts

The necessity of dematerialization of consumption through the development of reusable goods market is presented in this article in the context of achieving sustainable development. On the example of consumer goods, a model of the reusable goods market was formed, based on material balance of socio-economic systems. The factors of influence on the demand of reusable goods market were determined. The recommendations for using ecological and economic instruments to manage dematerialization shifts in the economy within each factor were developed.

Keywords: *dematerialization of consumption, reusable goodsmarket, ecological and economic instruments, modeling, factors of influence*.

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Streszczenie

W artykule w kontekście osiągnięcia zrównoważonego rozwoju została przedstawiona konieczność dematerializacji konsumpcji poprzez rozwój rynku towarów wielokrotnego użytku. Na przykładzie towarów konsumpcyjnych został ukształtowany model rynku towarów wielokrotnego użytku na podstawie materialnego bilansu systemów społeczno-gospodarczych. Zostały wyznaczone czynniki wpływające na wielkość popytu na rynku towarów wielokrotnego użytku. Zostały opracowane zalecenia dotyczące zastosowania narzędzi ekologicznych i gospodarczych w celu zarządzania zmianami dematerializacyjnymi w gospodarce w ramach każdego z czynników.

Słowa kluczowe: *dematerializacja konsumpcji, rynek towarów wielokrotnego użytku, instrumenty ekologiczne i gospodarcze, modelowanie, czynniki wpływu*

Аннотация

В статье в контексте достижения целей устойчивого развития обосновывается необходимость дематериализации потребления посредством развития рынка товаров повторного потребления. На примере продукции широкого потребления сформирована модель рынка товаров повторного использования, основу которой составляет материальный баланс социально-экономических систем. Определены факторы влияния на объем спроса на рынке товаров повторного использования, разработаны рекомендации по применению эколого-экономических инструментов для управления дематериализационными сдвигами в экономике в рамках каждого фактора.

Ключевые слова*: дематериализация потребления, рынок товаров повторного использования, эколого-экономические инструменты, моделирование, факторы влияния.*

Introduction. The modern stage of human development is characterized by an ever-increasing man-made load on the natural ecosystems of the planet. At the same time, excessive and inefficient consumption of material resources leads to an aggravation of ecological problems. The reduction of the volume of the material component of the economic life of the society is beneficial both from the environmental (eco-destructive load decreases) and from the economic point of view (resource costs decrease and economic efficiency increase)[F Hinterberger, 1997]. A key component of this hypothesis is the change in the philosophy of production and consumption of goods and services in the sense of replacing the material component of the economy with information, for example, the transition from physical goods to services that they provide. This concept is called "dematerialization of the economy". A significant contribution to its development was made by scientists S. Bringezu [S Bringezu, 2003], V.C.Coroama, L.M. Hilty [V Coroama, 2014], O. Giarini, W. Stahel [O Giarini, 1993], R. Herman, S.A. Ardekani, J.H. Ausubel [R Herman, 1990],W. McDonough, M. Braungart[W McDonough, 2002],I. T. Penn, A.Arbor [I Penn, 2001], F. Schmidt-Bleek [F Schmidt-Bleek, 1998], J.K. Steinberger, F. Krausmann [J Steinberger, 2013], R. O. Vos, J. Newell [R Vos, 2011] and others.

As part of modern studies of dematerialization, scientists are actively studying

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one of its areas – "reduction of the need for the product" or dematerialization of consumption, described in [HVarian, 2010]. Scientists in the publications [V Coroama, 2014; O Giarini, 1993; I Penn, 2001;J Steinberger, 2013; V Thomas, 2003;R Vos, 2011] have investigated the essence and approaches to the dematerialization of consumption, which is to reduce demand for new goods by elimination of unnecessary products, repeated use of durable products for at least all of its regulatory lifetime, joint use of goods, etc., which ultimately leads to a decrease in material and resource consumption of consumer demand.As for the practical implementation of this trend, in our opinion, an alternative to the traditional model of consumption of many goods of long-term use may make their temporary use with the subsequent transfer of property rights (or temporary ownership) of the product to another owner, that means re-application. Scientific researches in this area are currently fragmentary and need further substantiation.

Although environmental benefits from the reuse of previously used reusable products are mostly apparent, a formalized quantitative assessment of relevant results and effects is difficult to obtain due to the lack of sufficient empirical studies on the effects of the functioning of re-use products markets. Examples of such markets are the markets of clothing, cars, baby goods, household appliances, etc. Given the large scale of the markets for reusable goods (RG), it is advisable to investigate the potential of different economic entities to influence the dematerialization shifts of the national and regional economy through the management of the development of such markets. In this regard, the ***purpose of this article*** is to study the factors of influence and construction of the model of the market of RG, which can provide useful information to substantiate the decisions in the field of dematerialization of consumption.

1. Dematerialization of consumption. One of the components of the process of dematerialization is "consumption and consumer behavior" [А Гончаренко, 2008]. Materialization, as a reverse process to dematerialization, depends on the number of consumers, as well as their individual and collective behavior. [I Wernick, 1996]. The number of consumers in the world is steadily increasing, enlarging the demand for goods and forming the lifestyle. In turn, increasing demand for goods leads to an increase in the volume of use of material resources in social-economic systems. Therefore, in order to construct a market model for RG, it is advisable to take into account the movement of material flows within the life cycle of goods (fig. 1). The transport and storage stages are presented on the schemeas a superstructure that interacts with the main stages, as storage and transport processes permeate each of the main stages of the life cycle.

Despite the fact that specific material costs per unit of product (for example, a telephone) to ensure its specific function with each new generation of goods normally reduce the volumes of production of such a product, which leads to multiple increases of aggregate material flows in the respective branches of production [Вехи, 1999]. In addition, producers stimulate increase of consumption of their products by launching new, improved designs that encourage buyers to buy product items on the market despite the insignificant level of physical and moral depreciation of goods that consumers already own.

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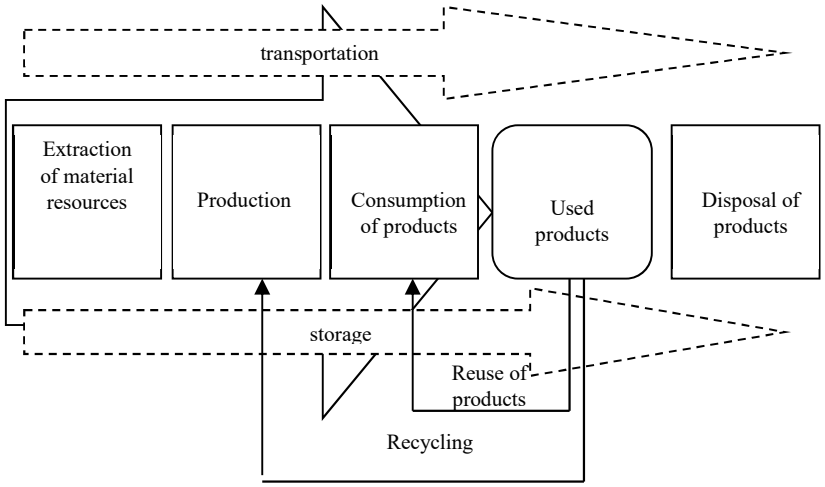
Figure 1. Material flows during the life cycle of products (improved by the authors on the basis of [V Thomas, 2003])



Generally, buyers understand that it is necessary to take care of the environment, buy more expensive environmentally friendly goods, remember about the future generations, use the materials rationally, etc. However, in practice, they act exactly the opposite (buying, expanding and spending). At the consumer level, it is extremely difficult to trace the significant relations between the goods that they buy, and, for example, the general deterioration of public health. Therefore, for the practical implementation of dematerialization changes in consumption, we will examine the ecological and economic aspects of the market for RG.

Formation of RG market model. The market of RG interacts closely with the market of new goods, therefore the capacity of these two markets directly influences the process of dematerialization. Consequently, this interconnection should be taken into account when shaping the RG market. By analogy with the material balance of socio-economic systems [А Гончаренко, 2013], the physical volume (capacity, physical volume (capacity, commodity weight) of the market of RG can be represented as follows:

$$Q_{use} = Q_{new} - Q_w, \qquad (1)$$

where Q_{use} – physical volume (capacity of the market) of RG;

Q_{new} – physical volume (capacity of the market) of new goods;

Q_w – physical volume of goods that are unsuitable for use and subject to utilization.

Assuming the balancing of the RG market, that is, when the supply on the market is equal to the demand for RG, the physical volume of RG (market capacity) Q_{use} can be considered as a balanced demand for goods. Therefore, in the framework of RG market modeling, we will investigate the demand function for such products taking into account the equation (1).

The classical economic theory considers the demand for goods as one of the defining categories of the market mechanism, and its analysis is a universal tool for cognition of the behavior of business entities

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[Вехи,1999; H Varian, 2010; E Dolan, 1974].

For the effective management of dematerialization changes in the RG market taking into account its interconnections with the market of new goods and volumes of used products, which is aimed at utilization, it is necessary to determine and take into account the main factors influencing the processes of both the production of new products and the exploitation of products that may be re-used, as well as processes of utilization of goods unsuitable for re-use.

Based on the classical factors reviewed by [Вехи,1999; H Varian, 2010; E Dolan, 1974], it is essential to highlight the following important groups of factors that influence the demand for RG (demand determinants):

1) the number of RG consumers;

2) incomes of consumers;

3) purchasing power of consumers;

4) environmental awareness of consumers (belongs to subjective factors);

5) prices for new and complementary goods;

6) price and deficit expectations of consumers.

It should be noted that in this study we do not consider Giffen goods for which the demand law is not applicable [ВГальперин, 2002].

At the same time, taking into account the specifics of RG and the material flow balance according to the equation (1), there is a number of additional factors that cause the formation and change of demand in the RG market.

In general, the function of demand for RG taking into account factor influence should be as follows:

$$F(Q_{use}) = f(x_1, \dots x_i, \dots x_n), i = 1 \dots n, \quad (2)$$

where $x_1, \dots, x_i, \dots, x_n$ – factors that influence the amount of demand for RG.

It should be noted that factors may have a multifaceted impact on demand depending on the conditions prevailing in the market. Therefore, the task of simulation is to find the nature and estimate the magnitude of the influence of essential factors of the demand for RG.

We fully agree with the authors [Вехи,1999; H Varian, 2010; E Dolan, 1974], who claim that demand for goods in general, as well as for RG, is primarily determined by their price. From this perspective, the balanced demand (capacity of the market) for a certain RG in terms of value can be represented as follows

$$Q_{use} \times p_{use} = Q_{new} \times p_{new} - Q_w \times p_w, \quad (3)$$

where p_{use} – price for RG;

p_{new} – price of a new product;

p_w – price of the utilization of product.

From formula (3) we define Q_{use}:

$$Q_{use} = \frac{Q_{new} \times p_{new} - Q_w \times p_w}{p_{use}}. \quad (4)$$

3. Factors influencing the model of the RG market. In accordance with the demand law in formula (4), the inverse dependence of the demand magnitude on the RG price is traced. The basis of this phenomenon is the effect of income, the effect of substitution and the law of decreasing marginal utility [Вехи,1999]. The action of these effects can also be expressed in terms of other influence factors on the demand for RG, that will be considered further.

One should agree with the authors [VThomas, 2003] that determine useful term use of products as one of the key factors influencing the market development of RG. We will consider this factor, taking into account the goals of our study. Typically, new goods are used by one consumer for a certain period of time, while they tend to have a longer useful life, limited by the

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expiration date or normative term of service. This assumption, to a certain extent, does not apply to goods rotated in the markets of the poorest countries of the world. This is due to the fact that the vast majority of consumers in these countries, due to their low purchasing power, are usually unable to increase the consumption of new products, reducing the actual lifetime of their predecessors. In addition, as developed countries, according to statistical data [S Anderson, 1994;Eurostat, 2016] produce and consume "new" goods much more than the developing countries, and, consequently, generate more RG, the focus of the study is on the RG markets of developed countries. The potential of the RG markets in these countries is much higher than that of the developing countries, mainly due to the high purchasing power of consumers in developed countries through higher wages and other incomes. Therefore, "under-utilization" of goods within the full useful life period in developed countries occurs more often. Consequently, effective management of market potential and material flow regulation in the RG markets of developed countries can have a more significant impact on the processes of dematerialization in a national and global scale.

Indicate the term of under-utilization of the goods within the term of its service / suitability through L_{use}, and the actual use term is through L_{new}, then the maximum possible duration of product use L_t , which is equal to the normative term of service, will make up $L_{new} + L_{use} = L_t$. From an economic point of view, in other similar conditions, an indicator $L_{new}$is closely linked to the level of depreciation of goods. It is logical to assume that in the general case, the longer the useful life of the product L_t and the shorter the period of its actual application L_{new} , the greater value RG has for the consumer, and, consequently, its price will be higher. From this perspective it is necessary to take into account the factor of the duration of the use of the product for the purposes of our study. Therefore, in order to form the model, we suggest considering the terms of use of the product by introducing appropriate coefficients that adjust the price of RG:

- coefficient taking into account the term of actual use of the product k_{Lnew}:

$$k_{L_{new}} = \frac{L_{new}}{L_t}, \quad (5)$$

- coefficient taking into account the term of underutilization of a product within the period of its service / suitability k_{Luse}:

$$k_{L_{use}} = \frac{L_{use}}{L_t}, \quad (6)$$

where

$$k_{L_{use}} + k_{L_{new}} = 1. \quad (7)$$

Based on the formulas (6) - (7), the values of the coefficientsk_{Lnew} andk_{Luse}vary from 0 to 1.For example, the closer to 1 will be the value ofk_{Luse}, the smaller term was used the new product and therefore its price in the market of RG will be higher.

In the analysis of the consumers' decision-making to choose a new product or RG, an important role, especially in developed societies, is played by ecological and economic characteristics of goods. The level of environmental friendliness directly affects the price of both new and used goods, since in case of any product, each of the stages of its life cycle is accompanied by a destructive load on the environment. In the scientific literature many indicators can be found, which, to a greater or lesser extent reflect the ecological component in the price characteristics of products[I Сотник, 2010; Л Мельник 1988; Л Мельник, 2006]. Based on the analysis of the indicators proposed by scientists, we came to the conclusion that for the purposes of our

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study, it is expedient to apply the modification of the eco-efficiency indicator, which is traditionally calculated as a return value to the eco-capacity of products, and most fully characterizes the environmental friendliness of the product. In order to simulate the RG market and build demand function, it is necessary to compare the efficiency of the new product and RG as a factor affecting the price of RG, taking into account the full environmental costs.Therefore, to make a comparison of a similar new product and RG we propose to use eco-efficiency coefficient based on indicators of total eco-capacity of goods.

According to [Л Мельник, 2006] the full ecological capacity of products is to be calculated as the sum of environmental capacity and loss-making capacity of products. Authors at [І Сотник, 2010] consider the methodical approach to calculating the coefficient of full eco-capacity at different stages of the product's life cycle at full ecological costs by types of resources (material, water, fuel and energy). Unlike the indicators justified by [І Сотник, 2010; Л Мельник, 2006], for the purposes of this study it is expedient to consider only environmental costs at the stage of consumption/operation of products. This is due to the fact that in the previous stages of the life cycle of the new product and RG, the economic and environmental costs will be the same, since before the consumption stage it is the same product in terms of dematerialization. At the stage of consumption/operation, the resource and environmental costs of the new product and RG, and hence the eco-efficiency of these goods, may be different, because new products, as they are new, tend to require less specific cost of resources for exploitation, repair, maintenance, etc., while RG, on the contrary, may require higher specific costs of resources for these purposes, increasing the destructive burden on the environment. As regards the disposal stage, its ecological and economic impact will be considered below.

Consequently, in a formalized form, the coefficient of comparative eco-efficiency (k_e), which reflects the difference in the eco-efficiency of a new product and RG (calculated on the basis of ecological capacity) at the stage of consumption/operation and influences the change in the price of RG compared to the new product, can be calculated as follows

$$k_e = \frac{TC_{e\ use}}{TC_{e\ new}}, \qquad (8)$$

where TC_{euse}, TC_{enew} – eco-efficiency in accordance with RG and new product at the stage of consumption/operation. In turn, the eco-efficiency index TC_e in the general form can be calculated as follows:

$$TC_e = \frac{1}{(p + y)}, \qquad (9)$$

where p, y – accordingly, are nature-capacity and loss-making capacity at the stage of consumption / operation.

Based on the formula (8), when calculating the coefficient of comparative eco-efficiency, the eco-efficiency of a new product is taken as a benchmark; therefore, the indicator will become values from 0 to 1. If this coefficient approaches to 1 this means that the eco-efficiency of RG is close to new products, that is why the price of RG will increase and vice versa.

Productivity of RG according to authors' research [V Thomas, 2003] also affects their price. The productivity of goods refers to the ability of the product to provide a service or perform the basic functions in a unit of time or another measurement base [Економічна, 2002]. Due to the variety of goods and functions they perform, approaches to the calculation of productivity indicators can vary significantly. Therefore, for the purposes of our study, it is expedient

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to use a relative indicator, namely the coefficient of change of productivity of RG compared with the new product. It is logical to assume that the higher the productivity of the RG is, the greater the value they have for consumers and the higher their market price is.

Change in the productivity of goods during their use should be expressed as the ratio of productivity of RG (i.e. at the moment of transition of the product to the category of RG) to the productivity of the new product as a benchmark. Then the quantitative coefficient of productivity change (k_{pr}) will fluctuate in the range from 0 to 1 and will be calculated as

$$k_{pr} = \frac{PR_{use}}{PR_{new}}, \qquad (10)$$

where PR_{use}, PR_{new} – accordingly, the productivity of the RG and the new product.

It should be noted that the demand for RG is also affected by the possibility of re-processing goods after their full use by consumers, that is, at the stage of disposal. According to equation (3), it is clear that the decrease in the volume of goods to be disposed leads to an increase of RG.This occurs, for example, by extending the useful life of the product or re-processing (recycling), etc.In forming RG market model we take this aspect into account through cost of products disposal and other factors that affect it. As concerning the cost of utilization, the factors of influence are the toxicity of goods and their components in the utilization, the quantity of heterogeneous materials in their composition, the level of structural complexity of products, mass, dimensions, etc. [В Білецький, 2003; Ю Лихачев, 2001; Наказ, 2003]. These factors should be considered on the basis of a comprehensive indicator of environmental perfection [ОГончаренко, 2015]. On the basis of the analysis of scientific literature, in particular [Л Мельник, 2006], for the purposes of our research we propose to modify this indicator and apply the ecological perfection coefficient (k_w,), which characterizes the level of technological ability to re-process components of a particular product. The growth of the coefficient will indicate an increase in the depth of processing of goods at the recycling stage. Therefore, by analogy with the calculations of traditional recycling rates [Generation, 2012], this coefficient can be calculated as the ratio of the mass of materials in the goods that are subject to re-processing or recycling to the total mass of the goods:

$$k_w = \frac{M_{nrec}}{M_{total}}, \qquad (11)$$

where M_{nrec} – mass of components (parts, nodes, etc.) of products that are subject to re-processing or recycling;

M_{total} – total weight of the product.

Thus, the coefficient of ecological perfection characterizes the specific weight of materials in the product that can be recycled. This value can range from 0 to 1. Evidently, the higher the given coefficient, the greater the proportion of materials can be re-processed, which, in turn, reduces the destructive load on the environment at the recycling stage. It should be noted that this coefficient affects the value of recycled goods for the consumer. Thus, the cost of utilization can be conditionally represented as two components: the cost of disposal and the liquidation value of the goods (i.e., the cost of materials, components of the product, which have been recycled and returned to the economic system for the production of new products). On the basis of this structure of the disposal price, the direction of the k_w effect on the cost of utilization can be explained: the higher the coefficient, the higher the price, and vice versa.

According to the classical list of factors of influence on demand, demand for RG is directly determined by the purchasing

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power of consumers, as discussed above. It should be noted that buyers can have different preferences, choosing between a new product and RG. So, it is logical to assume that high-income consumers are more likely to buy new products, and consumers with lower purchasing power are sometimes forced to buy RG due to their budget constraints.Thus, for the purposes of our research, we use the consumer purchasing power indicator (θ), which varies in range $0 \leq \theta \leq 1$.The purchasing power indicator, which is equal to 1, means that the buyer has absolute ability to buy any product, both the new one and RG. Conversely, if $\theta = 0$, then the buyer does not have the ability to buy any product at all. Consequently, consumers with a high purchasing power under other equal conditions will increase the demand for new goods (Q_{new}), reducing the demand for RG. At the same time, it will later mean that new products that are underutilized by these consumers will go to the RG market, increasing the supply in this market and reducing the price of RG.

In the study of RG market model it is also necessary to consider transaction costs (τ), which are incurred by buyers when searching for RG and comparing it with a new product, its delivery, etc. It should be noted that the acquisition of a new product is also accompanied by transaction costs for its search, analysis of consumer properties and functions, delivery, etc. At the same time, transaction costs for the purchase of RG will differ from the transaction costs of the new product, since when purchasing a RG, the consumer will have to compare not only different analogous products but also analyze the expediency of purchasing RG instead of the new product using different, specific sources of information than when buying new products. In general, transaction costs for the purchase of RG are composed of the costs of obtaining the necessary information on prices, quality, location of waste land, as well as expenses related to transportation of product, registration of documents, conclusion of agreements, legal protection of consumers' rights in case of their violation, etc. Even if the RG is passed to the consumer for free, transaction costs (τ) will be greater than 0.

Thus, based on the carried out above analysis, the main factors affecting the demand for RG are the normative and actual terms of product use, goods' efficiency and productivity, the possibilities of recycling of the used goods, purchasing power of consumers, transaction costs. In accordance with the selected factors, the components of the formula (3) need to be supplemented:

- coefficient that considers the actual use of the product, transaction costs, coefficients of comparative eco-efficiency and changes in the productivity of the RG will affect the price of RG in the following way:

$$p_{use} = (p_{new} - p_{new} \times k_{L_{new}}) \times k_e \times k_{pr} + \tau, \quad (12)$$

or taking into account the formula (6):

$$p_{use} = p_{new} - p_{new} \times k_{L_{use}} \times k_e \times k_{pr} + \tau; \quad (13)$$

- consumers' purchasing power affects the demand for new goods in the following way: $\theta \times Q_{new} \times p_{new}$;

- ecological perfection coefficient affects the cost of utilization of goods and the amount of waste: $k_w \times Q_w \times p_w$.

On this basis, formula (3), which reflects the balanced demand in the market of RG, will take the following form:

$$Q_{use} \times (p_{new} \times k_{L_{use}} \times k_e \times k_{pr} + \tau) = \\ = \theta \times Q_{new} \times p_{new} - k_w \times Q_w \times p_w. \quad (14)$$

Consequently, based on the above listed factors and made assumptions, taking into account (14), we present the physical volume of RG (capacity of the market) Q_{use} like:

$$Q_{use} = \frac{\theta \times Q_{new} \times p_{new} - k_w \times Q_w \times p_w}{p_{new} \times k_{Luse} \times k_e \times k_{pr} + \tau}. \quad (15)$$

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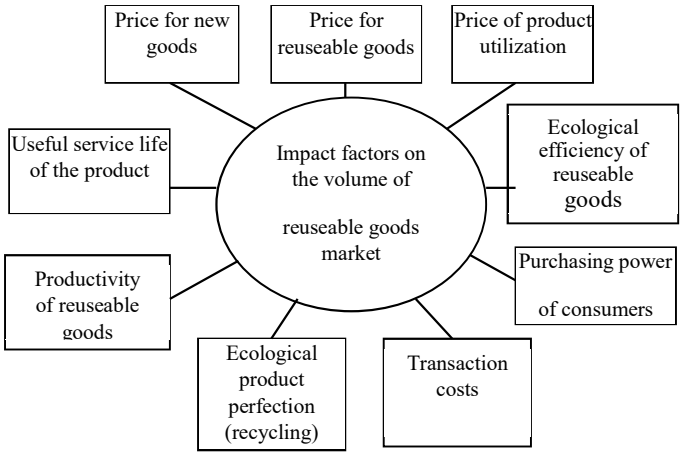
Thus, formula (15) characterizes the physical demand for RG as a key characteristic of the RG market model. Managing this parameter by changing the above mentioned factors can affect the material and commodity flows in the socio-economic system.

In fig. 2 we summarized the main factors that influence the processes of dematerialization of consumption through the market of RG.

Figure 2. The main factors influencing the the reuseable goods market volume (developed by the authors)



4. Ecological and economic instruments for the RG market management

In order to implement dematerialization of consumption there is a need to manage the physical volumes of RG in the market. We will formulate the main directions of the implementation of this process.

Price for new goods. In other similar conditions the increase in prices for new products on the market may lead to an increase in demand for RG due to the effect of replacement, which will reduce the demand for new products. This, in turn, contributes to the reduction of material flows in the socio-economic system, that is, the process of dematerialization. If the price for new goods remains unchanged, then the volume (commodity weight) and demand on the RG market also remain unchanged, without affecting the dematerialization changes.In the case when prices for new goods decrease, there is a reorientation of consumer demand in favor of the purchase of new goods, and at the same time the reduction of the demand for RG, which may negatively affect the dematerialization processes. Thus, it is obvious that the policy of dematerialization should be aimed at maintaining prices for new products at a high level. As a rule, for such a market economy the following environmental and economic instruments of influence are used:

- taxes on environmental orientation [Л Мельник, 1988], which function as a market regulator of RG, maintaining prices for new products at a high level and accumulating funds for solving global or local environmental problems. An example of such a tax is a civil environmental tax, an environmental tax on various product groups [Beauregard-Tellier, 2015; Environmental, 2015];

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- an import duty, by which it is possible to maintain high prices for new goods imported into the country for consumption, thus stimulating an increase in demand for RG;

- ecological payments for the use of primary extracted material resources are included in the price of new goods, which thus increase the value of these goods for the buyer and allow to reduce demand for them;

- direct regulation of prices, which allows, subject to the monopoly situation on the market, to influence the price level in accordance with the objectives of dematerialization, etc.

Price for RG. Due to the fact that the price of RG is a determining factor for the impact on the volume and demand on the market of RG, it is advisable to consider its change in two planes: price as a subject of influence on volume and demand on the RG market and price as an object of influence of changes in demand and supply of RG and new products. In the first case, the reduction of the price of RG makes them more affordable and attractive to consumers, and at the same time increases their demand and reduces the demand for new goods, which, in the end, causes a decrease of material flows, and, consequently, dematerialization. If the price of RG does not change on other equal terms, then there are no positive changes in dematerializational shifts. If the price of RG is increasing, then in such conditions the demand for RG may decrease, which will lead to a reorientation of consumers for the purchase of new goods, and, consequently, an increase of material flows that does not meet the objectives of dematerialization.

In the second case, when considering the price of RG as an object of influence, the following should be defined. If the demand for RG is much lower than their supply, this can lead to a fall in the price of RG even to 0, and vice versa – a sharp increase in demand for RG leads to an increase in the price of RG that may in the long run lead to an increase in the mass of new goods for further satisfaction of demand for RG [V Thomas, 2003]. Thus, it is obvious that the markets for RG and new products are closely linked and characterized by deep interdependence; therefore, when regulating the reduction of prices for RG, it is necessary to use a number of ecological and economic instruments aimed at stimulating the environmentally determined activity of business entities, which operate on the RG market, namely:

- tax benefits on value added tax (VAT), profit tax, property tax, which will encourage sellers to reduce prices for RG;

-implementation of accelerated depreciation for fixed assets of RG market participants, which will increase the investment attractiveness of such a market;

- the use of excise duties, which may be, on the one hand, an instrument of influence on commodity producers, stimulating them to reduce their production, including material costs, and, consequently, the price of goods as a result of withdrawal of part of their income by the state in order to address it on solving–urgent environmental problems, and on the other hand, an instrument of influence on consumers, forcing them to reorient to consumption of RG due to high prices for new goods;

- reduction of import duty on some RG groups. For example, lowering the import duty on cars and clothes that were in use-would stimulate lower prices for RG and increase the mass of goods in the relevant market;

- benefits for various types of payments, such as land payments, utility bills for business entities operating in the field of RG,

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which allow vendors to reduce their prices for RG, suppliers to increase their mass in the market and to form consumer demand;

- provision of loans on preferential terms for entrepreneurs in order to expand their activities in the RG market;

- direct regulation of prices by the state, in particular, direct reduction of prices for certain groups of RG and etc.

The cost of utilization of goods. As a rule, in world practice, the price (cost, expenditures) of the product utilization is included in the price of the new product. However, in the context of our study to determine the impact of this component on the market of RG, it is expedient to consider it separately from the price of the product itself. Consequently, if the cost of goods disposal is significant, consumers will try to extend the use of RG within and outside of the standard period of its use in order to postpone its costs for disposal at a later date, or to sell or give away RG to another person, the next consumer, transferring these costs to them. As a result, the commodity mass in the RG market will increase, reducing the volumes of goods to be disposed of, and, consequently, reducing the destructive burden on the natural environment.If the price for disposal will be reducing on other equal terms, consumers can utilize goods long before the full term of their use is completed, and consequently reduce the mass of goods on the RG market, increasing the demand for new goods, which inevitably leads to an increase in material flows in the economic the system.Thus, it is obvious that for the RG market management, in accordance with the dematerialization objectives, it is necessary to maintain a high level of price (cost) of utilization, first of all, for goods which useful life is not fully exhausted and, possibly, to reduce the cost of utilization for RG that have exhausted all of its life resource. The following environmental and economic instruments can be used for this purpose:

- environmental taxes, which carry out the function of maintaining the cost of utilization of goods at a high level;

- ecological payments for the placement of waste, which are included in the price of disposal and allow to reduce the volume of their disposal;

- direct state regulation of the utilization price, which allows maintaining high utilization prices for certain groups of goods, etc.

It should be noted that the policy of maintaining of high prices for utilization requires rigorous administrative control over compliance with legislation in order to prevent the formation of unauthorized landfills.The use of the above-described ecological and economic instruments should not be aimed at encumbering the work of the entrepreneurs in the sphere of utilization of RG, but on encouraging the maintenance of high prices for the utilization of goods.

The useful service life of the goods. As have been already noted, prolongation of the general useful life of goods will prolong their exploitation in the form of RG at other conditions, which will generally contribute to reducing the volume of production of new goods, and hence the process of dematerialization of the economy. Conversely, with the reduction of the normative term of the use of goods in the absence of effective mechanisms for the reprocessing of materials, the volumes of products subject to utilization will increase, which will increase the ecological destructive load. Also, the negative effects on the environment and dematerialization are characterized in modern trends of the creation by manufacturers and resellers of artificial demand for new models of goods. The management of the term of use can be achieved at the expense of

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both price and non-price tools. It is expedient to include in the price tools payments, compensations to the consumer for lengthening the term of use of goods or their packaging, which can be paid by producers or by state, local authorities through special funds or organizations. A container deposit system is a good example, when the consumer is paid for a return to the supermarket of glass or plastic containers. Non-price instruments may include information campaigns carried out by public or non-governmental organizations for the population on explanation of the ecological and economic effects of environmentalizing consumption and processes of dematerialization, raising the ecological consciousness of members of society regarding the need for the most expedient use of RG, etc.

Productivity of RG. From the model we have constructed, it is apparent that the productivity factor, namely its increase, can lead to an increase in the volume of RG and demand for them, which corresponds to the goals of dematerialization of the econony. That means, if the productivity of RG and the new product is not substantially different from the price, the consumer will be inclined to buy the RG for less money. Conversely, if the productivity of a new product is much higher than the productivity of RG, even at a lower price, the consumer may prefer a new product. On the other hand, increasing the productivity of new products allows them to be further used as RG with greater value for consumers. In this regard, the state should create favorable conditions for the production of goods that maintain high productivity throughout the entire useful period which can be achieved through such instruments of ecological and economic incentives as:

- reduction of VAT, income taxes for commodity producers who produce products with higher productivity compared to analogous products;
- implementation of accelerated depreciation, which will facilitate the expanded restoration of fixed assets of commodity producers, who create products with higher productivity compared with analogous products;
- reduction of the import duty on RG, which have, in comparison with their counterparts in the domestic market, higher productivity, which can stimulate the decreasing of prices for RG and increase their mass of goods.

In addition to these tools, similar to the ones described above, preferential credit and financial mechanisms for the development of entities in innovation area, as well as those of the market of RG that import and distribute high-efficiency RG, subsidies, direct regulation of prices for high-performance RG etc. can be used as leverage factors.

Ecological perfection of goods. As mentioned above, taking into account formula (15), increasing the value of the indicator of ecological perfection contributes to the increase in demand for RG, and, consequently, dematerialization of consumption. The achievement of higher levels of recycling as RG, as well as new products is possible if commodity producers consider the increased requirements for the recirculation of components of new products at the stage of their design and further production, as well as the improvement and development of direct processing technologies.

To motivate commodity producers and actors engaged in recycling to conduct their activity on the basis of dematerialization, to create appropriate favorable conditions for them, with the help of the use of ecological-economic instruments, most of which were

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described above, the following means are suggested: tax and customs privileges; accelerated depreciation of respective fixed assets; reduction of various types of payments such as land payments, utility costs for business entities engaged in recycling activities; provision of preferential loans, subsidies to business entities in the field of recycling to support and develop their activities; budget financing of research works on the improvement of constructions of goods and processing technologies, etc.

Transaction costs. As follows from equation (15), the reduction of transaction costs, affecting the price of the product, leads to an increase in demand for RG and its decline on new goods. At the same time, the growth of transaction costs may lead to a decrease in demand for RG and its disappearance at all. Reducing transaction costs to a certain level can lead to an increase in demand for new products, that in the future will turn into RG to meet the increased demand for them [V Thomas, 2003]. In general, it can be stated that reducing transaction costs for the purchase of RG at a certain stage will contribute to the objectives of dematerialization. Such reduction, in our opinion, can be ensured through the creation of information nodes by the subjects of the market of RG in the information and telecommunication environment (Internet) for the rapid access of customers-consumers to the necessary information about the goods and the provision of related services for the purchase of RG. An example of such information centers can be modern webpages for purchase and sale of different RGs. The state in this case can independently create or stimulate entrepreneurs to issue the necessary information and other infrastructure with the help of the above-described ecological and economic tools, in particular tax, credit privileges, grant programs, etc. for business entities that create information services to facilitate the search for RG and their cheapening, finance relevant scientific and applied researches, carry out educational, training activities, keep warehouse stores of RG, etc.

Ecological efficiency of RG. As already noted above in the description of the formula (8), the closer the value of the ecological efficiency of RG to the efficiency of the new product, the higher the price of RG and, consequently, the lower demand for them in other similar conditions. At the same time, increasing the environmental efficiency of new products, which subsequently pass into the category of RG leads to a general reduction of the destructive burden on the environment. This leads to a certain ecological and economic contradiction – the increase in the environmental effectiveness of products does not contribute to an increase in the volumes of the mass of RG, but causes a reduction of ecological destructive load.That is, on the one hand, in accordance with the goals of dematerialization, it is expedient to develop a market of RG, increasing demand for them through lowering prices, on the other – it is necessary to increase the ecological efficiency of new products, which subsequently increases the price of RG. The resolution of this contradiction involves the conduction of balanced policy by the state and local authorities in the field of dematerialization in relation to the development of new product markets and RG. This policy should help to form optimal prices for RG, which stimulate the development of the RG market and minimize the destructive burden on the natural environment. Depending on the specifics of a particular commodity market, the level of the optimal price for RG will change, that is why an additional marketing research should be carried out to balance prices for different types of RG. After clear-

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ing out the specific tasks of dematerialization through the development of the market of a certain RG, it is expedient to solve them using ecological and economic tools, described in details by [Л Мельник, 2006], most of which were proposed above to manage dematerializational shifts under the influence of the cost of utilization, useful life term, the productivity of RG.

Purchasing power of consumers, as already noted above, in case of its growth, does not always have a positive effect on the demand for the market of RG, since, as a rule, consumers with a high purchasing power are in a position to choose new products, so the state authorities should pay special attention to stimulate the environmentally-minded choice of buyers. Increasing the purchasing power of the population is one of the main goals of the social and economic policy of the state, a guarantee of stable economic development. However, as can be seen from equation (15), increasing the purchasing power of consumers usually leads to an increase in demand for new goods, stimulating the expansion of consumption, contrary to the state's environmental goals, including dematerialization of the economy. At the same time, consumers with high purchasing power are inclined to choose better products (both new and RG) with increased environmental efficiency, which in the end contributes to reducing the load on the environment. Thus, there is a "boomerang effect", the negative impact of which may be mitigated, in our opinion, by conducting information campaigns among the people and commodity producers to clarify the ecological and economic effects of environmentalizing consumption and processes of dematerialization, increasing environmental awareness of society members, etc.

It should be noted that during the development of the RG market, we have focused on its universality, which, of course, caused some assumptions related to the complexity of taking into account in a universal model the specifics of the markets for specific RG. On this basis the assumed model was created, describing mainly consumer goods that can be reused by other consumers. In addition, since the usefulness of heterogeneous goods varies substantially, taking into account the time factor in the model, which is universal in nature, the model is somewhat complicated. Therefore, to simplify the calculations, we did not take into account the time factor in analytical formulas. In our opinion, this assumption does not affect the ability of the model to reflect the essential features and properties of real processes that are studied and modeled. However, the further use of this model for the analysis of specific product groups and markets, depending on the needs and objectives of the next researches, will require taking the time factor into account when modeling the market for a specific RG.

Conclusions. Thus, the model developed by us is an important informational tool for making decisions in the field of dematerialization of consumption at different levels of management which aimed to achieve positive ecological and economic effects of dematerialization shifts. The investigated factors of influence on the components of the model and the proposed ecological and economic tools allow to deeper understand and manage dematerializational changes at the stage of consumption in socio-economic systems on the basis of sustainable development.

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