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## Article

# Economic modeling in the management of transition to bioeconomy

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**ECONOMIC MODELING IN THE MANAGEMENT OF TRANSITION TO BIOECONOMY**

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**Abstract**

The management of the transition to bioeconomy has developed relatively recently, to cope with the challenges of the 21<sup>st</sup> century. The determinants of transition are related to economic, social, biological and environmental evolution. In particular, the envisaged factors consist in demographic increase, excessive unsustainable consumption, industrial development, climatic changes, depletion of traditional or non-renewable resources. This article presents, first, the conceptual model of the transition process, making a review of the specialized literature. The authors render applicability to the sustainable economic model developed in the primary sector, which is the first biomass-producing industry with potential to generate new products, used in the secondary and tertiary industrial sectors. The second part of the article defines the behavioral research model. The article aims at providing an applicative perspective to the behavioral model, through the economic integration of data collected from the biomass industry. The third part of the article presents the results of the case study, interpreted in the light of the responses to the questionnaire transmitted to the respondents. Data were collected using a questionnaire addressed to management and employees in the biomass industry. Structural equation modeling (SEM) was used, and d splints were analyzed by software-ul Smart PLS 3. One of the main goals of this paper is to identify and assess the relationship between the sustainable development of Bioeconomy through the indicators of performance obtained by producers of biomass in the framework of the economic model of transition to the bioeconomy. The conclusions of our research are in line with the existing literature and confirm the theoretical assumptions, underlining that the performance and sustainable development of the producers is a direct consequence of the association of a number of factors such as innovation and technology, regulation, knowledge and skills of the human factor.

**Keywords:** bioeconomy, behavioral model, technology, research, innovation, environment.

**JEL Classification:** Q57, O32, C39, C83

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## **Introduction**

Evolutionary anthropological studies highlight the challenging factors that society is facing as a whole. Worldwide demographic growth cannot be sustained at the same pace as finite natural resources. Climate change due to environmental pollution caused by industrial development is another major danger, which leads to significant ecosystems imbalances. Faced with these challenges, the strategy proposed by the European Commission in the bioeconomy sector (European Commission, 2012) identifies risks in geopolitics and proposes a series of ambitious goals, including: decreased dependence on finite resources, adaptation to climate change and mitigation, food security and new jobs created in rural areas.

Managing the transition to bioeconomy in order to achieve the objectives set by the European Forum entails a collection of data, such as development of knowledge of the sectors generating biomass, feedback on economic interests and data on national government policy as a starting point to a documented analysis to determine the current stage in the transition. Economic modeling is the next step in the Contextual Conversion Scenario to respond to predictable estimations communicated by decision makers. Research activities in the field of bioeconomy will significantly contribute to the knowledge of biomass production potential, identifying the potential barriers to the development of this new industry.

Until now, many industrialized countries have developed strategies and policies for a circular economy based on the reuse of biomass. Romania, in turn, has an environmental strategy that allows the future development of bio-economy. Current studies identify the need to determine the intersectoral correlations, respectively the modalities of the relationship between the different sub-sectors of the bioeconomy, which are generating new products.

This article aims to develop a model for analyzing sectoral interdependencies, taking into account exogenous variables such as resource production, production expenditures, government policy, investment in technology, R&D and innovation, to assess the prospects of transforming the traditional economy.

## **1. Presentation of the management model in the economic literature**

Economic literature abounds in models for assessing the transition to bioeconomy. Authors such as Rick Bosman and Jan Rotmans have studied comparatively the two models of management of the transition to bioeconomy in Finland and the Netherlands. The research paper (Bosman and Rotmans, 2016) contains a series of recommendations tailored to the national economic characteristics of the two countries. As such, the authors note a useful suggestion to develop the public-private partnerships in which both public decision makers and the private sector find the right solutions to meet the challenges in managing the transition to bio-economy. An example is provided by the partnership between the European Commission and the Bioindustry Consortium, whereby the state and the private sector invest in innovative technologies for bio-industry to generate new biomass products. This inevitably implies a change in the behavior of the human factor, which understands the need to move

from the traditional economy to the circular economy, by reference to a new sustainable economic model that embraces the innovative factor (Carrez and van Leeuwen, 2015).

A management system for the transition to the bioeconomy needs to know in detail what the functional requirements for transforming a traditional economy into the bioeconomy are. Sustainability of analysis models has been the subject of research in economist work (Hockings et al., 2006). The modeling of sectoral interrelationships is constantly evolving, requiring a quantitative and qualitative analysis. For example, it is possible to analyze in the short term the impact on the price evolution of a bio product produced in a secondary sector as a result of the increase in the prices of the basic resources of the primary sector. In addition, the evaluation criteria are varied, belonging to a multitude of disciplinary sciences, from biodiversity to food safety (European Commission, 2012). For this reason, there is no perfectly integrated model of management that aggregates the totality of the exogenous variables, for these reasons as we mentioned related to the continuous development of the interdependence relations and the multitude of variables.

Economic modeling requires a permanent adaptation to the specific economic context, being integrated into a scenario adjusted for government policies and private demand for biomass and bioenergy products (Angenendt et al., 2018). This contextual, specific approach is particularly useful in the decision-making process in order to develop a technology appropriate to the development in the biomass-producing sectors and to assess the contributions of these sectors to the production of positive externalities on competitiveness and production in the tertiary sector as well the pharmaceutical industry, the chemical industry, or the biofuels industry. Nowicki et al. (2007) detailed the economic analysis at the level of the economic sub-sectors (for example, horticulture as a sub-sector of agriculture) and, accordingly, the modeling was determined at the level of products that could contain bio-ingredients.

From the perspective of the economic models used in the research work, they can be classified into dynamic models of general equilibrium applicable to analyze multi-sector macro interdependencies (i.e. energy – agriculture – bioenergy – bioindustry) developed by economists such as Pogonietz (2000), Van Meijl (2006), Banse et al. (2014), economic equilibrium models applicable to certain economic sectors (Izaurrealde et al., 2012) defined as partial models and bottom models (Janssen et al., 2010), which respond to contextual questions related to technological, procedural or behavioral development, studying in detail the procedural aspects related to the generation of biomass sources, respectively the production of the economic and ecological effects resulting from these processes, whether and to what extent they meet these expectations. Temporary definition and location in geographic space is of particular significance to conceptualize the management model. This explains why a model performs better in one country than in another or can give clues as to the evolution of the transition to the bio-economy during a period of time.

Research studies conducted in the European Economic Area often have common benchmarks for contextual analysis. This is largely due to the two projects launched at the European Union level by the European Commission, which substantiate the framework for assessing the transition to the bio-economy. The first project was launched in November 2012 and refers to the Analysis Toolbox to respond to the EU's Bioeconomic Strategy (System Analysis Tool framework for the EU Bio Based Economy Strategy SAT – BBE within the EU 7th Framework Programme). The first research project makes an inventory

of industries with the potential to generate biomass products and identifies barriers to the development of the new industry. The second project was launched by the European Commission in February 2013 and aims at integrating the data collected in the first project and at conceptualizing them in a computer system. The institution that processes this data is the European Observatory for Bioeconomy. The conceptual model used describes the interaction between society and the environmental factors. The management system is defined by the human, demographic, consumerist factor, biophysical processes and the limited natural resources, the technological progress and innovation, and last but not least, the governance policy of the state.

The economic modeling of human behavior is influenced by the economic context and cultural affiliation of individuals, in accordance with the principles of the universal theory of multilineal evolution. Thus, condensing the opinions of anthropologists Leslie Alvin White (1975) and Julian Haynes Steward (1972), the change of mentality gradually takes place in a process of awareness of the need for transformation.

From the perspective of the transition to bioeconomy, at national level, we observe the potential generated by certain industries, specific to the basic sectors, for the production of biomass, such as agriculture, zootechnics, fish farming, wood processing, secondary sectors such as bio-industry (i.e. biodegradable plastic products, biofuels), the food industry and tertiary sectors, interdependent on the first two, such as the chemical and pharmaceutical industries.

The National Strategy for Research, Development and Innovation 2014-2020 identifies, on the basis of a public consultation, the areas of intelligent specialization for the development of bio-economy (GD no. 929 / 21.10.2014). There is a constant need for information and communication on biomass production, support for environmental research and limitation of certification costs, to increase productivity and competitiveness of sectors with the potential to generate new, affordable products. Additional investment is needed in technology, so as indicated by the data collected in the research (PwC, 2017). According to the study, the share of GDP gross value added in agriculture is positioning Romania on the first place in the European Union. Given the large number of nurseries in the agricultural sector compared to the European average, the productivity of the sector is relatively low. Also, the yield of agricultural production, relative to arable land, is low compared to the European average due to the fragmentation of agricultural holdings, the level of professional training of farmers, the low level of capitalization and the regulatory framework.

The conceptual model is essential to manage the transition to the bio-economy development. The reflective indicators demonstrate the efforts of civil society, the political and business to meet objectives bioeconomy or sustainable resource management, development of new technologies for biomass production, support processes to reuse resources, food security, increase food quality and pharmaceutical, economic and social prosperity by creating new jobs, developing infrastructure for recycling and, last but not least, encouraging sustainable consumption patterns. Economic reforms, environment and research policies adopted, changing forms of organization are necessary elements to turn negative externalities in the bioeconomy benefits.

## **2. Econometric model of the behavioral model for the management of transition to bioeconomy**

According to the study by Mariusz Maciejczak (2015) on the determinant productive factors for bioeconomy, it is noted that Romania is the best placed from the EU Member States to produce biomass from waste. Based on this, we have conducted a case study in the biomass industry for enterprises active in the agricultural sector, considering the main biomass sources, namely grain crops.

We determine the performance of biomass producers according to the two indicators: the percentage indicator of the variation of biomass production, based on waste reuse, and the variation in the rate of revenue from sales of production relative to operating costs. These will be dependent variables in the model.

The independent variables are as following:

- Innovation, research and development (indicators: investments in biotechnology or new infrastructure, patents, patents or licenses issued, number of R&D employees, the existence of biotechnology labels or processed organic products needed to inform consumers or distributors – i.e. ecolabels);
- Regulation (public funding programs, tax incentives provided in national legislation, incentives for investments in the field);
- Knowledge and skills (no information or communications sent by producers on the benefits of using biomass within the production-distribution chain, for awareness of the importance of the field among each participant, no qualified personnel, no training courses for the training of specialists in the field of bio-economy, no participation in bioeconomy discussion forums, for transfer of expertise;
- Motivation of employees to determine the extent to which they are stimulated to integrate into the workforce, incentives for outstanding performance, motivation for the transition to bioeconomy;
- The performance of the production process (the existence of an integrated management information system, the existence of a circular flow of product reuse, based on their characteristics, i.e. biodegradable products, reintegrated into agriculture as a resource for generating new production, product lifetime.

### **2.1. Brief description of the biomass sector in Romania**

Biomass is part of the alternative energy resources and can be divided into four general categories:

- Wastes: agricultural waste, agricultural waste, crop residues, wood waste, urban wood waste and urban waste;
- Forest products: wood, wood residues, trees, shrubs and wood scraps, sawdust, bark etc. from clearing forests;

- Energy crops: short rotation woody crops, herbaceous woody plants, herbs, starch crops (corn, wheat and barley), sugar crops (cane and beet), crop crops (herbs, lucerne and clover), soybean, sunflower, saffron);

- Aquatic plants: algae, water weeds, hyacinth water, cane and fats.

Biomass is the fourth most important global energy source after coal, oil and natural gas it is (Ladanai and Vinterback, 2009). Typically, biomass production can be divided into two categories: bio ENER GIE (the process by which biomass products it is burned to generate heat and electricity) and biofuels (biomass products are converted into liquid fuel using the replacement of petroleum products in transport).

Agricultural waste is another segment of biomass. Although Romania has a wide variety of crops, only a few of these are used for energy production, mainly due to the technical limitations of the conversion process (Colesca and Ciocoiu, 2013). The main sources of energy from their crop processing:

- Oilseeds (rape, sunflower and soybean) used for biodiesel production;

- Sugar and starch crops used for the production of bioethanol (wheat, corn, corn, barley, potatoes and sugar beet);

- Woods (hells) used for heat and energy production.

Unfortunately, in Romania there are not many incentives for the use of modern biomass technologies to transform this into thermal and electrical energy. Thus, the latest available data indicate a total consumption of 3859 ktone/year, of which 3240 ktone /year consumed in the old traditional rural stoves and 619 ktone/year in the consumer industry and tertiary (Bioheat 2016).

It terms of bioenergy, Romania has not progressed very much compared to 2007. In 2007 local production of biodiesel and bioethanol started. At the level of 2016, the potential of biodiesel was of about 400,000 tons/year and 120,000 tons/year for bioethanol (NREAP, 2017). Romania's potential to supply biodiesel production (sunflower, soybeans, rape) was around 580 thousand tons / year and bioethanol production around 560 thousand tons/year (consisting of 41 thousand tons / year of corn seeds and 150 thousand tons one / year of wheat germ) (ENERO, 2017).

The most promising way for the production of biofuels is rapeseed (EC, 2003). In 2016, circus 161.000 tons of biofuels, accounting for 3.2% of total transport fuels (EBRD, 2017) was produced in Romania. Directive 2003/30 / EC on the promotion of the use of biofuels or other renewable fuels for transport was included in the national legislative framework and in accordance with the law, biofuels shall replace gasoline and gasoline up to 10% by 2020.

## **2.2. Research Methodology**

In order to achieve an economic modeling in the management of the transition to bioeconomy, the following statistical hypotheses were formulated:

- H<sub>1</sub>: The motivation of the employees has a positive impact on organizational performance;

- H<sub>2</sub>: The management quality is positively correlated with the organizational performance;
- H<sub>3</sub>: The strategies and the commercial policies have a positive influence on organizational performance;
- H<sub>4</sub>: Operational integrated processes have a positive impact on the organizational performances;
- H<sub>5</sub>: Employees' motivation is positively related to the performance of the organization.

A survey-based assay was carried out with the help of a questionnaire and the research hypothesis were tested using Partial Least Square model. Data were processed using the SmartPLS 3 software (SmartPLS GmbH, Boenningstedt, Germany) (Ringle et al., 2015). The main purpose of its analysis it was the analysis of the transition to bio-economy of biomass-producing enterprises in Romania.

The objective of this study is validating the economic model by analyzing data collected from Biomass energy sector in Romania. The paper also analyzes the impact of the econometric model, represented by innovation, regulation, level of knowledge and skills, production process performance and human factor motivation in the performance of biomass producers.

The data collection was done through a survey which was addressed to employees and managers in the biomass production sector. Biomass companies were selected in proportion to their size. The sample chosen was random and the sample size was calculated by multiplying the number of indicators by 5-10 (Kristensen et al., 2010). Thus, the size of the sample should have at least 15 indicators  $\times$  5 = 75 respondents. The authors collected data from 90 respondents out of which 80 were valid. The questions were either binary, with answers (Yes = 1, No = 0), or they used a 7- point Likert scale where the choices ranged from "very little = 0" to "very much = 1". The questionnaire has been tested several times to ensure that language, format, and order of questions are appropriate.

The following five proxy variables were considered important factors in the implementation of the model (Table no. 1): innovation in the production process (Malerba, 2002; Mainar-Causapé et. al., 2017), sector level regulation (Crafts, 2006; Mengat et. al., 2018), knowledge and skills level (Boyatzis, 2006; Müller et. al., 2009), production process performance and motivation of employees.

**Table no. 1: Description of the variables in the model**

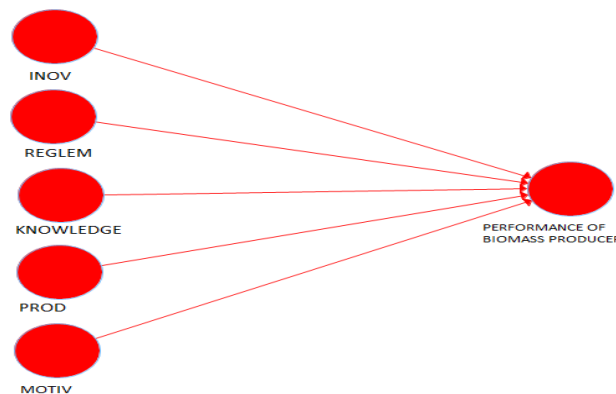
<b>Innovation (INOV)</b>	
Inov_1	Existence of investments in biotechnology
Inov_2	Labeling for biotechnology or processed organic products
Inov_3	The existence of patents or license issued
<b>Regulation (REGLEM)</b>	
Reglem_1	Funding programs from public funds
Reglem_2	Tax incentives provided for in national law
Reglem_3	Incentives for investment in the field



<b>Knowledge and competences (KNOWLEDGE)</b>	
Knowledge_1	Information or communications submitted by producers on the benefits of using biomass in the production-distribution chain
Knowledge_2	Training courses for the purpose of training specialists in the field of bioeconomics
Knowledge_3	Participation in bioeconomy discussion forums for transfer of expertise
<b>Performance of the Production Process (PROD)</b>	
Prod_1	The existence of an integrated management information system
Prod_2	The existence of a circular flow of product re-use based on their characteristics
Prod_3	Product life
<b>Motivation of the employees (MOTIV)</b>	
Motiv_1	Motivation employees to determine the extent to which they are stimulated to integrate into the workforce
Motiv_2	Incentives given for outstanding performance
Motiv_3	Employee motivation for the transition to bio-economy

The variables described above will be the independent model latent variables of the model, while the reflective dependent variable is the "biomass producer performance" determined by two proxy variables: "percentage change of biomass production based on waste reuse" and "variation rate of revenue from the sale of production in relation to operating expenses" (Mohr-Jackson, 1998).

The dependent variable together with the independent variables described above lead to the construction of the structural model that will be tested and validated in the next chapter (Figure no. 1).



**Figure no. 1: The structural model incorporating the results of managerial decisions on the transition to bioeconomy**

The questionnaires were addressed to both executive and corporate executives in June 2018 and were finalized at the end of July this year. In Table no. 2 show the distribution of biomass production companies as well as the respondents of the questionnaire. They were selected in proportion to the distribution of enterprises, thus obtaining a sample approaching the optimal theoretical combination.

**Table no. 2: Distribution of respondents**

	<b>Producers of Biomass</b>	<b>Sample</b>
<b>SME</b>	82	80
<b>Big Enterprises</b>	8	10
<b>Total</b>	90	90

The analyzed sample consisted of 90 executives and managers from companies operating in the biomass industry in Romania, stratified by sex, age, income, status and level of education, directly interviewed directly, the questionnaire containing 20 of questions.

In the elaboration of the questionnaire the stratified sample method was applied. The data were collected during June 1 – July 30, 2018, using an open questionnaire and the main limitation of the data collection process was the lack of co-operation of the individuals surveyed. The main objectives of the study were: to identify respondents' level of knowledge regarding bio-economy based on education level, gender, age and interests' respondents; assessing innovation and R&D in enterprises; determine the degree of regulation in the sector; assessing the knowledge and skills of employees and assessing the production process of biomass enterprises in the perspective of the transition to bioeconomy.

**3. Results and discussions**

The degree of significance of the conceptual model variables will be verified before the model is analyzed. This will be done by calculating and interpreting the coefficients "Dillon-Golstein" and "Cronbach's Alpha" (Tenenhaus et al., 2005). The values of these indicators can be seen in table no. 3.

**Table no 3: Reliability and validity of the variables**

<b>Construct</b>	<b>Dillon Golsteins' rho</b>	<b>Cronbach's Alpha</b>	<b>Composite Reliability</b>	<b>AVE</b>	<b>VIF</b>
<b>INOV</b>	1.000	1.000	1.000	1.000	2.221
<b>REGLEM</b>	1.000	1.000	1.000	1.000	1.418
<b>KNOWLEDGE</b>	0.712	0.723	0.821	0.712	1.528
<b>PROD</b>	0.621	0.691	0.679	0.677	2.798
<b>MOTIV</b>	0.678	0.682	0.682	0.651	2.392

From the table above, it can be noted that the values associated with the variables in the model are all greater than 0.7, which is why it can be concluded that all five latent variables are significant in our analysis. In addition, the collinearity of the latent variables has been tested. According to Hair et al. (2013) collinearity between independent variables is present if their VIF values are greater than 5. According to the data in the table, we can conclude that the exogenous variables in the model are not collinear.

The econometric analysis was carried out by the Partial Least Squares – Structural Equation Modeling (PLS-SEM) method. This consists in the creation of two sub-models, namely the structural model "internal model" and the measurement model, quantification, "external model". The PLS-SEM model was chosen because it is more robust than other similar methods (i.e. CB-SEM), but also less sensitive to small samples, asymmetric distributions or the presence of multicollinearity (Hair et al., 2013).

**3.1. The measurement model**

The measurement model was achieved by the convergent and discriminating validity method. From a statistical point of view, the relation between the reflexive and the dormant variables can be determined by means of structural equation modeling (SEM):

$$\{x = \Psi_x \vartheta + \varepsilon_x \tag{1}$$

$$\{y = \Psi_y \eta + \varepsilon_y \tag{2}$$

where:

$\eta$  - endogenous latent variable;

$\vartheta$  - exogenous variable;

x and y - observed variables;

$\Psi_x$  and  $\Psi_y$  - matrices of the systems of equations corresponding to latent variables;

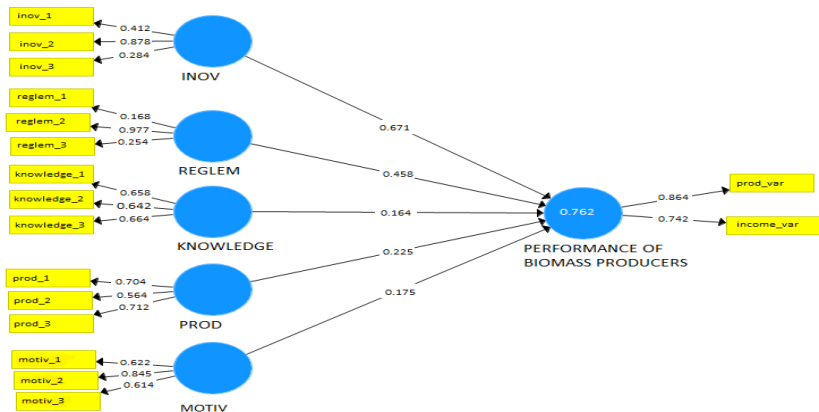
$\varepsilon_x$  and  $\varepsilon_y$  - the residual variables.

**3.1.1. Convergent validity**

When a latent variable explains a significant part of the variance of its constructs, the convergent validity must be verified (Nakasul, 2017). The convergent validity is examined by the extraction of variance indicator (AVE – average variance Extracted), which measures the variation that a latent variable is capturing its variables associated with the total variance of the variance, including the variance of the error of measurement (Rust Huang, 2012). At a level above 0.5, the latent variable explains more than half of the variance of its latent variables (Čihák et. al., 2013).

According to Chin (2010), the variables for which the coefficients are less than 0.5 are excluded. Thus, the following variables will be excluded from the model: inov\_1, inov\_3, reglem\_1 and reglem\_3. These are variables whose coefficients are less than 0.5 in figure no. 2.

**Model I**

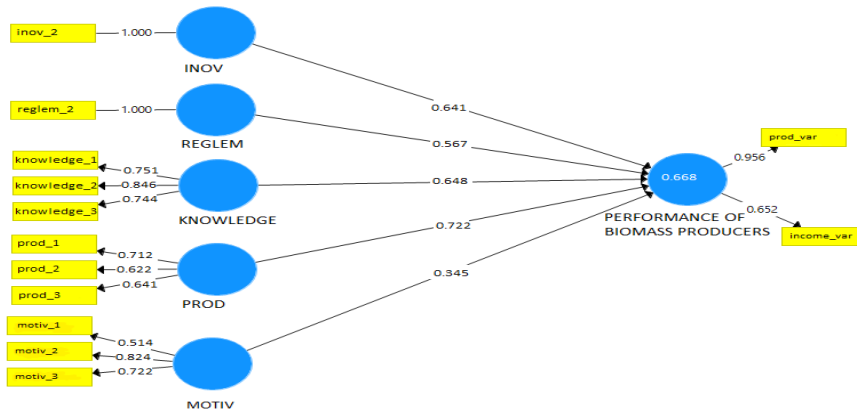


**Figure no. 2: PLS-SEM Measurement Model 1**

Source: Results determined by the authors valuing the SmartPLS 3 software

After excluding the above variables from the model, a new model was obtained from the previous one. By SEM-PLS a second model resulted (Model II), as outlined in Figure no. 3.

**Model II**



**Figure no. 3: PLS-SEM Measurement Model 2**

Source: Results determined by the authors valuing the SmartPLS 3 software

As can be seen from Figure no. 3, all coefficients in the model are greater than 0.5, meaning that they are significant and valid. Thus, the convergent validity of the model is conformed.

**3.1.2. Discriminant validity**

The AVE indicator can be used to verify the discriminatory validity of the model (Fornell and Larcker, 1981). The authors consider that if the square values of the correlation coefficients between the latent variables is less than the computed value of AVE (Table no. 4), the discriminant validity is confirmed.

**Table no. 4: Correlation coefficients between the latent variables**

Latent variables	AVE	Square of the corr. coefficients of the latent variables				
		Inov	Reglem	Knowledge	Prod	Motiv
<b>INOV</b>	1.000	1				
<b>REGLEM</b>	1.000	.621	1			
<b>KNOWLEDGE</b>	0.712	.679	.512	1		
<b>PROD</b>	0.677	.528	.491	.531	1	
<b>MOTIV</b>	0.651	.513	.324	.552	.621	1

Source: Data analysis was performed by the authors valuing SmartPLS 2.0 M3 software

By comparing the square of the correlation coefficients between the latent variables in the model IU structural and indicator values AVE, discriminant validity is confirmed.

### 3.2. The structural model

The structural model (inner model) results from Figure No. 2 in which the relations (path) of exogenous variables (latent) and endogenous (reflective) are described. The structural equation (Zhang, 2009) of the model is as follows:

$$\eta = \Gamma\eta + \Lambda\phi + \psi\zeta \quad (3)$$

where:

$\eta$  - vector of latent endogenous variables;

$\phi$  - vector of latent exogenous variables;

$\psi$  - vector of residual variables;

$\Gamma$  and  $\Lambda$  - the path coefficient matrices.

The structural model is evaluated by the values of the coefficients and the R-square value (R\_squared). According to figure no. 3, the R-square value is 0.668, which means that about 66.8 % of the variability of biomass producers' performance is explained by the variability of the model. Moreover, the coefficient values of the structural model are all positive, which means that the higher the values the latent variables have, the higher the performance of the manufacturers. Of the five indicators, the variable with the greatest impact is "performance of the production process" (factor 0.722), followed by "knowledge and skills" (factor 0.648) and "innovation" (factor 0.641). Organizational performance with the least impact is given by indicators "degree of regulation of the sector" (factor 0.567) and "employee motivation" (factor 0.345).

Indicators reflect emerge of endogenous variable "performance producers of biomass" have values over as 0.5. It follows that these variables in the reflective model (prod\_var and income\_var) are statistically significant. The high values of the coefficients of the reflexive variables, i.e. the "change in biomass production (factor 0.956) and the " rate of income from the sale of production relative to operating costs" (factor 0.652) shows that the performances of biomass producers are well represented by the two indicators. Multiple factors, in general, increase reliability and improve the performance of the model compared to the unique factors. In our model, the dependent variable is composed of two variables that reflect economic performance, a financial variable, and the other operational variable. In addition, a variable has a higher impact because it has high coefficient values reflecting more powerful measurement paths. This is also underlined by the high values of the two coefficients of endogenous variables.

Moreover, hypothesis testing their research described it above, it was made a Bootstrap test on a sample of 300 respondents to generate t-values and standard deviations of the model parameters. Bootstrapping allows the assignment of precision measurements to the sample estimates. The results are presented in Table no. 5.

**Table no. 5: Hypothesis testing results**

Hypothesis	Path Coef.	Std. Error	t-value*	P_value
<b>H<sub>1</sub>: INOV -&gt; Biomass Prod Performance</b>	0.643	0.224	3.823	0.013
<b>H<sub>2</sub>: REGLEM -&gt; Biomass Prod Performance</b>	0.562	0.369	2.701	0.035
<b>H<sub>3</sub>: KNOWLEDGE -&gt; Biomass Prod Performance</b>	0.684	0.172	3.289	0.027
<b>H<sub>4</sub>: PROD -&gt; Biomass Prod Performance</b>	0.754	0.131	2.368	0.039
<b>H<sub>5</sub>: MOTIV -&gt; Biomass Prod Performance</b>	0.222	0.248	1.234	0.282

Note: \*t-value 2.58 (sig. level = 5 %)

Valid hypotheses are those with values of p-value less than 0.05, while the others with p-values higher than 0.05 are not. Therefore, we can conclude that H<sub>1</sub>, H<sub>2</sub>, H<sub>3</sub> and H<sub>4</sub> are valid hypotheses, while H<sub>5</sub> is not. These results confirm the economic studies according to which the innovation, the degree of regulation, the level of knowledge and skills and the production process are significant factors for the performance of biomass producers (Campbell et al., 2008; Cardenete et. al., 2014), but argues that motivation is an important factor in the performance of biomass producers (Wagner, 1994; Lewandoski, 2015).

In conclusion, we can state that the degree of innovation, the level of regulation in the sector, the level of knowledge and skills, the performance of the production process have a positive impact on the performance of biomass producers in Romania.

**Conclusions**

Using economic modeling in the management of the transition to bioeconomy with SEM-PLS structural equations, the paper identifies and then evaluates the relationship between the determinant characteristics of the conceptual management model of the transition to bioeconomy and the economic performance of the biomass production companies. The results indicate that a significant proportion of variability of endogenous variables is explained by exogenous latent variables.

The survey used in our research highlights that integrated business processes used by an enterprise have a positive impact on performance and sustainable development. Important factors that converge towards performance regarding innovation of the production process, the level of knowledge and skills, the performance of the production process and the motivation of employees. In this context, the significant contributions of management processes (including surveillance and inspection) lead to an increase in motivation for the transition to bio-economy of these corporations. This argues the high value of the process-level coefficients of this model.

The econometric analysis has shown that the entrepreneurial confidence in government policies for the development of bio-economy is very low. We also note that the principle of Corporate Social Responsibility (CSR) remains an abstract concept without practical

application, as suggested by the modest results obtained for the human factor motivation indicator.

The results of the behavioral model, analyzed through the structural equations modelling, confirm the conclusions of the studies in the economic literature, emphasizing that innovation, the level of regulation in the sector, the level of knowledge and skills and the performance of the production process are determinants of the management of the transition to the bioeconomy.

Some of the recommendations of the Bosman and Rotmans (2016) research study are fully applicable to Romania as regards the need to develop public-private partnerships to meet the needs of the transition to bioeconomy.

A limitation of this study is given by the relatively small number of respondents to the survey and by the fact that the paper analyzes a single industry. Other limitations of this research could be related to the subjective answers of the questioned persons and the number of constructs and reflective variables. These limitations could be overcome in future research by increasing the sample size and the number of constructs and reflective variables, as well as introducing open questions in the questionnaire.

Additional studies in the field of bioeconomy transition on producer performance should be extended to other sectors or industries, and research may, as such, include some likely macroeconomic effects. The analysis could also be developed by analyzing how companies in the industry have funded their efficiency towards a sustainable development of the biomass sector.

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