ECONOMIC CYCLES AND DISEMBODIED TECHNICAL CHANGE OF ROMANIA'S ECONOMY DURING THE PERIOD 1863-1913

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Abstract: *This paper intends to reveal the features of economy dynamics from 1863 to 1913, which represents the most important part of Romania's first transition to market economy. If the Kondratieff long economic cycles vision is adopted the respective period may be divided into two quasi-three decennial cycles (1863-1887 and 1888-1913, respectively), which differed from the point of the macroeconomic policy promoted by public authorities and by the foreign trade regime. The analysis is based on a series of econometric estimations related to elasticity between the gross domestic product and gross value added and rate of disembodied technical change proper. In this context, some methodological proposals are made in order to obtain a better understanding of the significance of the estimated parameters and reveal the form of the trajectory of economic growth. The implementation of the respective methodological proposals allows us to compare the dynamics of Romania's economy during the two above-mentioned economic cycles and to highlight their common features and differences at macroeconomic and sectoral level. The main conclusion of the analysis is that the extension of market relations and of the role played by market economy institutions favoured the development of non-agricultural activities and the acceleration of economic growth.*

Keywords*: representative index, representative rate, economic sectors, linear regression intercept, gross value added, trajectory of economic growth*

JEL Classification*: B41, E30, E32, J11*

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Introduction

The 1863-1913 period is very important for Romania's economic and social development. For the above-mentioned time interval the statistical data are available in V. Axenciuc (2012), so that we are able to analyze the dynamics of main economic and social indicators. During the respective time interval Romania experienced the most important part of the first transition to market economy (Annex 1).

The first transition to market economy took place in the context of economic growth[1]. The trend of the economic activity development did not exclude sensible fluctuation of main economic indicators. Therefore, it is possible to detect quasi-three decennial economic cycles of Romania's economy during the 1863-1913 period. The respective economic cycles were determinated not only by the factors which usually were manifest in developed market economies of the above − mentioned period, but also by the specific features of the extending of market relations and development of the productive apparatus in Romania[2].

In this context, when we detect the features of the economic growth during Romania's first transition to market economy, it is very important to identify the different stages of institutional framework development and structural changes in the economy. Also, we should not ignore the stability in time of the economic growth and the main orientations of the macroeconomic policies promoted by the gouvernments led by Liberal or Conservative party.

Consequently, in this paper, we pay special attention to the identification of the features of the economic growth from the point of view of disembodied technical change at the macroeconomic and sectorial level during the economic cycles of the analyzed period.

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[1] Estimations made in V. Axenciuc (2012) show that in 1914 the gross domestic product was 3.62 times higher than in 1862, corresponding to an average economic growth rate of 2.50 %. But if the comparison is made between the year 1862 and the year 1913, we obtain an average economic growth rate of 2.79 % which corresponds to a multiplication of 4.07 times of the gross domestic product during the analyzed period. The difference between the two average economic growth rates mentioned above reveals the negative impact of the breaking–out of the World War I on Romania's economy. Under these conditions, when we investigate the features of dynamics of Romania's economy during the first transition to market economy, a better solution is to consider only the 1863-1913 period and not 1863-1914. The year 1914 may be included in the period of World War I, which is characterized by great distortions and lack of reliable statistical data.

[2] F.M. Pavelescu (2013) largely reviewed the main concepts and notions related to economic cycles and also proposed some criteria for the identification of economic cycles of Romania's economy during the 1860-2010 period.

1. Identification of economic cycles of Romania's economy during the 1863-1913` period

Considering the data presented in V. Axenciuc (2012) related to the estimation of the gross domestic product during the 1862-1947 period, we are able to identify six Juglar-type economic cycles[1] of Romania's economy, which lasted, strictly from statistical point of view, between 5 and 11 years[2], namely: a) 1862-1866, b) 1867-1876, c) 1877-1887, d) 1888-1897, e) 1898-1907 and e) 1908-1913[3].

In F. M. Pavelescu (2013) the above-mentioned Juglar-type cycles were re-united in quasi-two decennial cycles, which reminds the Kuznets-type cycles[4], namely: A) 1862-1877, B) 1878-1897 and C) 1898-1914. The three quasi-two decennial cycles of Romania's economy between 1862 and 1914 are defined by considering two major events which happened during the analyzed time interval: A) the War of Independence of 1877-1878; and B) the end of the implementation of the market economy institutions in non-agricultural economic branches. They lasted between 15 and 21 years. The rate of economic growth was 2.34% during the period 1862-1877, 2.41% during the 1877-1897 period and 2.75% during the 1897-1914 period. The examination of the rate of economic growth related to the above-mentioned economic cycles permits to support the assumption that economic progress accelerated in the context of the extension of the role of market mechanisms in the coordination of economic activities and the development of non-agricultural branches (Annex 2).

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[1] The economic cycles of Juglar type were firstly identified in C. Juglar (1862). The fluctuation in economic activity is explained by the renewal of fixed capital. Also, the assumption that the above-mentioned economic cycle lasted for 8-12 years was adopted. In economic literature, Juglar cycles are also called "bussiness cycles". Hence, we may admit the assumption that the above-mentioned cycles are in fact quasi-decennial ones.

[2] It is to note that the cycles of 1862-1866 and 1908-1913, respectively appear to be shorter due to the lack of statistical data. In fact, also the above-mentioned economic cycles are quasi-decennial ones. The 1862-1866 period is a part of the 1859-1866 economic cycle, while the 1908-1913 period is a part of the 1908-1918 economic cycle.

[3] F.M. Pavelescu (2013) reviewed not only from point of view of the dynamics of gross domestic product, but also from point of view of the main economic and political events and other qualitative transformation which occurred in the analyzed period. In this context, the average rate of growth of gross domestic product was computed for each of the Juglar-type cycles. The respective indicator was 3.20% between 1862 and 1866, 4.65% between 1866 and 1877, 3.44% between 1877 and 1887, 1.29% between 1887 and 1897, 5.53% between 1897 and 1907 and 3.58% between 1907 and 1914.

[4] Kuznets cycles were initially defined in S. Kuznets (1973) in order to reveal the impact of demographic phenomena, like migration, on the cyclical behavior of economic activity in constructions. Afterwards, the occurrence of Kuznets economic cycles was explained by the extension and renewal of the infrastructure. The length of respective economic cycles was estimated at 15-25 years. Therefore, we may admit that Kuznets cycles are quasi-two-decennial ones.

If we consider the principles of the legal framework related to foreign trade and the fiscal facilities granted to entrepreneurs, who intended to establish and develop industrial activities, the structure of the economy and the degree of enlargement of the labour market, we are able to group the Juglar cycles in two quasi-three decennial ones, namely: I) 1863-1887 and II) 1888-1913[1]. It is to note the respective economic cycles lasted 25 years and 26 years, respectively. If we consider the length of time and the evolution in the long run of Romania's economy, we may admit that the above-mentioned cycles are in fact two phases of two different Kondratieff-type cycles (Annex 3). The estimated rate of economic growth was 2.83% for the period 1863-1887 and 2.76% for the 1888-1913 period.

The rate of economic growth is only one of the indicators of the economic progress of Romania during the analyzed time interval. The 1862-1913 period was characterized by important changes in economic activity, especially by an increase of the role of non-agricultural activity, on one hand, and of the public authorities' implication in order to support the modernization of the society and the adaptation of institutions to trends which were manifest in Europe, on the other hand. Considering the statistical data presented in V. Axenciuc (2012), we are able to extend the analysis related to Romania's economy evolution during the 1863-1913 period to the other aspects, such as: a) estimation of the elasticity proper of the gross domestic product related to total gross value added; and b) estimation of the rate proper of disembodied technical progress both at macroeconomic and at sectoral level.

2. Elasticity of gross domestic product related to gross value added at the macroeconomic level

If we consider some of the algebraic properties of the OLS method we are able to improve the interpretation of the significance of the estimated elasticity of gross domestic product and gross value added at the macroeconomic level during the analyzed period. Firstly, we make some methodological comments on the estimated parameters.

[1] F. M. Pavelescu (2016b) highlighted the main features of the economic cycles of 1862-1887 and 1888-1914, respectively. Therefore, **during the 1862-1887 period**, the main features of Romania's economy were: a) strong dominance of agriculture in economic activity; b) the existence of a very limited labour market and 3) the implementation of the principle of free trade in the external economic relations. **The economic cycle of 1888-1914** is characterized by: a) the development of industrial and commercial activities, even the agriculture remained the most important branch of economy; b) the extension of labour market and the adaptation of changes in the institutional framework in order to favour the increase in the employment in industrial and other non-agricultural activities; and c) the protectionist orientation of foreign trade policy.

2.1. Methodological comments on the estimated elasticity of gross domestic product and gross value added at the macroeconomic level

The elasticity of gross domestic product related to gross value added at the macroeconomic level can be estimated with the help of a simple linear regression, respectively:

$$lnGDP = a_1 + b_1 \cdot lnGVAT \quad (1),$$

where:

lnGDP = natural logarithm of index with fixed base of the gross domestic product

a_1 = intercept of the linear regression defined by the expression (1)

b_1 = estimated elasticity of gross domestic product related to gross value added to macroeconomic level

lnGVAT = natural logarithm of index with fixed base of the gross value added to macroeconomic level

If we consider F. M. Pavelescu (1986) the estimated value of b_1 is:

$$b_1 = \frac{cov\ (\ln GDP; lnGVAT)}{D^2(lnVAT)} \quad (2),$$

where:

cov (lnGDP; lnGVAT)= covariance between the natural logarithms of indices with fixed base of gross domestic product and natural logarithms of indices with fixed base of the gross value added at macroeconomic level.

D^2= variance of natural logarithms of indices with fixed base of the gross value added at macroeconomic level.

b_1 may be also written as:

$$b_1 = v_{b1} \cdot s_{b1} \quad (3)$$

$$v_{b1} = \frac{lnGDP_R}{lnGVAT_R} \quad (4),$$

where:

ln GDP_R = natural logarithm of representative index[1] of gross domestic product

[1] TherRepresentative index was defined in F. M. Pavelescu (1986) as the geometrical mean of the indices with fixed base of the analysed indicator.

ln $GVAT_R$ = natural logarithm of representative index of valued added at the macroeconomic level

$$s_{b1} = \frac{strcov(lnGDP;lnGVAT)}{CV^2(lnGVAT)} \quad (5)$$

where:

strcov (lnGDP; lnGVAT) = structural part of the covariance between natural logarithms of indices with fixed base of gross domestic product and the natural logarithms of indices with fixed base of gross value added at the macroeconomic level

$$strcov(lnGDP, lnGVAT) = \frac{cov(lnGDP;\ lnGVAT)}{lnGDP_R \cdot lnGVAT_R} \quad (6)$$

CV(ln GVAT) = coefficient of variation of the natural logarithms of indices with fixed base of gross value added at the macroeconomic level.

It is to note that we may express lnGDP as:

$$\ln GDP = \ln GVAT + \ln(1 + DgTAX) \quad (7),$$

where:

DgTax = degree of taxation *i.e.* ratio between taxes to gross value added at the macroeconomic level

The expression (1+DgTAX) may be considered in this paper as a transformed form of degree of taxation of economic activity. In this context, we further use the following expression:

$$\text{TrDgTAX= (1+DgTAX)} \quad (8),$$

where: TrDgTAX-= transformed form of degree of taxation.

In this context, we may write b_1 as:

$$b_1 = 1 + \beta_1 \quad (9),$$

where:

β_1= elasticity of transformed form of degree of taxation related to gross value added at the macroeconomic level.

$$\beta_1 = (v_{b1} - 1) \cdot s_{\beta 1} \quad (10)$$

where:

$$s_{\beta 1} = \frac{strcov(lnTrDgTAX;lnGVAT)}{CV^2(lnGVAT)} \quad (11)$$

strcov (lnTrDgTAX; lnGVAT) = structural part of the covariance between natural logarithms of indices with fixed base of transformed form of taxation degree and the natural logarithms of indices with fixed base of gross value added at the macroeconomic level.

s_k may be also written as:

$$s_{b1} = 1 + (\frac{lnTrDgTAX_R}{lnGVAT_R}) \cdot (s_{\beta 1} - 1) \quad (12)$$

where:

$lnTrDgTAX_R$ = natural logarithm of representative index of transformed form of degree of taxation

The estimated value of intercept (a_1) is equal to:

$$a_1 = \ln GDP_R \cdot (1 - s_{b1}) \quad (13)$$

Formula (13) reveals the residual compensatory nature of the intercept of a linear regression mentioned in F. M. Pavelescu (2004).

Also, formula (13) is equivalent to:

$$a_1 = \ln TrDgTAX_R \cdot (1 - s_{\beta 1}) \quad (14)$$

In other words, if we compute the linear regressions $lnGDP = a_1 + b_1 \cdot lnVAT$ and $lnTrDgTAX = \alpha_1 + \beta_1 \cdot lnVAT$, respectively, we obtain:

$$a_1 = \alpha_1 \text{ and } b_1 = 1 + \beta_1$$

We may notice that if $b_1<1$, we are in the case of a negative correlation between the natural logarithms of indices with fixed base of transformed degree of taxation and the natural logarithms of indices with fixed base of gross value added at macroeconomic level.

A situation of $b_1>1$ reveals a positive correlation between the natural logarithms of indices with fixed base of transformed degree of taxation and the natural logarithms of indices with fixed base of gross value added at macroeconomic level.

2.2. Estimated elasticity of gross domestic product related to gross value added at the macroeconomic level

Considering the data in V. Axenciuc (2012), we estimated the parameters of linear regression $lnGDP = a_1 + b_1 \cdot lnGVAT$ related to the following time intervals: A) 1863-1887, B) 1888-1913 and C) 1863-1913.

The analysis of the modelling factors of the estimated parameters reveals that during both quasi-three decennial cycles, 1863-1887 and 1888-1913, the degree of taxation tended to increase, the indicators v_{b1} being above unit 1 in all the three linear regressions (Table 1). Also, we should note the very intense correlation between the dynamics of gross domestic product and of the gross value added at the macroeconomic level. Pearson coefficients of correlation R(lnGDP; lnGVAT) are equal to 0.9998 for the 1863-1887 period, 0.9995 for the 1888-1913 period and 0.9998 for the 1863-1913 period.

Table 1 - Estimated parameters and their modelling factors in case of linear regressions $lnGDP = a_1 + b_1 \cdot lnGVAT$ related to Romania's economy during the 1863-1913 period

Period	1863-1887	1888-1913	1863-1913
a_1	0.0052 (3.3344)	0.0110 (4.8156)	0.0076 (3.5492)
b_1	1.0236 (248.7038)	0.9873 (162.3764)	1.0235 (364.1031)
R^2_1	0.9996	0.9991	0.9996
F	61853.6	26352.2	132574.0
R(lnGDP;lnGVAT)	0.9998	0.9995	0.9998
$lnGDP_R$	0.3077	0.3195	0.6688
$lnGVAT_R$	0.2955	0.3125	0.6470
v_{b1}	1.0413	1.0225	1.0352
s_{b1}	0.9830	0.9656	0.9886

N.B. *Student test statistics are presented in brackets. R^2_1=coefficient of determination, F=Fisher test statistics, R(lnGDP; lnGVAT)=Pearson coefficient of correlation between natural logarithms of indices with fixed base of gross domestic product and natural logarithms of indices with fixed base of gross value added at the macroeconomic level, $lnGDP_R$=natural logarithm of representative index of gross domestic product, $lnGVAT_R$ =natural logarithm of representative index of gross value added at the macroeconomic level*

The elasticity of gross domestic product related to gross value added at the macroeconomic level is above unit 1 during the 1863-1887 period (1.0236) and 1863-1913 (1.0236), and below unit 1 during the 1888-1913 period (0.9873).

The size of the above-mentioned elasticities is the outcome of the positive correlation between the natural logarithms of indices with fixed base of the transformed form of degree of taxation and the natural logarithms of indices with fixed base of gross value added at the macroeconomic level during the time intervals 1863-1887 and 1863-1913. The data presented in Table 2 show that R(lnTrDgTAX; lnGVAT) is equal to 0.7671 for 1863-1887 and 0.7665 for 1863-1913. The respective Pearson coefficient of correlation related to the 1887-1913 period is equal to -0.3926 and explains the below unit elasticity

of gross domestic product related to the gross value added at the macroeconomic level[1].

Table 2 - Estimated parameters and their modelling factors in case of linear regressions $lnTrDgTAX = \alpha_1 + \beta_1 \cdot lnGVAT$ related to Romania's economy during the period 1863-1913

Period	1863-1887	1888-1913	1863-1913
α_1	0.0052 (3.3344)	0.0110 (4.8156)	0.0076 (3.5492)
β_1	0.0236 (5.7352)	-0.1271 (-2.090)	0.0235 (8.3545)
R^2_1	0.5885	0.1540	0.5875
F	32.8927	4.3679	69.7981
R(lnTrDgTAX;lnGVAT)	0.7671	-0.3926	0.7665
$lnTrDgTAX_R$	0.0122	0.0070	0.0228
$lnGVAT_R$	0.2955	0.3225	0.6460
$v_{\beta 1}$	0.0413	0.0225	0.0353
$s_{\beta 1}$	0.5719	-0.5645	0.6653

N.B. *Student test statistics are presented in brackets. R^2_1=coefficient of determination, F=Fisher test statistics, R(lnTrDgTAx; lnGVAT)=Pearson coefficient of correlation between natural logarithms of indices with fixed base of transformed degree of taxation and natural logarithms of indices with fixed base of gross value added at the macroeconomic level, $lnTrDgTAX_R$=representative index of gross domestic product, $lnGVAT_R$=representative index of gross value added at the macroeconomic level.*

The negative elasiticity of the transformed form of degree of taxation related to the gross value added at the macroeconomic level highlights that the trend of increasing of taxation degree was an unstable one.

Hence, it is very important to analyze the stability in time of the dynamics of gross domestic product and of the gross value added at the macroeconomic level. Also, we have to extend the analysis of stability in time of the dynamics of the gross value added at sectoral level, because during the analyzed period Romania's economy underwent some structural changes in the context of the extending of industrial and services activities. A way to investigate the stability in time of the dynamics of gross value added at sectoral and macroeconomic level is the use of the concept of disembodied technical change.

[1] The analysis of the size of the estimated parameters confirms the methodological comments we made earlier on the modelling factors of the estimated elasticity of the gross domestic product related to gross value added at the macroeconomic level.

3. Estimations of rate of disembodied technical change proper of Romania's economy during the 1862-1914 period

The concept of disembodied technical change, initially proposed by J. Tinbergen, assumes that technical progress is continuous in time. Hence, the rate of disembodied technical change is defined as the elasticity of output related to time factor. Because usually the estimation is made by the OLS method it is very important to review some of its algebraic properties in order to obtain an improved interpretation of the estimated parameters.

3.1. Significance of estimated rate of disembodied technical change proper

The rate of disembodied technical change proper can be practically obtained by estimating the parameters of the linear regression $\ln Y = c_1 + \gamma_1 \cdot t$, (15),where:

lnY= index of natural logarithm of the output
c_1 = intercept of the linear regression defined by the expression (15)
γ_1 = rate of disembodied technical change proper
t = time factor
If we consider algebraic properties of OLS mentioned above we obtain the following expression of the estimated rate of disembodied technical change proper(γ_1)[1]:

$$\gamma_1 = \ln(1 + RY_R) \cdot s_{\gamma 1} \quad (16)$$

$$s_{\gamma 1} = \frac{strcov(\, lnY; t)}{CV^2(t)} \quad (17)$$

$$c_1 = lnY_R \cdot (1 - s_{\gamma 1}) \quad (18),$$

where:

RY_R= representative rate of the output[1]

[1] We use the notion of rate of disembodied technical change proper because in our case we consider only the factor time as an explanatory variable of the natural logarithm of the output. Usually, the rate of disembodied technical change is estimated in the context of production functions. An example is the Cobb-Douglas production function with non-constant returns to scale and disembodied technical change. But if the disembodied technical change is considered in a production function with (n-1) production factors, the estimated value of the respective indicator (γ_n) is influenced by collinearity, revealed by the coefficient of collinear refraction ($T_{n\gamma}$). In other words, we obtain γ_n=$\gamma_1 \cdot T_{n\gamma}$. Hence, we may consider the estimated value $\gamma_1$as the rate of disembodied technical change proper. The occurrence of coefficients of collinear refraction in multiple linear regressions was firstly emphasized in F. M. Pavelescu (1986), where they were defined as "coefficients of alignment of dependent variable to considered explanatory variable".

strcov (lnY;t) = structural part of the covariance between the natural logarithms of indices with fixed base of the output and the time factor

CV(t) = coefficient of variation of time factor

lnY_R = natural logarithm of representative index of the output

The relationship between lnY_R and $lnRY_R$ is given by the expression:

$$\ln(1 + R_R) = \frac{2}{(n+1)} \cdot lnRY_R \tag{19}$$

We may note, that if we know the estimated parameters of the linear regression $\ln Y = c_1 + \gamma_1$, we can determine $\ln(1 + RY_R)$ by formula:

$$\ln(1 + RY_R) = \gamma_1 + \frac{2}{(n+1)} \cdot lnc_1 \tag{20}$$

If we take into account that in estimating the rate of disembodied technical change proper we consider the indices with fixed base, we are able to write the expression $\ln(1+RY_R)$ as a weighted arithmetical mean of the natural logarithms of the annual indices. In other words, we have:

$$\ln(1 + RY_R) = \sum_{k=1}^{n} \frac{2 \cdot (n+1-k) \cdot lnInd_k}{n \cdot (n+1)} \tag{21}$$

where:

n= the number of years of the analyzed period

$lnInd_k$= natural logarithm of annual index of the output corresponding to the year k.

Considering that the average annual rate related to dynamics of the output (RY_M) is defined by expression:

$$\ln(1 + RY_M) = \frac{1}{n} \cdot \sum_{k=1}^{n} lnInd_k \tag{22}$$

we are able to compare $\ln(1+RY_R)$ with $\ln(1+RY_M)$.

If we note:

$$g_t = \frac{2 \cdot t}{n \cdot (n+1)} \tag{23}$$

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[1] The notion of representative rate was firstly defined in F. M. Pavelescu (1986) as the constant rate which would ensure the obtaining of the representative index of the analyzed indicator.

and $g_{Indk} = \frac{lnInd_k}{\sum_{k=1}^{n} lnInd_k}$ (24)

we may write:

$$\ln\left(\frac{1+R_R}{1+R_M}\right) = \ln(1 + RY_M) \cdot strcov(lnInd_k; t) \quad (25)$$

where:

$strcov(lnInd_k; t)$= structural part of the covariance between logarithms of annual indices of output and time factor.

$$strcov(lnInd_k; t) = n \cdot (\sum_{k=1}^{n} g_{Indk} \cdot g_t) - 1 \quad (26)$$

Based on the formula (26) and if $\sum_{k=1}^{n} lnInd_k > 0$, it is possible to reveal that $\ln\left(\frac{1+RY_R}{1+RY_M}\right) > 0$ if $\ln Ind_k$ is positively correlated with the time factor. The above-mentioned condition implies that $\ln Ind_k$ tends to decrease as the time passes. In other words, we face a conventional concave (decelerated) trajectory of the output dynamics.

In a particular case, when the output dynamics is strictly exponential we have $\ln(1 + RY_M) = \ln(1 + RY_R)$

If the output dynamics accelerated during the analyzed period, *i.e.* we detect a trend for the increase of $\ln Ind_k$ as the time passes, we may speak about a conventional convex (accelerated) trajectory of the output dynamics. In such a situation we deal with a negative correlation between $\ln Ind_k$ and the time factor so that we deal with: $\ln\left(\frac{1+RY_R}{1+RY_M}\right) < 0$.

Information related to the form of trajectory of output dynamics are also given by the factor $s_{\gamma 1}$. In fact, when $\ln Y_R > 0$, we may detect three situations, namely:

A. $s_{\gamma 1} < 0$, when the output registered an unstable dynamics. In this case we have: $c_1 > 0$ and $\gamma_1 < 0$

B. $0 < s_{\gamma 1} < 1$, when the output registered a growth trend on a conventional concave (decelerated) trajectory. In this case we have: $c_1 > 0$ and $\gamma_1 > 0$

C. $s_{\gamma 1} < 1$, when the output recorded a growth trend on a conventional convex (accelerated) trajectory. In this case we have: $c_1 < 0$ and $\gamma_1 > 0$

In this context, we can use two criteria in order to identify the form of trajectory of the output growth, namely: the value of the expression $\ln\left(\frac{1+RY_R}{1+RY_M}\right)$, on the one hand, and the value of the factor $s_{\gamma 1}$, on the other hand. Hence, we may consider that output

growth has a certain trajectory if it is confirmed by both criteria mentioned above. When the application of the two criteria leads to contradictory results we consider that we are not able to detect the form of trajectory of output growth.

Depending on the relationships established between γ_1, $\ln(1+RY_M)$ and $\ln(1+R_R)$, we may determine not only a conventional concave or convex trajectory of output growth, but also the variants of moderate or strong of the two great trajectories.

We should note that the conditions for the occurrence of conventional concave trajectory of the output growth are: $c_1 > 0$ and $\ln(1+RY_R) > \ln(1+RY_M)$. In this case we may define:

1. The conventional strong concave trajectory of the output growth if $\ln(1+RY_R) > \ln(1+RY_M) > \gamma_1$ and
2. The conventional moderate concave trajectory of the output growth if $\ln(1+RY_R) > \gamma_1 > \ln(1+RY_M)$

Analogously, we are able to define the moderate and strong variants of the conventional convex trajectory of the output growth, having in view a first condition: $\ln(1+RY_M) > \ln(1+RY_R)$

We have a conventional moderate convex trajectory of the output growth if: $\ln(1+RY_M) > \gamma_1 > \ln(1+RY_R)$

The strong variant of conventional convex trajectory of the output growth occurs if: $\gamma_1 > \ln(1+RY_M) > \ln(1+RY_R)$

The respective algebraic properties of the estimated rate of disembodied technical change proper will be further used in the analysis of the features of the dynamics of Romania's economy output during the 1863-1913 period.

3.2. Estimated rate of disembodied technical change proper in case of Romania's economy during the period 1863-1913

We have estimated the rate of disembodied technical change proper during the 1863-1913 period. The above-mentioned indicator was related not only to the gross domestic product, but also to the gross value added both at the macroeconomic and sectoral level[1].

[1] We adopted the "classical" trisectoral vision of economy: A) primary sector, which includes, agriculture, hunting, forestry and fishing, B) secondary sector, which includes industry and constructions, C) tertiary sector, which includes services.

Therefore, over the 1863—1887 period, we think that gross domestic product grew at an average rate of 2.83% on a strong convex trajectory. We may also notice the high stability in time of the dynamics of the above-mentioned indicator, the Pearson coefficient of correlation R (lnGDP, t) being equal to 0.9262 (Table 3). In this context, the parameter γ_1 is equal to 0.0313. The estimated rate of disembodied technical change proper related to gross value added at the macroeconomic level (0.0303) is smaller than one related to gross domestic product, as a result of the increase of taxation degree. The form of trajectory dynamics is a conventional strong convex one.

Table 3 - Estimated rates of disembodied technical change proper obtained with the linear regressions $lnY = c_1 + \gamma_1 \cdot t$ and their modelling factors related to Romania's macroeconomic and economic sectors during the period 1863-1887

Output	GDP	GVAT	GVAS1	GVAS2	GVAS3
c1	-0.0989 (-2.5060)	-0.0989 (-2.4623)	-0.0770 (-1.0562)	-0.1114 (-2.9560)	-0.1580 (-3.4152)
γ_1	0.0313 (11.7784)	0.0303 (11.2302)	0.0251 (5.1214)	0.0353 (13.9462)	0.0373 (11.9722)
R^2_1	0.8578	0.8458	0.5328	0.8943	0.8617
F	138.7309	126.1169	26.2286	194.4966	143.3331
R(lnY;t)	0.9262	0.9197	0.7299	0.9456	0.7671
lnY_R	0.3077	0.2955	0.2496	0.3481	0.3263
$\ln(1+RY_R)$	0.0237	0.0227	0.0192	0.0268	0.0251
s_{Y1}	1.3215	1.3346	1.3086	1.3199	1.4841
$ln(1+RY_M)$	0.0279	0.0268	0.0204	0.0357	0.0318
$\ln(\frac{1+RY_R}{1+RY_M})$	-0.0042	-0.0041	-0.0012	-0.0089	-0.0067
$\ln(1+RY_R)-\gamma_1$	-0.0076	-0.0076	-0.0059	-0.0086	-0.0122
$\ln(1+RY_M)-\gamma_1$	-0.0034	-0.0035	-0.0047	0.0004	-0.0055
RY_M (%)	2.83	2.72	2.06	3.64	3.23

N.B. GVAS1=value added of Primary Sector, GVAS2=value added of Secondary Sector, GVAS3=value added of Tertiary Sector, Student test statistics are presented in brackets. R^2_1=coefficient of determination, F=Fisher test statistics, R(lnY;t)=Pearson coefficient of correlation between natural logarithms of indices with fixed base of output and time factor.

We should note that during the analyzed period the value-added grew on a strong convex trajectory in the three considered economic sectors. Also, we are able to detect a relatively high stability in time of gross value added dynamics at sectoral level, in a context when the Pearson coefficient of correlation (R(lnY; t)) takes on values between 0.7299 and 0.9456. We may also notice the differentiation of the average rate of growth between the primary sector (2.06%) and the sectors of non-agricultural economic

branches (3.64% in case of the secondary sector and 3.23% in case of the tertiary sector).

Estimates related to the 1888-1913 period reveal that the average rate of gross domestic product is equal to 2.76% (Table 4), which is very close to the value recorded during the 1863-1887 period. The gross value added at the macroeconomic level grew at an average rate of 2.73%, practically equal to that registered during the period 1863-1887.

Table 4 - Estimated rates of disembodied technical change proper obtained with the linear regressions $lnY = \alpha_1 + \cdot \gamma_1 \cdot t$ related to Romania's macroeconomic and economic sectors during the 1888-1913 period

Output	GDP	GVAT	GVAS1	GVAS2	GVAS3
c1	0.0057 (0.1222)	-0.0035 (-0.0737)	0.0795 (0.8815)	-0.1079 (-2.500)	-0.0477 (-1.5772)
γ_1	0.0232 (7.7473)	0.0234 (7.6002)	0.0107 (1.8396)	0.0339 (39.1569)	0.0319 (16.2823)
R^2	0.7144	0.7065	0.1236	0.8600	0.9576
F	60.0208	57.7628	3.3843	147.4649	265.1131
R(lnY;t)	0.8452	0.8405	0.3515	0.9274	0.9576
lnY_R	0.3195	0.3125	0.2246	0.3502	0.3827
$ln(1+R_R)$	0.0237	0.0231	0.0166	0.0259	0.0283
s_k	0.9823	1.0112	0.6459	1.3081	1.1246
ln(1+R_M)	0.0272	0.0269	0.0177	0.0344	0.0327
$\ln(\frac{1+R_R}{1+R_M})$	-0.0035	-0.0038	-0.0010	-0.0085	-0.0044
$ln(1+R_R)-\gamma_1$	0.0004	-0.0003	0.0059	-0.0080	-0.0035
$ln(1+R_M)-\gamma_1$	0.0039	0.0035	0.0069	0.0005	0.0008
R_M (%)	2.76	2.73	1.78	3.50	3.32

N.B. GVAS1=value added of the Primary Sector, GVAS2=value added of the Secondary Sector, GVAS3=value added of Tertiary Sector, Student test statistics are presented in brackets. R^2_1=coefficient of determination, F=Fisher test statistics, R(lnY; t)= Person coefficient of correlation between natural logarithms of indices with fixed base of output and time factor.

At the sectoral level, we notice that the average rate of growth of the gross value added obtained in the primary sector is smaller in comparison with that recorded during the previous quasi-three decennial economic cycle. In the non-agricultural sectors the rates of growth of the gross value added for 1888-1913 are very to those recorded during the previous quasi-three decennial cycle. The stability in time of the gross value added is very high in case of non-agricultural economic sectors, Pearson's correlation coefficients (R(lnY; t) being equal to 0.9274 in case of the secondary sector and 0.9576 in case of the tertiary sector. The gross value added obtained in the primary sector experienced a

low degree of stability in time, because in case of the above-mentioned sector we have (R(lnY; t)= 0.3515).

In this context, all the estimated parameters of disembodied technical change proper related to 1888-1913 are smaller in comparison with those corresponding to the 1862-1887 period. The form of trajectory dynamics is unclear in case of the gross domestic product and gross value added obtained in the primary sector.

The gross value added had a conventional moderate convex trajectory of growth at the macroeconomic level. The same form of trajectory dynamics may be detected also for the secondary and tertiary sectors.

Estimates related to the whole period 1862-1913 highlight a very high stability in time of the dynamics of gross domestic product and gross value added at the macroeconomic level, the Pearson coefficients of correlation R(lnY; t) being higher than 0.9650. We notice the same in case of the gross value added of the secondary and tertiary sectors, where the above-mentioned coefficients of correlation are higher than 0.9820. The stability in time of the dynamics of gross value added obtained in the primary sector is enough high, because the Pearson coefficient of correlation is equal to 0.8066 (table 5).

Table 5 - Estimated rates of disembodied technical change proper obtained with the linear regressions $lnY = \alpha_1 + \cdot \gamma_1 \cdot t$ related to Romania's macroeconomic and economic sectors during the 1862-1913 period

Output	GDP	GVAT	GVAS1	GVAS2	GVAS3
c1	-0.0486 (-1.5801)	-0.0531 (-1.7116)	0.0121 (0.2067)	-0.1049 (-3.7761)	-0.1141 (-4.2054)
γ_1	0.0276 (26.8354)	0.0269 (25.8863)	0.0187 (9.5529)	0.0350 (37.6168)	0.0336 (37.0196)
R^2	0.9363	0.9319	0.6506	0.9665	0.9655
F	720.1401	670.1023	91.2586	1415.0236	1370.4519
R(lnY;t)	0.9676	0.9653	0.8066	0.9831	0.9826
lnY_R	0.6688	0.6460	0.4971	0.8044	0.7598
$ln(1+R_R)$	0.0257	0.0248	0.0191	0.0309	0.0292
s_k	1.0726	1.0822	0.9757	1.1304	1.1501
$ln(1+R_M)$	0.0275	0.0269	0.0190	0.0351	0.0322
$\ln(\frac{1+R_R}{1+R_M})$	-0.0018	-0.0020	0.0001	-0.0041	-0.0030
$ln(1+R_R)-\gamma_1$	-0.0019	-0.0020	0.0005	-0.0040	-0.0044
$ln(1+R_M)-\gamma_1$	-0.0001	0.0000	0.0004	0.0001	-0.0014
R_M (%)	2.79	2.72	1.92	3.57	3.28

N.B. GVAS1=value added of the Primary Sector, GVAS2=value added of the Secondary Sector, GVAS3=value added of the Tertiary Sector, Student test statistics are presented in brackets. R^2=coefficient of determination, F=Fisher test statistics, R(lnY; t)=Person coefficient of correlation between natural logarithms of indices with fixed base of output and time factor.

Now we are able to detect a conventional strong convex trajectory for the of gross domestic product. The same type of trajectory of growth may be for emphasized for the gross value added at the macroeconomic level and by the tertiary sector. The trajectory of the gross value added of the secondary sector is a conventional moderate convex one, while the trajectory of the gross value added of the primary sector is a conventional strong concave one.

On the other hand, we notice that the estimated rate of disembodied technical change proper is the highest in case of the secondary sector (0.0350). The size of the above-mentioned indicator related to the tertiary sector (0.0336) is close to the value recorded for the secondary sector but is sensibly different from the value estimated for the primary sector (0.0187).

At the macroeconomic level, we notice that the rate of disembodied technical change proper related to gross domestic product (0.0276) is higher than the same indicator related to gross value added (0.0269). This is a consequence of the existence of a trend of the increase in the degree of taxation during the first transition to market economy.

Conclusions

The estimates of rates of the disembodied technical change proper at the macroeconomic and sectoral level and also of their modelling factors reveal that during the period 1863-1913 Romania's economy witnessed a moderate rate of gross domestic product growth (2.79%). The form of trajectory was a conventional strong convex one, highlighting the trend of acceleration of the economic development as market mechanisms extended their role in coordination of the economic activities. The intervention of the public authorities in the economic activities grew over time, this fact being revealed by the increase in the degree of taxation and also by the positive correlation between the gross value added at macroeconomic level and the gross domestic product.

The trend for a speed-up of the rate of economic growth was supported by the development of activities which were usually grouped in the secondary and tertiary sectors. The rate of growth of the gross value added obtained in the primary sector, which employed more than 80% of the active population, was sensibly lower and on a conventional moderate concave trajectory. On this basis, it is possible to establish a correlation between the extension of market relations and institutions related to market economy and the rate of economic growth at sectoral level. In other words, the sectors where the implementation of the market relations and market economy institutions was more advanced experienced an acceleration of the development of their activities. The primary sector, where the agriculture played the most important role, faced a sensible

lower rate of development, in the context of a blockage of the extension of modern market relations and persistence of feudal practices.

We may identify both common features and differences of the dynamics of economic activity during the two quasi-three decennial cycles of the 1862-1913 period.
Therefore, the average rates of growth of the gross domestic product and gross value added at the macroeconomic level of the period 1862-1887 were very close to those registered during the 1888-1913 period. During both economic cycles the sensible differentiation between the rates of growth of the primary sector and the non-agricultural sectors are manifest. The rate of growth of the gross value added and the rate of disembodied technical change proper of the secondary sector was greater than those estimated for the tertiary sector. Dynamics of secondary sector has a very high stability in time in the context of a conventional moderate convex trajectory.

Among the differences between the features of the economic cycle of 1863-1887 and the economic cycle of 1888-1913 we mention: a) the correlation between the gross domestic product and the gross value added at the macroeconomic level; b) stability in time of the dynamics of the gross domestic product and the gross value added at the macroeconomic level and at the primary and secondary sectors level; c) the size of the rate of technical change proper.

The above-mentioned differences between the dynamics of the economic activity at macroeconomic and sectoral level are the consequences of the changes which occurred in the Romania's economy as the market relations and market economy institutions were built and consolidated and industrial and services activities extended.

Therefore, the radical change in the macroeconomic policy and foreign trade regime towards protectionism of 1887 determined a negative correlation between the dynamics of the taxation degree and the dynamics of gross value added at the macroeconomic level during the 1888-1913 period. At the same time, the stability in time of dynamics of the output, is significantly lower during the 1888-1913 period in comparison with the 1863-1887 period, in the case of gross domestic product, gross value added at the macroeconomic level and primary sector. In the case of the tertiary sector we see a sensible increase of stability in time of the dynamics of gross value added.

The respective evolution is a consequence of the occurrence of important blockages in the development of the main economic branch, *i.e.* the agriculture, in the context of a long delay in of an extended agrarian reform. In the case of services, we notice that the dynamics of the activity of the respective sector tended to become more and more stable as the macroeconomic developed and market relations extended and the state's institutions were modernized.

Annex 1 - Stylized Facts about the two Romania's transitions to market economy

Due to specific social-political conditions, which occurred after the World War Two, Romania, like other Central and Eastern European countries, experienced two transitions to the market economy. The first transition to market economy determined a transformation both from institutional and economic structure point of view. On the institutional side, the process consisted in transforming the institutional framework from a feudal-type one to one in which the market relations played the decisive role in correlation with economic and social activities. Historical experience shows that the first transition to market economy was deeply linked with the implementation in the productive apparatus of the objectives of the first industrial revolution. Consequently, the first transition to market economy favored the transition from a pre-industrial economy to an agrarian-industrial one. We should note that the first transition to market economy took place in all the countries which in our days are defined as consolidated or emerging market economies.

The second transition to market economy was experienced only by Central and Eastern European countries and was defined, from institutional point of view, as a transformation from a centrally-planned command economy to a market economy. The respective transition to market economy caused also to sensible changes in the sectoral structure of economy and employment. This way, the process of transition from an industrial-agrarian economy to a services economy was accelerated.

F.M. Pavelescu (2013 and 2016a) favored the idea that Romania's first transition to market economy took place during six decades. The process began with the creation of the Romanian national unitary state as a result of the Union between Walachia and Moldavia and establishing the United Principalities (1859), which in 1862 adopted the name "Romania" and ended during the first years after the World War I, with the adoption in 1921 of an extended Land Reform which permitted that market relations to be practically manifest in all economic activities and sectors.

Also, the papers mentioned above assumed that, in the case of Romania, the second transition to market economy took place during the 1990-2004 time interval. The second transition to market economy began in 1990, with the collapse of the centrally planned economy and finished in 2004, when the level of gross domestic product was, in real terms, greater than the 1989 level, the contribution of the private segment to the gross domestic product was higher than 70% and when international bodies, like International Monetary Fund, World Bank and the European Commission, considered that Romania's economy was a functionally market one.

Annex 2 - Features of the Kuznets-type cycles of Romania's transition to market economy

The three Kuznets type cycles of Romania's economy during the first transition to market economy were identified and analyzed in F. M. Pavelescu (2013 and 2016a).

Therefore, the **1862-1876 economic cycle** is marked by the beginning of the first transition to market economy at the same time with the creation and consolidation of the fundamental institution of the Romanian national unitary state and the diplomatic efforts for gaining of State Independence. At that time the economic structure was highly dominated by agricultural activities. The international economic relations were modelled by the principle of free trade.

The 1877-1897 economic cycle is marked in the beginning by the gain of State Independence in 1877 and at the end by the completion of the first transition to market economy in non-agricultural activities in the late 1890's. At that time the macroeconomic policies promoted by public authorities underwent sensible changes. Therefore, after 1887, a protectionist orientation is manifest in international economic relations. Also, the governments adopted a series of legislative measures to support the entrepreneur's efforts for the establishment and development of industrial activities.

The 1898-1914 economic cycle is marked by the existence of a Lewis-type duality, which was generated by the different development of market relations in agriculture and non-agricultural activities. Due to the delay of a new agrarian reform, the production relationships related to the main branch of economy, which employed more than 80% of active population, *i.e.* the agriculture, continued to be defined by reminiscences of late feudal type practices, while in the non-agricultural activities the market relations and institutions were predominant. During the analyzed period the institutional framework related to foreign trade maintained the protectionist orientation.

Annex 3 - The first two Kondratieff type cycles of Romania's modern economy

The standard theory related to Kondratieff cycles assumes that the respective long economic cycle is defined by the existence of a two phases, an upward one and a downward one. The length of time of each of the phases is 25-30 years. In other words, a phase of Kondratieff cycle is a quasi-three decennial one. Therefore, the above-mentioned long economic cycle lasts for 50-60 years.

Considering the evolution of Romania's economy during the 1831-1947 period, F. M. Pavelescu (2016b) assumes that it is possible to identify two Kondratieff type cycles during the above-mentioned time interval, namely: I) **First Kondratieff type cycle of Romania's modern economy during the period 1831-1887** and II) **Second Kondratieff Type cycle of Romania's modern economy during the 1888-1847 period.** The respective Kondratieff Type cycles are defined having in view not only the first transition to market economy, but also a pre-transition phase to market economy in the context of Reglement Organique implementation in the Romanian Principalities of Wallachia and Moldavia, between 1832 and 1858, on the one hand, and the interwar period, years of World War II and the first post-war years, in other words the 1919-1947 period.

Hence, we were able to define the first Kondratieff-type cycle during the 1831-1887 period, with an upward phase during 1831-1858 and a consolidation phase during the period 1859-1887. The second Kondratieff type cycle may be identified during the 1888-1947 period, with an upward phase during the 1888-1918 period and a consolidation phase during the 1919-1947 period.

It is important to note that in case of Romania's economy of the analyzed period we may speak about an upward phase of Kondratieff-type cycles and a consolidation phase and not about an upward phase and a downward phase, as the standard theory related to long economic cycles assumes. Because the first transition to market economy lasted for a long period and at the same time with the nation's building and state's institutions modernization processes, the economy grew in each of the two phases of the Kondratieff cycles. In fact, during the second phases of the respective long cycles we notice a new stage of economic and social progress whose premises were created during the first phases.

Therefore, the 1831-1858 period, prepared the conditions for a larger role of market mechanisms in the context of feudal–type relationships maintaining, on the one hand, and in the beginning of the nation's building and state's institutions modernization process. The 1859-1887 period consolidated the role of market relationships in the context of prevailing agricultural economy and ensured the establishment and

modernization of public services which were essential for an European state in the analyzed period.

The 1888-1913 period created conditions for the starting of the mechanical industrial activities and consolidated the nation's building process. The positive evolution of Romania's economy was brutally interrupted by the break-out of the World War I. In these conditions, we may assume that the 1914-1918 time interval is part of the second Kondratieff cycle of Romania's economy, even if feasible statistical data are not available. The 1919-1947 period, especially the interwar years (1919-1939), marked the consolidation of the role of industry in the economic development and of the modernization of the national unitary state's institutions. The remarkable progress both in economic and social–cultural activities was hindered by the break-out of the World War II and of its outcome during the first postwar years.

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