ADAPTATION OF THE BULGARIAN ECONOMY TO DIGITAL TRANSFORMATION CHALLENGES: EMPIRICAL EVALUATION

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Abstract:

The paper focuses on the challenges facing the Bulgarian economy in terms of the new model of European integration in the EU's Single Digital Market in the (post)pandemic Covid-19 realities at the macroeconomic level through an empirical study of adaptation to digital transition. The empirical evaluation proves the hypothesis that the transition to a digital economy in Bulgaria is associated with growth in GDP and an improvement in the country's human development index for the research period 2010 - 2020. Yet, there exist institutional weaknesses in the regulatory and business environment of Bulgaria, due to which the current technological divergence compared to the average levels in the EU will be expected to deepen in the next decade, which will represent an obstacle to the faster integration of Bulgaria into the Single Digital Market of the EU. This necessitates a change in the financing of investments for an accelerated sustainable digital transition of the Bulgarian economy by strengthening the levers of institutional intervention (at the national and supranational level) and over-regulation of the activities of economic entities with the resulting restrictions and risks.

Keywords: *technological adaptation, digital transformation, factors of digital transformation, sustainability*

JEL classification: *E00, L26, O33*

Introduction

The digital transformation of the economy is associated with deep structural changes in such areas of production as the construction of new value chains with a local and regional focus based on new technologies (technological algorithms, artificial intelligence, blockchain technologies, the Internet of things, cloud technologies, etc.), digital business models and digital investment solutions (WEF, 2020). Important advantages of technological transformation include optimization of the production management process, decentralization, transparency, reduction of operating costs, etc. However, these processes raise serious challenges for SMEs, which require attracting significant financial resources for readjustment (in terms of resource productivity) to the new technological realities and the new digital paradigm for business operations in the Fourth Industrial Revolution. The theory of sustainable development requires the integration of economic development with social inclusion and environmental protection. This points to the connecting role of technology and the transition to a digital economy for a complete transformation of production processes and relations, the distribution and consumption of goods in the course of the Fourth Industrial Revolution in the world, the “great reset” (Schwab, K.et al., 2020) and the importance of moderate

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"stakeholder/inclusive capitalism" (WEF, 2020) in the interest of all stakeholders in the context of Covid-19 (UN, 2015) by applying the "better and broader recovery" approach (WEF, 2021).

According to Oxford Economics Research (2011), the digital economy is associated with the "third wave" of capitalism (the first wave refers to the period of emergence of joint-stock companies, the second wave - the discovery of the telegraph and the construction of the railway infrastructure), in which conditions are created for risk-taking through resource allocation and wealth creation through information transfer, cloud storage and sharing, etc. technologies. The "digital capitalism" involves the exchange of data through algorithmic mechanisms (based on artificial intelligence) with a view to realizing corporate profits from large digital platforms, which raises questions about the moral boundary in the use of digital technologies (i.e., protection of human rights and freedoms), the problems of digital marginalization, cybercrime, etc.

The aim of the paper is to focus on the challenges facing the adaptation of the Bulgarian economy to the new model of European integration in the EU's Single Digital Market in the (post)pandemic Covid-19 realities at the macroeconomic level through an empirical study of variables affecting the digital transition of Bulgaria. Research limitations of the present paper include, among others: 1) the role of digitalization of financial services (generally included in the concepts of "fintech", "regtech", etc.); 2) aspects of digital security and data protection in the digital transformation of economic processes; 3) "green" growth of the digital economy.

Description of the Problem

The adaptation of Bulgarian business to the technologically-driven digital transition in Industry 4.0 requires in-depth analysis and implies a synthesis between a theoretical, economic, comparative and empirical approach to identify the weaknesses of Bulgaria's business and institutional environment, which lead to the technological divergence of the country compared to the average levels in EU. Among the problematic factors for Bulgaria should be considered the difficulties faced by innovative SMEs in accessing alternative forms of financing, the country's unsatisfactory positions in the rankings of international digital and innovation indices, and the "stylized" facts about Bulgaria's transition to a digital economy.

Bulgarian SMEs rarely use sources of financing from the capital market, mainly large companies provide a larger share of financing through the stock market due to credit history requirements and low volatility in revenues and profits. As for the venture financing market as an alternative source of capital for Bulgarian SMEs, there are obstacles such as information asymmetries, low activity of institutional investors, lack of institutional support. Venture capital financing of Bulgarian SMEs represents 0.018% of GDP by 2020 and remains concentrated in the ICT sector and related activities, predominantly in Sofia and the South-West planning region in general. Internal sources (retained earnings and sale of assets) have a major share in the financing of Bulgarian SMEs due to difficult access to bank financing in the course of the pandemic Covid-19 crisis and the general deterioration of the business environment in Bulgaria. The most common innovation activity among the most innovative Bulgarian companies (they are about 1/3 of all enterprises in Bulgaria) is associated with changes in business processes with a view to cost optimization. The group of high-tech fast-growing SMEs in Bulgaria is below 10% and confirms that the country does not have a sufficiently secured workforce with digital skills to generate high added value in high-tech productions and services.

Bulgaria's low investment levels in digital transition for the period 2010-2020 are also confirmed by the results in the EU Digital Economy and Society Index (DESI), according to which the country ranks last among the EU countries. In the European Innovation Scoreboard and the Regional Innovation Index of the EU, Bulgaria steadily maintains a place in the group of "emerging" modest innovators. The low innovation potential is associated with institutional

weaknesses ("captured" state, high corruption risk, undermining of democratic foundations and rule of law, etc.), but also the very low level of R&D spending, low investment in digital skills of human capital, limited cooperation between academic units, higher schools and business in technology transfer due to insufficient protection of intellectual property.

For Bulgaria, the analysis of the country's ranking in the international digital indices leads to the establishment of the following **stylized facts** about the transition to a digital economy:

•digital transformation at the national level is carried out as a priority by large enterprises (i.e., „global players"), which are closely integrated into the national innovation system and actively benefit from the existing technological infrastructure of Industry 4.0. Among SMEs that are characterized by an accelerated transition to digital transformation (so-called "digital leaders"), innovative start-up companies in the technological sectors stand out, realizing significant R&D expenses by attracting venture capital, undertaking productive and process innovations with an active strategy for integration into global value chains within Industry 4.0 (especially in digital industries such as mechanical engineering, electronics, ICT services, etc.), and which have an active patent and export business activity. According to UNIDO research (2019), between 0.14% and 1.5% of companies in developing countries are defined as "digital leaders" and important prerequisites for the emergence of such companies are the country's size (measured by GDP), a diversified industrial base, a well-functioning institutional framework;

•there are significant limitations in Bulgaria's national innovation system due to institutional and structural weaknesses at the macroeconomic level; lack of close integration between business - public administration - academia in the technological-digital transition. This requires building an adequate institutional, regulatory and legislative framework for Bulgaria's digital adaptation, promoting the development of the "eco" system of digital transformation (including financing through venture capital, encouraging entrepreneurship, public-private investments in R&D, etc.);

•declining rates of industrialization of production and falling innovation activity in the course of the global Covid-19 pandemic with limited incoming FDI in Bulgaria; weak economic growth, trend toward deglobalization of trade activities, rising inflationary expectations in the course of the external military conflict in Ukraine;

•lack of financial opportunities and limited access to external financing for SMEs to provide new technologies for the transition to a digital economy.

Challenges to the digital transformation of SMEs in Bulgaria exist in terms of:

•implementation of an institutional approach according to the strategic framework of Bulgaria to dynamize the growth of innovative start-up enterprises in high-tech sectors in conditions of external factors (military situation in Ukraine and problematic supply of energy sources) generating internal instability for Bulgaria with political, economic, financial and social consequences;

•the upcoming establishment of unified (common) data spaces, their ongoing upgrading and integration into the European spaces and increasing the intensity of their use by all interested parties and guaranteeing security in the digital space;

•so far 15 years of membership in the EU, Bulgaria continues to be a country with limited potential for innovation and technologically driven digital transition to Industry 4.0 due to an unsatisfactory level of financial and human capital in the conditions of a "captured" status with high levels of corrupt practices (Applied Research Foundation, 2021).

Methodology and Data

To assess the potential for a transition to a digital economy in Bulgaria, a two-stage multifactor regression analysis is applied for the period 2010-2020. In the first stage, the dependent variable is real GDP growth (source Eurostat), and in the second stage, the dependent variable is the index of human development of Bulgaria (Human Development Index, UN source).

The following factor variables for Bulgaria in the multiple regression analysis were identified:

- financing through risk capital as a percentage of GDP (source Eurostat);
- employment as a percentage of the total population (source Eurostat);
- electronic commerce as a percentage of total commerce (source Eurostat);
- e-government (source Eurostat);
- ICT sector as a percentage of GDP (source Eurostat);
- multifactor productivity (source Eurostat);
- readiness index for network connectivity (source World Economic Forum);
- index for the purposes of sustainable development (source UN);
- global innovation index (source WIPO);
- export of high-tech production as a % of total exports (source Eurostat).

The hypothesis (H_1) of the paper is: the transition to a digital economy in Bulgaria is associated with growth in GDP and with an improvement in the country's human development index for the research period 2010 - 2020.

The identification of the variables with the greatest influence on the growth of real GDP and the human development index in the transition to a digital economy for the period 2010 - 2020 is carried out by applying multiple regression analysis using the following equations:

In stage 1: $Y_{realGDPgrowth}=\beta+\beta_1X_1+\beta_2X_2+ \ldots\beta_pX_p + \varepsilon$ (1)

where: $Y_{realGDPgrowth}$ is the dependent variable real GDP growth;

X_1, X_2, X_p are independent variables

ε is the standard error

In stage 2: $Y_{human\ development\ index}=\beta+\beta_1X_1+\beta_2X_2+ \ldots\beta_pX_p + \varepsilon$ (2)

where: $Y_{human\ development\ index}$ is the dependent variable human development index.

Results

Using a least squares model (LSM) with multiple regression analysis, at stage 1 is tested the relationship between growth in real GDP and the factors: index of readiness for network connectivity (WEF Network), index for the purposes of sustainable development (Sustainable Development), global innovation index (Global Innovativeness), financing through venture capital as a percentage of GDP (Venture Capital), multifactor productivity (Multifactor Productivity) and ICT sector as a share of GDP (ICT GDP).

The following results were obtained:

Table 1

Least squares model, 2010-2020 observations used

Dependent variable: real GDP growth

	coefficient	standard error	z	p-value
const	-7,94416	2,88246	-2,756	0,0059***
WEF_Network	3,00031	0,268604	11,17	5,72e-029***
Venture Capital	0,399024	0,0757420	5,268	1,38e-07***
Multifactor Productivity	0,839710	0,100690	8,340	7,46e-017***
Sustainable_Development	-9,85846	0,569372	-17,31	3,65e-067***
Global_Innovativeness	4,63648	0,252682	18,35	3,36e-075***
ICT_GDP	4,09961	1,03077	3,977	6,97e-05***
Mean of the dependent variable			2,050000	
Standard deviation of the dependent variable			1,538506	
Sum of squares of residuals			4,244389	
Standard error of the regression			1,456775	
Simple coefficient of definition			0,885442	
Adjusted R-square			0,713604	
F (5,1)			376,5151	
P-value (F)			0,002651	
Log-likelihood			-7,475146	
Akaike information criterion			22,95029	
Bayesian information criterion Schwarz			22,11733	
Hannan-Quinn			19,61588	
rho			-0,105114	
Durbin-Watson			2,893754	

Source: own calculations

The multiple regression model is applicable as p-value (F) = 0.002651 < α = 0.05. From Table 1 above it is evident that the coefficients β before the included variables are smaller than α = 0.05.

Therefore, the multiple regression model has the form:

$$Y_{realGDPgrowth}=-7,94416+3,00031X_2+0,399024X_3+0,839710X_4-9,85846X_5+4,63648X_6+4,09961X_7 \quad (3)$$

The following statistically significant dependencies can be deduced from equation (3) above:

- a change in the value of the readiness index for network connectivity in Bulgaria by one unit is associated with an increase in real GDP by 3.00 units for the period 2010-2020;

- the improvement of the value of the index for the goals of sustainable development in Bulgaria by one unit is associated with a reduction of the real GDP by 9.85 units and this is related to

the significant investment costs for adapting the country to achieving the Sustainable Development Goals 2030 of the United Nations;

- the increase in the value of the global innovation index of Bulgaria by one unit is related to an increase in the real GDP by 4.63 units;

- the growth of the ICT sector as a percentage of GDP by one unit is associated with an increase in the real GDP of Bulgaria by 4.09 units for the considered period;

- the increase in financing through venture capital in Bulgaria is associated with an increase in real GDP for the analyzed period by 0.39 units;

- the growth of multifactorial productivity in Bulgaria is associated with growth of real GDP by 0.84.

From Table 1 above, it can be seen that the coefficient of determination is $R^2 = 0.88$ and shows that 88% of the change in the variance of the dependent variable $Y_{\text{growth of real GDP}}$ depends on the change in the statistically significant variables included in the LSM factor variables. The Durbin-Watson coefficient is 2.89 and reports the absence of autocorrelation in the analyzed statistical series.

As conclusions from stage 1, it can be summarized that the LSM and multiple regression analysis confirms that the transition to a digital economy in Bulgaria is associated with growth in GDP for the researched period 2010 - 2020 due to improvement in the values of the global innovation index, increase in the share of the ICT sector in the country's GDP and in the connectivity readiness index. On the other hand, however, the transition to a digital economy in Bulgaria leads to a decline in real GDP due to the needed re-adjustment in the socio-economic sphere and the requirements for significant investments to achieve the goals of sustainable development.

The results of linear regressions with the dependent variable human development index at **stage 2** indicate the following:

A multicollinearity test was applied due to the presence of variables with a correlation coefficient greater than 0.70. Application of the VIF (variance inflation factor) test to account for multicollinearity, establishes a VIF > 5 and requires the removal of the following variables from further analysis:

- employment as a percentage of the total population;

- electronic commerce (as % of total commerce);

- network connectivity readiness index.

Using a least squares model (LSM) with multiple regression analysis, at second stage is tested the dependence between the human development index of Bulgaria and the factors: financing through venture capital as a percentage of GDP (Venture Capital), multifactor productivity (Multifactor Productivity), index for sustainable development (Sustainable Development), global innovation index (Global Innovativeness), ICT sector as a percentage of GDP (ICT GDP), electronic government (E-Government), export of high-tech production as a percentage of total exports (High Tech Export).

The following results were obtained:

Table 2

Least squares model, 2010-2020 observations used

Dependent variable: Human Development Index

	coefficient	standard error	z	p-value
const	0,767502	0,00391094	196,2	2,94e-054***
Venture_Capital	0,000331921	0,000142246	2,333	0,0196**
Multifactor Productivity	0,002544670	0,000109525	23,23	2,08e-119***
ICT GDP	0,0163300	0,00139902	11,67	1,72e-031***
Sustainable Development	0,00840253	0,000641956	13,09	3,81e-039***
Global Innovativeness	0,00555648	0,000499688	11,12	1,00e-028***
E-Government	0,00023448	1,35847e-05	17,26	9,31e-067***
High Tech Export	0,01058671	0,00190785	5,549	2,87e-08***
Mean of the dependent variable			0.802333	
Standard deviation of the dependent variable			0.009341	
Sum of Squares of Residuals			0.000184	
Standard error of the regression			0.006058	
Simple coefficient of definition			0.737090	
Adjusted R-square			0.579344	
F (3,5)			38.90674	
P-value (F)			0.000686	
Log-likelihood			35.83162	
Akiake information criterion			-63.66324	
Bayesian information criterion Schwarz			-65.36568	
Hannan-Quinn			-65.36568	
rho			0.244650	
Durbin-Watson			2,297497	

Source: own calculations

The multiple regression model is applicable as p-value (F) = 0.000686 < α = 0.05. It is evident from Table 2 above that the coefficients β before the included variables are statistically significant, as they are smaller than α = 0.05.

Therefore, the multiple regression model has the form:

$Y_{\text{human development index}} = 0,767502 + 0,000331921X_1 + 0,00254467X_2 + 0,0163300X_3 + 0,00840253X_4$

$+0,00555648X_5+0,00023448X_6+0,01058671X_7$ (4)

The following statistically significant dependencies can be deduced from equation (4) above:

- an increase in venture capital financing as a percentage of GDP is associated with an insignificantly small increase in the human development index in Bulgaria by 0.0003 units;

- the growth of multifactor productivity is associated with a negligible growth of 0.001 in the human development index of Bulgaria for the period 2010-2020;

- the growth of the ICT sector as a percentage of GDP is related to the growth of the human development index by 0.016;

- the increase in the index for the purposes of sustainable development is related to a negligible increase in the human development index by 0.008;

- an increase in the value of the global innovation index is associated with a growth in the human development index by 0.006;

- the improvement in Bulgaria's e-governance is related to a growth in the human development index by 0.00023;

- the change in the export of high-tech production as a percentage of Bulgaria's total export for the considered period is associated with an increase in the human development index by 0.011 per country.

From Table 2 above, it can be seen that the corrected coefficient of determination $R^2 = 0.57$ and shows that 57% of the change in the variance of the dependent variable $Y_{\text{index of human development}}$ of Bulgaria depends on the change in the factor variables included in the statistical model. The Durbin-Watson coefficient is 2.297 and reports the absence of autocorrelation in the analyzed statistical series.

As conclusions from stage 2, it can be summarized that the statistical analysis confirms that the transition to a digital economy in Bulgaria is related to an improvement in the human development index for the research period 2010 - 2020, mainly due to the improvement of the export of high-tech production in the total export of the country and an increase in the share of the ICT sector in the GDP.

Conclusions

The successful transition to a technologically driven digital economy requires the creation of a favorable environment for digital transformation through structural transformations in the institutional framework and business environment, quantitatively and qualitatively assessed at the macroeconomic, regional and company level. An important element in the digital transition is the creation and maintenance of an innovation "ecosystem", which is linked to measures that promote digital business and state entrepreneurship through investments in human capital, R&D and innovation based on an established digital strategic framework and policy.

Regarding Bulgaria's adaptation to a technologically driven digital economy, the economic and empirical analysis leads to the establishment of the following conclusions at the macroeconomic level:

- a new strategic framework was adopted, with which the Bulgarian regulatory base is harmonized at the EU level in the direction of Bulgaria's integration into the Single Digital Market. Through various institutional mechanisms and instruments, it is planned to accelerate the digital transition of Bulgaria in order to reach average European levels in digital technologies by the end of the program period (stimulating R&D and innovation in priority areas of the economy and establishing a new sustainable model for financing stakeholders in the digital transition, etc.) with a view to overcoming weaknesses in the business and institutional environment;

- a challenge to the implementation of the new regulatory and institutional framework remains the successful imposition of the new open model of coordination and cooperation between all

interested parties to achieve the national goals for a high-tech and competitive economy of Bulgaria in the next decade;

- the empirical evaluation of the potential for Bulgaria's transition to a digital economy for the period 2010-2020 confirms the hypothesis that the transition to a digital economy in Bulgaria is associated with growth in GDP per capita and an improvement in the index of human development. The most influential factors in the course of Bulgaria's digital transition are the improved position in the country's global innovation index for the analyzed period, a rise in the share of the ICT sector in the country's GDP, an improvement in Bulgaria's position in the connectivity readiness index, as well as an increase in the share of export of high-tech production in total exports of the country. On the other hand, however, the transition to a digital economy is associated with significant imbalances in real GDP for re-adjustments and investments to achieve sustainable development goals.

Future Directions

Important directions in future research on the digital transition are to extend and enrich the empirical and economic analysis with comparative analyzes of other developing countries in the Western Balkans with a view to the successful integration of the region into the EU Digital Single Market by the end of 2030. The research could be greatly enriched by regional comparative studies to empirically test the gap in economic development of urbanized and provincial regions of Western Balkan countries due to differences in connectivity and penetration of digital technologies.

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