

SECTORAL DYNAMICS AFTER 2008-2009 CRISIS IN BULGARIA: PANEL DATA ANALYSIS BY CLASSICAL PRODUCTION FUNCTION

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Abstract: The paper presents selected results from an empirical analysis of the dynamics of nonfinancial sectors in Bulgaria for the period since the start of the global crisis in 2008-2009. This analysis utilizes sectoral data for key variables like revenues from main activity (sales of produced goods or services), number of employed, and annual size of the long-term assets resembling the aggregate fixed capital in the sectors. Annual data for the period 2008-2020 is used for the following 13 sectors: A- Agriculture, forestry and fishing; B- Mining and quarrying; C- Manufacturing; D- Electricity, gas, steam and air conditioning supply; E- Water supply, sewerage, waste management and remediation activities; F- Construction; G- Wholesale and retail trade; repair of motor vehicles and motorcycles; H- Transportation and storage; I- Accommodation and food service activities; J- Information and communication; L- Real estate activities; M- Professional, scientific and technical activities; N- Administrative and support service activities (excluded sectors: P- Education; Q- Human health and social work activities; R- Arts, entertainment and recreation; S- Other service activities). The methodology utilizes panel regression methods adapted for panel data analysis based on fixed effects models. Implementing a traditional panel data approach, classical models of production function are estimated after the necessary double-log transformation into linear equations. Additionally, a panel regression model is estimated using intensive variables e.g. the log-levels of the labour productivity and capital intensity. The paper reports a selection of major results from the empirical analyses conducted by classical production functions estimated by panel data for this particular selection of major nonfinancial business sectors. In large extent these results confirm the expectations about a significant impact of the major factors of production on the sectoral economic dynamics in Bulgaria for the studied period.

Keywords: production function, nonfinancial sectors dynamics, panel analysis, Bulgaria.

1. INTRODUCTION

The transition to market economy in Bulgaria experienced several periods characterized by features specific for the respective socio-economic conditions, both domestic and international. During the early transition (first half of 1990s) it was commonly agreed that it is crucial for the economic resurrection to overcome the technological backwardness and poor organization of the inherited domestic capital. It is a fact that the early transition was characterized by insignificant progress in privatization, foreign investment, and substantial manufacturing decline in Bulgaria. “Usual suspects” for this were corruption, collapsing infrastructures, multilevel bureaucratic barriers, and many ineffective reforms. After the hyperinflation crisis of 1996-97 and the introduction of currency board arrangement in 1997 Bulgaria has succeeded to achieve satisfactory financial stabilization and to provide conditions for steady economic growth till the global crisis of 2008-2009.

As a result of the global crisis the investment processes were hindered, especially by public sources – ups and downs of public investment activities could be explained by EU funding cycle, with a particular intensification since the start of 2014-2020 programming period (OECD, 2021). This proved to be valid also for the post-crisis period – Tanchev and Terziev (2018) report a clear evidence for a significant impact of EU funding on Bulgarian economic growth evaluated by regression analysis with quarterly data for the period 2008-2014.

If the target of public investment is more or less definite (namely, renewal of the national transport and communal infrastructures), a substantial share of the private investment was related to the digitalization of economy and society. Contemporary IT developments had considerable effects on both industrial and financial sector which invoked their diversification and expansion (Pirimova, 2019). Moreover, the enhancement of production facilities through renovation and digitalization brought in a upsurge in the sectoral productivity. In particular, the wide digitalization in financial and distribution services contributed to the internationalization of production (supply of goods and services) and capital markets accompanied by influx of foreign direct investments (Pirimova, 2019). Todorov and Durova (2016) analyze the dynamics of the long-run factors of growth (e.g. productivity and population growth rates, rates of growth of investment and employment). Growth accounting techniques were implemented for the study of supply-side growth determinants in order to measure their contributions to real GDP growth.

Studying different consecutive periods of growth of Bulgarian economy, applying alternative methods for growth accounting, Raleva (2014) derives a conclusion for post-2008 period (when the real output increased by just 0.9% on average for 2010-2013) that the contribution of labor was negative (within -1.3 to -1.7 percentage points). Todorov

(2016) reviews the alternative approaches adopted by few Bulgarian authors applying growth accounting method based on a two-factor Cobb-Douglas production function, commenting on the methodological differences between them. In order to implement a similar framework, this author admits that measuring the growth rate of capital stock appears to be the most problematic methodological issue. He generated this stock time series by applying the traditional perpetual inventory method (using a capital-output ratio of 2.2 and assumed rate of depreciation 0.05). Furthermore, applying OLS method on annual data for the total economy this author obtains a statistically significant estimate of 0.254 for the elasticity of capital input for the period 1996-2004; in the same time, the labor input is found to have almost unit elasticity: 0.985 (Todorov, 2016).

Although there is a lack of sound empirical work on sectoral dynamics in Bulgaria, different authors provide indications about the diversity in this respect. Pirimova (2019) suggests that Bulgarian industry is the only sector exhibiting a persistent resurgence since the global crisis, keeping positive growth rates in the post-recovery period (2014 afterwards). The major contribution in this respect is provided by Manufacturing “*influenced by the gradually normalizing domestic and foreign demand and export (in EU and world countries) of industrial production, the advanced stage of reorganization of the activities of the privatized companies and their technical retrofitting*” (Pirimova, 2019).

The current paper suggests some preliminary results of the econometric analysis of production dynamics of the major economic sectors of the Bulgarian economy as a function of the capital and labor inputs. It is generally considered that the capital acquisitions and enhancement should predominantly contribute to sectoral development through a range of positive effects (e.g technological renewal, know-how transfer, export facilitation, and other positive spillover effects). The analysis covers the period 2008-2019 in order to avoid methodological inconsistencies in the statistical data classification and measurement of sectoral variables following the introduction of ISIC Rev.4 (UN, 2008) by Bulgarian official statistics since 2008.

2. MATERIALS AND METHODS

The econometric model presented in Section 3 is estimated on the basis of official data for the main economic sectors, Classification A21, as provided by the Bulgarian National Statistical Institute for the period 2008-2019 (NSI, 2022). This period covers the global crisis years and the following resurgence up to the last year before the Covid-19 crisis (which distorts severely the data for 2020). Some sectors have experienced decline in output (mining, construction) and others have reduced the labor input along with overall upward trend in output (table 1). In any way, exploration of sectoral structures appear to be essential for the analysis of dynamics of productivity of sectoral economic activities (Gospodinova, 2019).

Table 1. Growth rates of the major economic sectors in Bulgaria (2008-2019)

Annual geometric mean growth rates of:	Employed	Fixed Capital	Production
A- Agriculture, forestry and fishing	1,8%	13,5%	7,2%
B- Mining and quarrying	-4,0%	2,0%	-3,5%
C- Manufacturing	-1,5%	2,8%	3,3%
D- Electricity, gas, steam and air conditioning supply	-1,3%	4,6%	2,4%
E- Water supply, sewerage, waste management and remediation activities	0,0%	-0,5%	2,9%
F- Construction	-4,8%	-3,4%	-2,1%
G- Wholesale and retail trade; repair of motor vehicles and motorcycles	0,1%	1,5%	3,6%
H- Transportation and storage	0,5%	4,2%	4,8%
I- Accommodation and food service activities	1,2%	3,4%	5,4%
J- Information and communication	5,8%	1,1%	6,3%
L- Real estate activities	1,1%	2,6%	1,7%
M- Professional, scientific and technical activities	3,2%	1,9%	3,9%
N- Administrative and support service activities	2,6%	8,6%	8,8%
* Revenues from sales of produced goods/services			

Source: National Statistical Institute (2022).

The data used for the analysis comprises of a panel of 13 sectors with 12 annual observations per each variable for each sector which could provide a pool of 156 observations. The following specifications of panel regression models were used in the forms:

$$P[i,t] = b[0] + b[1]*FC[i,t] + b[2]*E[i,t] + u[i,t] \quad (1)$$

$$\ln(P[i,t]) = c[0] + c[1]*\ln(FC[i,t]) + c[2]*\ln(E[i,t]) + v[i,t] \quad (2)$$

$$\ln(PpE[i,t]) = d[0] + d[1]*\ln(FCpE[i,t]) + w[i,t] \quad (3)$$

where: b, c, and d are the coefficients (model parameters) to be estimated; $P[i,t]$ is the dependent variable (volume of sales of produced goods or services by sector “i” in year “t”, thousand BGN); $FC[i,t]$ is the fixed capital (approximated by the volume of tangible long-term assets of sector “i” in year “t”, thousand BGN); $E[i,t]$ is the number of employed by sector “i” in year “t”; PpE is the labor productivity (Production per Employee); $FCpE$ is the capital intensity (Fixed Capital per Employee); u, v, and w are disturbance terms. However, due to the panel nature of the data each of these disturbance terms is assumed to be a “composite error” variable that has the following structure: $a[i] + m[t] + e[i,t]$, where $a[i]$ ($i=1, \dots, N$) is an unobserved sector effect (time-constant sector-specific component), $m[t]$ ($t=1, \dots, T$) is an unobserved time effect (annual time intercept), and $e[i,t]$ is an idiosyncratic error. In order to capture any eventual trend effects in the dynamics of the variables, 11 time-dummy variables $d2-d12$ have been introduced in the model for estimating the time-specific components (for the years 2009 to 2019, with 2008 as the reference year). Since the sectors chosen cannot be considered as a random sample a fixed-effects panel regression approach has been implemented by introducing sector dummy variables as well. This way, the model estimates have been obtained by the “least squares dummy variables” (LSDV) method. It cannot be assumed here for the independent variables to be uncorrelated with the unobserved sector-specific effect, so the chosen estimation method is recommendable in such a case. This way, 12 dummy variables have been introduced as well (Sector A chosen as a reference unit).

3. RESULTS AND DISCUSSION

The estimation results for the three specifications are presented in table 2. Practically each model suffered from heteroskedasticity and serial correlation which required re-estimation of the standard errors of parameter estimates as HAC (heteroskedasticity and autocorrelation consistent). For the first model this brought in insignificant parameter estimate for the fixed capital (employed with insignificant parameter in both cases). In any way, the linear specification is not considered as theoretically suitable – production function theory requires operation of multiplicative basic specification which is estimated in its log-log transformed model (equation 2).

Table 2. Empirical results from the estimated panel data models
Dependent variables: Production / $\ln$ (Production) / $\ln$ (Labor productivity)

Linear specification	Coefficient	Std. Error*	t-ratio	p-value
Const	1.11e+07	7.34e+06	1.509	0.1571
Fixed Capital /FC/	1.155	0.633	1.825	0.0930
Employed	-11.68	48.6	-0.240	0.8143
LSDV R-squared	0.975			
Joint F-test on named regressors				0.2258
Robust test for differing group intercepts (Welch F)				<0.0001
Wald joint test on time dummies (Chi-square)				0.00015
Log-Log specification	Coefficient	Std. Error*	t-ratio	p-value
Const	2.8678	1.3972	2.053	0.0626
$\ln$ (Fixed Capital)	0.2692	0.0772	3.485	0.0045
$\ln$ (Employed)	0.7811	0.1555	5.023	0.0003
LSDV R-squared	0.995			
Joint F-test on named regressors				<0.0001
Robust test for differing group intercepts (Welch F)				<0.0001
Wald joint test on time dummies (Chi-square)				<0.0001

Log-Log Intensive	Coefficient	Std. Error*	t-ratio	p-value
Const	3.4791	0.3209	10.84	<0.0001
Ln (FC per Employed)	0.2602	0.0784	3.317	0.0061
LSDV R-squared				
Robust test for differing group intercepts (Welch F)				<0.0001
Wald joint test on time dummies (Chi-square)				<0.0001

Note: Author's calculations using NSI data. (*) Robust /HAC/ standard errors reported.

In the double-log specification the partial regression coefficients – being the elasticities of capital and labor – have been estimated as statistically significant at a level below 0.01. The same result is obtained also for the bivariate model (equation 3) using the intensive variables which provided the estimate of the elasticity of labor productivity by capital intensity. The panel diagnostics of all equations revealed that LSDV approach is justified for both sector- and time-specific components – the null hypotheses are strongly rejected in both tests: (i) test for non-differing group intercepts $\alpha[i]$; (ii) test for joint insignificance of time intercepts $m[t]$.

In opposite to the initial expectations, capital input showed almost three times lower elasticity as compared to the labour input. On average, the output of a sector grows by 0.27% associated to 1% increase in fixed capital input. Almost the same value is obtained for the intensive variables: the labor productivity grows by 0.26% on average per sector, associated to 1% increase in the capital intensity. The latter result reflects the imbalances between the relatively higher growth rates of the capital compared to those of labor input, including the fact that some sectors have experienced even decrease of employment along with increase of output (Table 1). These minor expansions of labor input led to a much larger elasticity to this production factor – the output grows by 0.78% (on average per sector) associated to 1% increase in labor input. It should be noted that all these elasticities reflect an averaging procedure that generates estimates on average per economic sector. Further investigation is to be performed in order to explore the divergences between sectors, for example, by introducing interaction terms in the specification.

4. CONCLUSIONS

There is no doubt that the capital intensification in particular economic sectors was of certain importance for their revival after the global crisis of 2008-2009 and generally, in conditions of increasingly globalized economic processes. As a small open economy Bulgaria is not an isolated case and the observed developments are not unexpected. Particularly, a range of analyses have been conducted on a variety of issues concerning the effects of foreign direct investments influx in Bulgarian economy – as an important source of fixed capital renewal and modernization. This aspect of the analysis of production factors impact on sectoral outputs still have little empirical support for Bulgarian economy. An update of firm-level data analysis still has a definite potential (Dimova, 2008). Additionally, recent external shocks have introduced substantial turbulences in particular sectors – mainly the Covid-19 crisis since 2020 and Ukraine armed conflict in the start of 2022. Needless to say, the analysis could be performed in a more comprehensive econometric framework, but still its results provide a basis for further enhancement and evaluation of the effects of these shocks from the last few years that are to be specifically investigated.

REFERENCES

- Dimova, R. (2008). The impact of labour reallocation and competitive pressure on TFP growth: firm-level evidence from crisis and transition ridden Bulgaria. *International Review of Applied Economics*, 22(3), 321-338.
- Gospodinova, S. (2019). Structural changes in gross value added and their relation to the economic growth of Bulgaria in the period 1997-2017. *Economics* 21, 20(1), 86-104.
- NSI (2022). *Business Statistics: Non-financial enterprises*. (www.nsi.bg Retrieved 07.03.2022).
- OECD (2021). OECD Economic Surveys – Bulgaria: Economic Assessment. Organization for Economic Cooperation and Development, January 2021.
- Pirimova, V. (2019). Opportunities for innovation and growth in the Bulgarian economy. *Trakia Journal of Sciences*, 17 (Suppl. 1), 243-251.
- Raleva, S. (2014). Impact of labour on economic growth in Bulgaria (1991-2013). *Economic Alternatives*, 3, 5-14.
- Tanchev, T., Terziev, M. (2018). EU funds and economic growth in Bulgaria. *Economic Studies*, 27 (1), 84-94.
- Todorov, I. (2016). Supply-side factors of economic growth in Bulgaria. *Economic Alternatives*, 2, 159-174.
- Todorov, I., Durova, K. (2016). Economic growth of Bulgaria and its determinants. *Economic Studies*, 25 (4), 3-35.
- UN (2008). *International Standard Industrial Classification of All Economic Activities. Revision 4*. Department of Economic and Social Affairs, Statistics Division, United Nations, New York.