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LABOUR INTENSIVENESS OF ECONOMIC GROWTH IN BULGARIA: ESTIMATES, IMPACT OF THE GLOBAL CRISIS AND DRIVERS[2]

The study of the employment intensiveness of economic growth has become topical in the light of observed high inequalities in Bulgaria, as well as demographic challenges and tightening of the labour market in recent years. To study it, we estimate the elasticity of employment and total hours worked with respect to GDP. We find that economic growth has an impact on both indicators of the labour input with a lag of 3 quarters. However, the employment elasticity of GDP (0.81) is much higher than the elasticity of the hours worked with respect to GDP (0.29), which is attributed to certain inertia in the dynamics of the latter.

Our results furthermore suggest that the relationship between economic activity and labour weakens during economic crises. There even seems to be a disconnect between economic activity and employment after the global economic crisis. The latter conclusion is drawn based both on the insignificance of the parameters estimating labour elasticity after the crisis and on an analysis of the breakdown of the GDP per capita growth by productivity and employment growth, where the contribution of extensive employment growth to the increase of the GDP per capita significantly subsides after the global crisis.

Finally, estimating the employment elasticity of GDP, we find that it is highly unstable in time and depends on the structure of value added in Bulgaria, but also on labour supply, size of the informal economy and, more generally, on the phase of the business cycle. Taking into account the non-registered sector, in particular, we find that the responsiveness of employment to GDP becomes much higher, quicker and does not essentially change during economic downturns.

JEL: E24; E26; E27; J23; C22

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Introduction

The relationship between economic activity and job creation has been the focus of many empirical works, as it can have useful policy implications by providing insights on the structural composition of the economy and its capability to generate jobs. This issue has become even more topical in recent years given that major strategic documents, such as the Europe 2020 for example, target a certain level of employment.

Following the global crisis from 2008, there is evidence of changes in the relationship between growth and employment and even (temporary) decoupling of the two indicators.[3] During the crisis this was partly attributed to the measures undertaken for the protection of the workplaces across EU countries.[4] In the post-crisis years some studies[5] provide evidence that in Bulgaria, in particular, the decoupling of economic activity and employment is also due to slow economic growth with pronounced seasonal character.

More generally, however, relevant studies attribute the disconnect between economic growth and employment to the introduction of disruptive technologies, such as artificial intelligence, which explain the observed decoupling not only of growth and employment but also of productivity and wages. We find that the observed disconnect between the gross domestic product (GDP) and employment in economies with a relatively large share of the informal sector is also due to measurement errors, related to the non-reporting of the shadow activities and jobs.

Generally, jobless growth does not necessarily imply worsening of the macroeconomic situation and does not always have a negative impact on social indicators, such as inequality for example. It is often argued that weakening of the relation between economic growth and employment may be natural in economies that are overcoming the productivity gap.[6] Other factors, related to structural specifics of economic growth, labour market specifics and institutions and even macroeconomic variables, such as inflation have also been found to have impact on the GDP elasticity of employment. We touch upon the nature and possible channels of impact of these factors in the analytical section below.

Finally, it should be mentioned that there are arguments in favour of the estimation of employment intensiveness of growth, rather than Okun's law. They are based on some measurement problems of the unemployment rate (definition and estimation) and the possibility to estimate various breakdowns of the employment intensiveness, such as by economic sectors.

However, the measure of employment intensiveness of growth should also be treated with caution. As stated by Kapsos (2005), GDP elasticity of employment proves to be highly unstable in time and, moreover, data on employment in persons does not take into account the general trend for reducing the working time per employee. Finally, Kapsos also notes

[3] See, for example, ECB (2016).
[4] See, for reference, Beleva (2011).
[5] See, for reference, Beleva (2018)
[6] For example, in Hudcovský M., M. Lábaj and K. Morvay (2017).

that the employment intensiveness estimates the labour input only in terms of quantity and does not consider its quality, which might also lead to misleading interpretations.

Our literature review showed that the relationship between economic activity and unemployment, or Okun's law, and the employment intensiveness of GDP have been largely studied in economic literature. Prominent examples include Mourre (2004) for the Euro area and United States, Saget (2000) – for the transition economies in the Central and Eastern Europe, Perugini (2009) – at subnational level and Kapsos (2005), providing global estimates.

Mourre (2004) finds that employment intensiveness of economic growth has increased in the period between 1997 and 2001 in the Euro Area and attributes it partly to higher GDP growth and, partly, to the high deceleration in the labour cost hike. He also shows that the increase in the part-time employment, together with changes in the sectoral composition of the gross value added (GVA), improved labour market institutions and active labour market policies, have also contributed to the intensified relationship between employment and growth.

Saget (2000) estimates the employment elasticity of growth in transition economies, paying special attention to gender inequalities and also to the factors behind it. She finds that in the 1990s there was no relationship between GDP and employment in Bulgaria and Ukraine and attributed it to the presence of large informal sectors in these economies.

Perugini (2009) estimates employment elasticities of GDP disaggregated by the regions in Italy and the main economic sectors. His analysis supports the proposition of a job-rich growth after the mid-1990s.

Finally, Kapsos (2005) shows that the employment intensiveness of growth has decreased between 1999 and 2003 globally, although large differences are observed by regions. He also finds a positive relationship between labour force size and share of the services in GVA and employment elasticity. Meanwhile, the impact of high labour taxes and uncertainty, measured by inflation, on the labour intensiveness of growth is estimated to be negative.

There is rich literature on the employment intensiveness of growth, but few estimates are available for the Bulgarian economy in particular. The latter are mostly done more than 10 years ago and within a larger panel of countries (see, for example Saget (2000) and Kapsos (2005)). There is, however, a recent study by Tsanov (2018), which investigates the validity and stability of the Okun's law in Bulgaria. The paper shows that while the relationship between GDP and unemployment is statistically significant and negative, it is not stable in the period under consideration. This lack of persistence is attributed mainly to the economic cycle.

In terms of methodological approaches, the wide range of studies that focus explicitly on the employment intensiveness of growth employ varied computational and econometric approaches. They range from simple calculations of the changes in the two indicators, to error-correction models and structural models with unobserved components. We have considered three of the above-mentioned approaches:

- *Direct calculation of the employment elasticity* – this method is straightforward to apply but has two important drawbacks – computed in this way, the employment elasticities display large variability from year to year. Additionally, it does not provide a direct tool for estimating the lag, with which economic activity influences employment most.
- *Application of error-correction models (ECM)* – this approach is appealing as it allows us to distinguish between short-term and long-term employment elasticity of growth. However, in our case, GDP and employment were cointegrated only at the low significance level and, applying the ECM, we did not obtain statistically good estimates of the presumed relationships.
- *Application of an ordinary least squares regression* – while this method is less sophisticated than the previously discussed ECM, its application resulted in robust and statistically well fit estimates, which we present later in this paper.

In our work, we try to address the need to provide a more recent estimate of the employment intensiveness of economic growth in Bulgaria and also to study whether the relationship between GDP and employment differs from that between GDP and the total hours worked, i.e. whether there is evidence of decreasing work time. The impact of the economic crisis has also been investigated, as well as other factors underlying the employment intensiveness of GDP in Bulgaria, with a focus on informality.

This study is structured as follows: first, a brief overview of the historical trends in GDP, employment and total hours worked is presented. It is followed by some methodological notes, presentation and analysis of the estimation results, analysis of the drivers of the changes in the relationship between GDP and employment in Bulgaria and conclusions.

Historical trends in economic activity and labour demand

The Bulgarian economy has moved from a high-growth expansionary period in 2000-2008[7], resulting from macroeconomic stabilization and favourable implications of EU membership, to a more balanced, but lower growth pattern after the economic crisis of 2009-2013 (as it can be inferred from Figure 1). Given that there are indications that the structure of economic growth is changing, a natural question arises about the implications of this transformation for employment creation.

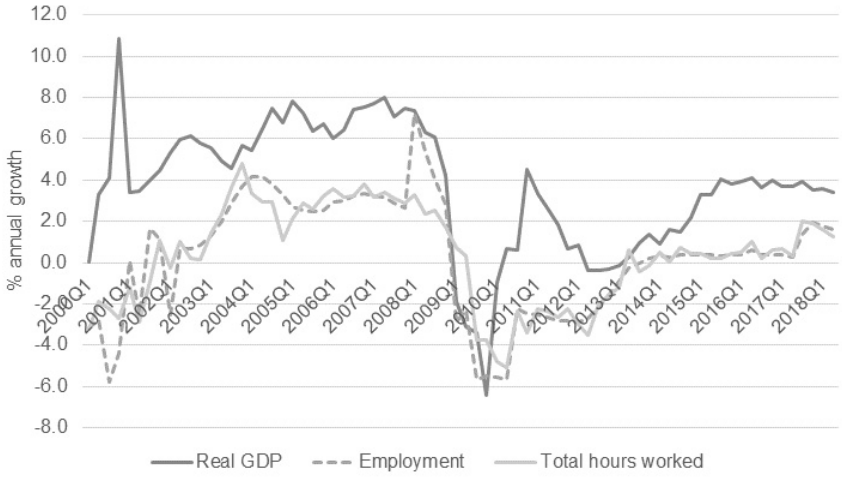
Comparing GDP and employment growth rates visually (Figure 2 and Figure 3), four distinctive periods can be discerned. The first one covers the years during and immediately after the financial and economic crisis of 1996 and 1997 that led to the introduction of the currency board in Bulgaria. It was characterized by a high variance in the relationship between GDP and employment. In the second period of economic expansion, coupled with positive expectations for EU membership and ongoing economic integration with the EU,

[7] For the period of the early transition, Beleva, Jackman and Nenova-Amar (1995) and Beleva and Tzanov (2001) provide an in-depth review and analysis of economic developments and policies on the labour market. Beleva et al. (2012) provide a thorough analysis of the labour market, incomes, social security and social assistance and education in the period 1990-2011.

there was high employment intensiveness of the GDP, where both GDP and employment growth rates were very much on the high side. A third period can be discerned when Bulgaria was hit by the global crisis after the second half of 2008. During this period, the relationship between employment and GDP again became volatile, although, not as much as during the previous crisis. Since 2014, GDP elasticity of employment seems to have become much more stable although somewhat lower as compared to the pre-crisis levels.

Figure 1

Annual non-seasonally adjusted growth of real GDP, employment and hours worked in 2000Q1-2018Q2

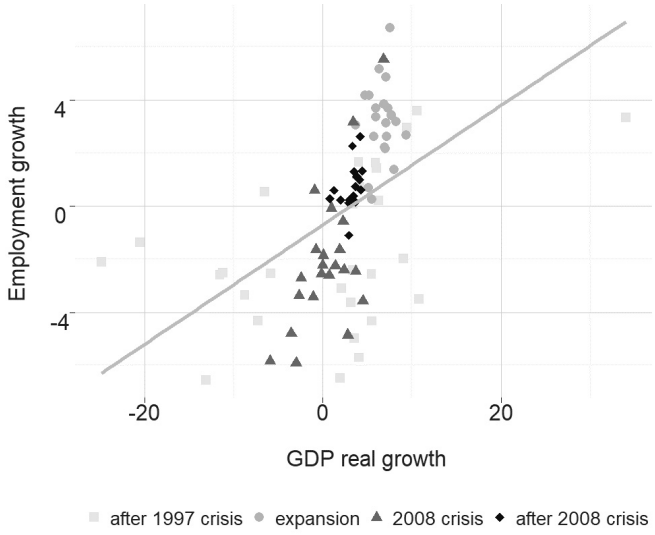


More generally, Figure 2 illustrates that Verdoorn law (1949)[8] did not apply to Bulgaria in the period under consideration. In the years of economic upturn, high economic growth came along with high job creation, thus limiting productivity gains. Meanwhile, after the global economic crisis, growth has been lower but to a higher extent productivity-driven. The latter observation provides indications of a decoupling of the economic growth and employment.

Following these visual observations, in the next sections we test the relationship between economic activity and employment, taking into account the four a priori identified periods. Dummy variables for the four identified periods would also provide numerical evidence on whether the Bulgarian economy is moving toward a less employment-intensive growth pattern, drawing on the reserves of the economy to boost productivity through innovations and on its slow but steady recalibration towards less labour-intensive economic activities.

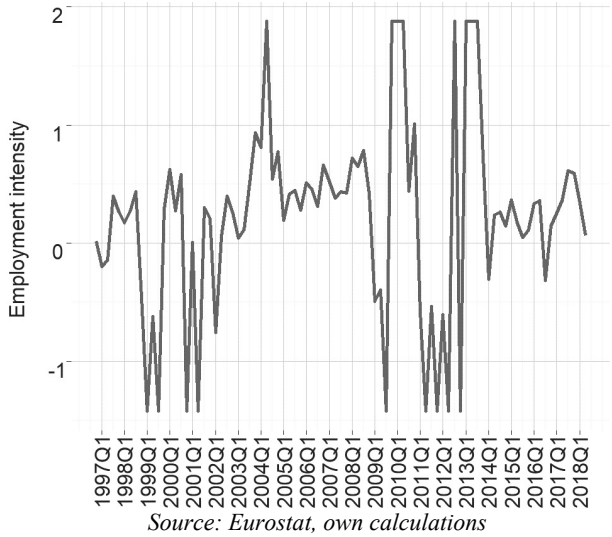
[8] Verdoorn law (1949) states that economic growth comes along with higher productivity, as it allows for higher labour division and specialisation.

Figure 2
Scatterplot of GDP and employment growth 1996Q4-2002Q4 (blue square), 2003Q1-2008Q2 (green circle), 2008Q3-2013Q4 (yellow triangle) and 2014Q1-2018Q2 (red diamond)



Source: Eurostat, own calculations

Figure 3
Calculated employment intensiveness of GDP (with 3 quarters lag, for which the correlation between employment and GDP is highest)



Source: Eurostat, own calculations

Methodology

In order to disentangle the relationship between GDP and employment and hours worked, we run a simple ordinary least square regression. The choice of this approach is justified in the introduction to this paper. We use non-seasonally adjusted quarterly data for the period 1995Q1 – 2018Q2. In particular, we take non-seasonally and calendar adjusted data for GDP in constant 2010 prices, employment in thousands of persons and total hours worked in number. All data is based on the national accounts, produced by the Bulgarian National Statistical Institute (NSI) and published on the Eurostat webpage.

We apply the following data transformations:

1. **Seasonal adjustment of the data**, using the 'seasonal' package under the software platform R. It presents an interface to X-13ARIMA-SEATS, which is a software for seasonal adjustment, developed at the United States Census Bureau.
2. **Testing and addressing of non-stationarity of the time series**. We applied the augmented Dickey-Fuller (1979) test. Its null hypothesis is for non-stationarity of the data series. Therefore, following the good practices in econometrics, we also cross-checked our findings with the KPSS (Kwiatkowski–Phillips–Schmidt–Shin (1992)) test, where the null hypothesis is for stationarity. Both tests confirmed the presence of a unit root in all used data series.

In order to smooth the data and remove the non-stationarity, we transformed the data in natural logarithms and then took first differences, proxying for growth rates of the respective variables.

Checking for non-stationarity again with the above-mentioned tests revealed the unit root of first differences as well. After a visual inspection of the analysed time series, the hypothesis of structural break in the time series was tested. We applied the test for stationarity with structural breaks, developed by Zivot и Andrews (1992). It showed that in all-time series we can reject the hypothesis of existence of a unit root, where the test also endogenously calculated probable periods of structural breaks. The results from the application of this test are presented in Table 1 below.

Table 1

Results from the application of the Zivot и Andrews (1992) test for stationarity with structural breaks

Time series	Test statistics	Critical level at significance level of 0.01	Potential structural breakpoint
GDP[9]	-10.0045	-5.34	2008Q3
Hours worked	-7.9764	-5.34	2008Q1
Employment	-8.0238	-5.34	2008Q3

[9] Excluding the period until 1998Q1 to avoid having a break in the time series due to the 1996-1997 economic and financial crisis.

Regression output

As already stated, the elasticity of the employment with respect to GDP is estimated by a linear regression using the least-squares method. All variables are taken in differences of natural logarithms to approximate percentage changes. In this way the obtained parameters can be directly interpreted as elasticities.

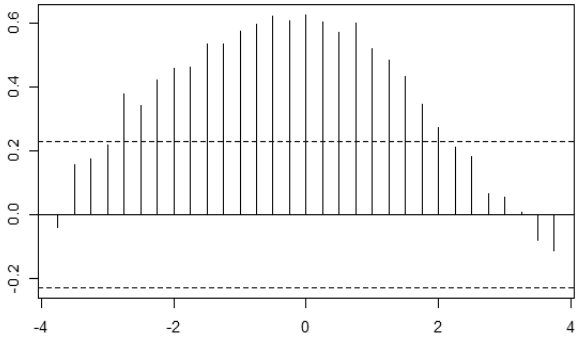
We tested for various lags of the GDP, ranging from simultaneous relationship to 8 lags (2 years). As it can be inferred from Figure 4, the correlation between GDP and employment was found to be strongest with a lag of 3 quarters.

We subsequently tested the specified regression models for serial correlation, heteroscedasticity and normality of the residuals and discovered both heteroscedasticity and non-normality of the residuals.

Concerning non-normality, we assumed that it is due to the presence of outliers. The latter is identified as the values that are outside the interval set by the interquartile range multiplied by 1.5[10]. The outliers were replaced by the corresponding values of the third (high values) or the first (for low values) quartiles, depending on whether the outliers were in the high or low end of the distribution of the values of the variables, included in the regressions.

Figure 4

Cross correlations between employment and lags of GDP (the numbers on the x-axis correspond to years)



Using the time series, cleared from outliers, we re-estimated the relationship between GDP and employment, treating the problem of heteroscedasticity by estimating heteroscedasticity corrected covariance matrices. They did not change the statistical implications of the model and the resulting model looks well fitted – the parameter values remained the same and statistically significant.

[10] For reference, see Tukey (1977).

Table 2

Summary of regression results for the estimation of the employment elasticity of economic growth

Variables	Estimate	Standard error	t-statistic	p-value	
Intercept	-0.005826	0.001178	-4.947	3.77e-06	***
GDP(-3)	0.811703	0.108790	7.461	6.79e-11	***
Dummy for 1996-1997 crisis*GDP(-3)	-0.511398	0.121540	-4.208	6.37e-05	***
Dummy for 2008 crisis *GDP(-3)	-0.637878	0.182494	-3.495	0.000755	***
Postcrisis dummy *GDP(-3)	0.124046	0.205997	0.602	0.548660	
Adjusted R^2:	0.3862	p-value of **F-statistic**:		2.579e-09	
p-value of the Durbin-Watson test for serial correlation *(H0: No serial correlation)*	0.1998	p-value of the Jarque-Bera test for normality of the residuals *(H0: normality of the residuals)*		0.7094	
p-value of the Breusch-Pagan test for heteroscedasticity *(H0: Homoscedasticity)*	0.09625	p-value of the Breusch-Godfrey test for serial correlation of order up to 1 *(H0: No serial correlation)*		0.7145	
Heteroscedasticity corrected covariance matrices					
Variables	Estimate	Standard error	t-statistic	p-value	
Intercept	-0.005826	0.0013239	-4.4003	3.120e-05	***
GDP(-3)	0.811703	0.0906584	8.9534	6.710e-14	***
Dummy for 1996-1997 crisis*GDP(-3)	-0.511398	0.1193893	-4.2835	4.821e-05	***
Dummy for 2008 crisis *GDP(-3)	-0.637878	0.2527445	-2.5238	0.01347	*
Postcrisis dummy *GDP(-3)	0.124046	0.1740851	0.7126	0.47807	

*Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1* **Error! Reference source not found.**

Table 2 presents a visual overview of the fit of the estimated regression and also confirms that it is broadly appropriate. The figure plotting the fitted values against the residuals does not show any specific patterns, so there is no evidence of non-linear relationships. In addition, the residuals seem to be normally distributed, according to the Normal Q-Q plot. The Scale-Location plot however provides indications of the existence of heteroscedasticity, which justifies the presence of heteroscedasticity corrected covariances in the table above. Cook's distance plot shows that there are no specifically influential observations.

The results from the estimation of the GDP elasticity of the hours worked are presented in the table below. Again, we corrected the time series for outliers. We also introduced dependent variable one- and two-period lag terms, as the regression diagnostics indicated the presence of serial correlation of the residuals.

Figure 5

Employment elasticity regression diagnostics plots

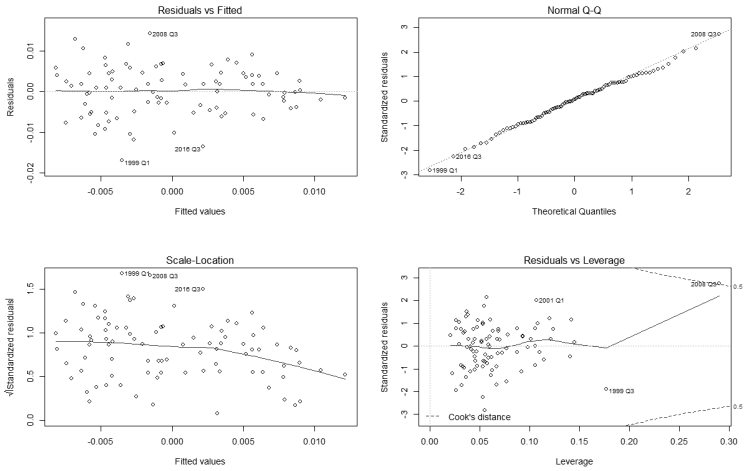


Table 3

Summary of regression results for the estimation of the elasticity of the hours worked with respect to economic growth

Variables	Estimate	Standard error	t-statistic	p-value	
Intercept	- 0.0021773	0.0009572	-2.275	0.025503	*
GDP(-3)	0.2907613	0.1022769	2.843	0.005626	**
Dummy for 1996-1997 crisis*GDP(-3)	-0.1815431	0.0989297	-1.835	0.070077	.
Dummy for 2008 crisis *GDP(-3)	-0.5946773	0.1365519	-4.355	3.78e-05	***
Postcrisis dummy *GDP(-3)	0.0783189	0.1370701	0.571	0.569287	
Hours worked (-1)	0.2720168	0.0990689	2.746	0.007401	**
Hours worked (-2)	0.3567967	0.0960751	3.714	0.000369	***

Adjusted R^2:	0.6946	p-value of **F-statistic**:	2.2e-16
p-value of the Durbin-Watson test for serial correlation *(H0: No serial correlation)*	n.a.	p-value of the Jarque-Bera test for normality of the residuals *(H0: normality of the residuals)*	0.7027
p-value of the Breusch-Pagan test for heteroscedasticity *(H0: Homoscedasticity)*	0.2301	p-value of the Breusch-Godfrey test for serial correlation of order up to 1 *(H0: No serial correlation)*	0.3343

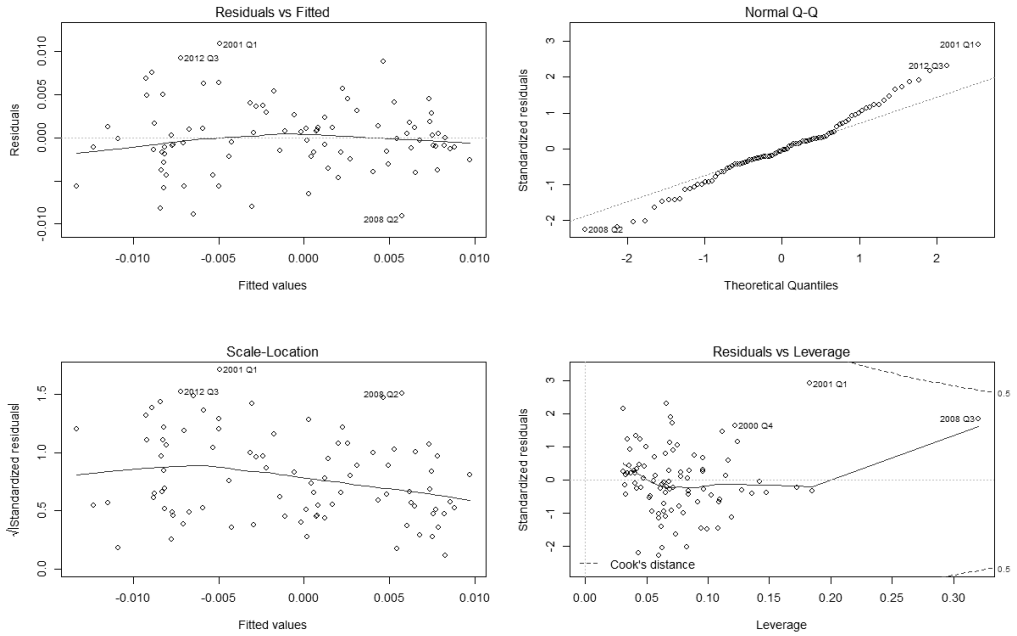
*Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*

As in the case with the employment elasticity of GDP, Figure 6 also gives a visual illustration of the fit of the estimated regression. The results might be considered as good. Similar to the previous regression, they do not indicate any non-linearities in the studied relationships. Additionally, the residuals seem normally distributed. The Scale-Location

plot generally confirms the hypothesis of homoscedasticity, despite a small kink in the line. Cook's distance plot again shows that there are no extremely influential observations.

Figure 6

Elasticity of the hours worked of GDP – regression diagnostics plots



Analysis of results

The estimated employment elasticity of GDP implies that one percentage increase in GDP generated 0.81 rise in employment with a 9-month lag in the economic upturn. During the two economic crises of 1996-1997 and 2008-2013, the relationship weakened to 0.30 and 0.17. In the period after the last crisis, GDP and employment seem disconnected, as the estimated parameter is not statistically significant.

The elasticities that we have obtained are higher, but broadly in line with comparable studies. The analysis of ECB (2016) on the employment-GDP relationship since the crisis estimates an average pre-crisis elasticity of 0.58 in the Euro Area. This value is lower than our estimate for Bulgaria and might due to differences in the economic structure or labour market flexibility. Similar to our results, the authors of this study also find a negative impact of the crisis on the studied relationship and lack of coherence in the dynamics of the GDP and employment in the post-crisis period.

The values of 0.30 and 0.17 obtained for the periods between 1996Q4-2002Q4 and 2008Q3-2013Q4 relate more closely with the results of the estimates of Kapsos (2005). He

estimates a GDP elasticity of employment of 0.50 in Bulgaria in the period 1999-2003. Taking into account that 2003 is not included in our sample for this period, the outcomes of the two estimations might be considered as consistent.

Employment threshold

The first regression of employment on GDP allows us to calculate the so-called **employment threshold**, or the GDP growth that corresponds to constant employment.

The model specification that we have adopted is the following:

$$\Delta Employment_t$$

$$\alpha_0 + \alpha_1.\Delta GDP_{t-3} + \alpha_2.Dummy1997_t.\Delta GDP_{t-3} + \alpha_3.DummyCrisis_t.\Delta GDP_{t-3} + \alpha_4.DummyPostcrisis_t.\Delta GDP_{t-3}$$

,

In this case the employment threshold can be calculated as:

$$Employment\ threshold_t = \frac{-\alpha_0}{\alpha_1 + \alpha_2.Dummy1997_t + \alpha_3.DummyCrisis_t + \alpha_4.DummyPostcrisis_t}$$

Applying the above formula, we obtain the following employment thresholds:

Table 4

Estimated employment thresholds in Bulgaria

Period	1995Q2-2002Q4	2003Q1-2008Q2	2008Q3-2013Q4	2014Q1-2018Q2
Employment threshold	1.94	0.72	3.35	0.62

Based on the above table, it can be seen that in times of economic distress, much higher growth rate of GDP was required to induce employment growth. That is justified by the so-called labour hoarding. The latter refers to the fact that in economically unfavourable times companies do not cut on labour proportionally to their output decline, but rather tend to keep jobs in order to avoid adjustment costs, which would be related to laying off workers and then employing again when the economic situation starts to improve again. That is why in times of economic slowdown the growth rates needed to resume employment growth are much higher. Based on the employment threshold estimates, it looks that employers are more willing to employ currently, but these results should be treated with caution as the parameter before the last regressor $DummyPostcrisis_t.\Delta GDP_{t-3}$ is not statistically significant.

Elasticity of total hours worked with respect to growth

Turning to the results from the estimation of the elasticity of the hours worked with respect to GDP, we find again that there is no longer statistically significant relationship after the economic crisis that started in 2008.

However, the elasticity of total hours worked of GDP is much lower than that of employment and amounts to 0.29 in times of expansion. This result is contrary to the economic logic, as we would expect a priori that employers would adjust to fluctuations in economic activity by changing the hours worked rather than the number of employed persons. In our view, the difference is due to the inclusion of the two lags of the total hours worked in the regression. It was done in order to account for the serial correlation of the residuals but leads to the decrease of the elasticity of the total hours worked to GDP from 0.80 to 0.29.

Based on this, we can conclude that the responsiveness of the total hours worked to the fluctuations in the GDP is lower than the one of the employment, measured in thousand of employed persons, as the hours worked display much higher dependency on their past values.

Rolling estimation of the employment elasticity

To test the statement that employment elasticity of GDP and Okun's law is rather volatile over time[11], we have constructed a series of rolling regressions. We have chosen ex-ante a window of 24 quarters. The reason for this choice is that each period in the development of the Bulgarian economy after 1995 seems to last approximately 6 years: from 1995 to 2000 crisis and stabilization with the introduction of the currency board, 2001 – 2007 were boom years, 2008 – 2014 were years of economic crisis and recovery and during the period after 2014 Bulgarian economy has experienced moderate but stable economic growth.

The adjusted R^2 of the rolling regressions varies between 0 and 0.6 and is higher in the period before the 2008 crisis with the exception of the initial years prior to the introduction of the currency board arrangement in mid-1997. Respectively the p-value associated with the estimated employment elasticity of GDP is generally significant at 1% with the exception of the rolling regressions covering both expansion years and financial crisis, where probably the poor fit could be attributed to a structural break.

[11] See, for example Perugini (2009) for employment intensity of growth in Italy, Kapsos (2005) for international comparisons and Tsanov (2018) for the Okun's law in Bulgaria. They all find high variability of the estimated coefficients, based on the sample time period selected.

Figure 7

Estimated employment elasticity of GDP on a rolling basis

The estimated employment elasticity of GDP with the rolling regressions is presented in Figure 7. For the entire period, the employment elasticity of GDP averages 0.68, which is higher but comparable to the observed coefficient for the regressions starting after 2010Q1 (0.58), where the estimated parameters are also highly statistically significant.

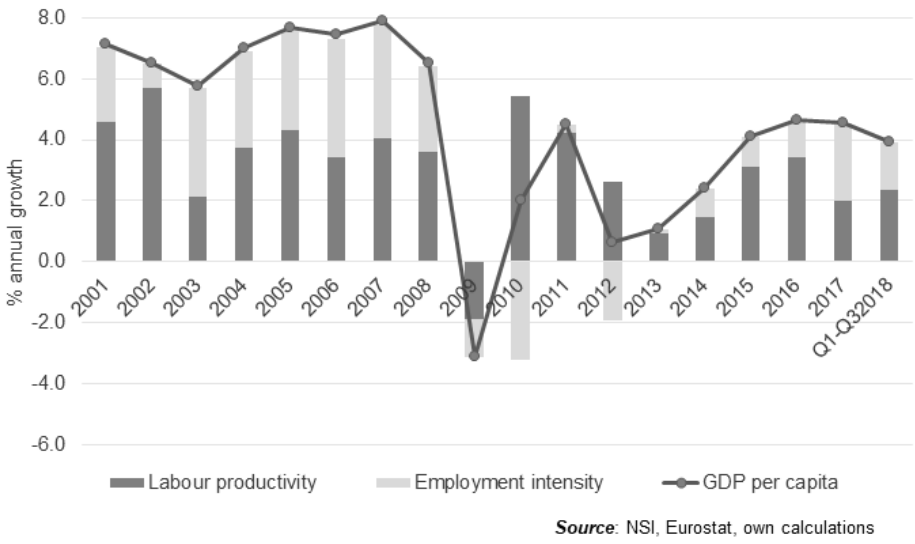
Breakdown of economic growth by labour productivity and extensive labour

In order to provide additional insights to the estimated employment elasticity of GDP and the results of the rolling regression, Figure 8 below presents a breakdown of the GDP per capita growth into labour productivity (GDP/employment) and extensive labour (employment/population) growth. It clearly illustrates the fact that before the 2008 global economic crisis economic growth in Bulgaria was more or less equally due to both labour productivity growth and increase of the employment and participation rates, i.e. increase in the quantity of the labour employed.

In the post-crisis period a clear tendency of a much higher contribution of labour productivity to economic growth is visually discernible. In the second half of 2017 there were signs that the employment intensiveness of the economic growth might recover, but these indications were not supported by the data for Q1-Q3 2018.

Figure 8

Breakdown of GDP per capita growth



Source: NSI, Eurostat, own calculations

Determinants of the employment intensiveness of growth

Informality

The shadow economy, its size and manifestations, is a natural starting point when investigating the factors that influence the employment elasticity of GDP, as it reflects also the extent to which the economic activity and employment are correctly measured.

The informal sector is commonly regarded as a buffer which facilitates the flexible adjustment of employment to changes in labour demand. Therefore, one could expect a threefold impact of a large informal sector of the employment elasticity of GDP:

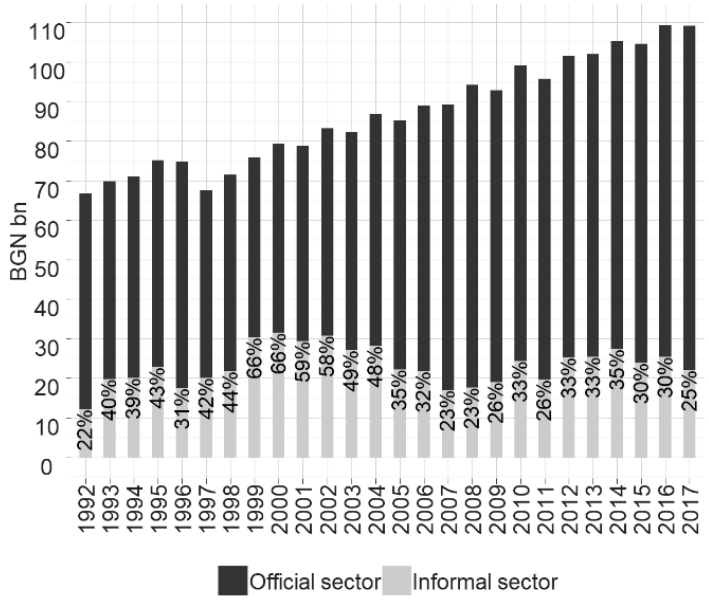
1. Higher shadow sector share increases the reactiveness of the formal employment to the official GDP, which means that the relationship between informality and the employment elasticity of GDP will be positive.
2. More spread informality in the economy would also imply that the relationship between GDP and employment would be less statistically significant, as neither of the indicators will take into account the development of the shadow sector.
3. The informal activities are concentrated in certain, typically labour-intensive economic sectors, implying a different relationship between output and employment at the sectoral level.

To estimate the size of the shadow sector in Bulgaria we apply Eilat and Zinnes (2002) approach. In particular, we regress the changes of final energy consumption against energy prices with one-year lag and the share of the industry (excluding construction) in the gross value added. All the changes in the energy consumption that are not due to either changes in energy prices, changes in the volume or structure of the GDP, are attributed to changes in the shadow economy. For reference value we take the estimate of the informal sector of 30.2% in 2016 in Bulgaria, provided by Schneider (2016).

Following this approach, we estimate that informal activities increased significantly during the economic and financial crisis of 1996-1997, reaching a peak in 2000, and subsequently gradually declined to below 20% in 2008. The 2008 global economic crisis has however again pushed the shadow activities on the rise, though they have lately subsided to an estimated level of 25.4% of the official GDP.

Figure 8

Informal economy size and share in official output



Taking into account that the informal activities tend to be mainly related to temporary employment[12], we can derive an estimate of shadow employment as well. In particular, we calculate it, based on the estimations of the shadow economy, taking into account the share of the compensation of employees by economic sectors and under the following assumptions:

[12] See for example Kyle et al. (2001), who establish such a finding, based on survey data.

- The informal activities are concentrated in the sectors with temporary employment. Under this assumption, the distribution of the shadow economy in Bulgaria in 2017 was[13]:

Agriculture	Manufacturing	Construction	Trade	Tourism	Other services
30%	10%	22%	10%	17%	11%

- The share of the compensation of employees in the gross value added is the same in the formal and unofficial sectors after correction for the employers' social contributions. This means that the production technology is the same, while the shadow sector employers gain additionally from unpaid social contributions.
- The net labour remuneration in the formal and informal sectors is the same. Otherwise, there would be shifts of labour between the sectors until the price of the labour is equalized.

Figure 9 depicts the share of informal output and employment in the officially reported GDP and jobs. It shows that shadow employment has been more volatile than the economic activities, where it was used. This is due to the fact that the economic sectors where informality is highest are predominantly labour intensive. Additionally, we note that there is some visual decoupling of the two indicators during the economic crises in the late 1990s and the one from 2009.

Based on this additionally obtained data on informal output and employment, we test the relationship between GDP and employment again in regression analysis. This time we find that, if we account for informality, employment becomes extremely responsive to changes in the economic activity, where the employment elasticity of economic growth stands at 1.37 and is highly significant. Contrary to our previous results, in this specification, we find that there is no lag in the response of employment to GDP and that the impacts of the previously identified subperiods are not statistically verified. Both conclusions correspond to our preliminary expectations that shadow employment is much more flexible and helps for the fast adjustment to economic activity and that in crises the previously observed decoupling between economic activity and employment are in fact due to informal job creation.

The results of the regression where the estimated informal activity and employment have been taken into account are presented in Table 5. The statistical properties of this model are much better as compared to the one, where informality is not accounted for (Table 2). However, it should be noted that, in order to tackle the problem of non-normality of the

[13] In our calculations, we assumed that although there is some temporary employment in the public services sectors, there are no informally hired people in these sectors, as they are much more strictly regulated.

residuals, we have excluded certain observations form this regression[14], which is acceptable in this case as the relationship is simultaneous and there is no autocorrelation.

Figure 9

Informal activity and employment shares in the respective official indicators

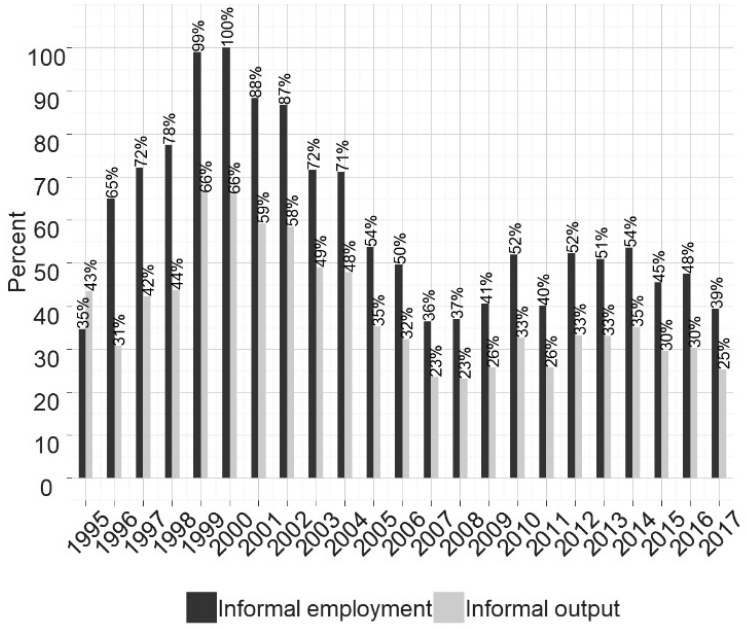


Table 5

Summary of regression results for the estimation of the employment elasticity of economic growth, taking into account informality in both economic activities and employment

Variables	Estimate	Standard error	t-statistic	p-value	
Intercept	-0.011928	0.001193	-9.996456	9.04e-15	***
GDP	1.371475	0.100701	13.619272	< 2e-16	***

Adjusted R^2:	0.7365	p-value of **F-statistic**:	< 2.2e-16
p-value of the Durbin-Watson test for serial correlation *(H0: No serial correlation)*	0.305	p-value of the Jarque-Bera test for normality of the residuals *(H0: normality of the residuals)*	0.5443
p-value of the Breusch-Pagan test for heteroscedasticity *(H0: Homoscedasticity)*	0.9561	p-value of the Breusch-Godfrey test for serial correlation of order up to 1 *(H0: No serial correlation)*	0.6802

*Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*

[14] We tested for multivariate outliers, applying Wilks (1963) approach in R. We identified multivariate outliers in the following quarters: 2009Q1, 2009Q2, 2009Q4 and 2010Q4.

Other determinants of the employment intensiveness of growth

Looking into the other drivers of the variability in the employment elasticity of GDP, we found rich literature linking lower use of labour in the value added to technological progress, but also structure of output by economic activities, labour supply and other various institutional and macroeconomic factors[15]. With respect to the former, we tried to account for the technological progress by adding a trend variable in the regression estimating the employment elasticity of GDP, but it did not prove to be statistically significant.

As data on the employment elasticity of GDP is available only for periods of 6 years (based on the rolling regressions, discussed above), the theoretical drivers of the employment elasticity of GDP are hardly subject to econometric estimation. Instead, we simply compare visually the obtained elasticities with indicator averages covering the same time period and compute some correlations between the obtained time series.

From visual inspection, we note that the employment intensiveness of economic growth follows quite closely the share of labour-intensive industries[16] in the gross value added (Figure 10). The increase in their share until the early 2000s is due to higher value added in public administration, construction and information and communication technologies (ICT). Meanwhile, output in professional, scientific, technical and support activities declined considerably. During the first years of the new millennium, the output generated in the public sector declined, while that of construction stabilized, so that ICT becomes the only driver of growth of the labor-intensive industries.

The second noticeable hump in the share of the labour-intensive sectors corresponds to the cyclical movements in the construction. They are supported also by the acceleration in the value-added produced in ICT and professional and scientific activities. However, the increase is moderated to some extent by the slight but steady decline in the output generated in public administration, education, health and defence.

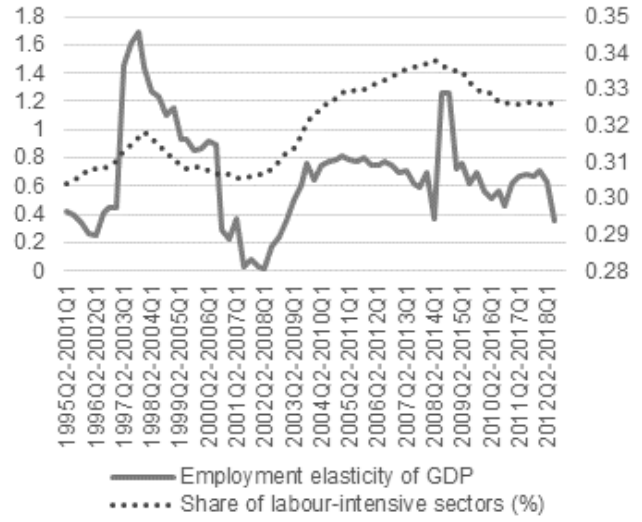
The supply of labour, measured by the size of the labour force (Figure 11), also exercises a significant impact on the labour intensiveness of economic activity. Labour force expanded until 2008, supported by high demand for labour and hiking wages. However, as a result of the economic crisis, the business sector implemented measures to optimize its operational efficiency and employment subsequently declined, which together with negative demographic developments took its toll on labour market participation as well.

[15] See, for example, Perugini (2009).

[16] The labour intensive sectors were identified by calculation of the share of the compensation of employees in the gross value added. They include Construction, Information and communication, Professional, scientific and technical activities; administrative and support service activities, Public administration, defense, education, human health and social work activities and Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies. Manufacturing is regarded as an aggregated sector, so that overall it is not considered to be labour intensive.

Figure 10

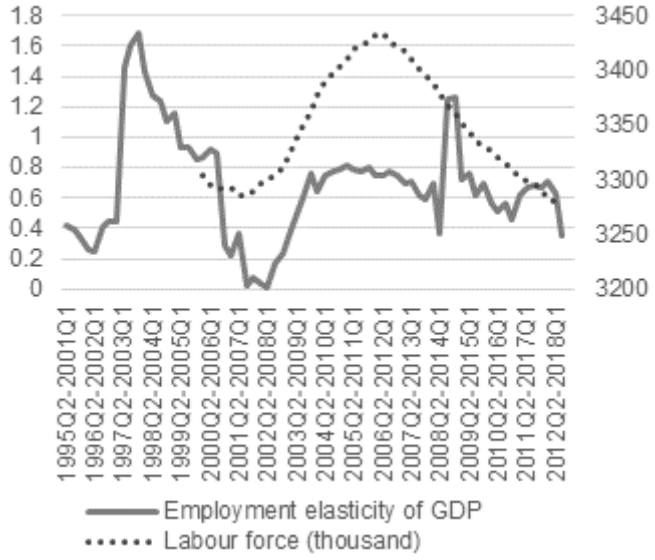
Labour elasticity of GDP and share of labour-intensive sectors in the value added



Source: Eurostat, own calculations

Figure 11

Labour elasticity of GDP and labour force



Source: Eurostat, own calculations

Labour costs, macroeconomic uncertainty and tradability of the goods and services produced are also generally estimated to have impact on the employment elasticity with

respect to GDP. However, these relationships are somewhat distorted in the case of Bulgaria. Below are some possible explanations.

With respect to labour costs (Figure 12), most studies[17] find a negative relationship with the employment elasticity of growth. This is justifiable given that when the labour becomes more expensive employers tend to look for ways to limit its contribution to output either by investing in new technologies or performing other optimizations. However, the share of labour in the GVA in Bulgaria has been low and still remains below EU average. Therefore, the observed positive relationship between employment elasticity of GDP and labour costs can be explained by taking into account that the observed increase in the labour costs in Bulgaria has been a result of the income convergence of Bulgaria with its EU partners and must have been compensated for by a decrease of the profit margins.

Figure 12

Labour elasticity of GDP and labour costs

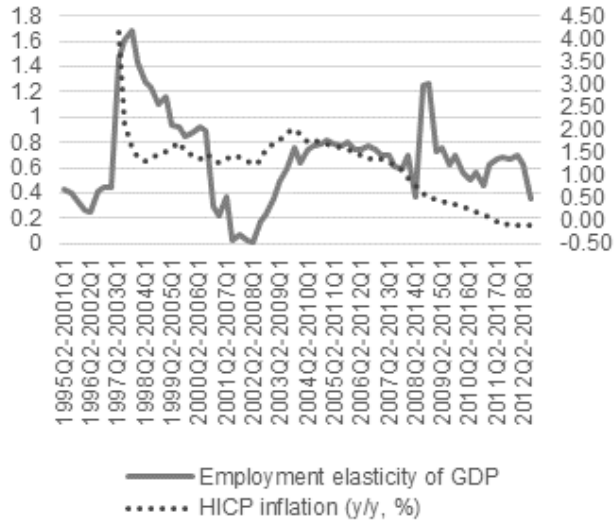
Source: Eurostat, own calculations

Inflation (Figure 13) is typically used as a measure of macroeconomic stability and is supposed to have a negative impact on the employment intensiveness of GDP. We can expect that as inflation (and therefore economy uncertainty) subsides, the employment intensiveness of GDP will be generally higher. However, empirically, we see that the relationship is actually positive. Maybe this is due to the fact that inflation has been low in the periods considered (below 4% on average even after the introduction of the Currency Board) and its dynamics was more or less determined by the phase of the business cycle and was not indicative of a lack of stability.

[17] See Dopke (2001) or Kapsos (2005), for instance.

Figure 13

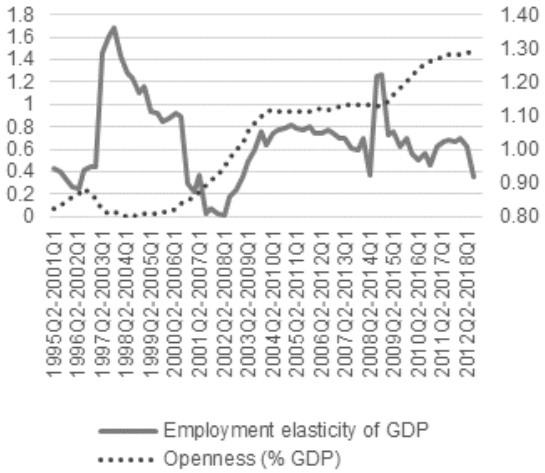
Labour elasticity of GDP and inflation



Source: NSI, Eurostat, own calculations

Figure 14

Labour elasticity of GDP and openness



Source: Eurostat, own calculations

Some authors [18] also claim that the employment elasticity varies depending on the tradability of the respective economic sector. We have tried to test this statement by

[18] See, for example, Dopke (2001) and Ait Ali, Ghazi and Msadfa (2017).

proxying tradability by the openness of the economy, calculated as the share of exports and imports in GDP (Figure 14). However, this variable also did not produce any significant link with the estimated employment intensiveness of growth. We think that this is also due to the significant reserves for internal restructuring of the output between labour costs and profit, while sustaining the competitiveness of the respective businesses.

Conclusion

In summary, we obtain an employment elasticity of GDP of 0.81 with a nine-month lag, which is somewhat higher but still comparable to other estimates of the GDP-employment relationship. Moreover, it is estimated to have been significantly lower during the two major crises experienced by the Bulgarian economy after the start of the transition – the 1996-1997 economic and financial crisis that lead to the introduction of the currency board and the downturn experienced after 2009 as a result of the global economic crisis. After 2014, the dynamics in the economic activity does not seem to be closely reflected in associated changes in the job creation.

The obtained regression model also allowed us to calculate the employment threshold in each of the four identified periods. We found that the GDP growth needed to start employing is around 0.60-0.75 percent, but it was expectedly much higher in the times of economic downturn.

An interesting observation can also be made, based on the results of the estimation of the elasticity of the total hours worked with respect to GDP. Contrary to our prior expectations, we discovered some inertia in the change in the hours worked, which is dependent on its past values and to a lesser extent is driven by fluctuations in the economic activity.

Testing the variability of the employment elasticity in time and the contribution of productivity and extensive employment growth to the increase in the GDP per capita, we confirmed the instability of this parameter in time and found that after the global economic crisis economic growth has been lower and attributed predominantly to labour productivity increases.

To explain the above observations, we briefly study the factors behind the dynamics in the employment elasticity of GDP. Informality stands out as a major cause for the change in the output-employment relationship during economic downturns. Our estimates show that if we take into account the non-registered sector, total employment adjusts to changes in total GDP much quicker and economic crises do not essentially change the relationship between the two indicators.

Without performing any rigorous analysis beyond correlation analysis, we also note that the sectoral composition of economic growth and labour supply tend to co-move with the employment elasticity of GDP. Meanwhile, we find that the sign and significance of the relationship with the labour costs, inflation and openness of the economy are distorted by the specifics of the development of the Bulgarian economy.

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