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Labour Taxation and its Effect on Employment Growth: Latest Estimations with Focus on the Czech Republic

*Lucie Kábelová – Ondřej Bayer**

Abstract:

The paper aims to assess effects of the tax wedge on the employment rate in the Czech Republic. To investigate the impact of the tax wedge on the employment growth, we used a one-equation cointegration model based on the Engle-Granger theorem on OECD data. The results are surprising, because of an unexpected positive relationship between endogenous and exogenous variables. The paper itself is divided into five main parts. The first part is an introduction to the topic and a review of the literature, the second part is on data, the third part is on the statistical methodology and the last two parts cover results and the final conclusion.

Key words: Personal income tax; Tax wedge; Employment growth.

JEL classification: J30, J38, H24.

1 Introduction

Labour taxation and its impact on the labour market has been a topic of several studies and discussions in recent years. The existing literature argues that high taxes reduce economic activity (Rosen, 2005) and that labour taxation has a negative effect on labour supply and labour demand, see, for example, (Nickell, 2003), (de Haan, et al., 2003), (OECD, 2006).

The topic of personal income taxation and tax burden on labour has been also very popular within the latest research. One way to measure the tax burden on labour is using the so-called tax wedge, which is also one of the indicators that OECD adopts. According to OECD, the tax wedge is calculated as a ratio between the amount of taxes paid by an employee and the corresponding total labour cost for the employer. (OECD, 2014). A similar definition can be found in existing literature as well, see, for example, (Dolenc, Vodopivec, 2005).

As stated by OECD, the total tax wedge in the Czech Republic was 42.8 per cent in 2017. This places the Czech Republic on the 8th place out of the 34 OECD countries. The average tax burden on labour is around 35.9 per cent in OECD.

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Recently, some of the OECD member countries started to reduce the (average) tax wedge, namely – Austria, Belgium, Canada, Denmark, Finland, France, Hungary, Ireland, Israel, the Netherlands, New Zealand, Portugal, Sweden, Turkey and the United Kingdom. All of these countries have reduced their tax wedge by more than 5 percentage points between 2000 and 2016. (OECD, 2017).

The size of the tax wedge can be considered as a key factor because it might affect (directly and indirectly) some other macroeconomic indicators. Often discussed is the impact of the size of the tax wedge on the level of employment and the willingness to work. Research shows that a higher level of taxation can reduce the willingness to work and employment. For example, (Baker, et al., 2005) concluded that raising the tax wedge brings down the real-income earnings of employees and thereby slowing down the real consumption. Other studies reported that lowering the labour rate as a production factor stimulates labour participation and increases employment. (Fiorito, Padrini, 2001).

One of the reviewed studies and completed by (Dobele, et al., 2014) discusses the different types of research done by other authors in the field of labour taxes and their effects on the labour market. Economic indicators affected by labour tax changes were aggregated as follows:

- rates of unemployment and employment, individuals' engagement (inactivity) in the labour market, number of hours worked, poverty and income inequality (Universita Bocconi, 2011),
- labour costs, net wages of employees, rates of unemployment and employment (Arpia, Carpone, 2004),
- number of hours worked, individuals' engagement in the labour market (Blundell (1995),
- rates of unemployment and employment, labour costs (Alesina, Perotti, 1994),
- labour costs (Padoa-Schioppa, 1992),
- unemployment rate (Planas, et al., 2007),
- unemployment rate, GDP (Daveri, Tabellini, 2000).

Some studies focused on the actual measurement of the impact of a change of the tax wedge on employment. Although the studies used different types of econometric models and were based on different panel datasets, a larger part of the studies shows a negative relationship between the tax wedge and employment.

Tab. 1 Effects of the tax wedge on the labour market

Researchers	Change of the tax wedge (TW)	Characteristics of effects
Nickell and Loyard (1999)	Decrease of TW by 5 p.p.	Decrease of unemployment by 13 p.p.
Daveri, Tabellini (2000)	Increase of TW by 10 p.p.	Decrease of labour input by 1-3 p.p.
World Bank (2005)	Increase of TW by 10 p.p.	Increase of unemployment by 4 p.p.
Bassanini, Duval (2006)	Decrease of TW by 10 p.p.	Decrease of unemployment by 2.8 p.p.
Dolenc, Laprošek (2010)	Increase of TW by 1 p.p.	Decrease of employment by 0.04 p.p.
Dolenc, Leprošek (2012)	Increase of TW by 1 p.p.	Decrease of employment by 1.7 p.p. (low-wage workers) Decrease of employment by 2.5 p.p. (high-wage workers)

Source: Reviewed studies and own processing.

Table 1 displays an overview of the selected reviewed studies. The results prove that an increase/decrease of the tax wedge has an impact on the employment/unemployment rate. In other words, the previous research shows that a decrease of the tax wedge might lead to an increase of employment, respectively a decrease of unemployment, and vice versa, an increase of the tax wedge might lead to a decrease of employment, respectively increase of unemployment.

The aim of this paper is to discuss the tax wedge as an indicator explaining the tax burden on labour and to analyse the impact of the tax wedge on the employment rate in the Czech Republic. To achieve the chosen goal, the Engle-Granger theorems were used in a single-cointegration model. The procedure was based on a simple static regression of selected parameters and stationary residual tests of static regression residues.

The rest of the paper is structured as follows. Sections 2 and 3 present data and the methodology. Section 4 discusses results and Section 5 concludes and gives some relevant recommendations.

2 Data

This analysis uses a tax wedge indicator based on the measures of OECD methodology. The tax wedge is calculated as a ratio between the amount of taxes paid by an employee and the corresponding total labour cost for the employer (Dolenc, Laprošek, 2012):

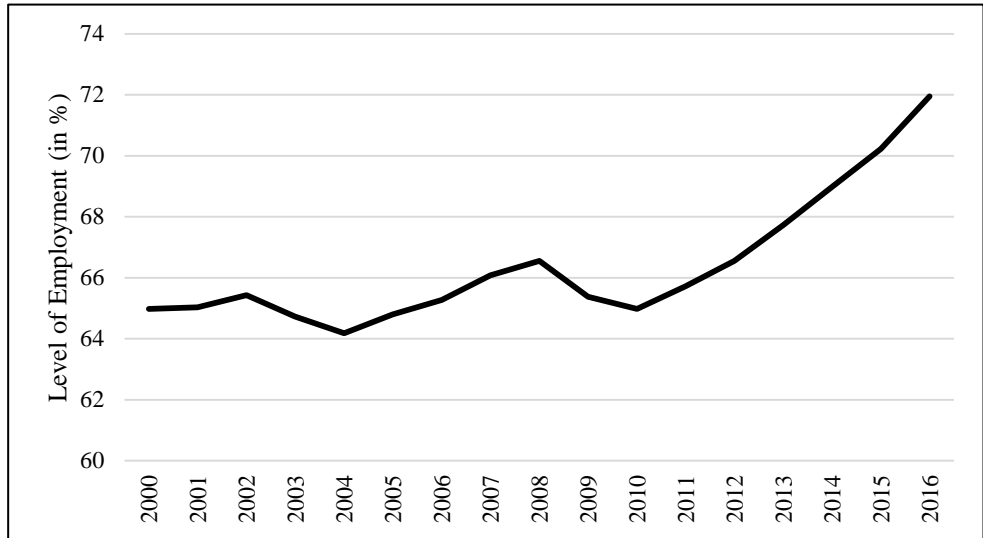
$$ATW = \frac{PIT+SSCe+SSCf+PT-CE}{w+PIT+SSCe+SSCf+PT}, \quad (1)$$

where ATW is the average tax wedge, PIT means personal income tax, SSCe stands for social security contributions paid by employees, SSCf represents social security contributions paid by employers, PT is used for payroll tax paid by employees, CB are cash benefits and w means the net wage.

OECD's current methodology constructs the tax wedge for eight types of taxpayers, defined as: single individual with no children and earnings at 67, 100 and 167 % of average earnings, single worker with two children receiving 67 % of average earnings, one-earner married couple with two children at 100 % of average earnings, two-earner married couple, one at 100 % of average earnings and the other at 33 % or 67 % (two children), two-earner married couple, one at 100 % of average earnings and the other at 33 % (no child).

For simplicity and clarity of the model, the three types of taxpayers (workers) were used in this analysis as an explanatory variable: single worker with no children and earnings at 67 % of average earnings (CZ_67), single worker with no children and earnings at 100 % of average earnings (CZ_100), single worker with no children and earnings at 167 % of average earnings (CZ_167).

As a dependent variable, the employment rate was used (CZ_ER). Figure 1 shows the rate of employment in the Czech Republic for years 2000 – 2016. Note the specific trend shifts in 2004, 2008 and 2010. These shifts could be a problem in terms of stationarity of this variable.

Fig. 1 The employment rate in the Czech Republic (2000 – 2016)

Source: OECD, own calculations.

As a controlling variable was adopted the unemployment rate (CZ_UR), because it is clear that employment and unemployment have a negative relationship.

3 Methodology

In order to reach the chosen goal, the Engle-Granger theorem was used in a one-equation cointegration model. PcGive statistical software was used to calculate the model. Methodology description is based on Arlt and Arltová (2009) and Bayer (2017).

The basic premise of the chosen method is the use of non-stationary original time series and testing their common order of integration and long-term relationship.

The procedure itself is based on designing a simple static regression of the selected variables and testing the static regression residue. The Engle-Granger theorem generally states that if residuals of a static regression are stationary, there is a long-term equilibrium relationship between the observed variables. The static regression analysis itself needs to be tested diagnostically in order to avoid bias due to the potential violation of the Gauss-Mark (GM) assumptions about the non-systematic component of the model.

3.1 Engle-Granger theorem

This procedure is based on the principle that non-stationary time series can be cointegrated if the residues of their static regression are stationary and the time

series have the same order of stationarity¹. Assuming that Y_t and X_t are $I(1)$, the cointegration of these series can be demonstrated if: $Z_t = \alpha X_t + \beta Y_t \sim I(0)$. The Engle-Granger theorem is based on the static regression:

$$Y_t = \beta_0 + \beta_1 X_t + \alpha_t \quad (2)$$

From this equation we find out whether there is a stationary series common for Y and X , since one can write:

$$\hat{\alpha}_t = Y_t - \hat{\beta}_0 + \hat{\beta}_1 X_t \quad (3)$$

Provided $\hat{\alpha}_t \sim I(0)$, then Y_t and X_t are cointegrated. This process, however, presupposes that the non-systematic component u_t has the character of white noise. Indeed, according to (Arlt and Arltová, 2009) one of three options may occur:

- α_t is white noise, i.e. $I(0)$,
- α_t is $I(0)$, but has a serial correlation, possibly exhibiting conditional heteroscedasticity, or
- α_t is $I(1)$.

In the first case, estimates of the static regression alone are interpretations of the long-term relationship of the monitored time series.

In the latter case, it is possible to eliminate the issue of autocorrelation and conditional heteroscedasticity by dynamising the model to the $ADL(p,q)$ model, which has the following general form:

$$Y_t = c + \sum_{i=1}^p \alpha_i Y_{t-i} + \sum_{j=1}^q \beta_j X_{t-j} + a_t \quad (4)$$

In the case of nonstationary residues, there is only a short-term relationship between the variables.

3.2 Test of stationarity

The first condition is a common order of integration of individual time series. For testing, the Augmented Dickey-Fuller test (ADF test) is used, which in this case takes the following form:

$$X_t = \phi_1 X_{t-1} + \sum_{i=1}^{p-1} (\gamma_i \Delta X_{t-i}) + a_t, \quad (5)$$

where t is the time index, ϕ_1 is the coefficient of a unit root, p is order of the AR process and a_t is the non-systematic component. The test hypothesis is as follows:

¹ This is a simplification, because it is possible to work with rows of a different order of integration, but in the chosen case $I(1)$ is sufficient.

$H_0: \phi_1 = 1$, against $H_1: \text{non } H_0$. The validity of the hypothesis is tested on the t-adf distribution².

The result of the stationary tests is as follows:

Tab. 2 t-adf values for chosen variables

	CZ_ER	CZ_100	CZ_67	CZ_167	CZ_UR
Basic data	2.141	-2.396	-1.571	-1.489	-0.847
1st diff data	-0.936	-4.664**	-3.966**	-3.024**	-2.369*

Source: Data OECD (2018), own calculation.

Table 2 shows that all the explanatory variables are I(1), though there is a problem with the explanatory variable that is not stationary after the first difference at the chosen significance level. Due to several structural breaks of the explanatory variable (see Figure 1) and the relatively small number of observations, it is evident that the ADF test is biased by the presence of significant structural breaks. The actual course of the development in employment shows that it is a series with the order of integration I(1) and therefore it will be further kept in the model.

3.3 Multicollinearity

Given the chosen solution with more explanatory variables, it is important to test the GM assumption about the full rank of the explanatory variable matrix so that the model is not distorted by interrelations of the explanatory variables. A correlation matrix of variables is sufficient for the testing (Table 3).

Tab. 3 Correlation matrix

	CZ_ER	CZ_100	CZ_67	CZ_167	CZ_UR
CZ_ER	1.000	-0.077	-0.374	-0.172	-0.774
CZ_100	-0.077	1.000	0.762	0.691	-0.042
CZ_67	-0.374	0.762	1.000	0.445	0.451
CZ_167	-0.172	0.691	0.445	1.000	-0.212
CZ_UR	-0.774	-0.042	0.451	-0.212	1.000

Source: Own calculations.

As stated in Table 3, the correlation coefficient reaches nowhere the critical level (+/- 0.8) and therefore it can be argued that the GM assumption is met.

² Statistical significance level is displayed by * convention, where * means 5% significance level and ** means 1% level of significance.

3.4 Autocorrelation

By violation of the GM assumption about residual independence conditions, autocorrelation of the non-systematic component of the model occurs. To test the presence of autocorrelation, the Breusch-Godfrey test can be used (called the AR test in the output of PcGive). In case of a linear regression:

$$Y_t = c + \beta_1 X_{1t} + \beta_2 X_{2t} + \dots + \beta_i X_{it} + a_t \quad (6)$$

The test is based on the assumption that the non-systematic component of a linear regression model can originate from $AR(p)$ and may take the form of:

$$a_t = \rho_1 a_{t-1} + \rho_2 a_{t-2} + \dots + \rho_p a_{t-p} + e_t \quad (7)$$

The estimated non-systematic component of the linear regression analysis model has the following form:

$$\hat{a}_t = c + \beta_1 X_{1t} + \beta_2 X_{2t} + \dots + \beta_i X_{it} + \rho_1 \hat{a}_{t-1} + \rho_2 \hat{a}_{t-2} + \dots + \rho_p \hat{a}_{t-p} + e_t \quad (8)$$

Using the standard index of determination R^2 it is possible to use the asymptotic approximation of χ^2 statistics, when $nR^2 \sim \chi_p^2$, where $n = T - p$, where T is the number of observation and p is the order of AR. The tested hypothesis is $H_0: \rho_1 = \rho_2 = \dots = \rho_p = 0$ against $H_1: \text{non}H_0$.

In the case of autocorrelation, the model can be expanded to ADL(p,q) or a suitable dummy variable can be used.

3.5 Heteroscedasticity

In the event of a disruption of the constant dispersion condition of the non-systematic component, heteroscedasticity occurs. The ARCH (AutoRegressive Conditional Heteroscedasticity) test is used for the testing. The test itself uses dynamic Quadratic Residue Testing in the following form:

$$\hat{a}_t^2 = c + \beta_1 \hat{a}_{t-1}^2 + \beta_2 \hat{a}_{t-2}^2 + \dots + \beta_q \hat{a}_{t-q}^2 + e_t \quad (9)$$

Using the asymptotic approximation $nR^2 \sim \chi_q^2$, where $n = T - p$, where T is the number of observation and p is the order of AR. The tested hypothesis is $H_0: \beta_0 = \beta_1 = \dots = \beta_p = 0$ against $H_1: \text{non}H_0$.

Similarly to the autocorrelation, the problem of heteroscedasticity can be eliminated by dynamisation or by possible inclusion of a dummy variable.

3.6 Normality

The final test of the GM assumption is testing normality of the non-systematic component. In general, it can be argued that with a large enough number of observations, the non-systematic component will have a normal distribution. However, in the case of a smaller number of observations, it is advisable to use the modified Jarque-Bera test (JB). The actual test is based on the testing of skewness

and kurtosis. The basic principle of the test is that the skewness of the normal distribution is equal to 0, and kurtosis of the distribution is 3. The derived test criterion takes the form:

$$JB = SK^2 + KU^2, \quad (10)$$

where the test of skewness is

$$SK = \left(\frac{T}{6}\right)^{\frac{1}{2}} \cdot \frac{\hat{m}_3}{\hat{m}_2^{3/2}} \quad (11)$$

For kurtosis testing:

$$KU = \left(\frac{T}{24}\right)^{\frac{1}{2}} \cdot \left(\frac{\hat{m}_4}{\hat{m}_2^2} - 3\right), \quad (12)$$

where $\hat{m}_i = \frac{\sum_{t=1}^T (\hat{u}_t - \bar{u})^i}{T}$ for $i = 2, 3, 4 \dots$

The zero hypothesis assumes a normal distribution of the non-systematic component. In case of the zero hypothesis's validity, the normality and obliquity normalised the normal $N(0,1)$ distribution. For hypothesis testing, we adopted the JB $\chi^2(2)$ statistic (Arlt and Arltová, 2009).

4 Results and Discussion

Once all the tests have been defined, it is possible to switch to the overall employment model in the Czech Republic and its dependency on the development of the tax wedge and the unemployment rate. The unemployment rate is used here as a control variable, while it is logical that overall employment and the unemployment rate have a negative relationship.

Static regression is:

Tab. 4 Static regression model for CZ_ER

	Coefficient	Std.Error	t-value	t-prob	Part.R ²
Constant	85.6181	22.7600	3.7600	0.0027	0.5412
CZ_100	1.7410	0.7089	2.4600	0.0303	0.3345
CZ_167	-1.8215	0.5324	-3.4200	0.0051	0.4938
CZ_UR	-1.6162	0.1917	-8.4300	0.0000	0.8556
D2008	-3.5434	1.1430	-3.1000	0.0092	0.4446
sigma	0.9251	RSS	10.2700		
R ²	0.8611	F(4,12)	18.6000	[0.000]**	
Adj.R ²	0.8148				

Source: Own calculations.

As Table 4 shows, the variables used did not produce a statistically significant tax wedge for the poorest, while the other variables are statistically significant – the dummy variable for 2008 (D2008) was used to offset the structural breaks of variables and to offset the main changes in the tax system (in 2008, the progressive taxation was changed to a linear taxation). The control variable shows that the model is logically correct.

The model residues are stationary and hence the long-term relationship between the variables is documented in the following Table 5:

Tab. 5 ADF residual test

D-lag	t-adf	beta Y_1	sigma	t-DY_lag	t-prob	AIC	F-prob
0	-2.812**	0.3716	0.7133			-0.6152	

Source: Own calculation.

Finally, the GM assumptions of the model must be tested using diagnostic tests – the output of the PcGive statistical software is as follows (Table 6):

Tab. 6 Diagnosis control

AR	test:	F(2,10)	1.0743	[0.3779]
ARCH	test:	F(1,15)	0.9758	[0.3389]
Normality	test:	Chi^2(2)	0.2766	[0.8708]
Hetero	test:	F(6,9)	1.1432	[0.4111]

Source: Own calculation.

Diagnosis shows that all the GM assumptions are met and the model can, therefore, be overridden directly by the static regression and the deducted coefficients are long-term multipliers (Table 6). The model has the following form:

$$\widehat{CZER}_t = 85.6181 + 1.741CZ100_t - 1.8215CZ167_t - 1.6162CZUR_t - 3.5434D2008_t \quad (13)$$

The results are quite surprising. According to the reviewed sources and literature (see Introduction), the tax wedge should be negatively correlated with the employment rate. In this case, there is one variable (single worker with no children and earnings at 100 % of average earnings) positively correlated and the other variable (single worker with no children and earnings at 167 % of average earnings) negatively correlated (the control variable proves that the logic behind the model is correct).

The reason why the taxpayer with average wage has a positive correlation might be due to the fact that the level of taxpayer's taxation is not enough to change his or her willingness to work. The average worker with 167 % of average wage is, in

observatory years, negatively correlated because of his or her mobility. In other words, these workers are able to change their jobs more often and possibly work abroad. Workers with 67 % of average wage are not statistically significant in this model, mainly because tax deductions almost cover the personal income tax. The dummy variable covers the complete tax reform in 2008, when the Czech Republic switched from the progressive taxation to a linear tax rate. If both tax variables are added up (there is assumption that both variables have the same weight), it is obvious that the tax wedge has a negative effect on employment. Overall, findings of the paper confirm that the reduction of the labour taxation might have a significant effect on the demand for labour and employment. According to the findings and recommendation of other studies (e.g. Dolenc, Laprošek, 2010) that the EU should continue with the trend of reducing the tax wedge, we recommend the same for the Czech Republic.

5 Conclusion

This paper analyses effects of the tax wedge on the employment rate in the Czech Republic. For that, the Engle-Granger theorems were used in a single-equation cointegration model. The findings indicate surprising results for one tax wedge, which is positively correlated with the employment rate. This phenomenon is based on the Czech system of tax deductions and the tax rate. Assuming the same weight of different tax wedges, the results are similar to those described in the literature. This paper is our first step into the research of a relationship between employment and tax wedges; further research will be focused on international comparison.

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