



Two Approaches to Cyclical Adjustment of Fiscal Balances: The Case of Czechia

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Abstract

This paper focuses on estimation of cyclically adjusted balance in Czechia with emphasis on period from 2010 onwards. The estimation is performed using two common approaches: Standard approach, known as OECD approach, uses the business cycle (output gap) as the relevant indicator of the cyclical position for each tax category. Alternative approach, known as ESCB approach, uses various macroeconomic variables and their respective cycles as relevant indicator for the cyclical adjustment. Therefore, each tax category is linked to the cycle of its own macroeconomic variable. In Czechia, the two approaches lead to different results which indicate the relevance of what the output gap is driven by and how the business cycle is reflected in wages, household consumption and profits. Given the tax system of Czechia, the cycle of wages and consumption is of particular importance. If the business cycle is driven by ups and downs of firms' profits, the standard approach overestimates its impact on fiscal revenues. Conversely, if the economic growth or downturn is driven by wages and consumption, the standard approach underestimates its impact on fiscal revenues. In many years the cyclically adjusted balance estimated by alternative approach varies from standard approach between 0.2% to 0.5% GDP.

Keywords: Fiscal policy, cyclical adjustment, tax revenues, fiscal balance

JEL Classification: E32, E62, H20, H61, H62

1. Introduction and Motivation

Tax revenues and thus the general government budget balance is sensitive to the business cycle (Bornhorst *et al.*, 2011). Measuring the impact of the cycle on fiscal stance requires cyclical adjustment. The cyclically adjusted balance (CAB) indicates how the overall balance would turn up if the balance was not affected by the cycle via higher or lower tax

revenues. Moreover, the cyclical adjustment of the budget balance is the first step in obtaining an estimate of the structural balance¹ which has become a key fiscal indicator, mainly for two reasons: First, the Act No. 23/2017 Coll., on Fiscal Responsibility Rules has introduced a numerical fiscal rule into the Czech budgetary process. It established the minimum value of structural balance (–1% of GDP) of the general government. Second, the year-on-year change in the structural balance is called “fiscal effort” indicating the size of fiscal restriction or expansion. For these reasons, it is an essential indicator for economic policy.

However, the problem remains as CAB (and the size of the cyclical component) cannot be measured directly and it must be estimated. The estimates are sensitive to the chosen approach and methods. There are two common approaches to cyclical adjustment: The standard approach relies on the business cycle, while the alternative approach does not. Instead, it relates certain tax bases (wages, consumption, ...) to their own cycle. The estimation of CAB for the purposes of fiscal rules carried out in Czechia are based on the standard approach.

Table 1: Disparities between both approaches in CAB estimation by Czech Ministry of Finance

	Standard Approach	Alternative approach
Elasticities estimation	Error correction model	First difference model
Gaps estimation	Output gap via Cobb–Douglas production function	Tax bases gaps via Hodrick–Prescott filter
Tax bases	Wages, capital and self-employed income (PIT)	Wages in private sector (PIT)
	Gross operating surplus (CIT)	Net operating surplus (CIT)
	Wages and salaries in total economy (SSC)	Wages and salaries in private sector (SSC)

Source: Lang, Mareš (2015)

Estimation based on alternative approach is published annually only in Fiscal Outlook² for the comparison of results. However, the different results may not stem from different approaches, but from distinct method of obtaining elasticities, gaps and various selection of tax bases. The aim of this paper is to estimate CAB of Czechia using the two approaches,

1 Structural balance is defined as cyclically adjusted balance adjusted for one-off revenues and expenditures.

2 Publication of Czech Ministry of Finance published annually in November

while applying a consistent method for estimating elasticities and obtaining the gaps. Additionally, the same selected tax bases will be used for both approaches. This harmonization means that any differences in CAB estimates will be attributable solely to the choice of approach which will enable comparison and evaluation of both approaches.

2. State of Art

First step of cyclical adjustment is identifying tax categories which may contain cyclical component. In the literature (*e.g.* Van den Noord 2000; Girouard and André 2005) four main tax categories are identified: Personal income tax (PIT), Corporate income tax (CIT), Social security contributions (SSC) and Indirect taxes (IT). Each tax category has its own macroeconomic variable which is strongly connected to it and hence serves as proxy tax base: PIT and SSC typically depend on wages and salaries; CIT depends on operating surplus and IT depends mostly on the consumption of households. These macro bases are found in the literature on the topic of cyclical adjustment (*e.g.* Bouthevillain *et al.* 2001; Price *et al.* 2014).

There are two main approaches to cyclical adjustment:

- a) Standard approach – also called “OECD” approach
- b) Alternative approach – also called “ESCB” approach

The OECD approach to cyclical adjustment relies on the output gap, defined as the deviation of actual GDP from its potential level, as the central indicator of the business cycle. It assumes that fluctuations in GDP adequately capture the cyclical behaviour of the various macroeconomic bases of tax revenues (such as wages, consumption, or corporate profits). In this approach, all tax categories are adjusted using a common cyclical indicator, *i.e.* output gap. In contrast, the ESCB approach adopts a disaggregated methodology. Instead of adjusting all tax revenues according to the overall output gap, it aligns the cyclical adjustment of each tax category with the fluctuations of its own specific macroeconomic base. For example, PIT would be adjusted based on the cycle of wages, while IT would be adjusted in relation to the consumption cycle, and CIT in line with the profit cycle. This method recognizes that the underlying tax bases may not move in sync with GDP, either in timing (phase) or amplitude. The key difference, therefore, lies in the treatment of the cyclical indicator: OECD approach uses a single and aggregate measure (the output gap), while the ESCB approach uses multiple, tax-specific, cyclical indicators. As a result, the two methods can lead to different estimates of the cyclical components of budget balance, especially when the macroeconomic tax bases diverge from GDP. However, if all macroeconomic bases were to move one-to-one with GDP, both approaches would converge to the same result.

2.1 The Standard Approach

Elasticities

This approach was explained and performed in Girouard and André (2005) and Price *et al.* (2014). The basis of this approach to cyclical adjustment is obtaining the relationship between each tax category and the business cycle (elasticity ε). The process of estimating the elasticity (ε) consists of two steps: The first step is to estimate a sensitivity of a given tax category revenue to its macroeconomic base (ε_b). The second step is to estimate the sensitivity of macroeconomic base to the output gap (ε_o). The sensitivity ε_o captures how responsive the base is to changes in the business cycle. For instance, if $\varepsilon_o = 1.4$ for CIT, this implies that a 1% increase in the output gap leads to a 1.4% increase in corporate profits. Multiplying those two elasticities result in estimate of the elasticity for a given tax category with respect to the output gap (ε).

Table 2: Elasticities of four main tax categories for standard cyclical adjustment in Czechia estimated by OECD

	Tax-to-base elasticity (ε_b)	Base-to-output elasticity (ε_o)	Tax-to-output elasticity (ε)
Girouard and André (2005)			
PIT <i>wages and salaries</i>	1.70	0.70	1.19
CIT <i>gross operating surplus</i>	1.00	1.40	1.40
SSC <i>wages and salaries</i>	1.10	0.70	0.80
IT <i>private consumption</i>	1.00	1.00	1.00
Price et al. (2014)			
PIT <i>wages and salaries, self-employment income, capital income</i>	2.33	0.74	1.65
CIT <i>gross operating surplus</i>	1.23	1.45	1.78
SSC <i>wages and salaries</i>	0.99	0.87	0.86
IT <i>private consumption</i>	1.00	1.00	1.00

Note: Elasticities in bold are used by MFCR for the cyclical adjustment.

Source: Girouard and André (2005) and Price *et al.* (2014)

The tax-to-base elasticities (ε_b) can be estimated either econometrically, or from tax code data. Price *et al.* (2014) used tax rules and income distribution data to estimate (ε_b) for PIT and SSC and estimated (ε_b) for CIT and IT as this allows for greater cyclical revenue sensitivity.³ They estimated elasticity (ε_b) based on error correction model (ECM). ECM was chosen to capture the lagged effects of macro bases (M) development to tax category revenues (T) and for more accurate identification of short-run elasticities (ε_b^{ST}) and long-run elasticities (ε_b^{LT}) as adjusting parameter λ , which describes how much of the deviation from long-term trend in $t - 1$ is corrected in time t , is included.

$$\Delta \ln T_t = c + \varepsilon_b^{ST} \Delta M_t + \lambda(\ln T_{t-1} - \varepsilon_b^{LT} \ln M_{t-1}) + \xi \quad (1)$$

where ξ is an error.

Short-term and long-term base-to-output elasticities (ε_o^{ST} and ε_o^{LT}) were also estimated econometrically.

$$\Delta \ln M_t = c + \varepsilon_o^{ST} \Delta \ln Y_t + \lambda(\Delta \ln M_{t-1} - \varepsilon_o^{LT} \ln Y_{t-1}) + \xi \quad (2)$$

As tax-to-base elasticities (ε_b) not only the short-term elasticities (ε_b^{ST}) were used since they will be gradually adjusting towards the long-term elasticities (ε_b^{LT}). Price *et al.* (2014) suggest using a two-year average (or three-year average) of the short-term elasticity in year t and the implicit lagged elasticity in year $t - 1$, which tracks sensitivity better than the short-term elasticity (ε_b^{ST}). For the base-to-output elasticities (ε_o) the elasticity (ε_o^{ST}) from equation 2 was used.

The cyclically adjusted tax category (T^*) is then calculated as:

$$T^* = T (Y^* / Y)^{\varepsilon_b \varepsilon_o} \quad (3)$$

where Y^* means a potential output and Y is a real output.

The gap

Fundamental step in the process of cyclical adjustment using the standard approach is to determine the potential output. There are two main methods for estimating potential output: purely statistical estimation using statistical filters (*e.g.* Hodrick–Prescott or Baxter–King filter) or production function method (*e.g.* Cobb–Douglas production function). The production function method is used for the estimation of potential output by all relevant institutions

3 Nevertheless, for indirect taxes the assumption of unit elasticity remained for the robustness issues affecting the estimates.

as it is advanced method using economic background and assumptions. The European Commission production function is described in Havik *et al.* (2014). The MFCR is using its own Cobb–Douglas production function to determine the output gap described in MFCR (2024a).

2.2 The Alternative Approach

While the cyclical adjustment using standard approach assumes all cycles to be closely synchronized with the business cycle, the alternative approach does not. Langenus (1998), Momigliano and Staderini (1999) show that when the different macroeconomic bases determining government revenues are at different phase of the cycle or they show different magnitudes of fluctuations, it may be consequential for cyclical adjustment in some countries.

Elasticities

This method is explained and performed in Bouthevillain *et al.* (2001).

Econometric estimation of tax-to-base elasticities entails regressing annual data for observed revenues (of each tax category T) against a measure of relevant economic activity (selected macroeconomic base M). Two specifications of estimation were selected. First:

$$\Delta \ln T_t = c + \delta_t + \beta_1 \Delta \ln M_t + A_t + \xi_t \quad (4)$$

where δ_t is a change in trend, A_t is discretionary fiscal policy measures / idiosyncratic features of the economy; the estimation of elasticity (β_1) is based on percentage changes and it produces an elasticity which reflects the response of the tax revenue to 1% change in relevant economic activity. This specification assumes no long-run equilibrium relationship and estimates only short-run elasticity. The second alternative equation for estimating elasticities uses time lagged variables in an ECM:

$$\Delta \ln T_t = c + \beta_1 \Delta \ln M_t + \lambda (\ln T_{t-1} - \beta_2 \ln M_{t-1} + \delta_t) + A_t + \xi_t \quad (5)$$

ECM adds an error correction term (adjusting parameter λ), which captures deviations from long-run equilibrium. This allows to estimate more accurate short-term elasticity (β_1) since long-term elasticity (β_2) and adjusting parameter λ is also obtained. Bouthevillain *et al.* (2001) identify the same four broad revenue categories to be dependent upon the cycle. For each of the selected tax category a relevant macroeconomic base is identified (see table 3). Elasticities for Czechia are estimated by Lang, Mareš (2015) which has been publishing the estimates of the cyclical component of the budget balance using the ESCB approach in the Fiscal Outlook for comparison with OECD approach.

Table 3: Elasticities of four main tax categories in Czechia for alternative approach estimated by MFCR (Lang, Mareš, 2015)

	Tax-to-base elasticity (β_i)
Lang, Mareš (2015)	
PIT <i>wages and salaries in the private sector</i>	1.00
CIT <i>net operating surplus</i>	1.02
SSC <i>wages and salaries in the private sector</i>	0.49
IT <i>private consumption</i>	1.00

Source: Lang, Mareš (2015)

Lang, Mareš (2015) used a method based on first-difference model (equation 4) and not error correction model (equation 5). Also, the different macro bases were used by MFCR than in Price *et al.* (2014), for instance, wages and salaries in the private sector only. This is the reason why tax-to-base elasticity of SSC is very distinct from Price (*et al.* 2014). Moreover, elasticity for PIT and IT came out statistically insignificant and MFCR adopted unit elasticity.

The gaps

For detrending the macroeconomic bases (M) to obtain their potential levels (M^*) and thus “the gaps”, Bouthevillain *et al.* (2001) and Lang, Mareš (2015) use the Hodrick–Prescott filter with $\lambda = 30$. The value of $\lambda = 30$ lies between the values advocated by the statistical literature.⁴ Cyclically adjusted tax category (T^*) is subsequently calculated as:

$$T^* = T (M^*/M)^{\beta_1} \quad (6)$$

4 Backus and Kehoe (1992) or Giorno *et al.* (1995) prefer to use $\lambda = 100$ for annual data. Ravn and Uhlig (2001) suggest λ value of 6 to 8 for annual data (as it corresponds to $\lambda = 1,600$ for quarterly data). Kaiser and Maravall (1999) also proposed value of 8 for λ as it corresponds to preferred critical length of 8 years.

3. Model and data

As the relevant literature, this paper also considers 4 tax revenue categories as cyclically sensitive: Personal income tax (PIT), Corporate income tax (CIT), Social security contributions (SSC) and Indirect taxes (IT). As far as the macroeconomic variables are concerned, compensation of employees, operating surplus and mixed income and final consumption expenditure of households were selected to serve as tax bases. Although these variables are not ideal tax bases, they are sufficient (see adj. R^2 of the models in Annex). It must be remembered that the aim of the paper is not to provide the most accurate cyclical adjustment possible but rather evaluate the differences emerging from both approaches.

Both, tax revenues and macroeconomic variables data come from Czech Statistical Office Database of National Accounts in ESA 2010 methodology. For PIT only *Tax on wages and salaries* and *Tax of unincorporated individuals* are included as *Tax on interest and dividend* is not as it accounts only for small part of the revenue. Also, it is not considered to be influenced by the cycle⁵ nor by compensation of employees. Indirect taxes for the purposes of this paper consist of *Value Added Tax* and certain *Excise duties and consumption taxes*. Detailed list can be found in Annex. Social Security Contributions in ESA 2010 methodology include *non-employed health insurance contributions paid by government* which were obviously excluded for the purposes of this paper.

For elasticities estimation, the tax revenues time series were adjusted for changes in rates, for changes in tax credits and for other government measures influencing revenues. These effects were quantified either according to explanatory memorandums (*e.g.* SSC) or percentage adjustment took place when the statutory tax rate changed (*e.g.* CIT). As described below, potential values of all macroeconomic bases were estimated by Baxter–King filter. Macroeconomic variables had to be used in constant prices and for the conversion from current to constant prices GDP deflators from AMECO database were used.

Cyclical adjustment of fiscal balance is performed for the period of 1999–2020 with the focus on 2010 onwards. Time series of all macroeconomic variables for estimating their potential values are from 1994–2023 as the longer time series provide better results. For elasticities estimation, period of 2001–2019⁶ for tax revenues of PIT and SSC is used and period of 2001–2022 for CIT and IT is used.

⁵ See Wolswijk (2007).

⁶ In 2020 and 2021 many measures by government were placed affecting tax statistics (waiver of SSC paid by certain employers, tax refund called Compensation Bonus, change of tax base for PIT, change of tax credits, ...).

3.1 Elasticities

Tax-to-base elasticities will be estimated by method used by Wolswijk (2007). This method allows to distinguish between short-term and long-term elasticities. Not distinguishing between short-term and long-term elasticities contributes to inaccurate estimations of the cyclically adjusted balance as the relationship between tax category (T) and macroeconomic base (M) is not captured correctly. This is because the responsiveness of tax revenues to changes in their macroeconomic bases differs over time: short-run elasticities capture immediate, often incomplete reactions, while long-run elasticities reflect the full adjustment. The distinction between long-run elasticities and short-run elasticities is, according to Wolswijk (2007), the correct approach assuming the levels of tax categories and macroeconomic bases are cointegrated and their differences are stationary.

Therefore, unit root tests were conducted in the time series of each tax category and macroeconomic base. The time series of all variables contain a unit root and are integrated of order $I(1)$. This was proved by the Dickey–Fuller unit root test (Dickey and Fuller, 1979) at the 5% significance level (see Annex). Although the time series are non-stationary, their joint movement over time was confirmed in all models using the cointegration test which was tested by the Granger test (Engle and Granger, 1987) based on the stationarity of the residuals and the results are presented along with other diagnostic tests (Engle, 1982; Breusch and Godfrey, 1986; Jarque and Bera, 1980) in Annex.

Long-term tax-to-base elasticities (β_1) will be estimated by following equation:

$$\ln T_t = c + \beta_1 \ln M_t + \gamma_t \quad (7)$$

where c is a constant and γ_t means an error.

Although time series of the tax category and the relevant macroeconomic base should reach equilibrium in the long run and their relationship can be expressed by this long-term elasticity (β_1), both variables may deviate from each other in the short-run which is crucial for cyclical adjustment. The short-term elasticity can exceed the long-term elasticity or fall behind. A model with first differences that stationarizes the time series of both variables was used to estimate the short-run tax-to-base elasticities (β_2). At the same time, the correction term γ_t from equation (7) was added to the model in form of lagged variable (γ_{t-1}). The error-correction model (ECM) is thus used to detect short-run fluctuations between those variables and to derive the short-run tax-to-base elasticities (β_2):

$$\Delta \ln T_t = c + \beta_2 \Delta \ln M_t + \gamma_{t-1} + \xi \quad (8)$$

The correction term γ_{t-1} describes the difference between the actual revenue of a given tax category and the expected revenue (the long-run equilibrium value). Parameter λ can be seen as an adjustment parameter that indicates the percentage of the previous year's deviation by which the current year is adjusted.

For standard approach, not only tax-to-base elasticities but also base-to-output elasticities are needed. Method of Wolswijk (2007) is not possible to be used here as autocorrelation would be present in long-run model since the bases are literally components of the output. Although autocorrelation would not affect the consistency of the estimated elasticities, it does affect the ability to perform valid statistical diagnostic tests (see Annex). Hence, this paper follows the method of Price *et al.* (2014) to estimate base-to-output elasticities:

$$\Delta \ln M_t = c + \delta_1 \Delta \ln Y_t + \lambda (\ln M_{t-1} - \delta_2 \ln Y_{t-1}) + \xi \quad (9)$$

As we can see in equation (9), the model is specified in first difference form and the δ_1 is interpreted as short-run base-to-output elasticity (essential for cyclical adjustment). Again, the ECM specification allows the estimation of short-run elasticities δ_1 and parameter λ , which describes how much of the past deviation from long run trend in past year is corrected in current year. The lags are controlled to obtain the best estimate of short-term elasticity δ_1 possible.

3.2 Position of the economy in the cycle

The standard approach requires estimating output gap while the alternative approach requires estimating gaps of relevant macroeconomic variables (wages, consumption, profits). To do so, Baxter–King filter will be used with minimum and maximum period for oscillation set to 2 and 8. Parameter k which specifies lead-lag length of the filter was set to value of three⁷. Why was the Baxter–King filter with these parameters selected? When applied to GVA⁸, it gives rather the same estimates of output gap as the Cobb–Douglas production function used by the MFCR (2024) for cyclical adjusting (see Figure 1).

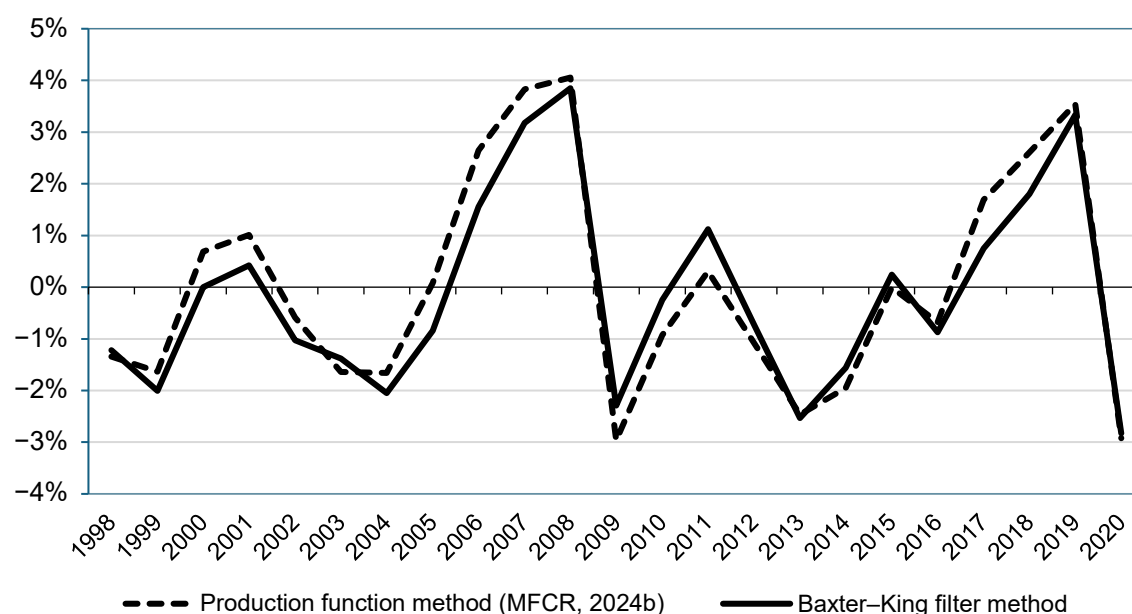
That is why Baxter–King filter was applied for estimating the gaps of the other bases as well. Although it is not a perfect method, the same shortcomings will be maintained

⁷ All values are suggested by Baxter and King (1999) for annual data and U.S. business cycle.

⁸ This paper follows the practice of MFCR, and the business cycle is not assessed by GDP (gross domestic product) but by GVA (gross value added). The real GDP is affected by irregularities in revenues of indirect taxes which can distort the actual path of the business cycle. Therefore, for the purposes of output gap estimations, real GDP has been replaced by real GVA, which excludes indirect taxes.

in both approaches and difference in CAB will be given only by the approach taken, not by the method of estimating the gaps.

Figure 1: Output gap of Czechia (1998–2020)



Source: MFCR (2024b) and author's own calculations

The alternative approach obviously requires selecting macroeconomic base for each cycle sensitive tax category to derive its cycle. Three macroeconomic variables are chosen to serve as such base: *Compensation of employees (D.1)* for PIT and SSC, *final consumption expenditure of households (P.31)* for IT and *operating surplus and mixed income (B.2n+B.3n)* for CIT. Typically, *operating surplus* is used as macroeconomic base for CIT. But it should be remembered operating surplus is not an independently estimated variable in National Accounts. *Operating surplus and mixed income* is calculated as balancing item (residual) between value added estimated by the output approach and the other income approach components (*compensation of employees* and *net taxes on production and imports*). Since the compensation of employees (part of GDP that goes to employees) is used as a base for PIT and SSC, then the whole residual (other part of GDP) was selected to serve as tax base for CIT.

The potential levels of all three macroeconomic variables for alternative approach will be estimated in the same way as the output gap for standard approach. Thus, the Baxter–King filter will be applied to those four variables in constant prices. The gap (representing the cycle) is calculated as:

$$gap = \frac{M - M^*}{M^*} \quad (10)$$

$$gap = \frac{Y - Y^*}{Y^*} \quad (11)$$

where M stands for compensation of employees, operating surplus and mixed income, household consumption, Y stands for gross value added.

3.3 Cyclical adjustment

After obtaining elasticities and potential values of macroeconomic variables, the cyclical adjustment process can take place in both approaches:

Alternative approach

Applying just short-term elasticity for the purposes of cyclical adjustment may remove more of the cycle than desirable. Tax-to-base elasticity (β) which is used in the process of adjusting is therefore average of short-term elasticity β_2 and long-term elasticity β_1 ⁹:

Each of the four tax category revenues will be cyclically adjusted according to the equation:

$$T^* = T (M^*/M)^\beta \quad (12)$$

Then cyclically adjusted balance in each year can be computed as the difference between cyclically adjusted revenues (CAR) and cyclically adjusted expenditures (CAe):

$$CAB = CAR - CAe \quad (13)$$

but because expenditure side of the budget is not being cyclically adjusted, then cyclically adjusted expenditures equal to total expenditures (TE):

$$CAe = TE \quad (14)$$

Cyclically adjusted revenues are the sum of cyclically adjusted four tax revenue categories plus the rest of the revenues (u) which are not being cyclically adjusted as it is assumed they are non-cyclical:

9 For detailed explanation see Mourre *et al.* (2014) and Price *et al.* (2014). β is computed as the three-year average of the short-term elasticity β_1 (in time t) and the implicit lagged elasticity (in time $t - 1$).

$$CAr = \sum T^* + u \quad (15)$$

Obviously, the revenues denoted by (u) are total revenues minus the sum of revenues of four tax categories which are the subject of cyclical adjusting:

$$u = TR - \sum T \quad (16)$$

Standard approach

In the process of cyclical adjustment, the elasticity (α) will be used. The elasticity (α) is a result of multiplying tax-to-base elasticity (β) and base-to-output elasticity (δ_1). Each of the four tax category revenues will be cyclically adjusted according to the equation:

$$T^* = T (Y^*/Y)^\alpha \quad (17)$$

Following procedure of adjusting the balance is the same as in alternative approach (equations 12–17).

4. Results and interpretation

4.1 Elasticities (results)

First step in the process of cyclical adjustment was to estimate the elasticities between tax categories and macroeconomic bases and between macroeconomic bases and output. Statistically significant elasticities: (i) Confirm relationship between the variables pointing to appropriately selected tax bases and (ii) Elasticities also quantify the sensitivity between the tax and macroeconomic variables. Table 4 and 5 provide estimates of those elasticities for both approaches. Detailed results of all models including statistical tests of all regressions can be found in Annex. This section only presents the results.

Personal income tax

Due to the reform in 2008, model with dummy was used to estimate tax-to-base elasticity. This was done to get the most accurate results possible as the 2008 reform changed not only the tax base but also the statutory rates. The model contained dummy variable for 2001–2007 = 1. Elasticity in alternative approach (1.35) is higher than the elasticity in standard approach (1.21) since the sensitivity of compensation of employees to output gap is below one.

Corporate income tax

This is the most sensitive tax category. Elasticity for alternative approach (1.44) is lower than the elasticity used for standard approach (1.97) as the sensitivity of operating surplus and mixed income to output gap is the highest among the three macroeconomic variables and above 1. Interestingly, when CIT is regressed against operating surplus only, valid statistic tests cannot be performed although the elasticity estimates are very similar. When operating surplus and mixed income is used in the models, elasticities hold basically the same and valid statistic tests are performed.

Social security contributions

This tax category holds typically the lowest elasticity values. The results confirm this, and the social security contributions show the elasticity below one for both approaches. The reason behind low elasticity is mainly cap on social contributions.

Indirect Taxes

Indirect taxes consist of VAT and selected consumption taxes and excise duties (see Annex for detailed list). Statistically significant relationship between this tax category and final consumption expenditure of households could not be found which is a common phenomenon in the literature and unit tax-to-base elasticity was adopted. That is not the case of base-to-output elasticity of household consumption. This elasticity holds below 1 which means that household consumption is not as volatile meaning that for alternative approach elasticity of 1 is used (tax-to-base) but for the standard approach elasticity of less than 1 is used due to the lower sensitivity of macroeconomic base to output gap.

Table 4: Tax elasticities estimated for the alternative approach

	Short-term elasticity (β_2)	Long-term elasticity (β_1)	Elasticity (β)
Personal Income Tax <i>compensation of employees</i>	1.29***	1.41***	1.35
Corporate Income Tax <i>net operating surplus and mixed income</i>	1.34***	1.55***	1.44
Social Security Contributions <i>compensation of employees</i>	0.88***	1.01***	0.95
Indirect Taxes <i>final consumption expenditure of households</i>	[1.00]	[1.00]	1.00

Note: *** denotes p -value < 0,001.

Source: Author's own calculations

Elasticities (β) capture sensitivity of tax category to its macroeconomic base considering short-term and long-term relationships. Elasticities in brackets have been found to be statistically insignificant and unit elasticity was adopted

See Annex for detailed results of the models including diagnostic tests

Table 5: Tax elasticities estimated for the standard approach

	Elasticity (β)	Base-to-output elasticity (δ_1)	Elasticity (α)
Personal Income Tax <i>compensation of employees</i>	1.35	0.90***	1.21
Corporate Income Tax <i>net operating surplus and mixed income</i>	1.44	1.36***	1.97
Social Security Contributions <i>compensation of employees</i>	0.95	0.90***	0.85
Indirect Taxes <i>final consumption expenditure of households</i>	1.00	0.77***	0.77

Note: *** denotes p -value < 0,001.

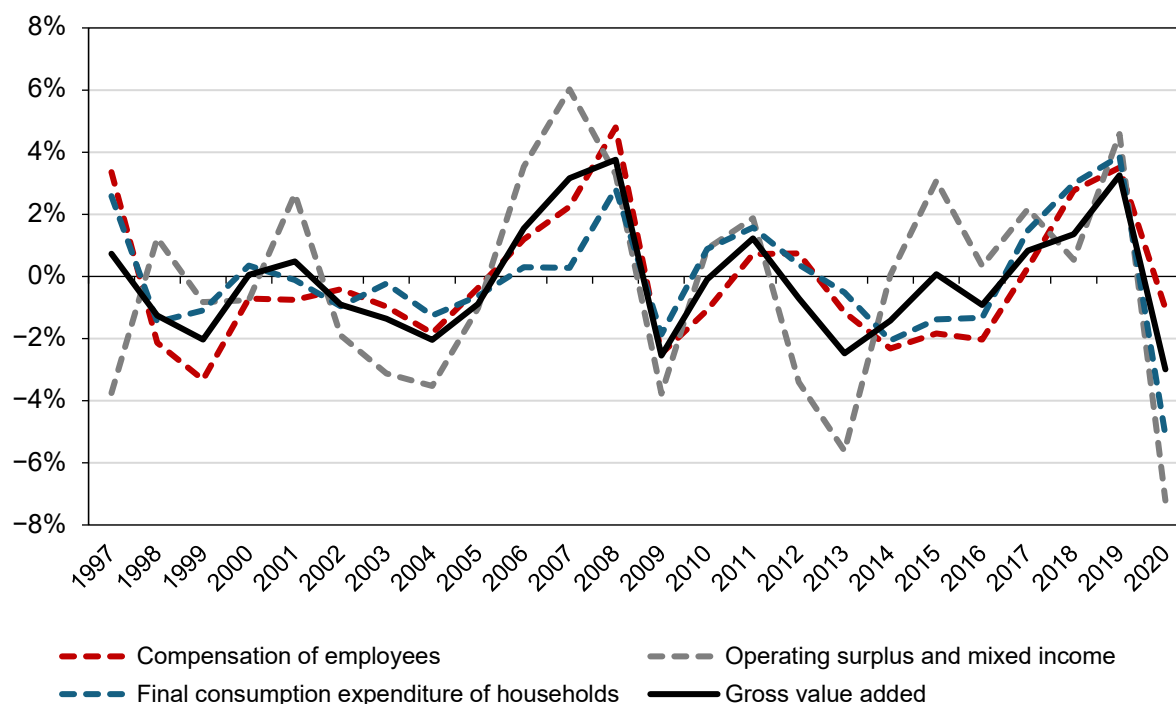
Source: Author's own calculations

Elasticities (α) capture sensitivity of tax category to output gap considering relationship between tax category and its macroeconomic base (β) and relationship between macroeconomic base and output gap (δ_1).

See Annex for detailed results of the models including diagnostic tests.

4.2 Position of the economy in the cycle (results)

As mentioned in Section 3, the Baxter–King filter was used for estimating the cycles of all four macroeconomic variables. The data from 1994–2023 were used which means cycles for 1997–2020 have been estimated given the BK filter was used with lead-lag length of 3. Cycles of all macroeconomic bases which will be crucial for the results of cyclically adjusted balance are shown in Figure 2.

Figure 2: “Gaps” of all macroeconomic variables (in % of GDP, 1997–2020)

Source: Author's own calculations

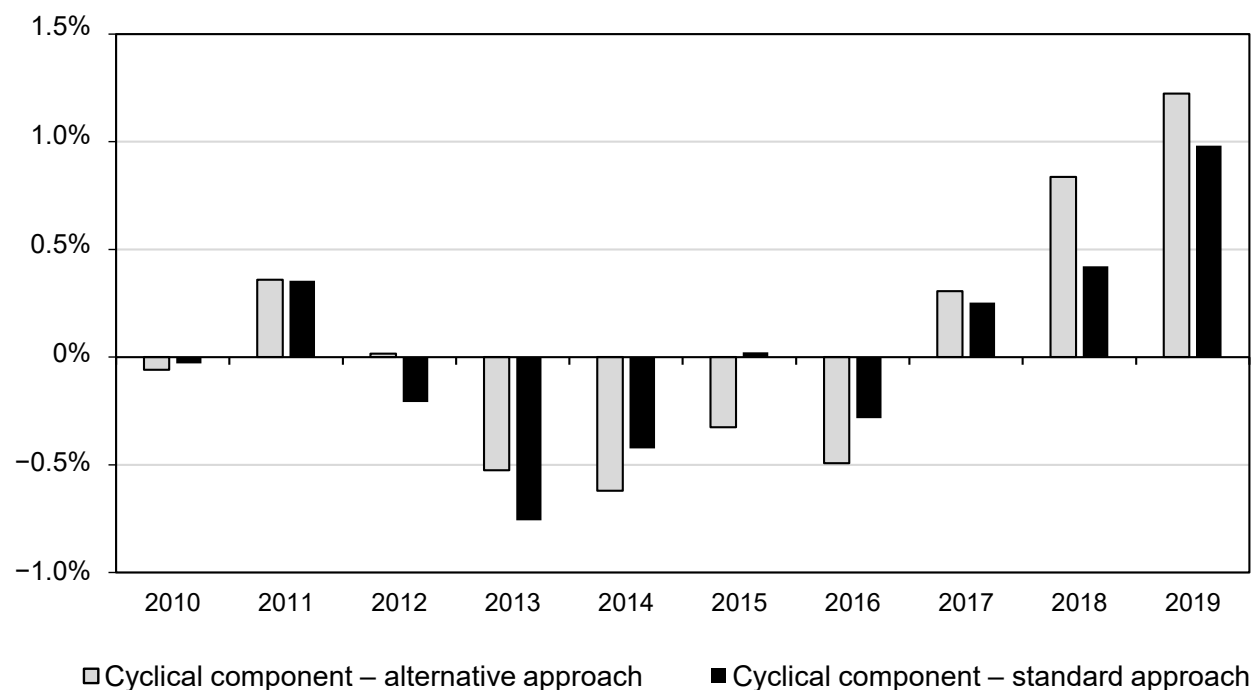
General conclusion is that there are not significant shifts in the cycles of macroeconomic variables. During GDP booms, all bases (profits, wages and consumption) tend to rise. During busts all bases tend to fall. One exemption can be seen in 2014 and 2015; wages and consumption experienced strongly negative gap while profits found themselves in positive gap. However, there is a clear difference in the amplitude of booms and busts between all macroeconomic variables throughout time series.

4.3 Cyclical adjustment (results)

Does this play a role for cyclical adjustment of fiscal balance using two different approaches? It seems so. Fundamental issue for the standard approach is whether the GDP is growing (falling). When the economy is growing (falling), the cyclical component tends to be large. When economy is not growing (falling), the cyclical component tends to be small. Standard approach is indifferent to what the driver of the output gap is. It does not matter whether boom or bust is being pulled by wages, profits or consumption. But the GDP as such is not a subject of taxation. The individual components that make up GDP (wages, profits, consumption...) are. If the boom is driven by profits and investment, the standard approach overstates the importance of positive gap for the fiscal revenues. Conversely, if GDP falls

because of profits and investment, this approach overestimates the impact of the downturn for the fiscal revenues.

Figure 3: Cyclical component of fiscal balance 2010–2019 (in % of GDP)



Source: Author's own calculations

Positive or negative cycles of macroeconomic bases also tend to be translated into increase in the share of GDP (see Figure 4 and 5). When wages and salaries increase their share on GDP, then it increases the implicit effective tax rate in the economy. On average, the implicit effective tax rate of PIT and SSC is 36.5% while the implicit effective tax rate of CIT is 12.6%.¹⁰ If the implicit effective tax rates on consumption, profits and wages were the same, then the changes of wages and profits ratios to GDP would not play a role. Since this is not the case in Czechia, the standard and alternative approaches lead to different results. Put simply, the fiscal balance in Czechia is sensitive mainly to how wages and household consumption change their ratios to GDP. As figure 3 shows, the cyclical component of fiscal balance estimated by alternative approach is distinct from standard approach between 2010–2019.

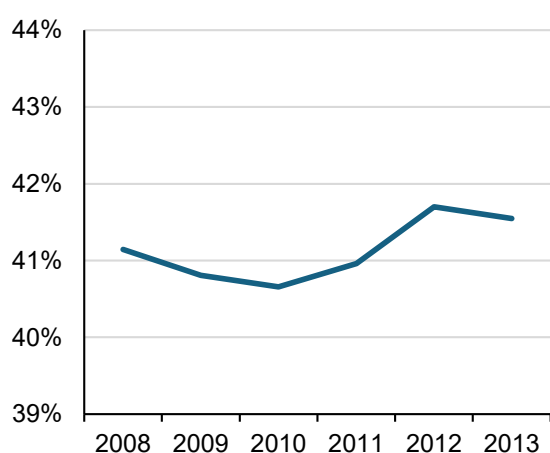
¹⁰ Implicit effective tax rate is computed as the tax category revenue in% of GDP divided by its macroeconomic variable in% of GDP (the average of 2001–2019).

2012–2013 recession

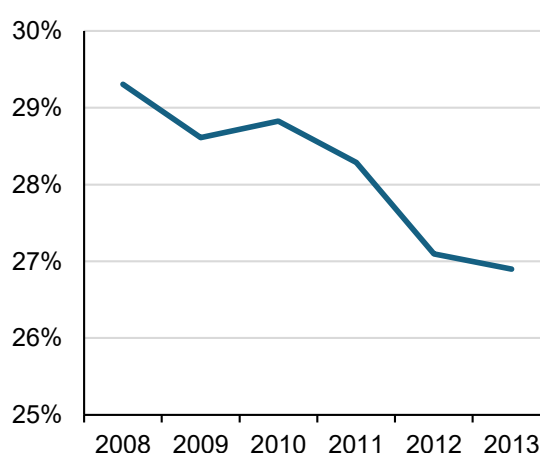
After 2009 bust, the real GDP bounced back and grew in 2010 and 2011 (2.6% and 1.8% y-o-y). But in Czechia a phenomenon called “W recession” appeared as the economy contracted again in both 2012 and 2013 (−0.7% and −0.1% y-o-y).

Figure 4: Individual macroeconomic variables share of GDP 2008–2013 (in % of GDP)

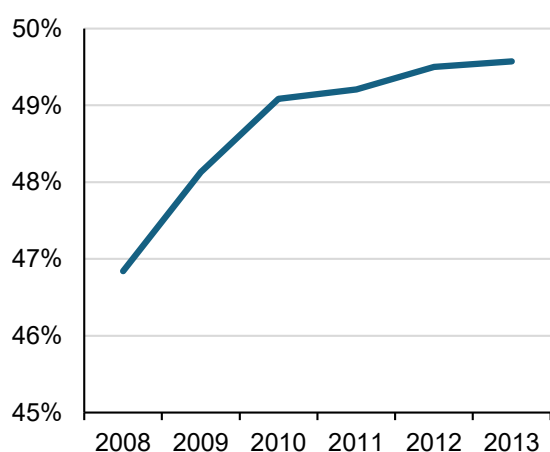
a) Compensation of employees (D.1)



b) Operating surplus and mixed income (B.2n+B.3n)



c) Final consumption expenditure of households (P.31)

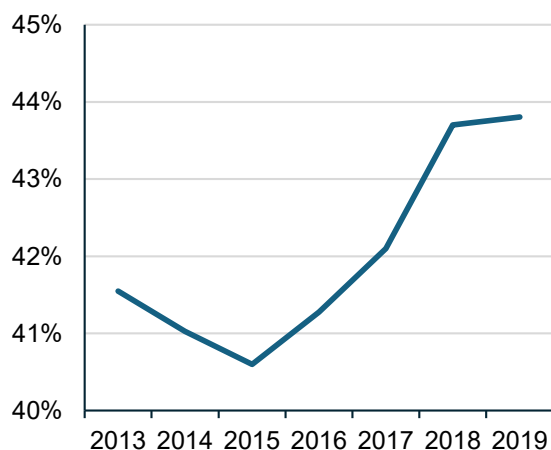
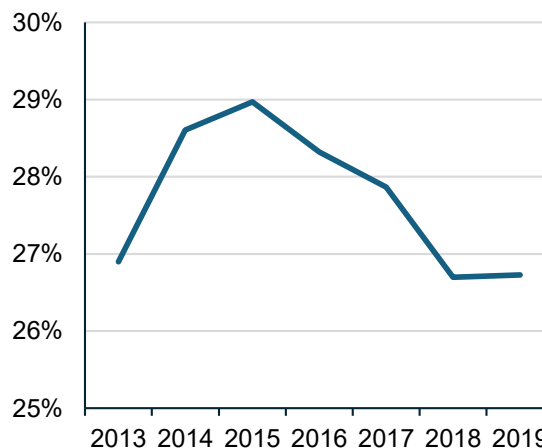


Source: CZSO (2024) and author's own calculations

As the Figure 2 shows, the negative output gap in 2013 reached the same bottom as in 2009 and the main cause was extremely negative gap of firms' profits. It should be noted that wages and household consumption also found themselves in negative gap, but not as deep as the output gap and profits' gap. Thus, the standard approach shows larger cyclical component in both 2012 and 2013 than the alternative approach. As mentioned above, standard approach might overestimate the effect of negative output gap to tax revenues as it was mainly pulled down by contraction of firms' profits. The period of 2012–2013 recession shows that for alternative approach it is not as important that GDP fell, but rather how the structure of GDP changed. Although GDP shrunk in both years, the ratio of household consumption to GDP increased as well as wages and salaries ratio to GDP increased. The ratio of profits to GDP fell substantially (Figure 4). Even though GDP as such shrunk, larger share of GDP was taxed at a higher effective tax rate. The alternative approach signals that the cyclical component was not as negative as the standard approach shows. The cyclically adjusted balance using alternative approach was 0.3% GDP worse in 2012–2013 than using standard approach.

2014–2016 recovery

During 2014–2016 the Czech economy experienced recovery resulting in economic growth of 2.2%, 5.0% and 2.5% y-o-y. As the Figure 3 shows, the alternative approach results in worse cyclical component suggesting that economic growth did not contribute as positively to fiscal balance as standard approach suggests. Again, for alternative approach it does not matter much whether GDP has grown or not, but rather what the key driver of the growth was and if and how the ratios of tax bases to GDP moved. During this recovery only the operating surplus and mixed income was in positive gap, wages and household consumption were in negative gap (Figure 2). Also, the ratio of wages and salaries to GDP fell while profits to GDP ratio increased (Figure 5). This is why the alternative approach results in a worse cyclical component than the standard approach. The cyclically adjusted balance using ESCB approach was 0.3% better in 2014–2016 than the standard approach shows.

Figure 5: Wages and profits share of GDP 2013–2019 (in % of GDP)**a) Compensation of employees (D.1)****b) Operating surplus and mixed income (B.2n+B.3n)**

Source: CZSO (2024) and author's own calculations

2017–2019 boom

The economic boom and positive gap in 2017–2019 were mainly driven by the positive wage gap and positive household consumption gap (Figure 2). Although the output gap was positive (2.3%) and operating surplus gap was also positive (2.6%), the wage gap (3.1%) and consumption gap (3.4%) exceeded them significantly. Put simply, economy was driven by the tax bases which are effectively taxed more, and standard approach underestimate this effect on the cyclical component of fiscal balance. This is why the alternative approach shows a higher cyclical component and thus worse cyclically adjusted balance than the standard approach in 2017–2019 (Figure 3). Moreover, those years saw an unprecedented increase in wages and salaries to GDP at the expense of operating surplus ratio to GDP (Figure 5). In 2015 compensation of employees accounted for 40.6% GDP and in 2019 they reached 43.8% GDP. The operating surplus and mixed income decreased during those years from 50.1% of GDP to 47.1% of GDP. As the 3% of GDP was gradually taxed by higher effective tax rate, it created “cyclical” (additional or windfall) fiscal revenues.

The results of CAB in Czechia using both approaches are presented in Table 6. Differences between both approaches are quite significant in couple of years. Results suggest it might be important which components are pulling up or down GDP due to different size of taxation being imposed on each of the component. If we exaggerate a little bit, alternative approach is indifferent whether the output is growing or not, but the changes in the structure of the output

are crucial. The key issue for alternative approach results is how the ratios of consumption, wages and profits to GDP change and what the economy / output is driven by.

Table 6: Cyclically adjusted balance of Czechia using both approaches 1999–2020 (% GDP)

	Alternative approach	Standard approach		Alternative approach	Standard approach
1999	–2.4	–2.5	2010	–4.1	–4.1
2000	–3.4	–3.6	2011	–3.0	–3.0
2001	–5.7	–5.9	2012	–3.9	–3.7
2002	–6.1	–6.0	2013	–0.8	–0.5
2003	–6.4	–6.4	2014	–1.4	–1.6
2004	–1.7	–1.7	2015	–0.3	–0.7
2005	–2.8	–2.7	2016	1.2	1.0
2006	–2.6	–2.6	2017	1.2	1.2
2007	–1.4	–1.6	2018	0.0	0.5
2008	–3.2	–3.1	2019	–0.9	–0.7
2009	–4.6	–4.7	2020	–4.6	–4.7

Note: Results in bold indicate years where the difference between both approaches is $\geq 0.2\%$ GDP.

Source: Author's own calculations

If the potential growth does not change and the economy stays flat from year to year (output gap stays the same), the cyclical component of fiscal balance will stay the same as well using the standard approach. But using the alternative approach, the cyclical component of the fiscal balance can change significantly. Even though output gap does not change, the ratios of consumption, wages and profits to GDP can change which translates into tax revenues captured by the model as “cyclical component”. Most of tax revenues in Czechia are determined by wages and consumption since tax burden is put on them first and foremost. If the economy doesn't grow but the ratio between wages and profits to GDP changes, it leads to a better fiscal outcome since in Czechia wages are taxed more than profits.

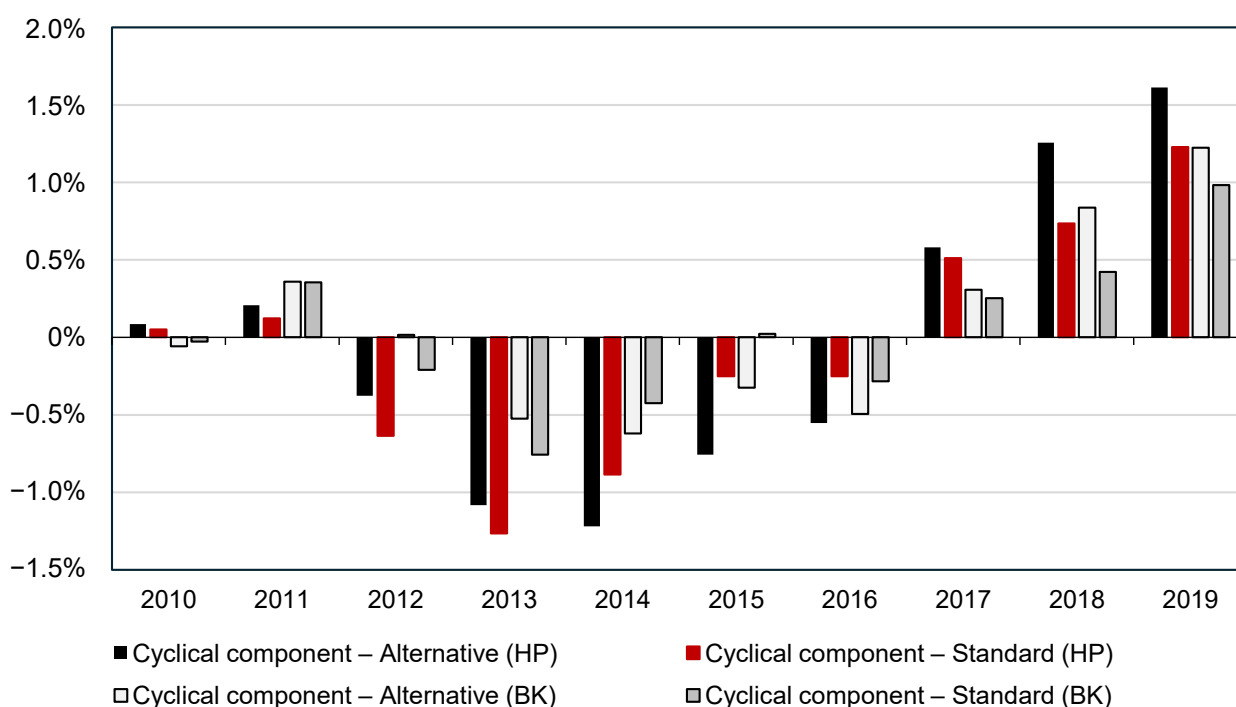
5. Discussion and limitations

Cyclical adjustment aims to identify “structural” government revenues by removing the effects of temporary economic fluctuations. Typically, those are captured by the business cycle (standard approach). But is the business cycle enough? This paper argues it is not as it seems crucial to consider how different tax bases behave over the cycle. The alternative approach addresses this by relying on the individual cycles of key macroeconomic variables such as wages, consumption, and corporate profits which better reflect the actual tax structure. But that is easier said than done. Important limitation of this approach lies in estimation the cyclical position of individual macroeconomic variables. While this allows for better alignment with the tax structure, it significantly increases the complexity of the estimation process. As Blanchard and Leigh (2013) point out, forecasting the output gap in real time is already challenging and subject to frequent revisions. Forecasting other macro variables and their gaps estimation is even more uncertain than overall output, especially in small open economies where these variables are influenced by external shocks, structural breaks, and policy changes. This introduces additional layers of estimation error and reduces the robustness of real-time structural balance assessments, which are often required for timely fiscal decisions. Policymakers should therefore weigh the improved theoretical precision of disaggregated methods against the practical challenges of applying them under time constraints and with incomplete data.

Also, the aim of this paper was not to estimate CAB perfectly, but rather to find out the difference between two approaches to cyclical adjustment. That is why a few things have been neglected. The paper does not focus on capturing the best possible link between macro bases and taxes. Namely, for PIT we should not consider only the wages of employees, but also self-employment income and capital income (Price *et al.*, 2014). This paper also focuses solely on revenue-side adjustment. While unemployment benefits are typically considered cyclical, in Czechia they represent one of the lowest shares of government spending in the EU and are negligible for adjustment purposes (Mourre *et al.*, 2019).

Possible objection regarding the results can arise from the choice of statistical filter due to its specifics. That is why all the gaps were also estimated by using Hodrick–Prescott filter with $\lambda = 30$ as Bouthevillain *et al.* (2001) recommend. However, the most important results of the paper hang on as Figure 6 shows. During the years (2014–2019) in which alternative approach results in higher cyclical component, the same results were obtained using HP filter. During the years (2012–2013) in which alternative approach results in lower cyclical component, the same results were once again obtained using HP filter. The main conclusion of the paper about the difference between both approaches is therefore rather robust.

Figure 6: Cyclical component of fiscal balance using Hodrick–Prescott and Baxter–King filter 2010–2019 (in % of GDP)



Source: Author's own calculations

6. Conclusion

This paper shows that the choice of cyclical adjustment methodology has a measurable impact on estimates of the structural fiscal balance in Czechia. The differences between standard (OECD) and alternative (ESCB) approach stem primarily from how each method conceptualizes the relationship between the business cycle and government revenues. It was confirmed that not only a business cycle plays a role for the cyclical adjustment but also the nature of the cycle has an impact. While the standard approach focuses primarily on overall GDP performance and the size of the aggregate output gap, the alternative approach shifts attention to the specific drivers of the cycle, particularly how wages, profits, and consumption behave, and adjusts each tax base according to its own cyclical pattern without any influence of overall output gap. This approach thereby captures more nuanced cyclical effects. It is important to realise GDP is not a subject to taxation in any country. The individual components that make up GDP (wages, profits, consumption, ...) are. Since these variables are taxed differently in each country, it might be essential which variable

drives the business cycle. It might not be sufficient to focus only on the economic growth as such, since the structure of the growth is also relevant for cyclical adjustment of fiscal balance. That is why alternative approach focuses on the underlying drivers of the cycle by tracking the performance of key tax bases such as wages, profits, and consumption.

In a converging economy like Czechia, where the tax system leans heavily on wages and consumption, this distinction proves crucial. When economic fluctuations are driven more by profits than wages or consumption, the standard approach tends to overestimate the cyclical component of revenues. Conversely, in wage or consumption led cycles, it underestimates it. This results in a divergence of up to 0.5% of GDP in the estimated structural balance which is a non-trivial amount for fiscal planning and compliance with fiscal rules.

This difference in standard (aggregated) and alternative (disaggregated) methodology leads to divergent results of structural balance in years where the business cycle is not broad-based. For instance, in 2017–2019, the positive output gap was primarily driven by wage and consumption growth, while the profit share declined. Given the heavy reliance on wage taxation, the alternative approach estimated a stronger cyclical component and hence a worse structural balance, by as much as 0.5% of GDP in 2018. Conversely, in 2012–2013, the recession was led by a fall in corporate profits, while wages and consumption remained relatively stable. Therefore, the alternative approach estimated a weaker cyclical component and a worse structural balance, differing by up to 0.3% of GDP from standard approach. These findings underscore that the structural balance is a sensitive variable shaped by both macroeconomic fluctuations and the internal composition of tax bases.

This has important implications for fiscal policy. In Czechia, structural balance targets are legally binding under Act No. 23/2017 Coll. Misestimating the structural balance due to inadequate adjustment for the type of economic cycle could lead to misguided fiscal tightening or excessive leeway. These findings have important implications for fiscal policy and economic governance. Structural balance estimates influence not only domestic budgetary decisions but also assessments of compliance with EU fiscal frameworks. Overestimating fiscal effort could lead to unjustified austerity, while underestimating it may risk fiscal slippage. Therefore, policymakers should consider refining their adjustment methods to reflect the structure of the economy and tax system more accurately. Specifically, Czech fiscal authorities may benefit from incorporating disaggregated adjustments for official fiscal assessments. More targeted monitoring of the cycles of wages, profits and consumption would improve the credibility and accuracy of structural balance estimates. Ultimately, acknowledging the heterogeneity of tax bases and their macroeconomic drivers enhances both the analytical foundation and the operational relevance of fiscal policy.

Acknowledgement

Funding: The paper was prepared as one of the outputs of a research project of the Faculty of Finance and Accounting at the University of Economics and Business “Challenges for Public Finances During a Polycrisis” registered by the Internal Grant Agency of University of Economics and Business under the registration number F1/4/2025.

Conflicts of interest: The author hereby declares that this article was neither submitted nor published elsewhere.

AI usage statement: The author confirms that no artificial intelligence (AI) or AI-assisted tools were used in the creation of this manuscript.

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Annexes

Annex I

This is the list of excise duties which alongside with D_211 Value added tax form the category of *Indirect taxes* for the purpose of this paper. Not all taxes which belong to D_214A and D_2122C are considered. The exclusion concerns Energy tax on electricity, Energy tax on natural gas, Energy tax on solid fuels, Sugar levies, Solar fee and Tax on renewable energy. They are either considered as non-cyclical or the revenue is negligible.

Table I.A: Selected components of excise duties and consumption taxes (D.214A and D.2122C)

D_214A + D_2122C	Excise duties and consumption taxes
C01	Excise duty on hydrocarbon fuels
C02	Excise duty on alcohol
C03	Excise duty on beer
C04	Excise duty on wine
C05	Excise duty on tobacco products

Source: Author's own elaboration

Annex II

Results of ADF Unit root test of all variables used in the models. As shown below, all variables are I(1).

Table II.A: ADF unit root test results

	t-ADF	p-value
PIT (level)	−2.339	0.234
PIT (first diff.)	−4.192	0.001
CIT (level)	−1.018	0.749
CIT (first diff.)	−5.116	0.000
SSC (level)	−1.633	0.457
SSC (first diff.)	−3.721	0.004
Compensation of employees (level)	−0.501	0.887
Compensation of employees (first diff.)	−3.106	0.026
Net operating surplus and mixed income (level)	−2.218	0.479
Net operating surplus and mixed income (first diff.)	−4.514	0.001
Final consumption expenditure of households (level)	−0.752	0.832
Final consumption expenditure of households (first diff.)	−3.931	0.002

Source: Author's own calculations

Annex III

Results of all regressions performed to obtain tax-to-base and base-to-output elasticities. For each model diagnostic tests are presented as well.

Tax-to-base models

Table III.A: Personal income tax – LR

Variable	Coeff.	Std. error	t-stat	p-value
ln PIT				
const	−8.2344	0.3918	−21.0200	0.0000
ln compensation_of_employees	1.4052	0.0271	51.8200	0.0000
dummy (2001–2007) = 1	0.1656	0.0140	11.8500	0.0000
Adj. R²	0.996			

Diagnostic tests	Test criteria	p-value
Cointegration: Engle–Granger test	−4.6311	0.0001
Autocorrelation: Breusch–Godfrey test	0.1213	0.7324
Homoskedasticity: ARCH test	0.1192	0.7299
Normality: Jarque–Bera test	1.0903	0.5797

Source: Author's own calculations

Table III.B: Personal income tax – SR

Variable	Coeff.	Std. error	t-stat	p-value
$\Delta \ln PIT$				
const	0.0067	0.0073	0.9155	0.3754
$\ln compensation_of_employees$	1.2888	0.1209	10.6600	0.0000
$\Delta dummy (2001-2007) = 1$	0.1487	0.0169	8.8180	0.0000
ECT_{t-1}	-1.1435	0.2419	-4.7270	0.0003
Adj. R^2	0.925			

Diagnostic tests	Test criteria	p-value
Autocorrelation: Breusch–Godfrey test	1.2779	0.2787
Homoskedasticity: ARCH test	0.1620	0.6873
Normality: Jarque–Bera test	0.5870	0.7455

Source: Author's own calculations

Table III.C: Corporate income tax – LR operating surplus and mixed income

Variable	Coeff.	Std. error	t-stat	p-value
$\ln CIT$				
const	-9.8904	0.8565	-11.5500	0.0000
$\ln operating_surplus_and_mixed_income$	1.5484	0.0614	25.2300	0.0000
Adj. R^2	0.973			

Diagnostic tests	Test criteria	p-value
Cointegration: Engle–Granger test	-2.9951	0.0354
Autocorrelation: Breusch–Godfrey test	1.3840	0.2577
Homoskedasticity: ARCH test	1.0972	0.2948
Normality: Jarque–Bera test	0.1754	0.9160

Table III.D: Corporate income tax – SR

Variable	Coeff.	Std. error	t-stat	p-value
$\Delta \ln CIT$				
const	0.0125	0.0140	0.8945	0.3862
$\Delta \ln operating_surplus_and_mixed_income$	1.3411	0.2237	5.9940	0.0000
ECT_{t-1}	-0.7038	0.2356	-2.9870	0.0098
Adj. R^2	0.729			

Diagnostic tests	Test criteria	p-value
Autocorrelation: Breusch–Godfrey test	0.0989	0.7581
Homoskedasticity: ARCH test	1.3702	0.2418
Normality: Jarque–Bera test	0.5606	0.7555

Source: Author's own calculations

Table III.E: Social security contributions – LR

Variable	Coeff.	Std. error	t-stat	p-value
$\ln SSC$				
const	-1.3707	0.0995	-13.7800	0.0000
$\ln compensation_of_employees$	1.0148	0.0069	146.1000	0.0000
Adj. R^2	0.999			

Diagnostic tests	Test criteria	p-value
Cointegration: Engle–Granger test	-3.9579	0.0017
Autocorrelation: Breusch–Godfrey test	0.0098	0.9226
Homoskedasticity: ARCH test	1.4317	0.2315
Normality: Jarque–Bera test	1.1818	0.5538

Source: Author's own calculations

Table III.F: Social security contributions – SR

Variable	Coeff.	Std. error	t-stat	p-value
$\Delta \ln SSC$				
const	0.0071	0.0024	2.9660	0.0102
$\Delta \ln compensation_of_employees$	0.8770	0.0399	21.9800	0.0000
ECT_{t-1}	-1.1343	0.1997	-5.6800	0.0000
Adj. R^2	0.973			

Diagnostic tests	Test criteria	p-value
Autocorrelation: Breusch–Godfrey test	0.0468	0.8320
Homoskedasticity: ARCH test	0.0206	0.8858
Normality: Jarque–Bera test	0.1722	0.9175

Source: Author's own calculations

Base-to-output models

Table III.G: Compensation of employees

Variable	Coeff.	Std. error	t-stat	p-value
$\ln compensation_of_employees$				
const	-0.5581	0.3405	-1.6320	0.1151
$\Delta \ln GVA$	0.8990	0.0998	9.0070	0.0000
$\ln compensation_of_employees_{t-1}$	-0.2949	0.1501	-1.9650	0.0606
$\ln GVA_{t-1}$	1.0747	0.1632	1.9420	0.0635
Adj. R^2	0.789			

Diagnostic tests	Test criteria	p-value
Autocorrelation: Breusch–Godfrey test	1.6715	0.2022
Homoskedasticity: ARCH test	0.1328	0.7155
Normality: Jarque–Bera test	1.0210	0.6002

Source: Author's own calculations

Table III.H: Operating surplus and mixed income

Variable	Coeff.	Std. error	t-stat	p-value
<i>In operating_surplus_and_mixed_income</i>				
const	−0.1148	0.2154	−0.5329	0.5988
$\Delta \ln GVA$	1.3640	0.1721	7.9260	0.0000
<i>In operating_surplus_and_mixed_income</i> _{t-1}	−0.2313	0.1497	−1.5450	0.1348
<i>In GVA</i> _{t-1}	0.9488	0.1383	1.5870	0.1251
Adj. R^2	0.807			

Diagnostic tests	Test criteria	p-value
Autocorrelation: Breusch–Godfrey test	2.0610	0.1640
Homoskedasticity: ARCH test	0.8803	0.3481
Normality: Jarque–Bera test	0.6369	0.7273

Source: Author's own calculations

Table III.I: Final consumption expenditure of households

Variable	Coeff.	Std. error	t-stat	p-value
<i>In household_consumption</i>				
const	0.1022	0.1299	0.7868	0.4388
$\Delta \ln GVA$	0.7676	0.0934	8.2170	0.0000
<i>In household_consumption</i> _{t-1}	−0.4220	0.1485	−2.8410	0.0088
<i>In GVA</i> _{t-1}	0.9435	0.1432	2.7800	0.0102
Adj. R^2	0.813			

Diagnostic tests	Test criteria	p-value
Autocorrelation: Breusch–Godfrey test	0.9901	0.3296
Homoskedasticity: ARCH test	0.3257	0.5682
Normality: Jarque–Bera test	0.4631	0.7933

Source: Author's own calculations

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