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The new ESCB methodology for the calculation of cyclically adjusted budget balances: an application to the Portuguese case

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Abstract
The analysis of public finance developments relies, amongst other indicators, on estimates of cyclically adjusted budget balances (CABs), which correct headline government balances for business cycle fluctuations. The European System of Central Banks (ESCB) endorsed in late 2018 a new aggregate methodology for the calculation of CABs, developed by Bouabdallah *et al.*, 2019. This paper presents the application of this new cyclical adjustment methodology to the Portuguese case, providing details on the calculation of the underlying fiscal-to-base and base-to-output elasticities. Additonally, it describes the output gap estimations used to assess the cyclical position of the economy. The paper also presents the analytical tool developed by Bouabdallah *et al.*, 2019 to disentangle the drivers of structural fiscal developments, providing details on its application to Portugal.

JEL: E62, H20, H60

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1. Introduction

In the last decades, the analysis of public finance developments has been relying, amongst other indicators, on estimates of cyclically adjusted budget balances (CABs), which correct headline government balances for business cycle fluctuations. When measured in levels, CABs are a good indicator of the underlying fiscal position of a country. Its changes represent a rough proxy for the discretionary action by governments and, as such, are considered indicators of the fiscal stance. CABs are computed by many institutions, including the European Commission, the IMF and the OECD, in each case according to specific methodologies and respective parameters. The Commission's estimates are used in the context of the European fiscal surveillance framework since the 2005 reform of the Stability and Growth Pact.

The European System of Central Banks (ESCB) adopted a methodology for the calculation of CABs in 2001 (Bouthevillain *et al.*, 2001). The measurement of the cyclical component relied on a trend/cycle decomposition of different macroeconomic variables, with the aim of better approximating the main bases of selected fiscal items. As such, it differed from the methodologies followed by other institutions, which gauge the cyclical component by applying a budgetary semi-elasticity to an aggregate output gap. Since then, Banco de Portugal has been following Bouthevillain *et al.*, 2001, presenting estimates of CABs for Portugal in its regular publications and other ad-hoc analysis (Neves and Sarmento, 2001, and Braz, 2006, provide further details on the application to the Portuguese case). Subsequently, in 2006, a disaggregated framework for assessing public finances was introduced, anchored in the ESCB CAB methodology (Kremer *et al.*, 2006). This framework proved to be a valuable tool in fiscal analyses, both in terms of past developments and projections, as it allowed for a detailed breakdown of the drivers of the structural change of revenue and expenditure items.

Over the course of time, several issues have emerged when using the ESCB methodology adopted in 2001, justifying its review. This review culminated in the adoption of a new aggregated method to compute CABs, similar to those used by other institutions, at the end of 2018. Bouabdallah *et al.*, 2019, present the developed methodology. It should be noted that the authors preserve the detailed analysis of structural developments through an adaptation of the previous disaggregated framework (see also Morris and Reiss, 2019).

This paper provides a brief overview of the new ESCB methodologies and illustrates its use to analyse the Portuguese public finances. It is structured as follows: Section 2 describes the previous methodology, focusing on its merits and limitations. The new CAB methodology is presented in Section 3. It includes details on the estimation of both fiscal-to-base and base-to-output elasticities – required for the computation of the budgetary semi-elasticity. The calculation of potential GDP underlying the output gap used by Banco de Portugal in the new CAB method is presented in a separate subsection. Results

for both potential GDP and fiscal balances, and also a comparative analysis with previous Banco de Portugal and current European Commission estimates, are also included. Finally, Section 4 elaborates on the revised disaggregated framework, illustrating its application with the 2015-17 fiscal developments in Portugal.

2. The former cyclical adjustment method

Since 2001, the analysis of fiscal developments undertaken by Banco de Portugal has relied on a commonly agreed methodology for the estimation of CABs developed by the ESCB Working Group on Public Finance (WGPF)[1] and presented in Bouthevillain *et al.* (2001). Its application to the Portuguese case is summarized in Braz (2006). This section provides a brief overview of this methodology.

Differently from most alternative methods, the ESCB methodology was disaggregated in the sense that, rather than focusing solely on GDP, it assumed that there is a set of other variables that provide better proxies for the macroeconomic bases driving fiscal developments. These macroeconomic variables were defined in real terms, so that the analysis did not adjust budget balances by price developments. As typically assumed in cyclical adjustment methods, the previous ESCB framework also considered that revenue from taxes and social contributions and expenditure on unemployment benefits are the only fiscal items affected by macroeconomic developments. Revenue items, such as personal income tax collected on capital income, as well as tax and social contributions referring to government employees, were considered non-cyclical at that time (and excluded from the analysis) to ensure a similar treatment to that followed on the expenditure side (in which non-cyclicality is assumed).

In practice, the former ESCB cyclical adjustment methodology can be broadly described as a three-step procedure. In a first step, the trend path is obtained for each of the macroeconomic variables deemed to have an impact on fiscal developments using a Hodrick-Prescott (HP) filter (Hodrick and Prescott, 1997) with a smoothing parameter λ equal to 30, for all countries.[2] The filter was applied to each relevant series over the observed period and to an extension period based on ESCB forecasts. Table 1 lists the relevant macroeconomic variables in the case of Portugal, as well as the associated revenue and expenditure items.

1. The Working Group on Public Finance is a sub-committee of the Monetary Policy Committee composed by representatives of the National Central Banks of the European Union and the European Central Bank.

2. A value of 30 for the λ parameter is consistent with the assumption of 8 years for the average duration of business cycles.

Cyclical fiscal item	Macroeconomic base	Elasticity
Taxes on household income (excluding taxes levied on capital income and public sector wage income)	Private sector wages Private sector employment	1,69 1,00
Taxes on corporate income	Private GDP(1)	3,14
Taxes on production an imports		
VAT	Private consumption	1,69
Tax on oil products	Consumption of non-durables	1,07
Car tax	Consumption of durables	1,33
Other	Private consumption	1,00
Social contributions (excluding actual social contributions referring to public employees and imputed social contributions)	Private sector wages Private sector employment	1,00 1,00
Unemployment benefits	Number of unemployed	1,00

TABLE 1. Elasticities of fiscal items with respect to the macroeconomic bases

Source: Braz (2006).
Notes: (1) The standard ESCB methodology used the gross operating surplus as a macroeconomic base of taxes on corporate income. However, in the specific case of Portugal, the private GDP was deemed to provide a more appropriate proxy.
Further details regarding the calculations of the elasticities may be found in Braz (2006).

In a second step, the cyclical component of the budget balance, *i.e.* the impact of cyclical developments on the balance, was computed using fiscal elasticities and the deviations of each relevant macroeconomic variable from its trend. In particular, for each item of revenue R_i and expenditure E_j assumed to be cyclical (listed in Table 1), the cyclical component (in levels) was obtained as

$$R^C_{i,t} = \eta_{R_i,B_i} \times \frac{B_{i,t} - B^*_{i,t}}{B^*_{i,t}} \times R_{i,t} \quad \text{and} \quad E^C_{j,t} = \eta_{E_j,B_j} \times \frac{B_{j,t} - B^*_{j,t}}{B^*_{j,t}} \times E_{j,t} \tag{1}$$

where

- B are the relevant macroeconomic bases for each fiscal item;
- B^* are the trend values of B obtained on the basis of the HP-filter; and
- η_{R_i,B_i} η_{E_j,B_j} are the elasticities of fiscal items with regard to the respective macroeconomic bases B_i and B_j .

The fiscal elasticities could either be estimated econometrically or derived from tax legislation or from other sources of information. Although preserving

a high degree of harmonization within the ESCB, the procedures to obtain the elasticities were very much country-specific.[3]

Finally, in the third step, the CAB was obtained by netting-out the cyclical component from the actual budget balance:

$$CAB_t = \left(\sum_j R_{i,t} - \sum_j R_{i,t}^C \right) - \left(\sum_j E_{j,t} - \sum_j E_{j,t}^C \right) \quad (2)$$

Insofar each cyclical component was computed on the basis of deviations between the respective macroeconomic base and its trend, as shown in equation (1), the CAB took into account composition of growth effects. The latter stem from the possibility that the different macroeconomic bases for government revenue and expenditure exhibit distinct developments and may be in different cyclical positions. This means that the estimates for the CABs take into account the fact that different compositions of economic growth impact differently public finances (e.g. growth driven by domestic demand should generate higher tax revenue than growth driven by net exports, exerting a more favourable impact on public finances).

The possibility to account for composition effects was one of the key advantages of the former ESCB method. Indeed, alternative methodologies compute the cyclical component of the budget balance solely on the basis of the aggregate output gap and a semi-elasticity measuring the response of the budget balance to changes in real GDP. In any case, the previous ESCB method still allowed the derivation of the semi-elasticity of the budget balance, calculated as described in Bouthevillain *et al.* (2001). At that time, the resulting figure for Portugal stood at 0.5, which was very close to the semi-elasticities used by the European Commission and the OECD (respectively 0.51 and 0.54). However, using a derivation formula consistent with that underlying the new methodology (see equation 6 below), but with data, elasticities and weights used at that time, the semi-elasticity would be slightly revised upwards from 0.5 to 0.53.

In addition to the possibility of taking into account and actually quantifying composition effects, the former ESCB methodology presented a number of other merits. The fact that it was based on relationships between cyclical budgetary items and specific macroeconomic variables allowed for a detailed structural analysis of both past and projected fiscal developments, as described in Kremer *et al.* (2006). Although harmonised, the framework left sufficient room for country-specific adjustments, safeguarding at the same time comparability of results and adaptability to country idiosyncrasies. Moreover, reliance on the statistical HP-filter ensured that the breakdown of the series into trend and

3. Braz (2006) and Neves and Sarmento (2001) provide a detailed description of the assumptions underlying the determination of elasticities for the case of Portugal.

cyclical components was transparent, easy to replicate and not subject to changes in technical assumptions. Finally, the HP-filter yields trend deviations that are symmetric by construction, guaranteeing that, over time, positive and negative cyclical components balance each other out. This feature minimized risks of optimistic biases towards the underestimation of structural deficits and it was therefore consistent with the prudence principle that should underlie the analysis of fiscal developments.

In practice, however, the limitations of the former cyclical adjustment methodology were also manifold. First, the composition effect (assessed as the difference between the cyclical component computed with the ESCB methodology and based that based on an aggregate semi-elasticity) was found to exhibit a counter-cyclical behaviour. This reflected the fact that private sector wages (which are less cyclical than GDP) were the main driver of the composition effect, resulting in an underestimation of the cyclical component of budget balances and somewhat muting the expected cyclicality of public finances. This effect might have been reinforced in the recent period by the inability of the HP-filter to adequately break down between trend and cycle the severe recessions experienced in many member states, leading to an over-estimation of the structural component of fiscal deteriorations. Moreover, the measurement of the composition effect in the previous ESCB methodology was also hampered by the so-called "deflator problem". Indeed, as macroeconomic bases for revenue items are in some cases only available in current prices, the practical implementation of the method required them to be deflated. For instance, by convention, compensation of private sector employees was deflated using the private consumption deflator and, as such, any divergence between the evolution of the latter and the GDP deflator was unduly attributed to the composition effect.

Finally, a more fundamental limitation of the former ESCB method is that it relied on an assessment of the cyclical position of the economy that was based on a statistical filter. Such assessment might not be aligned with that gauged by macro experts on the basis of more informed estimates of output gaps obtained using structural methods (like that presented in Subsection 3.5). In addition, there was another practical limitation related to the mitigation of the so-called "end-point" bias by means of the application of the HP-filter to series that were extended with macroeconomic forecasts.[4] Developments in the extension period should reflect the assessment of long-term macroeconomic equilibria and, ideally, should follow agreed guidelines. Although the extension period projections were subject to a peer review, there were no specific guidelines ensuring cross-country comparability.

4. The "end-point" bias is a well documented limitation of the HP-filtered. It reflects the fact that, in the beginning and in the end of the sample period, trend values are chiefly determined by actual values and thus cyclicality tends to be muted. This problem is typically addressed by extending the actual series using forecasts.

3. The new cyclical adjustment method

3.1. Overview

In light of the aforementioned limitations of the former ESCB cyclical adjustment method, the WGPF conducted a review and adopted a new methodology to be implemented as of 2019 (Bouabdallah *et al.*, 2019). This section presents a detailed description of the new cyclical adjustment method and its application to the specific case of Portugal.

In the new ESCB methodology the CAB (*i.e.*, the budget balance that would prevail if the economy was at its potential level) is determined by an aggregate procedure. Indeed, it is obtained by subtracting the cyclical component of the budget balance – computed as the product of the semi-elasticity and the output gap – from the headline budget balance in percentage of GDP. Formally:

$$cab_t = \frac{BB_t}{Y_t} - \varepsilon^{BB} \times og_t, \tag{3}$$

where $\frac{BB_t}{Y_t}$ stands for the headline balance in percentage of GDP, ε^{BB} is the budgetary semi-elasticity and og_t is the output gap obtained on the basis of the production function approach for calculating potential output described in Subsection 3.5. As further explained in Appendix A, cab_t should be interpreted as the ratio of the cyclically adjusted balance to (nominal) potential GDP, given that the semi-elasticity captures the impact of the business cycle both on the numerator and the denominator[5].

Taking into account that the change in the output gap can be proxied by the difference between real GDP and potential GDP growth rates, it can be assumed that $dog_t \approx \frac{dY_t}{Y_t}$. Hence, the aggregate semi-elasticity can be expressed as:

$$\varepsilon^{BB} = \frac{d\left(\frac{BB_t}{Y_t}\right)}{dog_t} \approx \frac{d\left(\frac{BB_t}{Y_t}\right)}{\frac{dY_t}{Y_t}}, \tag{4}$$

This budgetary semi-elasticity is obtained as the difference between the semi-elasticity of revenue and the semi-elasticity of expenditure ($\varepsilon^{BB} = \varepsilon^R - \varepsilon^E$), defined as[6]

5. Nominal potential GDP is obtained using real potential GDP estimates and the actual GDP deflator. Throughout this article *ratios to potential GDP* should be interpreted as *ratios to nominal potential GDP*.

6. Note that the semi-elasticity of the balance may be written as

$$\varepsilon^{BB} = \varepsilon^{R} - \varepsilon^{E} = \left(\eta^{R} - 1\right) \cdot \frac{R_t}{Y_t} - \left(\eta^{E} - 1\right) \cdot \frac{E_t}{Y_t}, \tag{5}$$

where η^R and η^E respectively represent the elasticty of total revenue and total expenditure to the output gap.

These elasticities can be defined as a product between a fiscal-to-base elasticity (η^{RB} and η^{EB}, measuring the response of revenue and expenditure to changes in the respective macroeconomic bases) and a base-to-output elasticity (η^{BY}, measuring the response of each macroeconomic base to changes in the output gap). Plugging this product into equation (5) yields:

$$\varepsilon^{BB} = \varepsilon^{R} - \varepsilon^{E} = \left(\eta^{RB}\eta^{BY} - 1\right) \cdot \frac{R_t}{Y_t} - \left(\eta^{EB}\eta^{BY} - 1\right) \cdot \frac{E_t}{Y_t} \tag{6}$$

Furthermore,

$$\varepsilon^{BB} = \varepsilon^{R} - \varepsilon^{E} = \sum_i \varepsilon_i^{R} - \sum_j \varepsilon_j^{E}, \tag{7}$$

where ε_i^R and ε_j^E represent each revenue and expenditure item contribution to the overall semi-elasticity (respectively i and j), whether assumed to be cyclical or non-cyclical. Four revenue categories and one expenditure item are considered to be sensitive to the business cycle: i) direct taxes paid by households (split into personal income tax and other current taxes); ii) direct taxes paid by corporations; iii) taxes on production and imports (split into VAT and other indirect taxes); iv) net social contributions (split into paid by employers and employees and by self- and non-employed);

$$\begin{aligned}
\varepsilon^{BB} = \varepsilon^{R} - \varepsilon^{E} &= \frac{d\left(\frac{R_t}{Y_t}\right)}{dog_t} - \frac{d\left(\frac{E_t}{Y_t}\right)}{dog_t} \approx \frac{d\left(\frac{R_t}{Y_t}\right)}{\frac{dY_t}{Y_t}} - \frac{d\left(\frac{E_t}{Y_t}\right)}{\frac{dY_t}{Y_t}} \\
&= \frac{\frac{dR_t Y_t - R_t dY_t}{Y_t^2}}{\frac{dY_t}{Y_t}} - \frac{\frac{dE_t Y_t - E_t dY_t}{Y_t^2}}{\frac{dY_t}{Y_t}} \\
&= \left(\frac{R_t}{Y_t} \cdot \left(\frac{\frac{dR_t}{R_t}}{\frac{dY_t}{Y_t}}\right) - \frac{R_t}{Y_t}\right) - \left(\frac{E_t}{Y_t} \cdot \left(\frac{\frac{dE_t}{E_t}}{\frac{dY_t}{Y_t}}\right) - \frac{E_t}{Y_t}\right) \\
&= \left(\left(\frac{\frac{dR_t}{R_t}}{\frac{dY_t}{Y_t}} - 1\right) \cdot \frac{R_t}{Y_t}\right) - \left(\left(\frac{\frac{dE_t}{E_t}}{\frac{dY_t}{Y_t}} - 1\right) \cdot \frac{E_t}{Y_t}\right) \\
&= \left(\eta^{R} - 1\right) \cdot \frac{R_t}{Y_t} - \left(\eta^{E} - 1\right) \cdot \frac{E_t}{Y_t}
\end{aligned}$$

and v) unemployment benefits. For the remaining non-cyclical revenue and expenditure items, the contribution to the aggregate semi-elasticity stems only from a denominator effect, as the base-to-output elasticities are nil.

It should be noted that in the new ESCB cyclical adjustment method the calculation of the semi-elasticity takes into account two sorts of time lags: those related to the tax code and the way it defines tax collection (relevant when taxes are levied on aggregates referring to the previous year – referred to as the collection lag)[7]; and those stemming from a lagged response of the macroeconomic bases to cyclical fluctuations (referred to as the cyclical lag). Therefore, the calculation of the semi-elasticity of revenue and expenditure reflects responses to the contemporaneous output gap, as well as to the output gap of $t-1$ (as a result of the individual impacts of the collection and the cyclical lags) and to the output gap of $t-2$ (due to the interaction of the collection and cyclical lags). For each revenue and expenditure item the semi-elasticity can, as such, be defined as:

$$\varepsilon_i^R = \varepsilon_{0,i}^R + \varepsilon_{1,i}^R + \varepsilon_{2,i}^R = \frac{d\left(\frac{R_{i,t}}{Y_t}\right)}{dog_t} + \frac{d\left(\frac{R_{i,t}}{Y_t}\right)}{dog_{t-1}} + \frac{d\left(\frac{R_{i,t}}{Y_t}\right)}{dog_{t-2}} \tag{8}$$

$$\varepsilon_j^E = \varepsilon_{0,j}^E + \varepsilon_{1,j}^E + \varepsilon_{2,j}^E = \frac{d\left(\frac{E_{j,t}}{Y_t}\right)}{dog_t} + \frac{d\left(\frac{E_{j,t}}{Y_t}\right)}{dog_{t-1}} + \frac{d\left(\frac{E_{j,t}}{Y_t}\right)}{dog_{t-2}}, \tag{9}$$

where the semi-elasticities with respect to the output gap in t, $t-1$ and $t-2$ are given by:

$$\varepsilon_{0,i}^R = \bar{r}_i\left(\eta_{0,i}^{RB}\eta_{0,i}^{BY} - 1\right) \text{ and } \varepsilon_{0,j}^E = \bar{e}_j\left(\eta_{0,j}^{EB}\eta_{0,j}^{BY} - 1\right), \tag{10}$$

$$\varepsilon_{1,i}^R = \bar{r}_i\left(\eta_{0,i}^{RB}\eta_{1,i}^{BY} + \eta_{1,i}^{RB}\eta_{0,i}^{BY}\right) \text{ and } \varepsilon_{1,j}^E = \bar{e}_j\left(\eta_{0,j}^{EB}\eta_{1,j}^{BY} + \eta_{1,j}^{EB}\eta_{0,j}^{BY}\right), \tag{11}$$

$$\varepsilon_{2,i}^R = \bar{r}_i\left(\eta_{1,i}^{RB}\eta_{1,i}^{BY}\right) \text{ and } \varepsilon_{2,j}^E = \bar{e}_j\left(\eta_{1,j}^{EB}\eta_{1,j}^{BY}\right), \tag{12}$$

where $\bar{r}_i$ and $\bar{e}_j$ stand for the 10 year average share of each revenue and expenditure item in GDP (for a detailed description regarding the computation of fiscal weights see Appendix B). Notice that in equations (11) and (12) the term 'minus 1' referring to the denominator effect disappears, as the

7. For each revenue item, the methodology allows the definition of the share of the tax which is levied with a collection lag, constant over time or time-varying.

semi-elasticities are referred to ratios to contemporaneous GDP. Furthermore, plugging equations (8)–(12) into equation (7), leads to:

$$\begin{aligned}\varepsilon^{BB} = &\sum_i \bar{r}_i \left[\left(\eta_{0,i}^{RB} + \eta_{1,i}^{RB}\right)\left(\eta_{0,i}^{BY} + \eta_{1,i}^{BY}\right) - 1\right] \\ &- \sum_j \bar{e}_j \left[\left(\eta_{0,j}^{EB} + \eta_{1,j}^{EB}\right)\left(\eta_{0,j}^{BY} + \eta_{1,j}^{BY}\right) - 1\right]\end{aligned} \tag{13}$$

As explained below, in the case of Portugal no collection lag is considered and, as such, the previous expression simplifies to:

$$\varepsilon^{BB} = \sum_i \bar{r}_i \left[\eta_{0,i}^{RB}\left(\eta_{0,i}^{BY} + \eta_{1,i}^{BY}\right) - 1\right] - \sum_j \bar{e}_j \left[\eta_{0,j}^{EB}\left(\eta_{0,j}^{BY} + \eta_{1,j}^{BY}\right) - 1\right] \tag{14}$$

At first sight, the definition of the CAB in (3) coincides with those underlying the methodologies adopted by other institutions, most notably the European Commission (EC). However, it differs from the EC methodology in a number of dimensions. The first difference relies on the fact that the ESCB methodology takes time lags into account. Second, composition effects are still (*ex post*) estimated in the new ESCB methodology. Indeed, although the latter is intrinsically aggregate, the various drivers of structural fiscal developments, including composition effects, are disentangled using the framework presented in Section 4 (which, ultimately, could also be applied to the EC CAB methodology). This disentanglement tool quantifies composition effects for each fiscal item assumed to be cyclical. This means that the new ESCB methodology retains one of the main advantages of the former, gauging the effects of macro bases evolving differently from what would be expectable given the assumed elasticities to the output gap. Moreover, the estimation of the composition effects is now improved, insofar some of the issues highlighted in the previous subsection (like, for example, the deflator problem) no longer apply. Finally, the estimation of fiscal-to-base elasticities introduces a number of refinements vis-à-vis the EC approach. In particular, the ESCB methodology takes into account a finer categorization of indirect taxes, comprising also taxes related to property, payroll taxes, stamp duty and VAT levied on investment.

In addition to improving both the estimation and the interpretation of composition effects, the new ESCB methodology also addresses most of the limitations of the previous. First and foremost, the new methodogy relies on more informed estimates of the output gap, departing from a purely statistical trend/cycle decomposition. Moreover, the new potential output estimates are subject to a peer review and ensure the consistency between the views of macro and fiscal experts on the cyclical position of the economy. This integration between macroeconomic and fiscal analysis is also beneficial from the point of view of communicating policy advice.

All cyclical adjustment methodologies rely on unobservable variables. In the case of the new ESCB cyclical adjustment methodology, the uncertainty

surrounding the determination of the potential output level should be highlighted. Regarding specifically production function approaches for the estimation of potential output, a frequent critique relies on the idea that these do not restrict the output gap to be symmetric across the business cycle (at least not within a relatively short time frame). Indeed, a negative bias in the estimation of the output gap would be reflected likewise in the cyclical component, introducing a bias towards smaller structural deficits. Against such a backdrop, a regular monitoring of potential output estimates is commendable.

Furthermore, all methodologies rely on simplified representations of each country's tax and benefits systems. Although in this regard the new ESCB methodology is more detailed than alternative frameworks, the complexity of those systems can only be partially captured on the basis of the relatively limited set of macroeconomic variables available from statistical sources.

Finally, these methods take into account an average structure of the economy and the labour market (embedded in the base-to-output elasticities). The weights used to combine the fiscal-to-base elasticities for each sub-component of expenditure and revenue into the aggregate semi-elasticity are also based on average shares. Because structural changes cannot be ruled out, they should be periodically revisited.

3.2. Data

The estimation of base-to-output elasticities for the calculation of the budgetary semi-elasticity draws on various sources of information. Most data concerning the macro bases are collected from the main annual national accounts aggregates, which are then complemented with annual sector accounts. All variables are expressed in nominal terms. On the income approach to GDP, gross operating surplus and mixed income is split by the main sectors (households and NPISH, general government and corporations) and other aggregates, like net entrepreneurial income of corporations and property income received by households, are used. On the expenditure approach to GDP, imputed rents are excluded from households' private consumption[8] and gross fixed capital formation on dwellings is identified.

The fiscal database is also mostly drawn from official national accounts, national tax lists[9] and government expenditure by function data (COFOG), the latter regarding old age and survivors' pensions and unemployment benefits. Information concerning the impact of discretionary measures largely

8. Imputed rents are transmitted by member states to Eurostat under the reporting of final consumption expenditure of households by consumption purpose. In the new CAB methodology, they are also deducted from operating surplus of households and NPISH on the income approach to GDP.

9. The questionnaire on national tax lists is sent by member states to Eurostat and contains detailed information on taxes and social contributions according to national classifications.

corresponds to official estimates made public in government documents, although they are in some instances adjusted by expert judgement. Additionally, data of *Taxation Trends* and the VAT gap published by the European Commission (DG-TAXUD) are used for the weighting of the fiscal items (European Commission, 2017; Poniatowski *et al.*, 2017).

3.3. Base-to-output elasticities

For each relevant macroeconomic base, the base-to-output elasticities η_i^{BY} have been estimated using a standard regression specified in log-differences to account for non-stationarity:

$$\Delta \ln \frac{B_{it}}{Y_t^*} = c_i + \eta_{0,i}^{BY} \cdot \Delta \ln \frac{Y_t}{Y_t^*} + \eta_{1,i}^{BY} \cdot \Delta \ln \frac{Y_{t-1}}{Y_{t-1}^*} + \mu_t \tag{15}$$

To control for serial correlation, all regressions were also run including a first order auto-regressive term. However, the AR(1) terms were found to have little or no effect on the estimated coefficients, confirming the robustness of the baseline results. Moreover, the regressions include one lag in order to capture the possibility that some macroeconomic bases respond to business cycle fluctuations with a delay (the cyclical lag).

Similar regressions have been run for three blocks: i) GDP – income approach; ii) GDP – expenditure approach; and iii) labour market. This allows checking the plausibility of the elasticities from an economic point of view. In particular, when weighted by the share of each macroeconomic variable in GDP, the respective elasticities should (approximately) add up to one. In the case of the labour market, the elasticities should be compatible with the breakdown of the labour force into employment and unemployment, as well as the decomposition of employment into employees and self-employed. The elasticities have also been computed for the different components of the sectoral breakdown of gross operating surplus and other macroeconomic aggregates deemed to proxy as much as possible the "true" macroeconomic base for each fiscal item.

By default, all elasticities have been obtained pooling data from a panel of EU countries for the period from 1995 to 2017. The panel regressions have been conducted with country fixed effects (and cross-sectional weights) but, because they may still fail to capture country-specific elements, individual, country-specific estimates were also obtained. The full set of panel and country specific estimates is presented in Table 2. The choice between panel and country-specific as the most plausible base-to-output elasticities was ultimately made on the basis of informed judgement by country experts. In any case, the chosen set of elasticities should broadly meet the aforementioned aggregation constraints, which is in principle made easier by making a consistent within each block.

In the case of Portugal, panel estimates were adopted for the GDP-income and labour market blocks, while country-specific estimates were used for the

GDP-expenditure block. Regarding the latter, the country-specific figures are sufficiently different for some of the macro bases to justify deviating from the panel estimates, specially in light of the idiosyncrasies of the Portuguese economy (like, for example, the higher volatility of consumption of durables). In the country-specific regressions, coefficients referring to the lagged response of macroeconomic variables to changes in the output gap were found to be non-significant. As such, in the GDP-expenditure block the base-to-output elasticities do not include a lagged component.

As presented in Table 2 the base-to-output elasticities of gross operating surplus and mixed income, household consumption excluding imputed rents and number of employees are obtained through the application of aggregation constraints.[10] In particular, the base-to-output elasticity for compensation of employees (η_W^{BY}) and the fiscal-to-output elasticity of indirect taxes (η_{IT}^{RY}) give rise to an implied elasticity for the total economy gross operating surplus and mixed income (η_{GOS}^{BY}), assuming additionally that subsidies are non-cyclical[11]:

$$\omega_W \cdot \eta_W^{BY} + \omega_{GOS} \cdot \eta_{GOS}^{BY} + \bar{r}_{IT} \cdot \eta_{IT}^{RY} = 1 \tag{16}$$

where ω_i and $\bar{r}_{IT}$ correspond to the average weights of the macro bases and of indirect taxes in GDP, respectively; and the fiscal-to-output elasticity of indirect taxes (excluding EU taxes) is defined as:

$$\eta_{IT}^{RY} = \sum_i \bar{r}_i \eta_i^{BY} \eta_i^{RB} \tag{17}$$

with subscript i for individual indirect tax items.

A significant share of household consumption refers to imputed rents, which are not cyclical, as confirmed by our regression analysis. Therefore, the elasticity of household consumption excluding imputed rental services (η_{Cadj}^{BY}) is derived such that:

$$\eta_{Cadj}^{BY} = \frac{\omega_C}{\omega_{Cadj}} \cdot \eta_C^{BY} \tag{18}$$

where ω_C and ω_{Cadj} refer to the average weight of household domestic consumption and consumption excluding imputed rents in GDP and η_C^{BY} represent the base-to-output elasticity of household domestic consumption.

10. In this regard, it is important to compare these implicit elasticities with the coefficients obtained directly from the regressions to confirm the plausibility of the results. In the case of Portugal, the implicit elasticities are very close to the direct estimates, entailing a minor impact on the overall semi-elasticity if the latter were used.

11. Notice that to obtain the lagged base-to-output elasticity, the same formula is applied, with the right hand side of the equation equal to zero.

Finally, the elasticity of employment (η_{Emp}^{BY}) and self-employment ($\eta_{SelfEmp}^{BY}$) give rise to an implied elasticity of employees (η_{L}^{BY}), assuming that self-employment is typically non-cyclical ($\eta_{SelfEmp}^{BY} = 0$):

$$\frac{\omega_L}{\omega_{Emp}} \cdot \eta_L^{BY} + \frac{\omega_{SelfEmp}}{\omega_{Emp}} \cdot \eta_{SelfEmp}^{BY} = \eta_{Emp}^{BY}, \tag{19}$$

where the elasticity of employment η_{Emp}^{BY} is derived based on the elasticities of unemployment (η_{U}^{BY}) and the labour force (η_{LF}^{BY})[12]:

$$\omega_{Emp} \cdot \eta_{Emp}^{BY} + \omega_U \cdot \eta_U^{BY} = \eta_{LF}^{BY}, \tag{20}$$

where ω in equations (19) and (20) stand for average weights in the labour force.

With regard to the choice of the appropriate macro bases for each fiscal item, alternatives are suggested for some taxes. These suggestions provide an harmonized solution for possible data unavailability of the true bases or the poor fit of some less straightforward proxy bases. In particular: i) the default base for direct taxes paid by corporations (net entrepreneurial income) can be replaced by gross operating surplus and mixed income of the total economy; ii) operating surplus of households and property income receivable are the suggested bases for personal income tax on business and capital income, and can also be replaced by gross operating surplus and mixed income of the total economy; and iii) consumption excluding imputed rental services is the default base for VAT on households consumption and other taxes on products but it can be substituted by total private consumption.[13] In the case of Portugal, we opted for gross operating surplus and mixed income of the total economy as the base for direct taxes paid by corporations and personal income tax with respect to capital and business incomes, while the default option for VAT was maintained.

Additionally, it should be mentioned that, although the choice of relevant macroeconomic bases is very much harmonised across countries, there is room for country-specific adjustments on the basis of economically-sound arguments. For instance, in the case of Portugal the suggested base for the stamp duty (investment on dwellings) is not applicable as it gives a negligible contribution

12. The default approach, followed by most member states, proposes to obtain the elasticity of employment from the estimated regressions, while the elasticity for unemployment is derived from equation (20). By deviating from the proposed method and using the unemployment elasticity as estimated in the regression, we obtain a higher elasticity for this item, more in line with the developments of the Portuguese labour market during the recent past.

13. The methodology suggests that whenever one of the alternative macro bases is chosen to replace the "true" base the fiscal elasticity should be adjusted to avoid impacting the aggregate semi-elasticity – for more details see equation (22).

to this tax's revenue which is mostly driven by financial and commercial transactions. Instead, nominal GDP is found to provide a better proxy for the macroeconomic base of the stamp duty.

Finally, other current taxes paid by households and other taxes on production, together with social contributions payable by the self-employed, are considered non-cyclical. This is in line with panel estimates of the elasticities of these tax aggregates with respect to the output gap. Hence, the base-to-output elasticity of these items is calibrated to zero, such that the corresponding contribution to the aggregate semi-elasticity is simply given by the denominator effect.[14]

Macroeconomic variables	**% in GDP or labour market**	**Method**	**Used for PT**	**Panel estimates**		**Country-specific estimates**	
				T	**T-1**	**T**	**T-1**
INCOME SIDE OF GDP							
Compensation of employees	45.7%	E	Yes	0.59*	0.31*	1.00*	0.20
Gross operating surplus & mixed income	41.9%	F	Yes	1.25	-0.34	0.81	-0.21
General government	3.0%	C		0.00	0.00	0.00	0.00
HHs & NPISH	17.9%	E		0.72*	0.01	0.28	-0.35
Corporations	21.1%	F		1.89	-0.69	1.37	-0.13
Additional variables:							
Oper. surplus of HHs & NPISH adj. for imputed rents		E		1.16*	0.03	0.65*	-0.23
Property income receivable, HHs & NPISH		E		1.45*	1.15*	1.03	-0.50
Net entrepr. income / Corporate profits		E		2.81*	-1.03*	3.41*	-3.52*
EXPENDITURE SIDE OF GDP							
Private consumption	65.5%	E		0.70*	0.12*	1.12*	-0.05
HH final consumpt. (domestic concept)	66.8%	E		0.69*	0.09*	1.22*	-0.06
Imputed rent component	6.5%	C		0.00	0.00	0.00	0.00
HH consump. excluding imputed rents	60.3%	F	Yes	0.76	0.10	1.35	-0.06
HH consump. of durables	5.7%	E		1.86*	0.29*	6.13*	-0.74
NPISH consumption	1.9%	C		0.00	0.00	0.00	0.00
Government consumption	10.6%	C		0.00	0.00	0.00	0.00
Gross capital formation	18.9%	F		4.45	-0.15	4.54	0.40
Gross fixed capital formation	18.6%	E	Yes	2.28*	0.62*	3.32*	0.76
Gross fixed capital formation, dwellings	3.6%	E		2.16*	0.65*	2.72*	1.75*
Exports of goods and services	34.6%	E		1.85*	-0.47*	1.71*	-0.80
Imports of goods and services	38.5%	E		2.44*	-0.30*	3.08*	-0.60*
LABOUR MARKET							
Labour force	100.0%	E		-0.06*	-0.02	0.06	0.00
Employment	88.2%	F		0.44	0.27	0.77	0.41
Employees	73.5%	F	Yes	0.31	0.24	0.78	0.40
Self-employment	14.7%	C		0.00	0.00	0.00	0.00
Unemployment	11.8%	E	Yes	-3.80*	-2.24*	-5.26*	-3.13*

TABLE 2. Base-to-output elasticities

Source: Authors' calculations and ESCB.
Notes: E = elasticities obtained through estimation, for which * denotes statistical significance ($p - value \leq 0.05$); C = calibrated elasticities; F = elasticities derived from the aggregation constraints.

14. In particular, equation (10) simplifies to $\varepsilon^R_{0,i} = -\bar{r}_i$ or $\varepsilon^E_{0,j} = -\bar{e}_j$.

3.4. Fiscal-to-base elasticities

Regarding the choice of fiscal-to-base elasticities, these are widely considered "structural" elasticities resulting from the tax code. In most cases, this would imply an elasticity equal to 1, with the exception of progressive taxes such as the personal income tax or, in some countries, social contributions. Usually, when tax elasticities appear to be cyclical it is due to a mis-measurement of the base. The first-best strategy followed in this methodology is to address this issue with the estimation of the base-to-output elasticities. In particular, the aim is to approximate as well as possible the base and adjust, when necessary, the corresponding elasticity. By prioritizing the estimation of the base-to-output elasticities, we avoid the problem of changes to the tax system distorting the estimation of fiscal elasticities. Notwithstanding, given that it is not always possible to approximate the tax base reasonably, direct fiscal-to-output elasticities were also estimated (correcting for the expected impact of tax changes) as additional information, in order to cross-check the plausibility of the final results.

In the case of Portugal, given that most taxes are broadly proportional, unit elasticities have been assumed in line with the suggested default option. The only exceptions refer to: i) personal income tax on earnings ($\eta^{RB} = 1.07$); ii) direct taxes paid by corporations ($\eta^{RB} = 1.95$); iii) VAT on households final consumption ($\eta^{RB} = 1.26$) and iv) stamp duty ($\eta^{RB} = 2.27$).

For the personal income tax (on average earnings, business income, capital income and social benefits), given its progressive nature, the corresponding elasticity should be preferably derived from the tax code and income distributions. In face of data unavailability, the default elasticities are those calibrated by the OECD (Price *et al.*, 2015).[15] The fiscal-to-base elasticity of personal income tax with respect to total earnings is calculated as a weighted average of the elasticity of personal income tax with respect to average earnings ($\eta^{RB} = 2.22$, OECD) and the unit elasticity of the number of employees:

$$\eta_W^{PIT} = \frac{\eta_{avgW}^{BY}}{\eta_W^{BY}} \cdot \eta_{avgW}^{PIT} + \frac{\eta_L^{BY}}{\eta_W^{BY}} \cdot 1 \tag{21}$$

where η_W^{PIT} represents the elasticity of personal income tax with respect to earnings; η_W^{BY}, η_{avgW}^{BY} and η_L^{BY} represent the base-to-output elasticities of earnings, average earnings and number of employees; and η_{avgW}^{PIT} corresponds to the fiscal elasticity to average earnings calibrated by the OECD.

For the remaining components of this tax (on business income, capital income and social benefits) we have deviated from the default option of using

15. In the case of personal income tax on social benefits, the same OECD elasticity as for earnings is suggested as the default option.

the OECD elasticities due to a poor fit of the considered macro bases. To avoid additional distortions, a simplifying but reasonable assumption of unitary fiscal elasticities was adopted.

For direct taxes paid by corporations, the true base is considered to be the net entrepreneurial income and therefore a tax elasticity of 1 is the default option suggested for this base. However, given the unavailability of projections for this series, we have opted to use the suggested proxy for the base, namely gross operating surplus and mixed income of the total economy. Therefore, we have adjusted the fiscal-to-base elasticity by the ratio between the base-to-output elasticities, such that the contribution of this revenue item to the budget semi-elasticity is not affected by the choice of the proxy base:

$$\eta_{adj}^{RB} = \frac{\eta_{truebase}^{BY}}{\eta_{proxy}^{BY}} \times \eta^{RB} \tag{22}$$

where η_{adj}^{RB} is the adjusted fiscal-to-base elasticity for direct taxes paid by corporations, $\eta_{truebase}^{BY}$ is the base-to-output elasticity of the true base (net entrepreneurial income), η_{proxy}^{BY} is the base-to-output elasticity of the proxy base (gross operating surplus and mixed income) and η^{RB} is the true fiscal elasticity equal to 1.

Given that different VAT rates are applied to different types of goods and services consumption, an elasticity above unity is assumed to gauge the effect of shifts in the composition of household consumption over the economic cycle. By examining the cyclicality of total consumption (excluding imputed rents) and consumption of durable goods, together with information on the share of consumer durables in overall consumption and on the standard and average effective VAT rates, it is possible to calibrate an elasticity of VAT with respect to household final consumption excluding imputed rents. This was done by simulating a 1% increase in household consumption (see Appendix C for a detailed description of the calibration).

With regard to the stamp duty, it was necessary to allow the fiscal-to-base elasticity to diverge from unity, despite being a proportional tax, because of the unavailability of data on the actual base. The suggested base, applicable to most member states, is gross fixed capital formation on dwellings. In Portugal, however, this tax is mostly levied on commercial and financial transactions, and therefore we opted to use GDP as the macro base – setting the base-to-output elasticity at 1 – and estimated the fiscal elasticity directly through the following regression[16]:

16. We set $\eta^{RB} = 2.27$, which corresponds to the contemporaneous coefficient, given that the coefficient of the lagged term is statistically insignificant.

$$\Delta \ln \frac{R_t}{Y_t^*} = c + \eta_t^{RY} \cdot \Delta \ln \frac{Y_t}{Y_t^*} + \eta_{t-1}^{RY} \cdot \Delta \ln \frac{Y_{t-1}}{Y_{t-1}^*} + \mu_t \tag{23}$$

Finally, it was decided not to include collection lags, as mentioned in Subsection 3.1. In the Portuguese tax system the main taxes collected with some lag are the corporate and personal income taxes. In the case of the former, data regarding the most recent years confirms that the final settlement of the tax regarding the previous year's revenue, which could be considered the share of the tax which is collected with a lag, represents in net terms a minor proportion of the total yearly tax receipt. Furthermore, this share has shown a strong volatility in the last years, complicating the assessment of an "average" collection lag for the entire period. With regard to the personal income tax, despite the withholding rates, a part of the tax is settled with a lag, following the filling of the income declaration of the previous year. Due to the unavailability of data and high volatility of these refunds net of additional payments regarding previous year income, the collection lag was assumed to be zero.[17]

3.5. Potential output

This subsection describes the method followed to estimate potential output (underpinning the output gap used to compute the cyclical component of the budget balances) and the data used. The corresponding results are also briefly presented.

The calculation of cyclically adjusted budget balances based on an aggregate approach requires the estimation of the output gap, *i.e.* the deviation of actual output from its potential level. Formally:

$$og_t = \frac{Y_t - Y_t^*}{Y_t^*} \tag{24}$$

where Y_t is real GDP and Y_t^* is potential output. The latter is an indicator of the overall supply of an economy, measuring the quantity it can produce when all resources are fully employed, following a sustainable and non-inflationary path. While potential output is an important tool for analysis and informed policy advice, it is an unobservable variable that requires caution in its use, given that its estimation involves various sources of uncertainty.[18]

17. These simplifying assumptions imply that any extraordinary developments in these lagged components will be reflected in the residual of the disaggregated analysis described in Section 4.

18. For a thorough discussion of uncertainty surrounding potential output estimates see Banco de Portugal (2017).

3.5.1. Methodology. In the methodology presented in this article, the computation of potential output follows a production function approach. Rather than focusing on simple statistical trends, this methodology gives some economic structure to the analysis, allowing to relate the quantity produced by an economy to the quantity of production factors and their productivity. Potential output is obtained as the outcome of the production function, when the quantity and productivity of the factors of production are at their reference value – or at their sustainable maximum levels.

A Cobb-Douglas production function is used, where real GDP (Y_t) is determined by the contributions of labour (L_t), capital (K_t), as well as their productivity (A_t). The production function takes the form:

$$Y_t = A_t L_t^{\alpha} K_t^{(1-\alpha)} \tag{25}$$

The constants α and $(1-\alpha)$ correspond to the elasticity of output with respect to labour and capital, respectively. Under the assumption of perfect competition, α can be calibrated to match the empirical average labour income share. We use a share of 64% as estimated and described in Félix and Almeida (2006).

Total factor productivity (A_t) is an unobserved variable with an encompassing nature, including factors such as the level of technology, human capital or the institutional framework. Indeed, A_t captures the share of production which is associated to any factor other than the quantities of the employed inputs. The actual value of this variable is usually computed as a residual, known as the *Solow residual*.

The labour input is measured by the total number of hours actually worked in the economy and is further broken down into:

$$L_t = Pop_t \times PartRate_t \times AvgHours_t \times (1 - URX_t) \times \gamma_t \tag{26}$$

where Pop_t is the working age population (between 15 and 64 years), $PartRate_t$ is the participation rate defined as the ratio of the labour force over the working age population, $AvgHours_t$ are the total hours worked per worker, URX_t is the unemployment rate defined as the number of unemployed over the labour force. γ_t is an adjustment term that considers the gap between national accounts employment and the implied level of employment of the Labour Force Survey.

Regarding the benchmark values for the estimation of potential output, in the case of the capital stock the standard assumption of a nil contribution to the output gap is considered, *i.e.* that actual values coincide with the potential capital stock.

The benchmark level of the labour supply is computed on the basis of the reference value of its various components, as specified in equation (26). More specifically, the actual value of working age population is taken on board –

as the population level is not deemed a cyclical variable – and HP-filters are applied to the series of the participation rate, average hours per worker and the adjustment term (γ). Finally, the benchmark unemployment rate, commonly referred to as NAWRU (non-accelerating wage rate of unemployment) – when estimated in a context of stable wage growth rates – corresponds to model-based estimates computed as described in Duarte *et al.* (2019).

Lastly, the calculation of potential output also requires an estimate for trend total factor productivity, which is computed as the HP-filtered *Solow residual*, following Félix and Almeida (2006). As for the smoothing parameter of the HP-filter, it was set to $\lambda = 7680$, also according to Félix and Almeida (2006), and in line with a $\lambda = 30$ for annual data.[19]

The production function approach followed here is broadly similar to the European Commission method, diverging nonetheless in some key features, namely the estimation of NAWRU and trend total factor productivity.

3.5.2. Data. A quarterly dataset is used, which relies on Statistics Portugal and Banco de Portugal databases. It includes official national accounts data regarding real GDP, employment and hours worked; and Labour Force Survey data about working age population and the labour force. The capital stock series is from the Banco de Portugal database and was built using the perpetual inventory method. Whenever the HP-filter is applied to a series, historical data (prior to 1995) and projections from Banco de Portugal are considered.

3.5.3. Results. Figure 1A illustrates actual GDP and potential output growth rates for the Portuguese economy. This figure depicts potential output estimates for the period 1995-17 obtained as described above, an HP-filtered GDP series (with a smoothing parameter of 30) and official European Commission estimates (Autumn 2018 forecast).

All methods point towards similar developments, in particular as regards Banco de Portugal production function approach and the European Commission method. Broadly, all approaches suggest that potential output was decelerating since the beginning of the sample, reaching negative growth rates during the last recession. In the most recent period, however, potential growth rates have been recovering. For 2017, the estimates lie between 1 and 1.5%, clearly below the figures estimated for the mid-nineties.

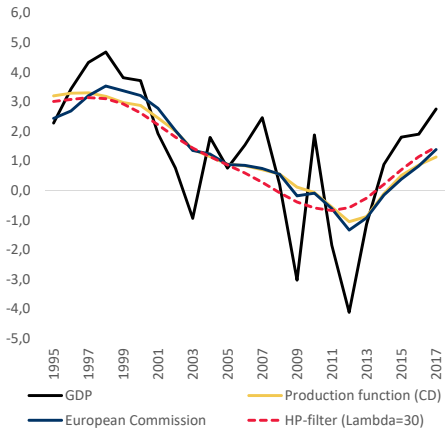
Figure 1B presents the output gap estimates implicit in the same three methods. Despite the small differences in growth rates, as these accumulate, they translate into more considerable differences in terms of output gap estimates. While there is a notable gap between estimates based on our production function and the Commission's in the beginning of the sample,

19. Notice that the HP-filter is applied to the logarithm of each of the variables and that the exponentiated trend is then plugged into the production function.

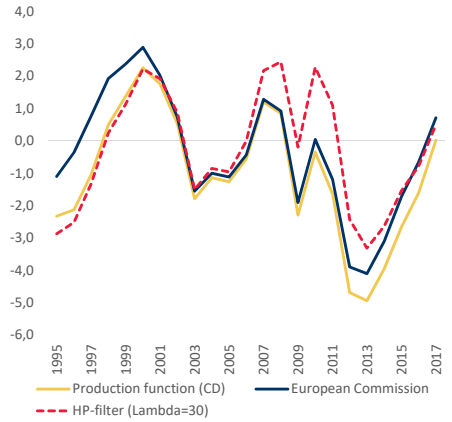
this gap narrows significantly since the early 2000s until the trough of the crisis, when differences become again relevant. In particular, the European Commission approach points towards more negative potential growth rates during the crisis (see Figure 1A), resulting in lower potential output estimates and therefore smaller output gaps.[20]

Since the late 2000s, the HP-filtered output gap has been diverging from the production function-based estimates, culminating in much smaller output gaps during the recent crisis, similarly to other statistical filters with no economic structure (see Banco de Portugal, 2017). In particular, around 2009, the HP-filter points towards a closed output gap, while the production function-based estimates point towards a negative gap of around 2%. The zero output gap is not a credible estimate during the economic and financial crisis, suggesting a better performance of the production function approach in cyclical turning points.

In the recent past, all methods suggest that GDP levels approached potential output levels, such that the negative output gap vanished by 2017.



(A) GDP and potential output growth rates in Portugal | In percentage



(B) Output gaps in Portugal | In percentage

FIGURE 1: Potential output and the output gap

Sources: Statistics Portugal, AMECO and authors' calculations.

20. The European Commission estimates a much higher trend impact of the crisis on unemployment, translating into higher NAWRU levels and therefore lower potential output estimates.

3.6. Results

The semi-elasticities of revenue, expenditure and the balance with respect to the output gap are obtained by plugging-in the weight of each fiscal item in GDP, the base-to-output and fiscal-to-base elasticities into equation (14). The results are presented in Table 3.

As expected, the semi-elasticity of revenue is close to zero (standing at -0.01). This reflects the fact that most tax revenues are highly cyclical (as shown by their fiscal-to-base elasticities equal or above unity). Thus, revenue *as a ratio to GDP* is relatively constant across the cycle (because the numerator and denominator move closely together). The small magnitude of the semi-elasticity of revenue implies that the respective cyclical component, *i.e.* the product between the semi-elasticity and the output gap, is also small. As such, the difference between actual revenue (as a percentage of GDP) and the cyclically adjusted revenue (as a ratio to potential GDP) is very modest (Figure 2).

By contrast, on the expenditure side only unemployment benefits are assumed to respond to cyclical developments. Since they account for a minor share of overall spending (and only 1.2% of GDP), the bulk of expenditure is unresponsive to the cycle. This yields a relatively large semi-elasticity with a negative sign (-0.56), mirroring the counter-cyclical behaviour of overall expenditure *as a ratio to GDP*. Therefore, in the case of the expenditure ratio, the cyclical component assumes a larger magnitude than in the case of revenue and exhibits stronger counter-cyclical fluctuations.

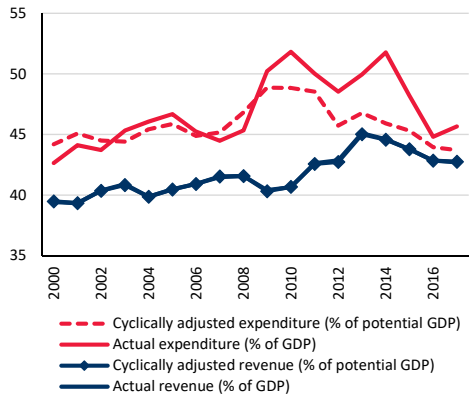


FIGURE 2: Actual and cyclically adjusted revenue and expenditure

Sources: Authors' calculations.
Note: The differences between the actual and the cyclically adjusted lines represent the cyclical components.

The combination of the semi-elasticities of revenue and expenditure yields an aggregate semi-elasticity of the budget balance of 0.54 (bottom right corner

Fiscal Item	Weight in GDP	Base	Base to output		Fiscal to base	Semi-elasticity		
			T	(T-1)		T	(T-1)	Total
i,j	$\bar{r}_i, \bar{e}_j$	$\bar{B}$	η_0^{BY}	η_1^{BY}	η^{RB}, η^{EB}	ε_0	ε_1	ε
Current taxes on income and wealth	**9.8%**					**0.02**	**-0.01**	**0.01**
Direct taxes paid by corporations	3.2%	Gross operating surplus & mixed income	1.25	-0.34	1.95	0.05	-0.02	0.02
Direct taxes paid by households								
Personal income tax	6.2%					-0.02	0.01	-0.01
on earnings	3.6%		0.59	0.31	1.07	-0.01	0.01	0.00
w.r.t. employees		Employees	0.53	0.33	1.00			0.00
w.r.t. average earnings		Compensation per employee	0.07	-0.02	2.22			0.00
on business income	0.4%	Gross operating surplus & mixed income	1.25	-0.34	1.00	0.00	0.00	0.00
on capital income	1.0%	Gross operating surplus & mixed income	1.25	-0.34	1.00	0.00	0.00	0.00
on social benefits	1.3%	Pensions	0.00	0.00	1.00	-0.01	0.00	-0.01
Other current taxes	0.4%	Not cyclical / nominal trend GDP	0.00	0.00	1.00	0.00	0.00	0.00
Taxes on production and imports	**13.9%**					**0.06**	**0.00**	**0.06**
VAT	8.1%					0.05	0.00	0.05
on HH final consumption	6.4%	HH consumption excl. imputed rent	1.35	0.00	1.26	0.05	0.00	0.05
on govern. and NPISH consumption	1.0%	Government intermediate consumption and social transfers in kind	0.00	0.00	1.00	-0.01	0.00	-0.01
on GFCF	0.7%	Gross fixed capital formation	3.32	0.00	1.00	0.02	0.00	0.02
Other indirect taxes	5.9%					0.01	0.00	0.01
Stamp duties	1.1%	Nominal GDP	1.00	0.00	2.27	0.01	0.00	0.01
Other taxes on products	3.6%	HH consumption excl. imputed rent	1.35	0.00	1.00	0.01	0.00	0.01
Other taxes on production	1.2%	Not cyclical / nominal trend GDP	0.00	0.00	1.00	-0.01		-0.01
Net social contributions	**11.8%**					**-0.05**	**0.04**	**-0.01**
Paid by employers and employees	11.5%		0.59	0.31	1.00	-0.05	0.04	-0.01
w.r.t. employees		Employees	0.53	0.33	1.00			0.00
w.r.t. average earnings		Compensation per employee	0.07	-0.02	1.00			0.00
Paid by self- and non-employed	0.3%	not cyclical / nominal trend GDP	0.00	0.00	1.00	0.00	0.00	0.00
Other (non-cyclical) revenue	**7.2%**		**0.00**	**0.00**	**0.00**	**-0.07**		**-0.07**
TOTAL REVENUE (1)	**42.7%**					**-0.04**	**0.02**	**-0.01**
Unemployment benefits	1.2%	Unemployment	-3.80	-2.24	1.00	-0.06	-0.03	-0.08
Non-cyclical expenditure	47.5%					-0.47		-0.47
TOTAL EXPENDITURE (2)	**48.6%**					**-0.53**	**-0.03**	**-0.56**
OVERALL BALANCE (3)=(1)-(2)						**0.49**	**0.05**	**0.54**

TABLE 3. Computation of the aggregate semi-elasticity of the budget balance

Source: Authors' calculations.
Notes: The figure for the semi-elasticity ε is obtained as per equation (14) as no collection lags are considered (*i.e.*, $\eta_{1,i}^{RB} = \eta_{1,j}^{EB}$=0). As such, there is no response of fiscal items to the output gap of $t-2$ (*i.e.*, $\varepsilon_{2,i}^{R} = \varepsilon_{2,j}^{E} = 0$).

of Table 3). This implies that a 1 pp increase (decrease) in the output gap is estimated to induce a 0.54 improvement (deterioration) in the headline balance as ratio to GDP.

Figure 3 plots the estimates for the CAB obtained on the basis of this semi-elasticity against the actual headline balance and the output gap. It shows that the headline balance tends to improve in peaks and to deteriorate in troughs. This is essentially driven by the counter-cyclicality of the expenditure ratio which illustrates the functioning of automatic stabilizers: in "bad" times, the headline balance deteriorates because the expenditure ratio rises and stimulates domestic demand, smoothing the cyclical fluctuations. In turn, the CAB exhibits both smaller fluctuations and a weaker, and negative, correlation with the output gap, implying an average counter-cyclicality. These features are reinforced when focusing on the structural balance, which is corrected also for the impact of temporary measures.[21]

According to the new ESCB methodology, since EMU accession and up to the onset of the crisis, the Portuguese structural balance hovered around -4% of potential GDP. It rock-bottomed at -8.5% in 2009 and then sharply increased during the Economic and Financial Assistance Programme (Programme, henceforth), while the output gap was declining further into negative territory. Since 2015, the structural deficit recorded a small improvement and is estimated to have stood at 1% of potential GDP in 2017.

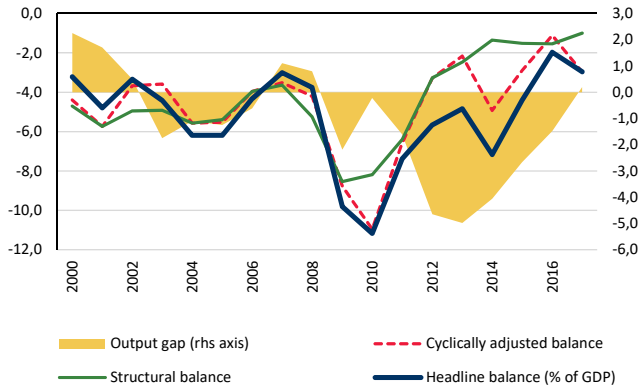


FIGURE 3: The cyclically adjusted and structural budget balances in the new ESCB methodology | In percentage of potential GDP

Sources: Authors' calculations.

The 0.54 semi-elasticity is slightly higher than the one implicit in the previous ESCB cyclical adjustment method (0.50 recomputed to 0.53, as

21. Table D.1, in Appendix D presents detailed descriptive statistics for both the CAB and the structural balances as per the new ESCB methodology.

explained in Section 2). Although the two figures are not entirely comparable, the difference between them is underpinned by a slight increase in total revenue and expenditure weights in GDP, more pronounced on the expenditure side, while the fiscal-to-base and the base-to-output elasticities are now estimated to be lower in most cases. Moreover, accounting for lagged effects also contributes to increase the semi-elasticity: in the new methodology, the contemporaneous component of the overall semi-elasticity stands at 0.49, with the remaining 0.05 being explained by the lagged responses (Table 3).

Across EU countries, the new semi-elasticities of the budget balance range from 0.32 to 0.64. Although there are some exceptions, lower semi-elasticities are typically associated with Eastern European countries, whereas higher semi-elasticities generally refer to economies with relatively large public sectors. The figure obtained for Portugal stands slightly above the EU (simple) average (0.46, see Figure 4).

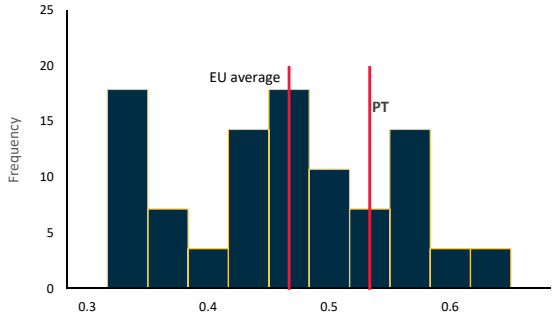


FIGURE 4: Empirical distribution of semi-elasticities across EU countries | In percentage

Sources: ESCB estimates and authors' calculations.

The new ESCB semi-elasticity for Portugal largely coincides with that recently obtained by the European Commission in the context of the regular update of the semi-elasticities used for fiscal surveillance (European Commission, 2019). Indeed, the most recent estimate by the Commission stands at 0.54, also revised up from the 0.51 figure obtained in 2014 (Mourre *et al.*, 2014). In spite of the relatively similar semi-elasticities, the fact that the ESCB and the European Commission rely on distinct assessments of the cyclical position of the economy yields differences also as regards CABs. In particular, CABs in *levels* estimated by the Commission are lower than those obtained on the basis of the new ESCB method throughout the whole 2000-17 period. Since the trough of the crisis the differential is larger, as the difference in the output gaps estimated by the two institutions is also wider (Figure 5).

In addition to the differences stemming from the assessment of the output gap, the ESCB and the European Commission also use distinct criteria to identify the temporary measures (and one-off factors) that are netted-out of

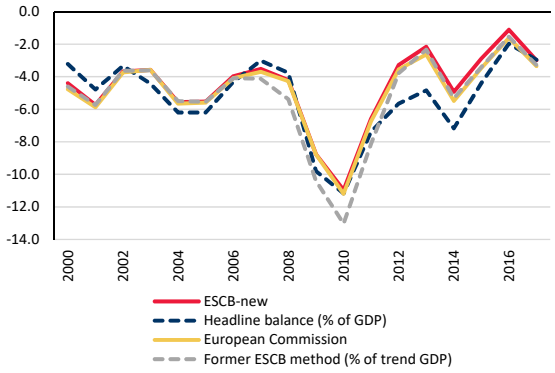
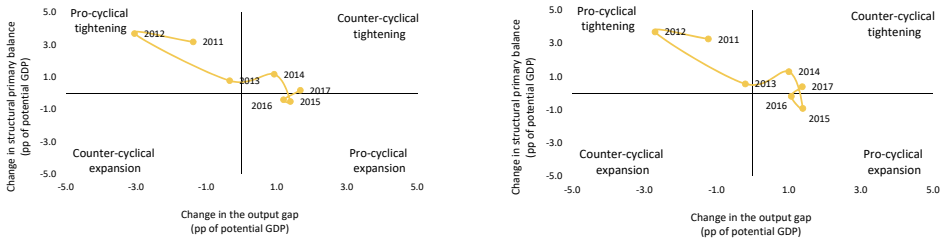


FIGURE 5: Estimates for the cyclically adjusted balance in Portugal: ESCB *vs* European Commission | In percentage of potential GDP

Sources: European Commission (AMECO data base and European Commission, 2019) and authors' calculations.
Notes: Figures referring to the European Commission were obtained using this institution's estimates for the output gap and the updated semi-elasticity published in European Commission (2019). Figures referring to the former ESCB cyclical adjustment method were obtained on the basis of (confidential) projections compatible with the December 2018 ESCB Broad Macroeconomic Projection Exercise.

the CAB to obtain the structural balance. Nonetheless, the assessments of the fiscal stance (as measured by the *change* in the structural primary balance, which further excludes the impact of interest payments) based on these two methodologies largely coincides. In particular, both assessments point to a



(A) ESCB methodology

(B) European Commission methodology

FIGURE 6: Fiscal policy stance according to the methods adopted in the ESCB and the European Commission | In percentage points of potential GDP

Sources: European Commission (AMECO database and European Commission, 2019) and authors' calculations.
Note: This comparison can only be made as of 2011 because information on the temporary measures and one-off effects considered by the European Commission is only available as of 2010.

broadly neutral stance of fiscal policy in the post-Programme years (Figure 6).

4. A revised disaggregated framework for the analysis of fiscal developments

4.1. Methodology

Since 2006, the ESCB has been implementing a framework for a detailed analysis of structural public finance developments, explained in Kremer *et al.* (2006). As a standardised method, it allowed a transparent and effective cross-country analysis of both past and projected fiscal developments. It identified the structural path of the main expenditure and revenue items, separating the effects of fiscal policy decisions from those of other factors and excluding the impacts of transitory elements beyond those of the economic cycle (such as temporary measures). The new ESCB CAB methodology allows the continuation of this analysis but it requires an adaptation of the framework. This section sheds light on the new adapted framework, developed in Bouabdallah *et al.*, 2019, and Morris and Reiss, 2019. An illustration for Portuguese public finances is provided, with a particular emphasis on the 2015-17 period.

On the revenue side, the overall structural change as a ratio to potential GDP encompasses changes in revenue referring to taxes (and social contributions) assumed to be cyclical, as well as in items that are unresponsive to the cycle: $\Delta sr_t = \sum_i \Delta sr_{i,t}$.

For each tax revenue item deemed to be sensitive to cyclical fluctuations, the change in structural revenue as a ratio to potential GDP can be written as

$$\begin{aligned}\Delta sr_{i,t} =& \Delta car_{i,t} - \Delta tm_{i,t} \\ =& \Delta r_{i,t} - \varepsilon_i^R \Delta og_t - \Delta tm_{i,t} \\ =& \Delta r_{i,t} - \bar{r}_i(\eta_i^{RB}\eta_i^{BY} - 1)\Delta og_t - \Delta tm_{i,t} \end{aligned} \quad (27)$$

where car_i is the cyclically adjusted revenue of item i expressed as a ratio to potential GDP, while tm_i is the effect of temporary measures as a ratio to GDP affecting item i. The remaining notation follows as defined before. The change in car_i can be further broken down into four components[22]:

- The impact of **permanent discretionary measures** as a ratio to GDP: $dm_{i,t}$. As aforementioned, this impact is largely based on official quantifications for the yield of measures presented in government documents.

22. For a detailed derivation, refer to Appendix E

Nonetheless, in some cases, it is adjusted on the basis of expert judgement.

- A (expected) **fiscal drag**: $car_{i,t-1}(\eta_i^{RB} - 1)\hat{Y}_t^*$, usually associated with tax progressivity, which emerges in the context of the personal income tax reflecting the non-indexation of tax brackets in the withholding tables. The difference between the progressive and proportional (unity) elasticities is multiplied by the potential GDP growth, which corresponds to the macro base's potential growth in the new methodology. It should, however, be noted that the growth of average income induces fiscal drag but growth in employment does not. As such, for calculating the fiscal drag it is assumed that the potential growth rate of average wages is identical to the potential growth rate of GDP per person employed. In some cases, the fiscal-to-base elasticity is higher than one due to the use of a proxy for the macro base (as with using gross operating surplus and mixed income instead of net entrepreneurial income for corporate income tax), or as a result of structure effects in the relation of a fiscal item and its macro base (like in VAT, for which the average rate stemming from consumption of durables is higher than that associated with consumption of non-durables). In these cases, the fiscal drag is assumed to be inexistent.

- Residuals from (unexpected) **composition effects**:
  $car_{i,t-1} \cdot \eta_i^{RB}[(\hat{B}_{i,t} - (\hat{Y}_t^* + \eta_i^{BY}\Delta og_t)]$, corresponding to the impact on tax revenue of macro bases ($\hat{B}_i$) not behaving according to the naive prediction yielded by the base-to-output elasticities ($\hat{Y}^* + \eta_i^{BY}\Delta og$), reflecting different types of shocks to the economy.[23]

- Other (unexpected) **residuals**: $res_{i,t}$, which captures the remaining developments of structural revenue. It is clearly more difficult to interpret and it may show deviations between the evolution of tax revenue and the naive estimate based on the tax to base elasticities and/or reflect mismeasurement errors in the other components.

Regarding other (non-cyclical) revenue, the structural ratio to potential GDP is computed as $sr_{ONCR,t} = r_{ONCR,t} - \varepsilon_{ONCR}^R \cdot og_t - tm_{ONCR,t}$, where $ONCR$ stands for other non-cyclical revenue. It can be subsequently broken down into somewhat narrower sub-items on the basis of the observed share of each item i in overall other revenue, excluding temporary measures, as follows:

$$sr_{i,t} = \frac{r_{i,t} - tm_{i,t}^R}{r_{ONCR,t} - tm_{ONCR,t}^R} sr_{ONCR,t} \tag{28}$$

23. With a cyclical lag the composition effect takes the form $car_{i,t-1}\eta_i^{RB}[(\hat{B}_{i,t} - (\hat{Y}_t^* + \eta_{0,i}^{BY}\Delta og_t + \eta_{1,i}^{BY}\Delta og_{t-1})]$.

The difference in each of these ratios vis-à-vis the previous year corresponds approximately to the simple annual change in ratios to potential GDP. As such, values differing from zero in the disaggregated analysis will show up, whenever, after excluding the impact of temporary measures, the growth of the non-tax item is not aligned with that of potential GDP.

On the expenditure side, unemployment benefits have a similar treatment to cyclical tax revenue. However, in this case there is no fiscal drag and the composition effect is computed on the basis of the difference between the growth rate of the respective macro base (number of unemployed) and what would be naively expected given the estimated elasticity, as described above. Moreover, as the macro base is defined in volume, the composition effect is computed on the basis of the potential growth rate of employment, instead of the growth rate of potential GDP.

For the other items of expenditure, which are considered non-cyclical, a similar treatment to non-tax revenue is applied. After computing the structural ratio to potential GDP of non-cyclical expenditure (NCE) as $se_{NCE,t} = e_{NCE,t} - \varepsilon^{E}_{NCE} \cdot og_t - tm_{NCE,t}$, the result is split according to the weight of the non-cyclical expenditure item j in overall non-cyclical expenditure observed in each year, with both the numerator and denominator adjusted for the impact of temporary measures:

$$se_{j,t} = \frac{e_{j,t} - tm^{E}_{j,t}}{e_{NCE,t} - tm^{E}_{NCE,t}} se_{NCE,t} \tag{29}$$

4.2. Results

The objective of this subsection is to apply the revised disaggregated methodology to past Portuguese public finance developments as a way of illustration. Although some charts present the data for the 2000-17 period, for the sake of conciseness, the descriptive analysis will focus on the three years after the end of the Programme for which outturn data is currently available, *i.e.* 2015 to 2017.

As shown in Figure 3, the structural balance in Portugal, computed in accordance with the new ESCB methodology, improved slightly from -1.4 per cent of potential GDP in 2014 to -0.9 in 2017. However, as the ratio of interest payments to potential GDP declined by 0.9 pp in the same period due to the significant reduction in the implicit interest rate on public debt, the structural primary balance deteriorated by 0.3 pp. This evolution is explained by a strong reduction in the structural revenue ratio (by 1.9 pp) that more than offset the decline in structural primary expenditure, which reached 1.5 pp (Figure 7).

Figure 8A shows that the bulk of the reduction in the structural revenue ratio in 2015-17 stems from the behaviour of non-tax revenue. Indeed, interest received by general government declined in this period, in a context of decreasing interest rates, and so did receipts from EU funds recorded as

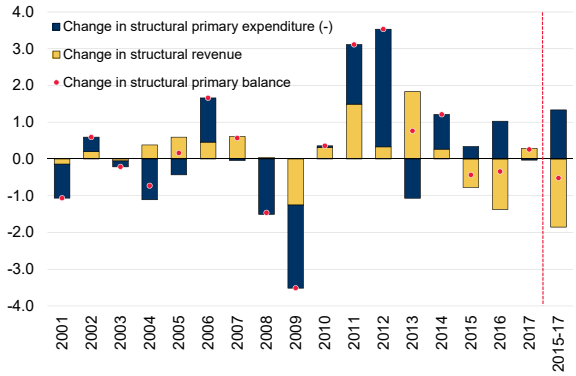


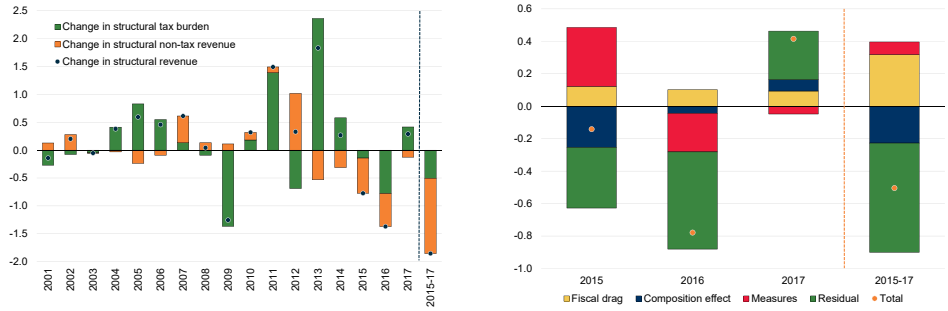
FIGURE 7: Change in the structural primary balance: revenue and expenditure contributions | In percentage points of potential GDP

Sources: Authors' calculations.
Note: An increase (reduction) in structural primary expenditure should be read as negative (positive) in the figure.

government revenue (an expected development in the first years of an EU support framework). Regarding the structural tax burden, the cumulative drop in the ratio to potential GDP is mostly explained by a negative residual and, to a smaller extent, a negative composition effect. By contrast, discretionary measures and the (personal income tax) fiscal drag contributed positively to the evolution of structural tax burden but these effects were not enough to offset the drop in the other two aforementioned components (Figure 8B).

The revised disaggregated methodology allows even a finer breakdown of the change in the structural tax burden by category (see Figure 9). Regarding the impact of (permanent) discretionary measures, the positive effect stems almost entirely from rises in indirect taxation. This especially refers to the tax on oil products but also to several other smaller taxes/fees. By contrast, there was in this period a decline in the VAT rate applicable to some restaurant services that negatively affected this tax's collection in both 2016 and 2017. This effect was reinforced by significant permanent discretionary changes in the context of the personal income tax: the 2015 reform and the elimination of a surcharge introduced during the Programme which yielded a non-negligible drop in revenue.

In this period the cumulative impact of the fiscal drag, relevant only in the case of the personal income tax, reached 0.3 pp of potential GDP. Although small, as it should be expected, this effect may be overestimated as it is



(A) Tax and non-tax revenue contributions 2001-17

(B) Breakdown of the change of the structural tax burden 2015-17

FIGURE 8: Breakdown of the change in structural revenue | In percentage points of potential GDP

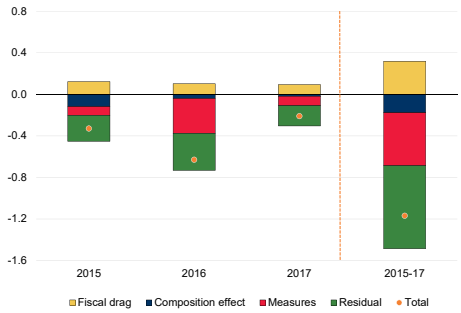
Sources: Authors' calculations.

assumed in its computation that there was no update of the tax brackets of the withholding tables. As significant modifications were introduced in the personal income tax in 2015-17, it is difficult to disentangle the impact of the regular update from that related to the changes in the tax code, particularly in the absence of a detailed analysis based on micro data.

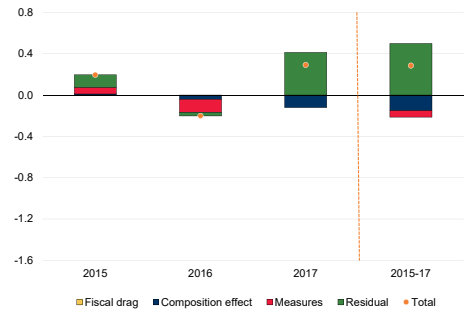
The composition effect is relatively small in each of the four main tax categories. Cumulatively over the period under analysis, it is broadly neutral regarding the taxes on production and imports. This reflects the fact that the behaviour of the main macro base for this aggregate – households' private consumption excluding imputed rents – was close to what could be expected on the basis of the naive prediction. Gross operating surplus and mixed income of the total economy exhibited, cumulatively over the three years, a slightly more mitigated evolution than the benchmark expectation. This affects taxes on income and wealth paid by corporations, but also the personal income tax levied on business and capital incomes, yielding a negative composition effect for these tax components. Finally, the composition effect associated to the compensation of employees of the economy as a whole, visible in the breakdown of social contributions and underlying the splitting of taxes on income and wealth paid by households, is positive but small over the 2015-17 period.

The residual component shows a significant negative magnitude over 2015-17, stemming to a large extent from direct taxes paid by households. This captures the fact that in this period there was an increase in net refunds in personal income tax, much concentrated in 2016, as well as a substantial drop in personal income tax collection on interest income, associated to the steep decline in market interest rates. The positive residual in direct taxes paid by corporations reflects the difficulties in obtaining a good fit for developments

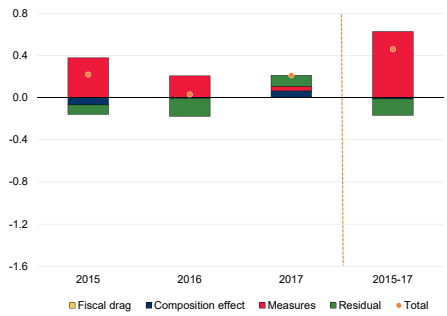
in actual receipts using a constant fiscal elasticity and a macro base. Indeed, in the case of Portugal, corporate income tax revenue is much concentrated in a relatively small number of large firms which justifies its considerable volatility and disconnection from its theoretical macroeconomic base. Taxes on production and imports also show a negative cumulative residual, which is partly attributed to the performance of the tax on real estate property. Also, the possibility of an overestimation of discretionary measures' impact should not be excluded as an explanatory factor. Lastly, the negative residual of social contributions stems entirely from the evolution of imputed contributions.



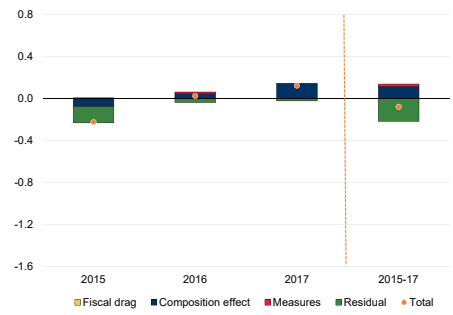
(A) Taxes on income and wealth paid by households



(B) Taxes on income and wealth paid by corporations



(C) Taxes on production and imports



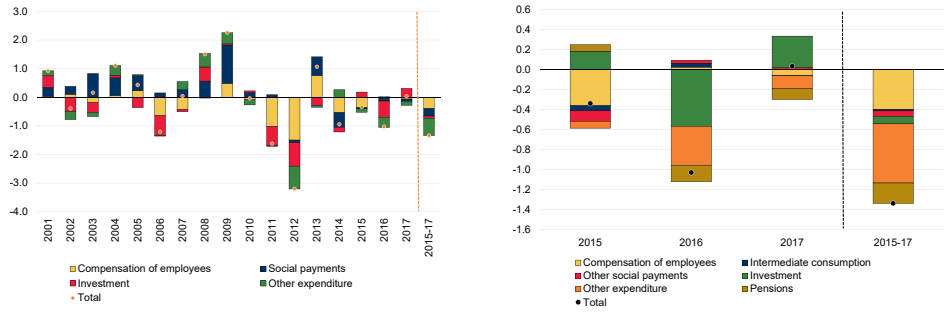
(D) Social contributions

FIGURE 9: Breakdown of the change of the structural tax burden by category | In percentage points of potential GDP

Sources: Authors' calculations.

On the expenditure side, all main items reduced their ratio to potential GDP in the 2015-17 period as a whole (Figure 10). The main contribution to the decline came from "other expenditure", which encompasses reductions in both subsidies and current transfers. Compensation of employees in the public sector also played a role, in spite of the small increase in the number of

public employees and the impact of the reversal of some wage cuts introduced just before and during the Programme. Pension expenditure also grew below nominal potential GDP as the increase in the number of pensioners and the annual update of pensions were rather limited. Investment has shown in the three years under analysis a volatile profile, which translated into a small reduction as a ratio to potential GDP. The contribution of the other items (intermediate consumption and other social payments) to changes in overall structural primary expenditure was negligible.



(A) Main primary expenditure items contributions 2001-17

(B) Finer breakdown of the change of the structural primary expenditure 2015-17

FIGURE 10: Breakdown of the change in structural primary expenditure | In percentage points of potential GDP

Sources: Authors' calculations.

5. Concluding remarks

The new ESCB methodology is broadly similar to aggregate cyclically adjustment methods adopted by other institutions, most notably the European Commission. Nonetheless, it presents a number of advantages compared to alternative frameworks. First, it takes time lags into account. Second, it allows for the disentanglement of the various drivers of structural fiscal developments, with a particular emphasis on the estimation of composition effects. Moreover, this estimation is now improved, insofar some of the highlighted limitations no longer apply. Finally, the estimation of fiscal-to-base and base-to-output elasticities introduces a number of refinements.

Additionally, the new ESCB methodology relies on more informed estimates of the output gap, departing from a purely statistical trend/cycle decomposition. Moreover, the new potential output estimates are subject to a peer review and ensure the consistency between the views of macro and fiscal experts on the cyclical position of the economy. This integration between

macroeconomic and fiscal analysis is also beneficial from the point of view of communicating policy advice.

According to the new ESCB methodology, the semi-elasticity of the budget balance with respect to the economic cycle stands at 0.54 in the case of Portugal. This result stems almost exclusively from the larger cyclical component of total expenditure as a ratio to GDP, as the semi-elasticity of the total revenue ratio is close to zero. When correcting the estimated cyclically adjusted balance for the impact of temporary measures, it is shown that since EMU accession and up to the onset of the crisis, the Portuguese structural balance hovered around -4% of potential GDP. It reached a minimum of -8.5% in 2009 and then sharply increased during the Programme. Since 2015, the structural deficit recorded a small improvement and is estimated to have stood at 1% of potential GDP in 2017.

The new ESCB semi-elasticity for Portugal largely coincides with that recently obtained by the European Commission in the context of the regular update of the semi-elasticities used for fiscal surveillance. However, the fact that the ESCB and the European Commission rely on distinct assessments of the cyclical position of the economy and temporary measures yields differences also as regards structural balances' estimates. The differences in levels can be significant in some years, particularly in the more recent period. However, the assessment of the fiscal stance (as measured by the change in the structural primary balance) is broadly similar.

Regardless of the methodology adopted, quantifying the effect of fluctuations in economic activity on public finances is inherently complex and requires several assumptions. All cyclical adjustment methodologies rely on unobservable variables. This, together with frequent *ex post* revisions, has lead to heightened criticism on the use of CABs in several *fora*. These views, however, are much centered on the fact that CABs (or more specifically, structural balances) are indicators on the basis of which fiscal targets are set and assessed in the context of the European fiscal surveillance mechanism. At the margins of this debate, CABs continue to be an useful and functional fiscal indicator, provided that the underlying methodology is well understood, allowing a proper interpretation of results.

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Appendix A: Mathematical derivation of the cyclically adjusted balance as a ratio to potential GDP

Let equation (A.1) define the cyclically adjusted budget balance:

$$cab_t = \frac{BB_t}{Y_t} - \varepsilon^{BB} \times og_t, \tag{A.1}$$

where, BB_t is the actual balance, Y_t is actual GDP, ε^{BB} is the semi-elasticity of balance (as a ratio to nominal GDP) with respect to the output gap and og_t is the output gap.

Let the semi-elasticity be defined as

$$\varepsilon^{BB} = \frac{d\left(\frac{BB_t}{Y_t}\right)}{dog_t}. \tag{A.2}$$

Since $dog_t \approx \frac{dY_t}{Y_t}$, (A.2) can be re-written as

$$\varepsilon^{BB} = \frac{d\left(\frac{BB_t}{Y_t}\right)}{dog_t} \approx \frac{d\left(\frac{BB_t}{Y_t}\right)}{\frac{dY_t}{Y_t}} \tag{A.3}$$

Plugging (A.3) into (A.1) implies

$$\begin{aligned} cab_t =& \frac{BB_t}{Y_t} - \frac{d\left(\frac{BB_t}{Y_t}\right)}{\frac{dY_t}{Y_t}} \cdot og_t = \frac{BB_t}{Y_t} - \frac{\frac{dBB_tY_t - BB_tdY_t}{Y_t^2}}{\frac{dY_t}{Y_t}} \cdot og_t \\ =& \frac{BB_t}{Y_t} - \frac{Y_tdBB_tY_t - BB_tdY_tY_t}{Y_t^2dY_t} \cdot og_t = \frac{BB_t}{Y_t} - \left(\frac{dBB_t}{dY_t} - \frac{BB_t}{Y_t}\right) \cdot og_t \end{aligned}$$

re-writing og_t as $\frac{dY_t}{Y_t^*}$ yields:

$$\begin{aligned} cab_t =& \frac{BB_t}{Y_t} - \left(\frac{dBB_t}{dY_t} - \frac{BB_t}{Y_t}\right) \cdot \frac{dY_t}{Y_t^*} = \frac{BB_t}{Y_t} - \frac{dBB_tdY_t}{dY_tY_t^*} + \frac{BB_tdY_t}{Y_tY_t^*} \\ =& \left(1 + \frac{dY_t}{Y_t^*}\right) \cdot \frac{BB_t}{Yt} - \frac{dBB_t}{Y_t^*} \end{aligned}$$

since dY_t measures the differential between the actual output level and potential output, it may be re-defined as $dY_t = Y_t - Y_t^*$. This implies

$$cab_t = \left(1 + \frac{Y_t - Y_t^*}{Y_t^*}\right) \cdot \frac{BB_t}{Yt} - \frac{dBB_t}{Y_t^*} = \left(\frac{Y_t^*}{Y_t^*} + \frac{(Y_t - Y_t^*)}{Y_t^*}\right) \cdot \frac{BB_t}{Yt} - \frac{dBB_t}{Y_t^*}$$
$$= \frac{Y_t}{Y_t^*} \cdot \frac{BB_t}{Y_t} - \frac{dBB_t}{Y_t^*} = \frac{Y_t BB_t}{Y_t^*} - \frac{dBB_t Y_t}{Y_t^* Y_t} = \frac{BB_t}{Y_t^*} - \frac{dBB_t}{Y_t^*}$$

Insofar dBB_t represents the gap between the actual budget balance and the balance compatible with output at its potential level, $dBB_t = BB_t - BB_t^*$, the definition of the cyclically adjusted balance in (A.1) can be re-written as

$$cab_t = \frac{BB_t}{Y_t^*} - \frac{dBB_t}{Y_t^*} = \frac{BB_t^*}{Y_t^*}, \tag{A.4}$$

making it clear that cab_t should be interpreted as a ratio to potential GDP.

Appendix B: Computation of average weights used in the calculation of the budgetary semi-elasticity

The calculation of the aggregate semi-elasticity is based on average weights in GDP of each of the relevant fiscal items. The weighting of the following items is based on official general government national accounts data for the 2008-17 period: current taxes on income and wealth, VAT, other indirect taxes, social contributions, other revenue and total expenditure. The average weight of spending on unemployment benefits is based on government expenditure by function data (COFOG), for the same time span.

Within current taxes on income and wealth, the split between direct taxes paid by corporations and households is based on data regarding direct taxes paid to the general government and the rest of the world. More specifically, these underlying shares are then applied to the direct taxes aggregate of the general government to ensure the exact splitting.

For the narrower subcategories of direct taxes, namely personal income tax and other current taxes, a similar approach is followed. In particular, the average weight of these items in the national tax lists for the period 2006-15 is applied to the average weight of direct taxes paid by households, calculated as above.

Finally, the split of the personal income tax revenue allocated to capital income, earnings, business income and social benefits is based on the Taxation Trends Report by the European Commission (European Commission, 2017). In particular, the share of personal income on capital income is proxied by the aggregate household's capital income taxes, which might slightly overestimate this component, given that it includes minor taxes other than the personal income tax. However, the actual split of the personal income tax in the aforementioned report clearly underestimates the shares for capital incomes for

some countries due to deductions and the difficulty of exactly pinpointing the revenue attributed to this component. The remainder of the personal income tax revenue is divided according to the actual average split of the tax published in the Taxation Trends Report tables for the 2007-16 period.

With regard to VAT, the average VAT weight from national accounts data is split according to average weights of each macro base – household consumption excluding imputed rental services; NPISH plus government intermediate consumption and social transfers in kind; and gross fixed capital formation (GFCF). However, the latter needs to be computed, given that only a share of GFCF is subject to VAT. To gauge the relevant base, one can draw on information from the Report on the VAT Gap (Poniatowski *et al.*, 2017) and use the effective VAT rate (based on the revenue attributed to households and the corresponding macro base) together with data regarding the VAT revenue attributed to GFCF. However, given the data limitations, a constant share of GFCF subject to VAT is computed based on the product of the average ratio between VAT revenue attributed to GFCF and consumption (in 2010-15) and the average ratio between consumption and GFCF (in 2006-15).

The weights of the narrower subcategories of indirect taxes have been computed based on the national tax lists, applying the corresponding average shares for the 2006-15 period to the national accounts aggregate average for 2008-17. The same approach is followed for social contributions.

Appendix C: Calibration of the fiscal-to-base elasticity for VAT with respect to households' final consumption

The following consumption structure is assumed for Portugal for time T and T+1:

	Consumption	
	T	T+1
Total consumption	100	101
Durables	9,4	9,9
Non-durables	90,6	91,1

Table C.1. Simulated consumption for period T and T+1
Source: Authors' calculations and ESCB.

First, it is assumed a total consumption of 100 for time T and a 1% increase in time T+1. The consumption of durables at time T is computed based on the average share, in 2008-17, of consumption of durables in total consumption excluding imputed rents. At time T+1 the consumption of durables grows, according to the estimated elasticities, namely:

$$C_{T+1}^{durables} = C_{T}^{durables} \times (1 + \frac{\eta_{Cdurables}^{BY} / \eta_{Ctotal}^{BY}}{100}) \tag{C.1}$$

where $C^{durables}$ corresponds to the consumption of durables and $\eta_{Cdurables}^{BY}$ and η_{Ctotal}^{BY} are the base-to-output elasticities of the consumption of durables and total household consumption excluding imputed rents. Finally, the consumption of non-durables is computed as the residual.

The corresponding VAT revenue for these levels of consumption is given in the table below and the implicit tax rates:

	VAT revenue		
	T	T+1	VAT rate
Total consumption	10,6	10,8	11,9%
Durables	1,7	1,8	22,2%
Non-durables	8,9	9,0	10,9%

TABLE C.2. Simulated VAT revenue in time T and T+1
Source: Authors' calculations and ESCB.

Here the VAT revenue is computed as:

$$VAT_t^i = C_t^i \times \frac{VATrate^i}{1 + VATrate^i} \tag{C.2}$$

where VAT_t^i corresponds to the revenue from VAT associated to a given type of consumption, C_t^i represents the corresponding consumption level (Table C.1) and the $VATrate^i$ is applied, as discriminated in Table C.2.

The tax rate applied to total consumption corresponds to the average effective VAT rate, namely the average ratio of VAT revenue in total consumption (excluding imputed rents) before VAT.[24] The average standard rate (in 2008-17) is applied to the consumption of durables, while the tax rate applied to the consumption of non-durables is calculated based on the respective simulated consumption and VAT revenue levels, where the latter was computed as an residual:

$$VATrate^i = \frac{VAT_t^i}{C_t^i - VAT_t^i} \tag{C.3}$$

where i refers to non-durables and $t = T$. In T+1 the total revenue is computed as the sum of the revenue from durables and non-durables.

24. More specifically, this ratio is approximated by $\frac{\bar{r}_{VAT}}{(\omega_{Cadj} - \bar{r}_{VAT})}$, where $\bar{r}_{VAT}$ is the average VAT revenue ratio over GDP and ω_{Cadj} the average weight of consumption excluding imputed rents in GDP (over 2008-17).

Finally, after simulating a 1% increase in total consumption and taking into account the composition of consumption, the fiscal elasticity ($\eta_{VAT}^{RB} = 1.26$) is given by the growth of VAT revenue between periods T and T+1.

Appendix D: Cyclically adjusted and structural balances: Descriptive statistics for Portugal

	Mean	Std. Deviation	Min (year)	Max (year)	Correlation with output gap
Headline balance	-5.26	2.35	-11.17 (2010)	-1.97 (2016)	0.31
Cyclically adjusted balance					
New ESCB method	-4.68	2.26	-10.89 (2010)	-1.06 (2016)	-0.14
European Commission	-4.89	2.21	-11.19 (2010)	-1.62 (2016)	-0.08
Former ESCB method(1)	-5.19	2.74	-13.03 (2010)	-1.56 (2016)	-0.40
Structural balance					
New ESCB method	-4.38	2.14	-8.51 (2009)	-0.91 (2017)	-0.29
European Commission(2)	-3.59	2.42	-8.5 (2010)	-1.3 (2017)	-0.23
Former ESCB method(1)	-4.89	2.54	-10.27 (2010)	-1.3 (2017)	-0.50

TABLE D.1. Headline, cyclically adjusted and structural balances: Descriptive statistics

Source: European Commission (AMECO data base and European Commission, 2019) and authors' calculations
Notes: (1) Figures referring to the former ESCB cyclical adjustment method are obtained on the basis of (confidential) projections compatible with the December 2018 ESCB Broad Macroeconomic Projection Exercise.
(2) Figures referring to the European Commission take into account this institutions' estimates for the output gap and the impact of temporary measures and one-off factors (Autumn 2018 forecast, with the exception of the update of the budgetary semi-elasticity). Since AMECO does not include data on temporary measures in the period prior to 2010, figures referring to the Commission's structural balance were computed only for the 2010-17 period.

Appendix E: Mathematical derivation of the disentangling of structural revenue developments

The change in the ratio to GDP of a given revenue item i can be expressed as

$$\Delta r_{i,t} = \frac{R_{i,t-1}}{Y_t}(\hat{R}_{i,t} - \hat{Y}_t) \tag{E.1}$$

which is equivalent to

$$\Delta r_{i,t} = \frac{R_{i,t-1}}{Y_t}(\eta_i^{RB}\hat{B}_{i,t} + \frac{DM_{i,t} + \Delta TM_{i,t} + RES_{i,t}}{R_{i,t-1}} - \hat{Y}_t) \tag{E.2}$$

Adding and subtracting $\hat{B}_{i,t}$ inside the parenthesis and considering $r_{i,t-1} = \frac{R_{i,t-1}}{Y_{i,t-1}} \approx \frac{R_{i,t-1}}{Y_{i,t}}$ the previous expression can be approximated by

$$\Delta r_{i,t} \approx r_{i,t-1}(\eta_i^{RB} - 1)\hat{B}_{i,t} + r_{i,t-1}(\hat{B}_{i,t} - \hat{Y}_t) + dm_{i,t} + \Delta tm_{i,t} + res_{i,t} \tag{E.3}$$

As the change in the structural revenue of each revenue item i as a ratio to potential GDP is defined as

$$\Delta sr_{i,t} = \Delta car_{i,t} - \Delta tm_{i,t} = \Delta r_{i,t} - \bar{r}_i(\eta_i^{RB}\eta_i^{BY} - 1)\Delta og_t - \Delta tm_{i,t}, \tag{E.4}$$

by incoporating equation (E.3) in (E.4), it follows that:

$$\Delta sr_{i,t} = r_{i,t-1}(\eta_i^{RB} - 1)\hat{B}_{i,t} + r_{i,t-1}(\hat{B}_{i,t} - \hat{Y}_t) - \bar{r}_i(\eta_i^{RB}\eta_i^{BY} - 1)\Delta og_t + dm_{i,t} + res_{i,t} \tag{E.5}$$

which can be simplified assuming $car_{i,t-1} \approx r_{i,t-1} \approx \bar{r}_i$:

$$\Delta sr_{i,t} \approx car_{i,t-1}(\eta_i^{RB}\hat{B}_{i,t} - \hat{Y}_t + \Delta og_t - \eta_i^{RB}\eta_i^{BY}\Delta og_t) + dm_{i,t} + res_{i,t}, \tag{E.6}$$

Since $\Delta og_t = \hat{Y}_t - \hat{Y}_t^*$, if we add and subtract $\eta_i^{RB}\hat{Y}_t^*$ and re-arrange, equation (E.6) can be simplified as

$$\Delta sr_{i,t} \approx car_{i,t-1}(\eta_i^{RB} - 1)\hat{Y}_t^* + car_{i,t-1}\eta_i^{RB}[\hat{B}_{i,t} - (\hat{Y}_t^* + \eta_i^{BY}\Delta og_t)] + dm_{i,t} + res_{i,t} \tag{E.7}$$

The four components explaining the change in structural developments of taxes and social contributions ratios to potential GDP are thus identified:

- (permanent) **discretionary measures**: $dm_{i,t}$, expressed as a percentage of nominal GDP
- **fiscal drag**: $car_{i,t-1}(\eta_i^{RB} - 1)\hat{Y}_t^*$
- (residuals from unexpected) **composition effects**: $car_{i,t-1} \cdot \eta_i^{RB}[(\hat{B}_{i,t} - (\hat{Y}_t^* + \eta_i^{BY}\Delta og_t)]$
- (other) **residuals**: $res_{i,t}$, also expressed as a percentage of nominal GDP.

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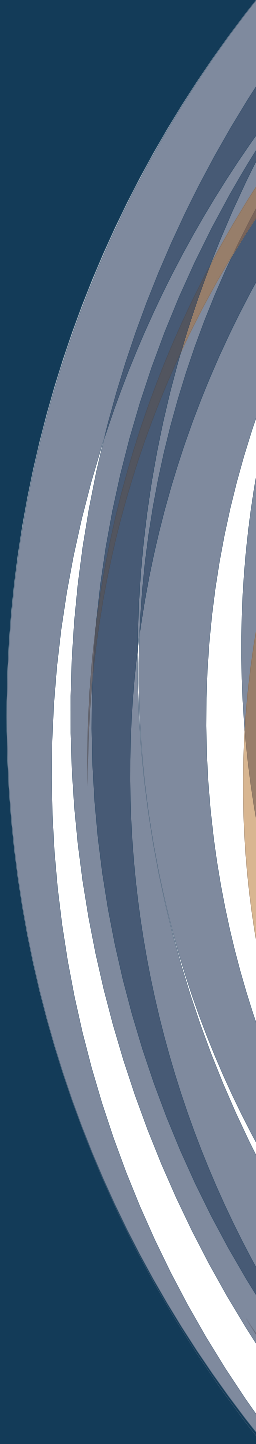

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