

# SHORT-TERM FORECASTING OF INDIRECT TAX REVENUES: AN APPLICATION FOR PORTUGAL\*

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## ABSTRACT

In recent times the prompt assessment of the evolution of the fiscal situation has become increasingly important. This topic is even more relevant in the case of Portugal, which is currently subject to an Economic and Financial Assistance Programme. In this context, this paper aims to produce short-term forecasts at an infra-annual frequency for the general government deficit, on a national accounts basis, in Portugal. It focuses on indirect tax revenues and uses “short-term forecasting” techniques which, in the literature, are essentially geared to economic developments. The results vary in line with the considered taxes: VAT, tax on oil products and tax on vehicle sales.

## 1. Introduction

Access to prompt, reliable information on the economic situation is crucial for policy-makers, as the results of the actions taken depend on the quality of the evaluation. This concern has led to the production of extensive literature in the area of short-term forecasting, both eminently theoretical, focused on the development of new analytical techniques, and having an empirical nature, concerning the relative evaluation of methodologies. To-date, the focus of this type of analysis has been mainly geared to economic developments, both in terms of the evolution of activity and inflation.<sup>1</sup>

In the current context of the sovereign debt crisis in euro area countries, the concern of estimating the short term evolution of fiscal variables has become prominent. This topic is particularly relevant for a country such as Portugal, under an Economic and Financial Assistance Programme, which encompasses a quarterly evaluation process based on performance criteria that translate into quantitative targets set on a level of certain public finance variables.

The preparation of short-term budgetary estimates benefits from the recent developments in the production of public finance statistics at an infra-annual frequency. On a public accounts basis, reference should be made to the reduction of the time taken to produce information and greater level of detail included in the monthly Bulletin of the Directorate General of the Budget (DGO). Regarding the national accounts basis, on which the budgetary commitments on a European Union level are established, the quarterly national accounts, by institutional sector, compiled by Statistics Portugal (*INE*) play a crucial role.

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<sup>1</sup> Bandura *et al.* (2011) present a discussion of the alternative methods in short-term forecasting, as well as the challenges that arise in this area of research.

This article aims to contribute to the production of short-term forecasts at an infra-annual frequency for the general government deficit on a national accounts basis in Portugal.<sup>2</sup> It focuses on indirect tax revenues<sup>3</sup>, given their importance in the overall tax burden and the fact that these taxes are more directly related to macroeconomic variables whose evolution is monitored on a monthly basis by Banco de Portugal. The data for the 1998-2012 period relating to State subsector tax revenues on a public accounts basis was used for the public finances information. These data are currently published every month by DGO, three weeks from the end of the reference period.

The results vary in line with the taxes considered. The long-term evolution of Value Added Tax (VAT) has a unitary elasticity with respect to an indicator that takes into account the consumption structure by products, taxed at different rates. In the short-term, the elasticity in relation to the prices and tax rates components of this indicator is also unitary, while the elasticity with respect to the volume component is clearly higher than one (1.5). The evolution of the tax on oil products (TOP) is explained by an indicator based on the tax rates per litre and petrol and diesel sales, with a unitary long-run elasticity and a short-term elasticity of slightly more than one. The tax on vehicle sales (TVS) is estimated solely on the number of vehicles sold and does not consider the level of taxation, as its translation into a synthetic indicator is difficult to achieve. As such, in this case, it is not possible to establish a long-term association between the revenue and the indicator constructed. The estimated relation is based solely on the short-term elasticity between the evolutions of the two variables, which is slightly lower than one. The evolution of the other indirect taxes is characterised by significant volatility and does not appear to be linked with economic activity. Although its projection is not addressed in this article, it should, however, be based on the application of several technical assumptions and the introduction of specific information, namely related to tax changes.

The article is organised as follows. Section 2 summarises the current structure of tax revenues. Section 3 describes the procedures used to estimate the evolution of revenue from the various indirect taxes. Section 4 presents an application to 2012. In order to analyse the robustness of the estimated results, an evaluation of the model in the last two years outside the period used for estimation, was also carried out. Finally, Section 5 presents the concluding remarks.

## 2. Tax revenue structure

General government tax revenues, defined as receipts from taxes on income and wealth (direct taxes) and taxes on production and imports (indirect taxes), have recorded an increase as a ratio to GDP in recent decades, particularly up to 2007. In 1995 the ratio of tax revenues to GDP stood at 20.8 per cent, rising to a peak of 24.0 per cent in 2007 and decreasing to 22.9 per cent in 2012. In this period, about half of the increase was explained by the behaviour of the revenue from taxes on production and imports.

In 2012, tax revenue stood at 37.8 billion euros, representing 56 per cent of total revenue. Indirect taxes in the same year represented around 60 per cent of total tax revenue. Special reference should be made to the importance of VAT, comprising 36 per cent of total tax revenue and around 70 per cent of indirect taxes (Chart 1). In terms of the proportion of indirect tax receipts VAT is followed by TOP (11 per cent), stamp duty and tobacco tax (both 7 per cent) and TVS (2 per cent).

In terms of the public accounts, State subsector tax revenues stood at 32 billion euros in 2012. This difference is largely explained by tax receipts from other general government subsectors, in particular Social Security (VAT), local government (personal income tax, corporation tax surcharge, municipal taxes

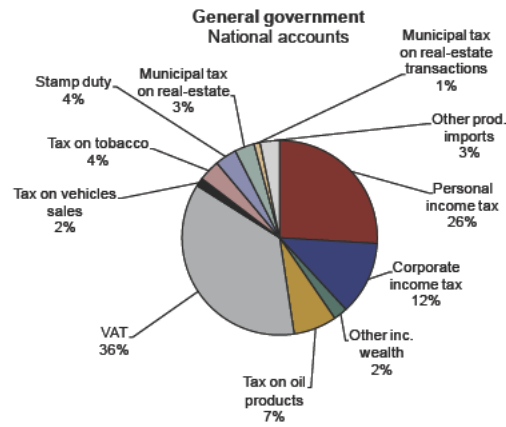
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**2** References to applications of such methodologies on fiscal variables are very scarce in the literature, e.g. see Lamo and Camba-Mendez (2004), who estimated the quarterly values of the budget balance in Germany and Italy from relevant quarterly macroeconomic series or Leal *et al.* (2011), who constructed a multivariate mixed frequencies model for the short-term monitoring of the budget balance in Spain.

**3** Indirect tax revenues are designated as taxes on production and imports in the national accounts.

Chart 1

STRUCTURE OF TAX REVENUE IN 2012



Source: INE.

on real-estate property and transaction)) and regional government (personal income tax, corporation tax and VAT). Additionally, in the national accounts, some of the amounts recorded in other items in the public accounts, such as sales of goods and services and/or other current and capital receipts, have been reclassified as taxes.

As regards the difference between the two types of accounting, it is worth noting that in the national accounts taxes are recorded both on a “cash” basis, as in the public accounts, and on a “cash-adjusted” basis. In the latter case, a time lag is considered in order to allocate the revenue to the respective financial year. Greater detail on these lags is given in the presentation of the models for each tax.

### 3. Estimation/projection of revenue from indirect taxes

#### 3.1. Value Added Tax

The indicator for VAT receipts can be approximated by the product of the tax rate ( $t$ ) by nominal private consumption prior to the application of the tax ( $C^*$ ). It should be noted that this procedure does not enable the observed level of revenue to be replicated as it only considers VAT receipts on private consumption and particularly excludes revenue associated with the intermediate consumption of the private sector<sup>4</sup>, public consumption (social benefits in kind and intermediate consumption components) and public investment. According to information provided by INE for the year 2010, the share of VAT revenue not covered by the procedure adopted was around 38 per cent.

The analysis assumed a time lag of 45 days between consumption expenditure and the collection of the tax, which is in line with the rule used to convert the data of the public accounts to the national accounts. 75 per cent of January and February revenue of the following year is added to and 75 per cent of January and February receipts of the same year is subtracted from the compilation of annual values of the current year. The relevant quarterly indicator for tax revenues on a public accounts basis can therefore be described as an average between the revenues associated with contemporary consumption ( $t_t C_{t^*}$ ) and those related with the previous quarter consumption ( $t_{t-1} C_{t-1}^*$ ).

$$I(vat)_t = 1/2 t_t C_{t^*} + 1/2 t_{t-1} C_{t-1}^* \tag{1}$$

4 As it is the case of some exempt sectors like banking, health and education.

This indicator for VAT receipts has to be re-expressed in more detail to take into account the different VAT rates on the various private consumption components included in the short-term macroeconomic scenario.

The theoretical average rate of VAT for the consumption component  $j$  in period  $t$  ( $to_t^i$ ) is calculated taking into account the tax rate  $i$  at time  $t$  ( $to_t^i$ ) and the weight of the consumption component  $j$  which is subject to the tax rate  $i$  ( $\alpha^{i,j}$ ).

$$\begin{aligned}
 to_t^j &= \sum_i to_t^i \alpha^{i,j} \\
 i &= 1, 2, 3, 4 \text{ (number of VAT rates)} \\
 \sum_i \alpha^{i,j} &= 1, \forall j
 \end{aligned}
 \tag{2}$$

These theoretical rates that reflect legislation are subsequently adjusted in order to achieve the actual rates ( $te_t^j$ ) for each consumption component. The tax rate used for each consumption component is, therefore, given by:

$$t_t^j = \frac{te_t^j}{to_t^j} \sum_i to_t^i \alpha^{i,j}
 \tag{3}$$

National accounts data for VAT revenues associated with the different consumption components, based on the four digit COICOP (Classification of Individual Consumption According to Purpose) in the 2008-2010 period, were used in the calculation of actual rates.<sup>5</sup> As this difference varies between sectors, the use of actual rates may be particularly important in estimating the effects of changes in VAT rates. In this case, it was assumed as a hypothesis that the ratio between the actual and theoretical rates would remain unchanged at the levels observed.<sup>6</sup>

Three VAT rates were considered in the analysis (reduced, intermediate and standard), as well as consumption exempt from VAT. Consumer spending before VAT for each consumption component ( $C_t^{*j}$ ) is also obtained from observed consumption expenditure ( $C_t^j$ ) and the respective average tax rate ( $t_t^j$ ), based on the following formula:

$$C_t^{*j} = \frac{C_t^j}{(1 + t_t^j)}
 \tag{4}$$

Nominal expenditure can be split between quantity ( $Q$ ) and price ( $P$ ), assuming that the difference between spending with and without VAT is reflected at the deflator level.

$$C_t^{*j} = Q_t^j P_t^{*j} = Q_t^j \frac{P_t^j}{(1 + t_t^j)}
 \tag{5}$$

It should be noted that the use of consumption before VAT as a tax base will enable a more accurate assessment of the effects on revenue resulting from changes in tax rates. The evolution of prices may not fully reflect the increase (decrease) in tax rates, particularly if there is a contraction (expansion) of profit margins. In this situation, the tax base decreases (increases) and receipts will accordingly be smaller (larger).

Considering four consumption expenditure components ( $j$  = consumption of vehicles, other durables, food and other non-durable goods), the VAT revenue indicator can be re-expressed as:

$$I(vat)_t = \frac{1}{2} \sum_{j=1}^4 t_t^j Q_t^j P_t^{*j} + \frac{1}{2} \sum_{j=1}^4 t_{t-1}^j Q_{t-1}^j P_{t-1}^{*j}
 \tag{6}$$

5 Given VAT developments in 2009, the average 2008 and 2010 values were used in the analysis.

6 The values of these ratios stood at 0.89 in the case of VAT on vehicles, 0.74 on food, 0.66 on the consumption of non-durables non-food and 0.62 on other durables.

This nominal indicator can be split into two components: an indicator based on quantities and tax rates  $Iqt(vat)$  and a price indicator  $Ip(vat)$ .

The quantities and tax rates indicator is defined by applying the various actual tax rates to the respective quantities consumed, determined on the basis of consumption series expressed in constant prices of a given year.

$$Iqt(vat)_t = \frac{1}{2} \sum_{j=1}^4 t_t^j Q_t^j + \frac{1}{2} \sum_{j=1}^4 t_{t-1}^j Q_{t-1}^j \quad (7)$$

As such, this  $Iqt$  indicator reflects not only the consumption volume but also the impact of changes in VAT rates in which  $Iq$  is the expression that measures the volume effect:

$$Iq(vat)_t = \frac{1}{2} \sum_{j=1}^4 Q_t^j + \frac{1}{2} \sum_{j=1}^4 Q_{t-1}^j \quad (8)$$

The expression that measures the effect of the tax rates is therefore obtained by difference and corresponds to a weighted average of the different tax rates, whose weights reflect each component's share of total consumption.

$$It(vat)_t = \frac{Iqt(vat)_t}{Iq(vat)_t} = \sum_{j=1}^4 t_t^j \left( \frac{Q_t^j}{\sum_{j=1}^4 Q_t^j + Q_{t-1}^j} \right) + \sum_{j=1}^4 t_{t-1}^j \left( \frac{Q_{t-1}^j}{\sum_{j=1}^4 Q_t^j + Q_{t-1}^j} \right) \quad (9)$$

The price indicator is obtained from the ratio between the nominal indicator and the quantities and tax rates indicator defined above.

$$Ip(vat)_t = \frac{I(vat)_t}{Iqt(vat)_t} = \sum_{j=1}^4 \left( \frac{t_t^j Q_t^j}{\sum_{j=1}^4 t_t^j Q_t^j + \sum_{j=1}^4 t_{t-1}^j Q_{t-1}^j} \right) P_t^{*j} + \sum_{j=1}^4 \left( \frac{t_{t-1}^j Q_{t-1}^j}{\sum_{j=1}^4 t_t^j Q_t^j + \sum_{j=1}^4 t_{t-1}^j Q_{t-1}^j} \right) P_{t-1}^{*j} \quad (10)$$

The price indicator therefore reflects a weighted average of the prices of the various consumption components, whose weights are related to the importance of the respective component in the calculation of the quantities and tax rates indicator.

The occurrence of several changes in VAT rates during the period considered were taken into account in the construction of these indicators:

- (i) June 2002: increase in standard rate from 17% to 19%
- (ii) July 2005: increase in standard rate from 19% to 21%
- (iii) July 2008: decrease in standard rate from 21% to 20%
- (iv) July 2010: increase in standard rate from 20% to 21%  
increase in intermediate rate from 12% to 13%  
increase in reduced rate from 5% to 6%
- (v) January 2011: increase in standard rate from 21% to 23%
- (vi) October 2011: increase in the reduced rate of 6% on electricity and natural gas to the standard rate of 23%
- (vii) January 2012: increase in the intermediate rate of 13% on restaurants to the standard rate of 23%

Information on the weights of each VAT rate associated with the four consumption components is given in table 1. For the most recent period these weights were modified in order to incorporate the last two changes in the tax rates. According to these figures, the average actual VAT rate on private consumption rose from 8.7 per cent in 2010 to 10.1 per cent in 2012.

Chart 2 provides information on the evolution of the constructed indicator vis-à-vis the observed revenue from VAT, with both variables evaluated at levels and at rates of change from the first quarter of 1998 to the fourth quarter of 2012.<sup>7</sup>

It should firstly be noted that the level of the indicator is persistently below observed VAT receipts (935 million euros on average in the period considered). This difference may be related to the fact that, as already mentioned, the indicator does not consider components other than private consumption which are also taxed under VAT. Another aspect which should be highlighted is the fact that revenues from VAT are highly seasonal. The trend towards higher first quarter levels is related to the fact that February revenue reflects December consumption.<sup>8</sup> Finally, it should be noted that the quarter-on-quarter evolution of VAT revenue also tends to be significantly volatile.<sup>9</sup>

Unlike the tax revenue published by DGO and the general government quarterly national accounts, the constructed indicator is, by definition, seasonally adjusted as it is based on quarterly national accounts seasonally adjusted for private consumption. The estimation of the relationship between VAT revenue and the constructed indicator is based on rates of change, which reduces volatility and avoids the problems associated with the seasonality of the series.

Based on the same period, and considering the variables measured in logs, the estimated equations for the long-term evolution and the short-term dynamics by way of an error correction model are as follows (t-ratios in parentheses):

Long-term solution:

$$VAT^* = 0.462 + 1.000I(vat) + 0.053S1 - 0.095S2 - 0.023S3 - 0.118Ds2009q2 \quad (11)$$

(32.80)                      (2.72)      (-4.97)      (1.20)      (-7.57)

**Table 1**

SHARE OF HOUSEHOLDS CONSUMPTION EXPENDITURE BY VAT RATES   AS A PERCENTAGE OF TOTAL				
	Standard rate	Intermediate rate	Reduced rate	Exempt
Durables: vehicles	100.0	0.0	0.0	0.0
Durables: non-vehicles	100.0	0.0	0.0	0.0
Non-durables: food	22.9	11.7	65.5	0.0
Non durables: non-food	43.9	14.4	24.3	17.5
from October 2011 <sup>(1)</sup>	48.0	14.4	20.2	17.5
from January 2012 <sup>(2)</sup>	61.1	1.2	20.2	17.5

**Source:** Authors calculations based in national accounts data from the period from 2008 to 2010.

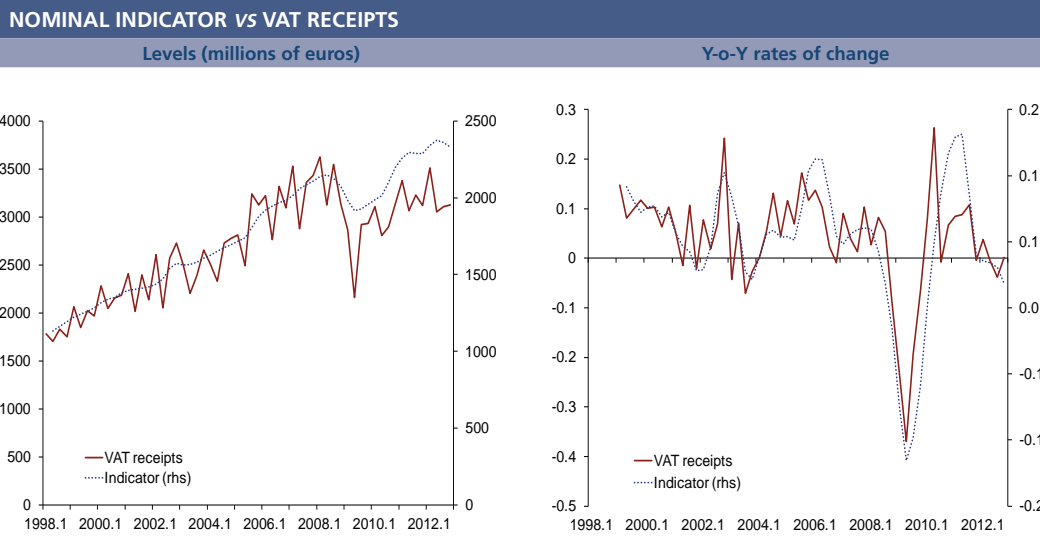
**Notes:** (1) In order to reflect the change of the VAT rate on the consumption of electricity and natural gas, from the reduced to the standard rate, assuming an unchanged consumption structure. (2) In order to reflect the change of the VAT rate on expenditure in restaurants, from the intermediate to the standard rate, assuming an unchanged consumption structure.

**7** The series presented are adjusted for the effect of the sale of State tax credits to *Sagres* in December 2003. The amount of VAT totalled 808.5 million euros, according to information disclosed by DGO.

**8** Based on available monthly data, the receipts were also particularly high in May, August and November, reflecting the fact that these are the months when VAT on a quarterly basis is collected.

**9** The original series, measured in first difference of logarithms, has an average value of 1 per cent and a standard deviation of 13 per cent. The seasonally adjusted series (using procedure X11 ARIMA) allows a significant reduction in the standard deviation, which, however, still remains at a very high level (7 per cent).

Chart 2



Source: Authors calculations.

in which the dummy variables  $S_i$  ( $i=1,2,3$ ) capture seasonal effects, while the variable  $Ds2009q2$  represents a permanent change from the second quarter of 2009.

Short-term evolution:

$$\begin{aligned} \Delta^4 VAT = & -0.010 + 1.527 \Delta^4 Iq(vat) + 1.000 \Delta^4 Ip(vat) + 1.000 \Delta^4 It(vat) \\ & (-1.66) \quad (7.58) \\ & - 0.701 \left[ VAT_{t-4} - VAT_{t-4}^* \right] \\ & (-5.56) \\ & -0.219 D2009q2 + 0.121 D2009q2_{t-4} \\ & (-4.90) \quad (2.57) \end{aligned} \quad (12)$$

$R^2 = 0.776248$

$F(4,50) = 43.37 [0.000]$

no. of observations = 55

no. of parameters = 5

AR 1-4 test:  $F(4,46) = 0.31366 [0.8674]$

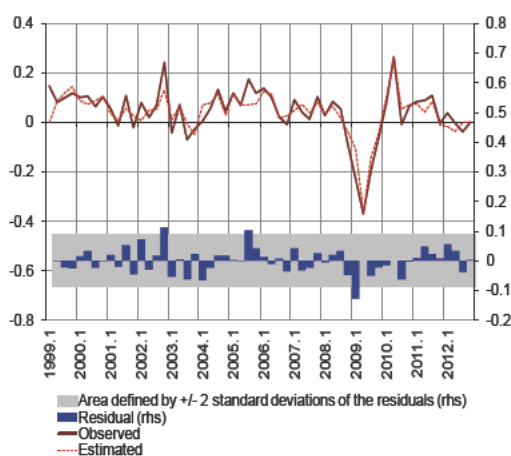
Chart 3 shows the fit of the equation in the sample period considered. In the long run it was assumed that VAT revenue follows the indicator with a unit elasticity, although some preliminary results pointed to slightly lower elasticities. On the other hand, several results justify the possibility of an elasticity of more than one, reflecting the fact that goods with higher income elasticity tend to be taxed at higher rates (see Braz and Cunha, 2009). It was therefore decided to introduce the restriction of a unitary elasticity, an assumption which was not rejected in estimations in which the obtained coefficient was statistically similar to one.

As regards the long-term evolution of VAT receipts, the data also suggest a permanent change in the relationship between revenue from VAT and the constructed indicator, which was taken into account through a dummy variable from the second quarter of 2009. Currently, there is no satisfactory explana-



Chart 3

FIT OF THE VAT RECEIPTS EQUATION | Y-O-Y RATES OF CHANGE (LOGS)



Source: Authors calculations.

tion for this phenomenon, but the unfavourable evolution of tax revenue in the said year was partially explained by an increase of refunds associated with a shortening of the deadlines for reimbursement. Finally, as revenues from VAT are subject to seasonal fluctuations, unlike private consumption in the quarterly national accounts, dummy variables to capture these seasonal effects were also considered ( $S_i$  refers to the specific effect for quarter  $i$ ). The results obtained point to the existence of a cointegration relationship between the levels of the indicator and VAT revenue.

Concerning short-term developments, reference should be made to the estimation of an elasticity of more than one (1.5) with respect to fluctuations in consumption in real terms. In the lower (higher) phases of the cycle the fact that lower (higher) revenue performance vis-à-vis the benchmark tends to be observed, can be explained by the higher (lower) propensity to tax evasion and fraud and changes in the consumption structure towards higher (lower) spending on goods with lower prices and/or taxed at reduced and intermediate rates, as well as other limitations in capturing non-linear effects. In the case of the reaction to changes in prices and tax rates a unit elasticity was assumed. Finally, in line with the observed long-term relationship, the results presented consider the existence of an outlier in the second quarter of 2009.

According to the results, a 1 per cent increase in nominal consumption, equally distributed between price and quantity and between the various expenditure components leads to a change of around 1.2 per cent in VAT revenue. If this increase were fully explained by a volume effect revenues would have grown 1.5 per cent. However, the importance of this impact differs depending on the consumption component affected. In this context, it is important to take into account the tax rates for each consumption component, as well as its proportion of total expenditure. Table 2 illustrates the sensitivity of VAT revenue to shocks in different consumption components. It is worth emphasising the importance of durable goods for VAT developments, particularly as regards the vehicle component. Despite its small proportion of total consumption, the high VAT rate and its significant volatility show its potential contribution to the evolution of tax revenues.



**Table 2**

SENSITIVITY OF VAT RECEIPTS TO THE DIFFERENT CONSUMPTION COMPONENTS					
	VAT average rate <sup>(1)</sup>	Weights of the bases in 2012	Standard deviation of the bases <sup>(2)</sup>	% impact in VAT receipts:	
				unit shock <sup>(3)</sup>	one standard deviation shock <sup>(3)</sup>
Vehicles	20.4	2.6	18.6	0.04	0.74
Other durables	14.4	3.6	7.3	0.05	0.40
Food	7.9	21.0	1.0	0.32	0.32
Non-durables non-food	10.2	72.9	2.8	1.11	3.12

**Sources:** *INE* and authors calculations.

**Notes:** **(1)** Actual rate calculated by the authors. It encompasses the recent change in the VAT rate for expenditure in restaurants. **(2)** Calculated with the y-o-y rates of change for the 1999-2012 period. **(3)** Percentage change in total VAT receipts stemming from a one per cent shock in the volume of the various consumption components.

### Incorporation of new monthly data

Given the quarterly frequency of the indicators calculated, it is important to study how the monthly information provided by DGO during the quarter under review should be incorporated. The availability of a new monthly observation, in addition to influencing the quarterly estimate resulting from the aggregation of the respective months, can also be used to correct the implicit forecast for the remaining months of the quarter that are not yet available. In this regard, an analysis showed that, on average in the past, the quarterly forecast errors would have been minimised if there had been no reaction to the monthly information that was being made public, either to extend or to compensate for the discrepancy between the monthly information and the projection obtained for the quarter as a whole. In any case, it is important to stress that at any point of time deviations may have a different nature and an analyst's real-time assessment of each specific case, when new monthly information is available, is fundamental.

### Identification of base effects

One disadvantage of using models expressed in rates of change relates to their inability to capture effects related to the evolution of the variable in the corresponding period of the previous year (usually called base effects). The lagged term (same quarter of the previous year) is frequently deemed to be statistically significant. However, the interpretation thereof is not straightforward. The evolution of this term may reflect an unusual occurrence in the same period of the previous year - tending to cause a base effect on the annual rate of change this year - or the correction of a base effect which took place two years ago and, as such, not a base effect for the current year rate of change. In this context, based on the estimated equation, an analysis of the significance of the residuals in the same period of the preceding year, considering several criteria for the selection of observations capable of producing a base effect, was carried out. The results are presented in Table 3 and point to the absence of a significant negative correlation between the contemporary period and the same period of the previous year residuals, regardless of the criteria used. This result could stem from the fact that, although in the specification adopted the variables are expressed in rates of change, it was considered an error correction term in the same period of the previous year and expressed in levels, with a high and statistically significant coefficient.

**Table 3**

CORRELATION BETWEEN RESIDUALS   VAT				
	k=0.0	k=0.5	k=1.0	k=1.5
$\rho(e_t, e_{t-k})$	-0.17	-0.32	-0.06	0.02

**Source:** Authors calculations.

**Notes:** "k" represents a scale factor to be applied to the standard deviation of the residuals in the identification of observations sufficiently significant to produce base effects. Thus, it is considered that the information is affected by base effects when the respective residual is outside the interval  $\pm k\sigma$ , with  $\sigma$  being the standard deviation of the estimated residuals.

### 3.2 Tax on oil products

TOP is a specific tax (cents/litre) on fuel sales. The natural indicator for the revenue associated with sales of fuels can therefore be expressed as,

$$I(top)_t = tp_t Cp_t + td_t Cd_t \quad (13)$$

in which  $tp_t$  and  $td_t$  are the specific taxes in period  $t$  on petrol ( $Cp_t$ ) and diesel ( $Cd_t$ ) sales respectively.<sup>10</sup>

Chart 4 shows the evolution of the tax rates, with information on the consumption of petrol and diesel being shown in chart 5. These graphs illustrate the significant increase in taxation on fuel over the last decade, especially for petrol, where the tax rose from close to 30 cents/litre in 2000 to a current level of around 60 cents/litre. In terms of consumption, it should be noted that diesel sales showed some stability - at a level of approximately 450 tons per month - as opposed to a clear reduction of petrol sales over the last decade, currently corresponding to approximately ¼ of diesel consumption.

Chart 6 shows the evolution of the monthly constructed indicator vis-à-vis TOP receipts expressed either in levels or in rates of change. The structural change in TOP receipts from 2008 is evident as this was the period from which the State began to transfer revenues to the enterprise *Estradas de Portugal*.<sup>11</sup>

The analysis of rates of change shows a strong link between the benchmark indicator constructed and TOP revenues, with the exception of the change occurring in 2008, as mentioned above. The introduction of a time lag in the indicator is due to the fact that revenues collected in a given month relate to sales recorded in the previous month. This is the time lag considered by *INE* in its compilation of national accounts from public accounts data.

Based on a sample of monthly data from February 2000 to December 2012, the estimated equation with

Chart 4

TAX ON OIL PRODUCTS | CENTS/LITRE

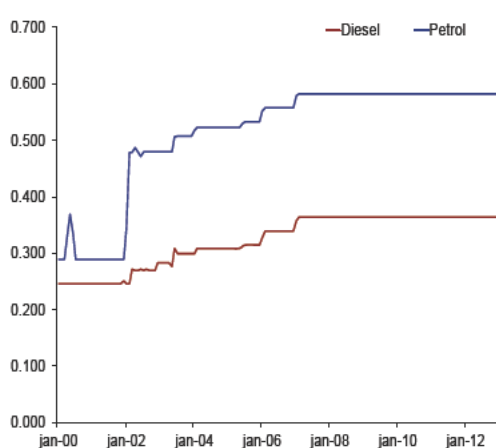
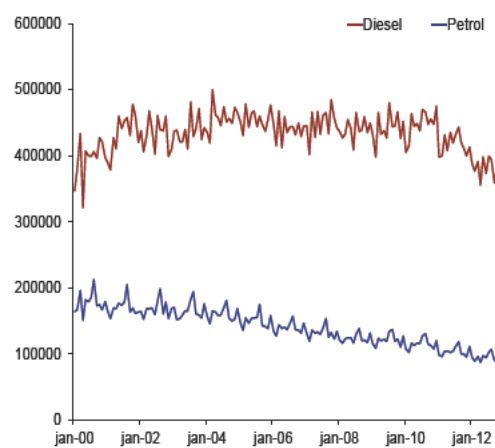


Chart 5

CONSUMPTION OF FUEL | TONS

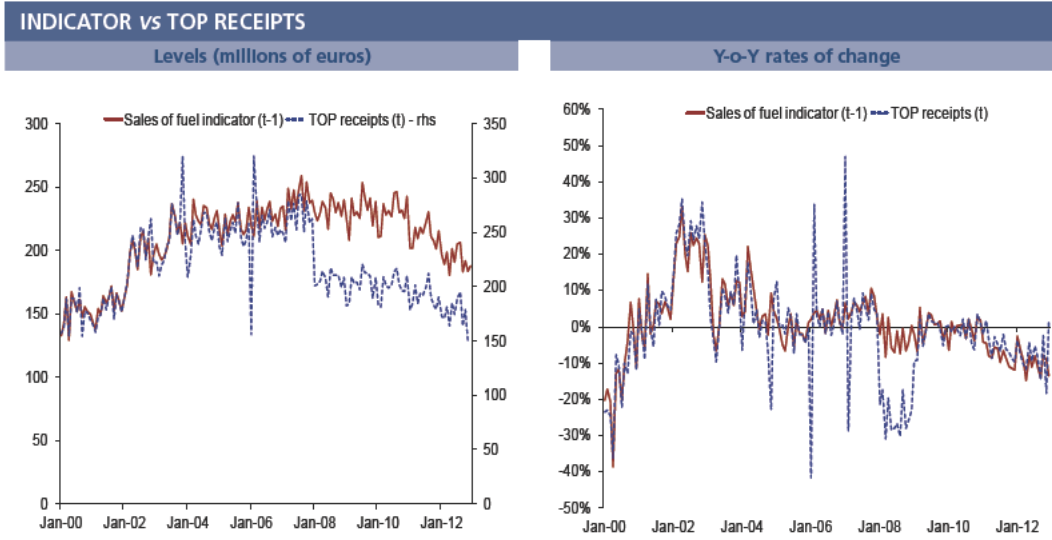


Source: Directorate General for Energy and Geology.

<sup>10</sup> Although TOP is also charged on other fuels which are consumed or sold, in terms of revenue, its significance is residual.

<sup>11</sup> Law no. 55/2007 of August 31. This change, although affecting State revenue on a public accounts basis, has no impact on the revenue of general government sector as a whole in terms of the national accounts.

Chart 6



Sources: Directorate General of the Budget, Directorate General for Energy and Geology and authors calculations.

variables expressed in logarithms and an error correction term is as follows:

$$\begin{aligned} \Delta^{12}TOP_t = & 0.010 + 0.239 \Delta^{12}I(top)_t + 0.796 \Delta^{12}I(top)_{t-1} - 0.208 Dh2008_{t-1} + 0.336 Out_t \\ & (1.38) \quad (3.93) \quad (13.20) \quad (-14.90) \quad (14.10) \\ & - 0.157 [TOP_{t-12} - I(top)_{t-12}] - 0.023 Ds2008_{t-12} \quad (14) \\ & (-3.58) \quad (-1.67) \end{aligned}$$

R<sup>2</sup> = 0.904103                      F(6, 148) = 232.6 [0.000]\*\*

no. of observations = 155              no. of parameters = 7

AR 1-7 test: F(7, 141) = 0.65465 [0.7100]

In which the following was considered:

(i) two dummy variables to measure the permanent change verified since 2008: *Ds2008* to measure the permanent change in the relationship between the indicator and the levels of tax revenue and *Dh2008* to measure the temporary effect on the rates of change in 2008.

(ii) a variable to account for outliers (*Out*). In February 2006 there was a significant decrease in revenues, which was offset in the following month. These deviations were repeated in the following year with the opposite sign because the model is expressed in year-on-year rates of change. The value of this variable was -1 in February 2006 and March 2007 and 1 in March 2006 and February 2007.

The results show that the constructed indicator assessed in the previous month goes a long way towards explaining the developments in TOP revenue. However, the evolution of the indicator in the same month also contributes towards an explanation of tax receipts, owing to the fact that a proportion of the tax receipts at the beginning of each month is also recorded as revenue in the same month. Not unexpectedly, the sum of the two coefficients of the contemporary and lagged terms is close to one.

A unit elasticity between the constructed indicator and TOP revenues was considered over the long-term as an assumption which was not statistically rejected in preliminary estimates. As in the case of VAT, the

results do not reject the existence of a cointegration relationship between the levels of the indicator and tax revenues.

The results of the estimated coefficients for the dummy variables, correcting the break in the series in 2008, point to a reduction of around 20 per cent in the level of TOP, which is consistent with the amount transferred to *Estradas de Portugal* in the said year. Similarly, the variable introduced to capture outliers in the year-on-year rates of change in February and March 2006 and 2007 have a high statistical significance, contributing around 30 percentage points to the growth rates of these months. Chart 7 shows the fit of the estimated model.

There is no evidence of significant base effects, regardless of the degree of restrictiveness used in the identification of observations affected by base effects (Table 4). As in the case of VAT, the existence of an error corrector term evaluated in the same period of the previous year allows the estimated model to correct the base effects endogenously.

### 3.3 Tax on vehicle sales

TVS tax is characterised by a complex structure which has undergone several changes over time. Currently, TVS is based on tables in which the amount of the tax depends on a vehicle’s engine size (cm<sup>3</sup>) and emissions (CO<sub>2</sub>). These tables also vary depending on whether a vehicle uses petrol or diesel. In this context, the construction of a direct indicator for the level of TSV revenue is a difficult task.

The obvious choice is to consider sales of light passenger vehicles as a benchmark to estimate the revenue performance of TVS.

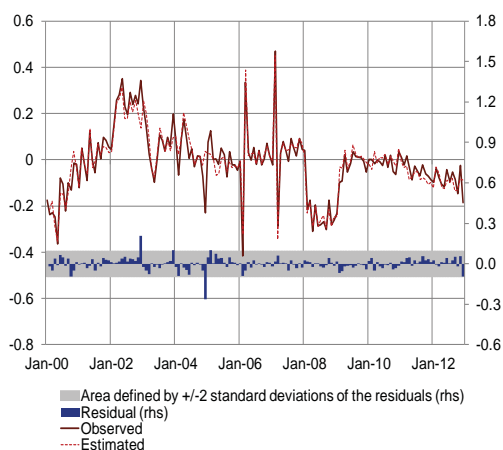
$$I(tvs)_t = (Qpas_t + 0.7Qcom_t)P_t \tag{15}$$

The variables  $Qpas_t$  and  $Qcom_t$  represent, respectively, sales of light passenger vehicles and light commercial vehicles in period  $t$ . The variable  $P_t$  measures the evolution of the price of vehicles on the basis of sub-section 7.11 of the Consumer Price Index designated “Acquisition of vehicles”.

A first difficulty relates to how to aggregate the sales of the two types of vehicles considered. It was decided to attach greater importance to the sales of passenger vehicles. The coefficient of 0.7 applied to

Chart 7

**FIT OF THE TOP RECEIPTS EQUATION | Y-O-Y RATES OF CHANGE (LOGS)**



Source: Authors calculations.

**Table 4**

CORRELATION BETWEEN RESIDUALS   TOP				
	k=0.0	k=0.5	k=1.0	k=1.5
$\rho(e_v, e_{t-12})$	0.08	0.11	0.13	0.07

**Source:** Authors calculations.

**Notes:** "k" represents a scale factor to be applied to the standard deviation of the residuals in the identification of observations sufficiently significant to produce base effects. Thus, it is considered that the information is affected by base effects when the respective residual is outside the interval  $\pm k\sigma$ , with  $\sigma$  being the standard deviation of the estimated residuals.

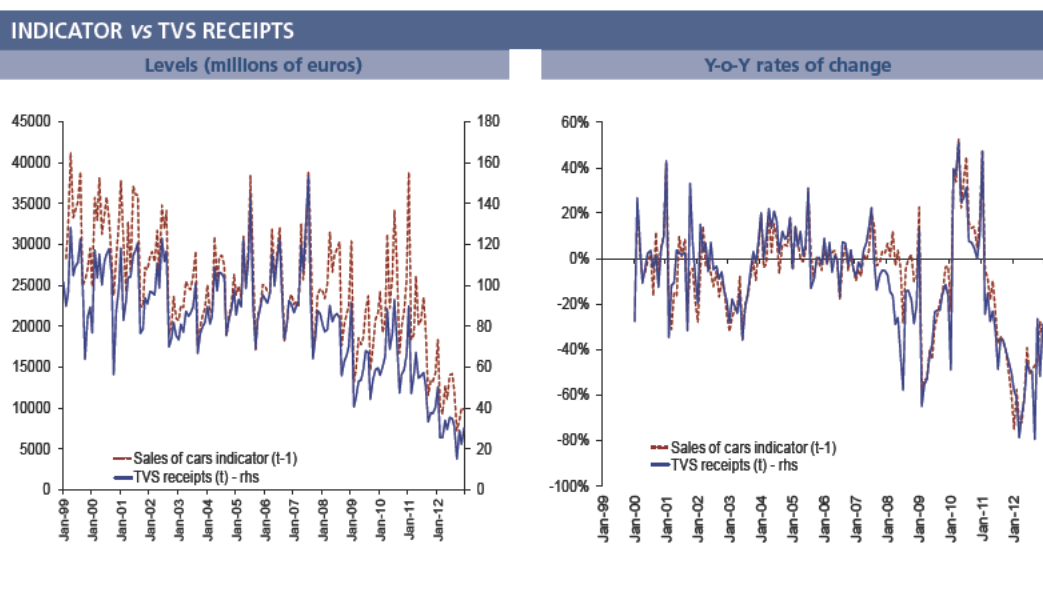
light commercial vehicles aims to reflect the quality effect related to the difference between the average price of the two types of vehicles, based on INE data for 2005. This assumes that, in general, the most expensive vehicles tend to pay more tax, in particular via the component of the tax related to engine size.

Chart 8 compares the evolution of the constructed indicator and TVS revenue, evaluated with the variables in levels and rates of change. Several legislative amendments occurred during the sample period and may have influenced the relationship between vehicle sales and TVS revenues. These changes were taken into account in the estimation process, by introducing dummy variables.

- 2007/Jan: coming into force of a set of measures to simplify the tax incentive programme for scrappage of vehicles at the end of life (more details on this change are presented in a box published in the Annual Report of Banco de Portugal, 2007).
- 2007/July: coming into force of the new tax, in replacement of the previous car tax.
- 2009/Jan: i) increase in taxation through TVS tables ii) elimination of the tax credit of 500 euros on the purchase of diesel vehicles with particle emissions not exceeding 5 milligrams per kilometre, and iii) change in the tax incentive programme for scrappage of vehicles at the end of life, eliminating the possibility of encompassing the purchase of vehicles with carbon dioxide emissions of more than 140 grams per kilometre.

As mentioned above, the existence of different tax tables and the successive changes in taxation over the past few years make it difficult to construct a benchmark indicator to measure the level of TVS receipts. Therefore, as it is not possible to estimate a long-term stable relationship between the variables expressed in levels, it was decided to estimate a model evaluated solely on rates of change. Based on a sample of monthly data from February 2000 to December 2012 and considering the variables expressed

**Chart 8**



**Sources:** ACAP, Directorate General of the Budget and authors calculations.

in logarithms, the following equation was estimated:

$$\begin{aligned} \Delta^{12}TVS_t = & 0.005 + 0.102 \Delta^{12}I(tvs)_t + 0.889 \Delta^{12}I(tvs)_{t-1} \\ & (0.63) \quad (2.15) \quad (18.00) \\ & - 0.195 Dh(2007Jul\_2008Jun)_{t-1} \\ & (-6.99) \\ & - 0.056 Dh(2009Jan\_2009Dec)_{t-1} \end{aligned} \tag{16}$$

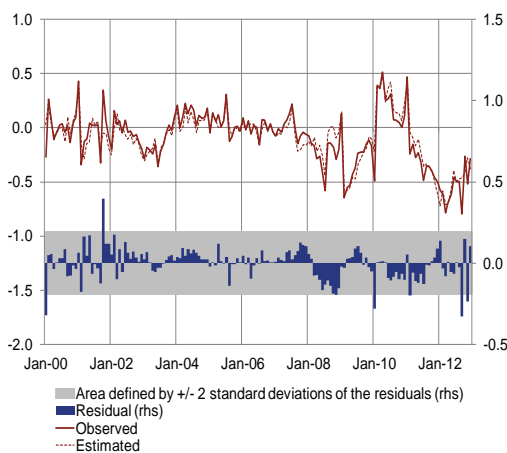
R<sup>2</sup> = 0.866864                      F(4,150) = 244.2 [0.000]\*\*  
 no. of observations = 155              no. of parameters = 5  
 AR 1-7 test: F(7,143) = 5.5235 [0.0000]\*\*\*

The results show the strong explanatory power of the indicator, particularly of the one period lagged term, although it should be noted that, as was the case for TOP, the contemporary term also appears to be significant.<sup>12</sup> The sum of these two terms is slightly less than one. Of the dummy variables tested, those related to the changes in July 2007 and, to a smaller extent, in January 2009 proved to be statistically significant, both negatively affecting the rates of change of TVS revenue. Chart 9 shows the fit of the estimated model.

Table 5 shows the results obtained with the procedure for evaluating the importance of base effects. In this case, regardless of the degree of tightness used for identification purposes, the procedure suggests the importance of base effects, which means that its use may improve the performance of the model presented above. This result should be related to the absence of an error correction term expressed in levels in the same period of the previous year.

Chart 9

FIT OF THE TVS RECEIPTS EQUATION | Y-O-Y RATES OF CHANGE (LOGS)



Source: Authors calculations.

<sup>12</sup> In the national accounts no adjustment is made to this tax revenue from data on a public accounts basis.



Table 5

CORRELATION BETWEEN RESIDUALS   TVS				
	k=0.0	k=0.5	k=1.0	k=1.5
$\rho(e_{t-1}, e_{t-2})$	-0.41	-0.48	-0.50	-0.34

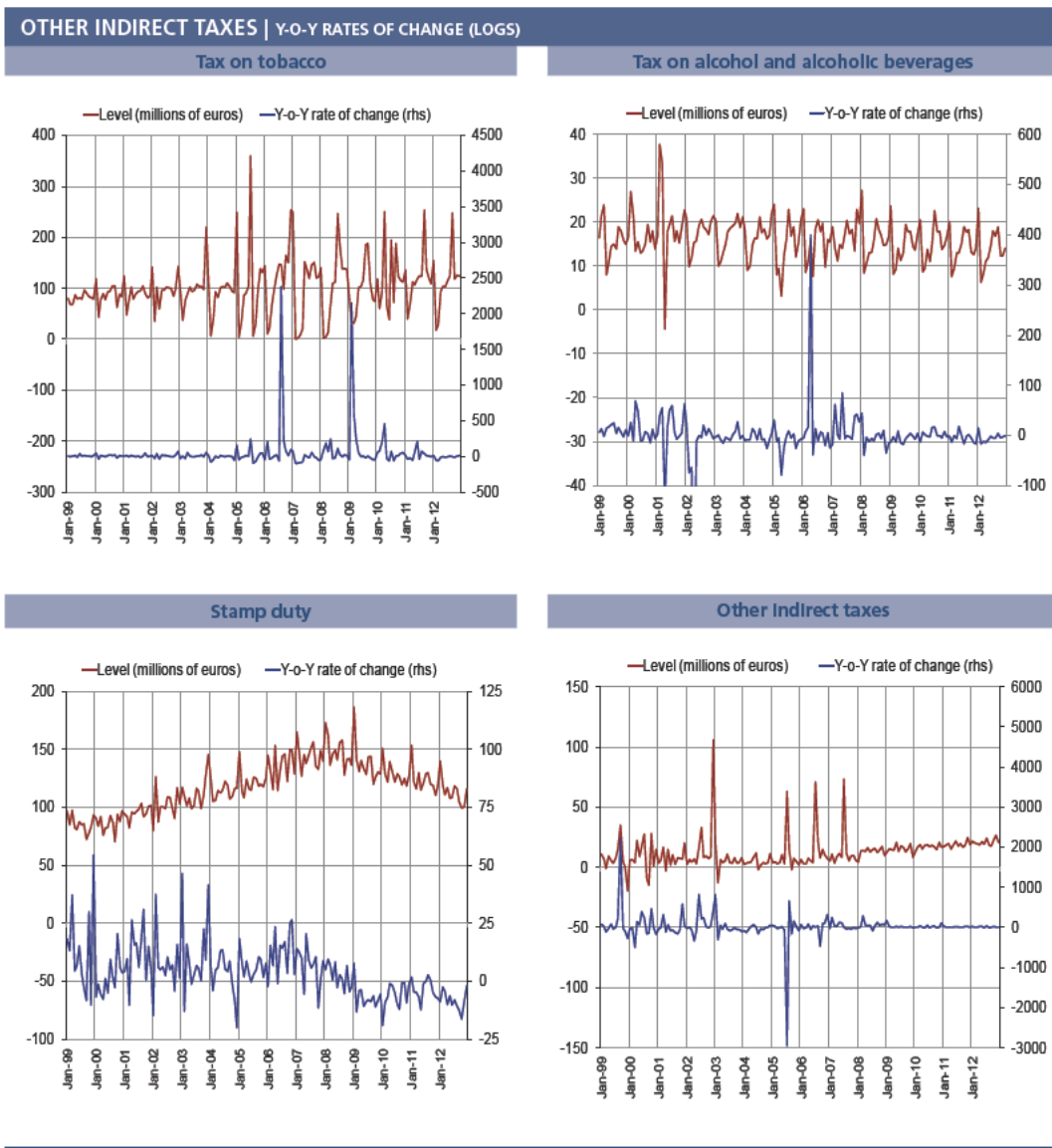
Source: Authors calculations.

Notes: "k" represents a scale factor to be applied to the standard deviation of the residuals in the identification of observations sufficiently significant to produce base effects. Thus, it is considered that the information is affected by base effects when the respective residual is outside the interval  $\pm k \sigma$ , with  $\sigma$  being the standard deviation of the estimated residuals.

### 3.4 Other indirect taxes

The evolution of the remaining indirect taxes is characterised by significant volatility, appearing to lack any link with economic activity (Chart 10). The projection of these components should be based on the application of several technical assumptions together with the introduction of specific information related to changes in legislation. These taxes as a whole represented around 17 per cent of total State revenue from indirect taxes in 2012.

Chart 10



Source: Directorate General of the Budget.



#### 4. An application to the year 2012

Table 6 shows the evolution of the macroeconomic scenario variables required to implement the procedure described above. In general, consumer indicators contracted sharply in 2012. Based on this information, the procedure described above was applied to the last year available, without any adjustment of the forecast concerning the residuals observed in the recent past (Table 7).

Total TOP, TVS and VAT revenue, in 2012, was 40 million euros (0.2 per cent) higher than what would have been estimated by the application of the procedure. This result reflects the positive deviation in revenues from TOP and TVS and negative deviation in VAT receipts.

In the case of TOP, it should be noted that the positive deviation may, inter alia, reflect the Special Tax on the Consumption of Electricity introduced in the State Budget for 2012 (with an estimated impact of 45 million euros), which is not related to the evolution of fuel sales.

VAT receipts, in 2012, as mentioned above were significantly affected by the remaining effect of the VAT increase on electricity in the last quarter of 2011 and the impact of the VAT increase on restaurants from the beginning of the year. The results show that the observed tax revenue for the year as a whole was lower than would have been estimated based on the relationship with the macroeconomic scenario, but only by 0.5 per cent, after taking into account the effects of changes in legislation in the actual rates of VAT. The direct effect of the measures behind this exercise is clearly lower than that considered in the preparation of the State Budget for 2012, by around 1 billion euros. It should also be noted that the

**Table 6**

ECONOMIC SCENARIO   Y-O-Y RATES OF CHANGE															
Quarterly variables															
Private consumption															
Total			Vehicles			Other durables			Food			Non-durables non-food			
non	vol	pr	non	vol	pr	non	vol	pr	non	vol	pr	non	vol	pr	
2012Q1	-2.9	-5.5	2.8	-42.7	-42.2	-0.9	-17.1	-11.7	-6.1	2.4	-0.7	3.2	-0.9	-3.7	2.9
2012Q2	-4.0	-5.7	1.9	-35.5	-34.4	-1.7	-17.1	-12.0	-5.8	2.4	-0.5	2.9	-3.4	-5.0	1.7
2012Q3	-4.0	-6.0	2.1	-34.4	-33.1	-1.9	-18.5	-14.5	-4.7	3.1	-0.2	3.3	-3.7	-5.5	1.9
2012Q4	-3.9	-5.3	1.5	-29.8	-28.7	-1.4	-16.5	-14.9	-1.9	2.9	-0.2	3.2	-4.1	-4.9	0.8
2012	-3.7	-5.6	2.1	-36.1	-35.2	-1.5	-17.3	-13.2	-4.7	2.7	-0.4	3.1	-3.0	-4.8	1.8

Monthly variables				
	Sales of light vehicles		Sales of fuel	
	Passenger	Commercial	Petrol	Diesel
Jan-12	-47.4	-14.0	-2.8	-2.6
Feb	-48.6	-68.5	-7.8	-5.6
Mar	-49.1	-66.0	-8.1	-9.5
Apr	-41.7	-63.1	-16.5	-12.8
May	-27.5	-55.9	-5.7	-8.4
Jun	-37.0	-53.4	-9.6	-11.0
Jul	-35.1	-54.8	-8.1	-7.7
Aug	-33.1	-58.1	-9.2	-10.9
Sep	-30.9	-54.1	-10.2	-14.2
Oct	-19.2	-45.2	-9.7	-6.8
Nov	-25.3	-49.9	-9.6	-8.2
Dec	-43.5	-57.0	-14.5	-12.0
2012	-37.9	-54.2	-9.4	-9.2

Sources: ACAP, Directorate General for Energy and Geology, Statistics Portugal and Banco de Portugal.

Table 7

PROJECTION ERRORS IN 2012								
	Total	TOP	VAT	TVS	Total	TOP	VAT	TVS
	Observed values				Y-o-Y rates of change			
	Millions of euros							
2012Q1	4 144	534	3 509	101	-4.6	-7.0	-1.9	-47.5
2012Q2	3 681	531	3 052	99	-3.7	-8.5	-0.5	-44.4
2012Q3	3 747	559	3 107	81	-5.7	-7.5	-3.8	-42.8
2012Q4	3 699	492	3 126	81	-2.4	-11.0	0.1	-29.4
2012	15 272	2 116	12 794	362	-4.1	-8.4	-1.5	-42.2
Estimated values								
	Millions of euros				Y-o-Y rates of change			
2012Q1	4 129	532	3 537	61	-5.0	-7.3	-1.2	-68.2
2012Q2	3 554	516	2 960	77	-7.1	-11.0	-3.5	-56.3
2012Q3	3 855	540	3 241	74	-3.0	-10.6	0.4	-47.9
2012Q4	3 694	497	3 124	73	-2.5	-10.1	0.1	-36.3
2012	15 232	2 085	12 862	286	-4.4	-9.8	-1.0	-54.4
Difference: observed - estimated								
	Millions of euros				Y-o-Y rates of change			
2012Q1	15	2	-27	40	0.3	0.4	-0.8	20.8
2012Q2	128	15	92	21	3.3	2.5	3.0	11.9
2012Q3	-108	19	-134	7	-2.7	3.1	-4.1	5.1
2012Q4	5	-5	2	8	0.1	-0.9	0.1	6.9
2012	40	31	-67	76	0.2	1.3	-0.5	12.2

Source: Authors calculations.

State VAT revenue in 2012 was negatively affected by the transfer to Social Security of 173 million euros under the Social Emergency Programme and the Extraordinary Social Support to Energy Consumers. Finally, as regards the quarterly values of the deviations, it should be noted that the negative deviation in VAT revenue in the third quarter of the year is likely to be due, to a large extent, to a highly significant increase in refunds (10.7 per cent). Gross revenues increased by 0.2 per cent in this quarter, in line with the very slight projected rise. The opposite was observed in the fourth quarter, i.e., the negative deviation was negligible because it was affected by a significant decrease in refunds (-11.7 per cent).

### Real time analysis

It is important to highlight the illustrative nature of this application. It is not an assessment of the procedure in real time as an estimation of equations for evaluating their performance outside the sample period was not performed. The 2012 observations were taken into account in the estimation of the equations used and, as such, may have influenced the assessment of the results of applying the procedure to the year 2012.

In order to examine this effect, an evaluation exercise on the procedure in real time was carried out both on 2012 and 2011. In this context, the equations used were re-estimated using only information available up to the beginning of 2011 and 2012, with a latter projection of each of the two years and an evaluation of the deviations from the observed values. The results are shown in Table 8.

In the case of VAT, the results indicate an underestimation of the out-of-sample projection, with the deviation being particularly significant for 2011 (about 4.1 per cent). This deviation arises from the fact that the revenue elasticity regarding the evolution of the volume indicator of consumption is higher when the most recent years are excluded (2.02 in the forecast for 2011 and 1.72 for 2012).<sup>13</sup> This would

<sup>13</sup> As the sample period is relatively small, the elimination of two full years can significantly affect the estimated coefficients.

Table 8

OUT OF SAMPLE ESTIMATION																
	Total				TOP				VAT				TVS			
	Estimated values				Y-o-Y rates of change				Estimated values, adjusted by the previous year error				Y-o-Y rates of change			
	Millions of euros				Y-o-Y rates of change				Millions of euros				Y-o-Y rates of change			
2011Q1	4 310	598	3 508	203	11.4	4.4	12.6	12.2	4 215	601	3 425	189	8.9	5.0	9.9	4.2
2011Q2	3 656	603	2 851	202	2.3	-1.1	4.4	-13.5	3 576	606	2 783	187	0.1	-0.6	2.0	-19.7
2011Q3	3 901	631	3 115	155	-3.8	-0.2	-3.0	-27.0	3 819	634	3 041	144	-5.9	0.3	-5.3	-32.2
2011Q4	3 711	577	3 019	116	-4.4	-3.1	-2.7	-36.3	3 634	579	2 947	107	-6.3	-2.6	-5.0	-40.8
<b>2011</b>	<b>15 578</b>	<b>2 408</b>	<b>12 493</b>	<b>676</b>	<b>1.3</b>	<b>0.0</b>	<b>2.7</b>	<b>-16.4</b>	<b>15 245</b>	<b>2 420</b>	<b>12 196</b>	<b>628</b>	<b>0.5</b>	<b>0.5</b>	<b>0.3</b>	<b>-22.4</b>
2012Q1	4 106	536	3 470	100	-5.5	-6.6	-3.0	-48.0	4 237	550	3 592	95	-2.5	-4.1	0.4	-50.8
2012Q2	3 539	544	2 891	104	-7.4	-6.1	-5.7	-41.4	3 576	559	2 919	98	-6.5	-3.7	-4.8	-44.5
2012Q3	3 701	577	3 035	89	-6.9	-4.4	-6.0	-36.8	3 865	592	3 189	84	-2.7	-1.9	-1.2	-40.3
2012Q4	3 650	488	3 081	82	-3.7	-11.8	-1.3	-29.1	3 669	500	3 091	77	-3.2	-9.5	-1.0	-32.9
<b>2012</b>	<b>14 996</b>	<b>2 145</b>	<b>12 476</b>	<b>375</b>	<b>-5.6</b>	<b>-7.2</b>	<b>-4.0</b>	<b>-40.1</b>	<b>15 347</b>	<b>2 201</b>	<b>12 790</b>	<b>355</b>	<b>-3.4</b>	<b>-4.7</b>	<b>-1.6</b>	<b>-43.4</b>

	Difference: observed - estimated				Difference: observed - estimated											
	Millions of euros				Y-o-Y rates of change				Millions of euros				Y-o-Y rates of change			
2011	354	-98	502	-50	2.3	-4.1	4.1	-6.2	687	-110	799	-2	4.5	-4.6	6.6	-0.2
2012	276	-29	318	-13	1.7	-1.3	2.4	-2.1	-75	-86	4	7	-0.5	-3.7	0.0	1.1

Source: Authors calculations.

involve predicting major effects of the recession in the evolution of VAT revenue. Compared to 2012 this deviation is less significant (2.4 per cent), and becomes virtually nil when the projection is adjusted by the average error observed in 2011. Regarding TOP and TVS, the real-time exercise generates deviations that, in broad terms, are not particularly significant.

## 5. Final remarks

This work illustrates the possibility of predicting the quarterly evolution of several public finances variables, benefiting from recent developments in the statistical domain. It focuses on indirect tax revenues and aims to help achieve the goal of producing short-term forecasts for the general government deficit in Portugal on a national accounts basis.

As usual, the creation of a procedure for regular use to enable the continuous monitoring and projection of short-term public finances variables implies its enhancement in terms of permanent research for data sources and alternative statistical methods. In addition to improving the methodology presented in this article, the challenge is broader and is particularly difficult in other areas of public finances in which the evolution of variables is more volatile and less related to the economic situation.

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