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The stability of tax elasticities in The Netherlands

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Abstract

We estimate long-run and short-run elasticities of Value Added Tax and Personal Income Tax revenues with respect to their bases for the Netherlands. We find VAT elasticities around one in the long-run and short-run. The long-run PIT elasticity is significantly below one, while the short-run elasticity is around one. We experiment with alternative definitions of the tax base for both taxes. We first find that elasticity estimates remain unaffected by using a broader base for both taxes. Second, the conclusion on whether elasticities differ between 'good' and 'bad' times depends whether the definition of these regimes is based on the deviation of tax revenues from the long-run level or on the output gap. Third, stability over time cannot be rejected for all elasticities, except for the long-run PIT elasticity to the broad base.

JEL codes: E62, H24, H68

Keywords: revenue elasticities, Value Added Tax, Personal Income Tax

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1 Introduction

The current crisis demonstrates that the sensitivity of revenues to its base differs by type of tax. The revenue of a progressive tax should fall more than proportionately to its tax base, while the revenue should develop more similarly for more proportional taxes. The ratio between labour tax revenues and its base, measured by the implicit tax rate, fell by 0.9% from 2007 to 2009 in the Euro Area.[1] Consumption taxes are considered as more proportional taxes but the implicit tax rate decreased by 4.7% (while statutory rates were hardly reduced during this period). Moreover, already starting in the nineties, total tax revenues in the Netherlands seem to grow less than might be expected from GDP developments. This observation feeds the concern that the revenue elasticity with respect to GDP is structurally reduced (Studiegroep Begrotingsruimte, 2012). This paper examines the relationship between tax revenues, tax bases and the output gap. We estimate long-run and short-run elasticities for the two most important taxes: Value Added Taxes (VAT) and Personal Income Taxes (PIT).

The analysis is relevant for two reasons. First, revenue elasticities play a prominent role in calculating cyclically-adjusted budget balances, which are key in the fiscal surveillance framework of the EMU. The European Commission uses the elasticity values provided by Girouard and André (2005) for this purpose. The OECD is expected to update the elasticities of individual tax categories in 2014 (Mourre et al., 2013).[2] The importance of tax elasticities in evaluating public finances is also illustrated by the many analyses that are performed by international institutions (EC, ECB, IMF and OECD) in this field. Second, forecasting tax revenues might benefit from updating elasticity values. When tax revenues turn out to be lower than projected, governments need to take additional measures, e.g. to abide the EU deficit rules. The paper aims to provide elasticities that are estimated on a recent sample.

The paper has two main contributions. First, existing studies consider rather narrow tax bases. In explaining VAT revenues, most studies measure the tax base by private consumption, while VAT is normally also imposed on other demand components.[3] We

[1] The arithmetic averages over the 17 Euro members are taken from European Commission (2011).

[2] To be precise, the overall budgetary elasticity with respect to the output gap is calculated as the weighted sum of the individual elasticities of five revenue categories and the elasticity of unemployment expenditure. Mourre et al. (2013) consider the impact of updating the weighting parameters but with keeping the individual elasticities unaltered.

[3] Wolswijk (2007) considers residential investment as separate base component. Morris et al. (2009)

experiment with a base extended with residential investment, government consumption and government investment. We find that estimates of VAT elasticities do not depend on the definition of the base. With both bases, elasticities are around one in the long-run and short-run. In regressions on PIT revenues the wage sum is mainly used to approximate the tax base. This might provide a poor approximation in view of two particular features of the Dutch tax system (IMF, 2006). First, contributions to pension funds are deductible from the income tax base and taxation is postponed until pensions are paid. Second, house owners benefit from a generous fiscal treatment: the full deductibility of interest payments on mortgages is only partially offset by taxing imputed rents. We experiment with a broader base, which only changes tax elasticities slightly. We find long-run estimates significantly below one and short-run values around one. The second contribution concerns the analysis of the stability of the elasticities. In particular, we assess the sensitivity of the results to incorporating the volatile crisis years 2009-2011. In addition, we test whether the tax elasticities vary between 'good' and 'bad' years. The conclusion on asymmetric responses seems to depend on whether the definition of the regimes is based on the deviation of tax revenues or of GDP from the corresponding long-run levels.

In the literature macro and micro approaches are distinguished. Our study is most closely related to the macro approach followed in Wolswijk (2007). He estimates error correction models (ECM) for five types of taxes for the Netherlands over the period 1970-2005. We use an update of the dataset (1970-2011) and correct for a structural break found in the construction of the PIT revenues. Wolswijk also examines differences in elasticities between good and bad years and finds asymmetric responses of VAT revenues but not of PIT revenues. While his classification of the regimes builds on estimated long-run values of tax revenues, our alternative measure is based on output gaps. Morris and Schuknecht (2007) incorporate asset prices in the error correction specification, which are measured by an equity price index and a residential property price index. For the Netherlands, the results for PIT revenues are not improved by including these asset prices, while the residential property prices only have a significant, positive effect on VAT revenues in the short run. Instead of including additional explanatory variables, we specify broad bases, capturing residential investment in the VAT base and deductible mortgage interests in the PIT base.

As mentioned above, Girouard and André (2005) is a prominent study, adopting a

fix the elasticity of VAT revenues to the sum of private and government consumption to unity.

micro approach to calculate the elasticity of income tax revenues for OECD countries in 2003. The effect on tax payments is simulated for a representative household at various earning levels. The aggregate elasticity is then calculated as the weighted average, where the weights are derived from the estimated earnings distribution. They report that the Netherlands has the largest elasticity of the OECD members: an increase in earnings by 1% raises PIT revenues by 2.4% (exluding social security contributions). The elasticity of indirect tax revenues with respect to consumption expenditure is not estimated but set to one in all countries.[4] Caminada and Goudswaard (1996) are another example using microsimulations to assess the effect of a large reform in 1990 on the elasticity of income tax revenues (including social security contributions). The reform is found to have reduced this elasticity from 1.48 in 1989 to 1.22 in 1990.

The outline of the paper is as follows. In the next section we describe the correction of tax revenues for discretionary measures and the specification of the estimated Error Correction Model (ECM). In Section 3 we present the estimated values of the elasticities of the VAT revenues with respect to two bases. At the end, we discuss the implications for the elasticities with respect to the output gap. The same structure is followed in presenting the PIT elasticities in Section 4. We end with some concluding remarks.

2 Methodological issues

In this Section we discuss two methodological issues. First we explain how we have corrected tax revenues for the impact of discretionary measures. Next, we discuss the estimated specifications of the ECM.

2.1 Correction for discretionary measures

We aim to estimate elasticities of tax revenues with respect to their bases for a given tax structure. Therefore, changes in tax revenues due to the endogenous development of the tax bases need to be distinguished from changes arising from policy and/or legislative changes (Barrios and Fargnoli, 2010). The series on tax revenues have to be corrected for the impact of discretionary measures, including in principle legal changes in tax rates, tax base definitions and tax administration. Furthermore, whether discretionary tax cuts

[4]Bouthevillain et al. (2001, Table A6) consider the same value of both elasticities.

or hikes are implemented can depend on the phase of the business cycle.[5] By correcting for discretionary measures, endogeneity problems are partially tackled in estimation (Wolswijk, 2007).

We apply the popular proportional adjustment method, introduced by Prest (1962) (see e.g. Wolswijk (2007) and Barrios and Fargnoli (2010)). By definition, the benchmark is given by the prevailing tax structure in the base year, meaning that adjusted tax revenues (AT) equal the observed tax revenues (T):

$$AT_0 = T_0 \tag{1}$$

In the following year, the projected effect of discretionary measures (D) is subtracted from actual revenues. For example, $D > 0$ in case of an increase in the tax rate:

$$AT_1 = T_1 - D_1 \tag{2}$$

If permanent, a discretionary tax change will not only affect revenues in the current year but also in all future years. The cumulative effects are captured by multiplying the corrected term in the current year ($T - D$) with the ratio of the adjusted to actual tax revenues in the previous year, or:

$$\begin{aligned} AT_t &= (T_t - D_t)\,(AT_{t-1}/T_{t-1}) \qquad t > 1 \\ AT_t &= AT_1 \prod_{s=2}^{t} (T_s - D_s)/T_{s-1} \qquad t > 1 \end{aligned} \tag{3}$$

Whether this method really contributes to a better estimation of the tax elasticities crucially depends on the quality of the forecasts of revenue losses and gains following discretionary measures.[6] In Sections 3 and 4, we will discuss in more detail the correction of VAT and PIT revenues, respectively.

2.2 Specification of ECM

We estimate an ECM in two steps. For a simple, proportional tax, the equation $\ln T = \ln \tau + \ln B$ holds, where τ denotes the tax rate and B the tax base. After removing the effects of discretionary changes in τ, the equation can be written as $\ln AT = \delta + \ln B$.

[5]Barrios and Fargnoli (2010) suggest that discretionary cuts in direct taxes are undertaken during expansionary phases while the reverse holds during slowdowns.

[6]See the comments in section 2.2.3 in Caminada (1996) on the quality of the corrections.

The implication that the elasticity with respect to the base equals one does not apply for more complex tax systems. For VAT, rates are differentiated between categories of goods and services. Substitution between VAT classes might result in a non-unitary elasticity. For the progressive PIT, an expansion of the base increases the average tax rate, implying that the elasticity exceeds one. Moreover, as the base is measured by an aggregate proxy, the estimate of the elasticity might be affected by the relationship between the true base and its proxy. Therefore, the long-run equation with base elasticity ω is specified as:

$$\ln AT_t = \delta + \omega \ln B_t + \varepsilon_t \tag{4}$$

A positive (negative) disturbance term ε indicates that actual revenues are above (below) the estimated long-run level. The short-run equation is expressed in terms of growth rates:

$$\Delta \ln AT_t = \beta \Delta \ln B_t + \gamma \varepsilon_{t-1} + u_t \tag{5}$$

The error correction term is the lagged disturbance term of the long-run equation (ε), meaning that the coefficient γ denotes the adjustment speed. The short-run tax elasticity is given by the estimate of β. In a final specification we allow for two types of asymmetries in the short run:

$$\Delta \ln AT_t = \alpha + \beta^+ \Delta \ln B_t^+ + \beta^- \Delta \ln B_t^- + \gamma^+ \varepsilon_{t-1}^+ + \gamma^- \varepsilon_{t-1}^- + u_t \tag{6}$$

with

$$\begin{aligned} \varepsilon_t^+ &= \varepsilon_t \quad \text{if } \varepsilon_t \geq 0; \quad = 0 \text{ otherwise} \\ \varepsilon_t^- &= \varepsilon_t \quad \text{if } \varepsilon_t < 0; \quad = 0 \text{ otherwise} \end{aligned} \tag{7}$$

$$\begin{aligned} \Delta \ln B_t^+ &= \Delta \ln B_t \quad \text{if } \varepsilon_t \geq 0; \quad = 0 \text{ otherwise} \\ \Delta \ln B_t^- &= \Delta \ln B_t \quad \text{if } \varepsilon_t < 0; \quad = 0 \text{ otherwise} \end{aligned} \tag{8}$$

First, we test whether the adjustment speed differs between 'good' and 'bad' times. Good times are defined in (7) as years in which the observed revenues are estimated to exceed its long-run level, or $\varepsilon \geq 0$. The opposite condition holds in bad years. The second asymmetry concerns the short-run elasticity. We consider two definitions of both regimes. Following Bruce et al. (2006) and Wolswijk (2007), the first definition is again based on the sign of the deviation from the long-run equilibrium, as shown in (8). In an alternative approach, the $\Delta \ln B$-series is split according to the sign of the output gap. A pitfall of the first definition is that the measure is based on the error terms of the long-run equation estimated in the first step. We favour the second approach as the output gap is taken from an external source.[7]

Variables on tax revenues (cash basis) and base components are constructed by CPB, mainly based on the National Accounts provided by Statistics Netherlands. Data on the (ex ante) effects of discretionary measures (on cash basis) are provided by the Ministry of Finance.

3 Value added taxes

3.1 Description of VAT data

The VAT rate structure consists of a standard rate (19% in 2011) and a reduced rate (6%), next to an important class of exempted goods and services. VAT reforms in the sample period mainly consist of changes in tax rates.[8] Figure 1 shows that the estimated effects of discretionary measures are well related to changes in the standard VAT rate. The red dots depict the change of the standard rate in %-points (left axis), while the full line shows the impact of all discretionary measures expressed as a %-change in VAT revenues (right axis).[9] For example, the last increase of the standard rate by 1.5%-points in 2001 is projected to have raised (ex ante) VAT revenues by 7.0%.

In most studies the VAT base is approximated by private consumption. Figure 2 compares the development of the resulting adjusted VAT revenues (right axis) to the development of private consumption (left axis; %GDP). Adjusted VAT revenues closely follow private consumption. However, VAT collected on private consumption only accounts for 51% of total VAT revenues.[10] Wolswijk (2007) suggests to include residential investment as an additional component of the tax base. We also consider a broader base, defined as the sum of private consumption, residential investment, government consumption and government investment (the last two items include expenditures on goods and services, excluding the health sector). The Figure shows that the broad base develops similarly as private consumption.

[7]Data on the output gap are taken from OECD, Economic Outlook. Calculations combine estimates of a production function with some smoothing of its components using a statistical filter.

[8]See Table VIII in European Commission (2013).

[9]The effects of increasing the standard rate in 1984 and 1987 are magnified by the increase in the reduced rate by 1%-point.

[10]Input-Ouput table G.1.3 in Statistics Netherlands (2012).

Figure 1: The increases in the highest VAT rate (left) and the effects of discretionary changes in the VAT system (right)

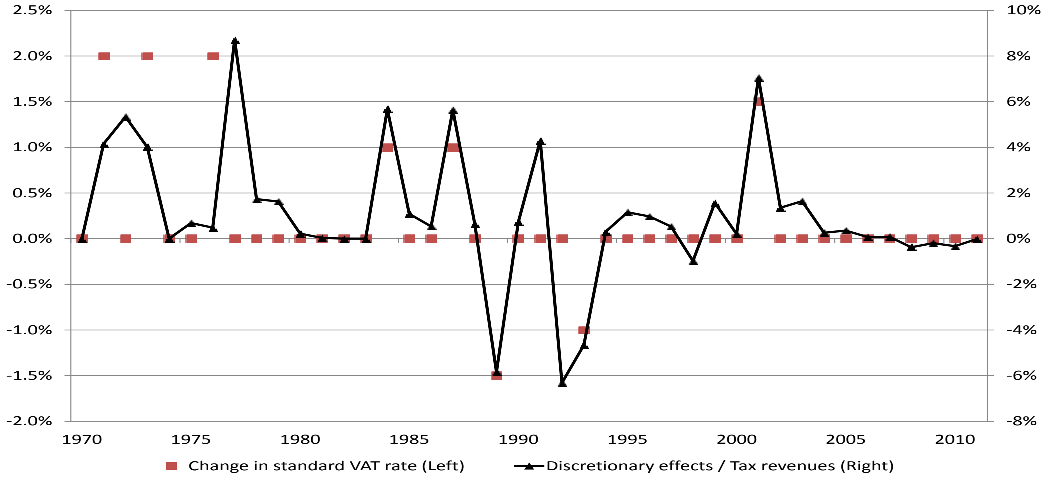
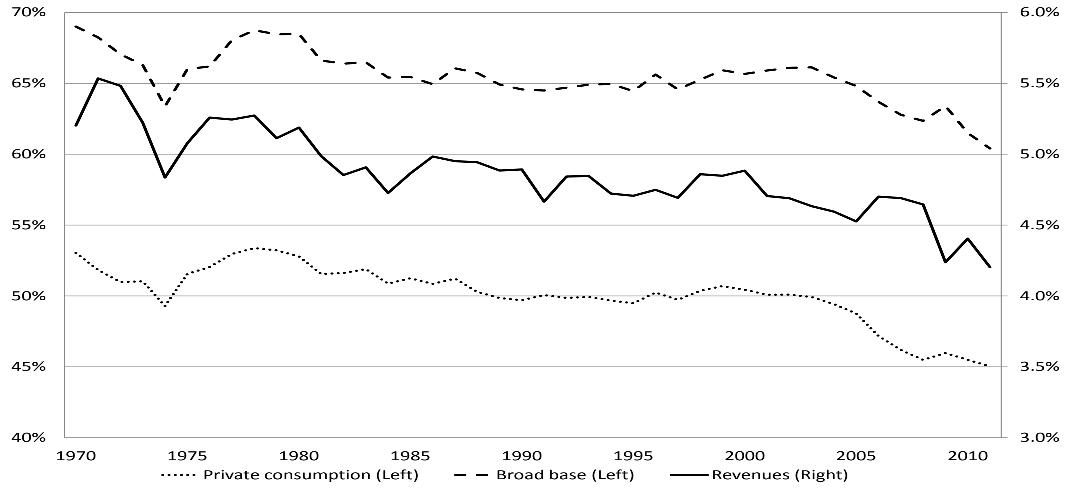


Figure 2: Adjusted VAT revenues, private consumption and broad base (%GDP)



Finally, we comment on a data problem that is underexposed in other studies. By definition, the tax base should be measured by expenditures excluding VAT payments. Unfortunately, VAT collected on individual demand components is not available for the whole sample and we have to use expenditures measured in current, VAT-inclusive prices. This would be a minor problem if the effective VAT rate was rather constant over the sample but this condition is not met.

3.2 Estimation results for VAT

We first report in Table 1 the estimation results using private consumption as tax base.[11] In column (1) we apply OLS to the full sample (1970-2011). The estimate of the LT elasticity is 0.97 and is significantly below 1, whereas the SR value of 1.02 is not significantly different from 1. The high adjustment speed indicates that VAT revenues adjust rather quickly to deviations from the LR equilibrium (ε). Since the OLS estimation of the LR equation in levels might suffer from biased estimates and incorrect standard errors, we also apply the Dynamic OLS estimator (Wolswijk, 2007).[12] Column (2) shows that the LR elasticity is hardly changed by the DOLS estimation, although it is no longer significantly different from 1. Using the DOLS-residuals in the SR equation also yields similar coefficients. In the final column we assess the sensitivity to the crisis years 2009-2011. Dropping these years is shown to yield similar coefficients.[13]

Next, we extend the regression with residential investment and the sum of government consumption and investment in Table 2. Incorporating these components seems to reduce the effects of consumption in the long run and short run in column (1). We explain the interpretation of these coefficients by way of a simple example. Suppose the same tax rate τ is imposed on two tax bases. Each tax base B_i is approximated by the function $f(C_i)$. Tax revenues are given by the definition:

[11]For the tax elasticities we test if the estimate is different from both zero and one. The latter p-value is reported next to the standard error in all tables.

[12]The Dynamic OLS approach improves the estimates by adding the lag, the current value and the lead of the difference of the explanatory variable. Additional leads or lags were not significant. Coefficients of these difference variables are not reported as they are of no economic interest. Standard errors are improved by applying the Newey-West correction.

[13]Including a constant term in the SR equation (5) hardly changes in general the VAT elasticities. In the absence of any correction for changes in the tax structure, the estimates, better known as tax buoyancy, equal 1.14 in the long run and 1.18 in the short run; both values are significantly larger than one (results are available on request).

$$T \equiv T_1 + T_2 = \tau(B_1 + B_2) = \tau\left[f(C_1) + f(C_2)\right] \tag{9}$$

Differentiating this definition while keeping the tax rate constant (i.e. after correcting for discretionary changes) gives:

$$\begin{aligned}\frac{dT}{T} &= \frac{T_1}{T}\left(\frac{dT_1}{dC_1}\frac{C_1}{T_1}\right)\frac{dC_1}{C_1} + \frac{T_2}{T}\left(\frac{dT_2}{dC_2}\frac{C_2}{T_2}\right)\frac{dC_2}{C_2} \\ &= \omega_1\varepsilon_1\frac{dC_1}{C_1} + (1-\omega_1)\varepsilon_2\frac{dC_2}{C_2} \end{aligned} \tag{10}$$

with tax shares ω_i and elasticities $\varepsilon_i(T_i, C_i)$. The last equation shows that the elasticity of tax revenues with respect to each base component equals the product of the tax share (ω) and the respective elasticity (ε). In other words, the coefficients in Table 1 are not directly comparable to the coefficients in Table 2. By considering an equal change in all demand components, the total elasticity is calculated as $0.70 + 0.19 + 0.08 = 0.97$ in the long run and $0.77 + 0.26 - 0.00 = 1.03$ in the short run. Notice both elasticities are close to the values found in Table 1. Furthermore, Wolswijk (2007, Table 2) reports similar coefficients for the period 1980-2002. His OLS estimate for private consumption equals 0.82 in the long run and 0.69 in the short run. The corresponding effects of residential investment are 0.16 and 0.13, while the latter estimate is not significant. The adjustment speed implies non-convergence but the estimate (in absolute value) is not significantly larger than one.

Alternatively, we define the tax base as the sum of private consumption, residential investment, government consumption and government investment. We again find in column (2) revenue elasticities around 1 in the long run and short run. Results are robust to applying the DOLS estimator and to limiting the sample (see last two columns).

We also examine whether the elasticities differ between 'good' and 'bad' times, using the two definitions of the tax base in the short-run equation (6). As significant asymmetries in adjustment speeds are found in none of the cases, we only report results on asymmetric tax elasticities in Table 3. Sancak et al. (2010) argue that the allocation of consumption expenditures between low-taxed and high-taxed goods and services changes during the business cycles. When the share of consumption subjected to the high tax rate increases (decreases) during an upswing (downturn), the tax elasticity might be larger in good times than in bad times. In a first approach, good (bad) years are defined as years for which the LR residual is positive (negative); see e.g. Bruce et al. (2006). The

Table 1: VAT elasticities using consumption as tax base

	(1) OLS full sample	(2) DOLS full sample	(3) OLS w/o 2009-11
Long-run			
Constant	-1.963***	-2.037***	-1.974***
	(0.118)	(0.211)	(0.132)
ln(Consumption)	0.968***	0.974***	0.969***
	(0.010)***	(0.017)	(0.011)**
Obs.	42	40	40
Adjusted R^2	0.998		0.997
Short-run			
Δln(Consumption)	1.019***	0.950***	1.002***
	(0.065)	(0.056)	(0.070)
Lagged LR residual	-0.630***	-0.545**	-0.434**
	(0.208)	(0.217)	(0.185)
Obs.	41	40	38
Adjusted R^2	0.854	0.843	0.868

Robust standard errors in parentheses. The *-symbol refers to the p-value of the test that the coefficient equals 0, with *** p<0.01, ** p<0.05, * p<0.1. Similarly, the *-symbol refers to the test that the elasticity equals 1.

results in the first column show that the SR elasticity exceeds 1 when revenues are larger than the LR value, while it is smaller than one in the other case. The p-value in the last row indicates that the difference between the elasticities is highly significant. This finding is in line with the asymmetric elasticities (1.01 versus 0.56) reported in Wolswijk (2007, Table 2b). However, the evidence is weak in a second approach using the sign of the output gap to distinguish the regimes.[14] The hypothesis of equal elasticities is now rejected with a p-value of 17.5%. However, the symmetry hypothesis is strongly rejected when the broad base is used in both cases (see last 2 columns). VAT revenues respond stronger to the broad base in good times than in bad times.

[14] The fraction of years for which the LR residual and the output gap have the same sign equals 76%.

Table 2: VAT elasticities using broad base

	(1) OLS full sample	(2) OLS full sample	(3) DOLS full sample	(4) OLS w/o 2009-11
Long-run				
Constant	-1.383***	-2.005***	-2.120***	-2.063***
	(0.282)	(0.098)	(0.120)	(0.100)
ln(Consumption)	0.697***			
	(0.097)***			
ln(Residential Invest)	0.193***			
	(0.044)***			
ln(Government)	0.075			
	(0.071)***			
ln(Broad base)		0.950***	0.959***	0.955***
		(0.008)***	(0.009)***	(0.008)***
Obs.	42	42	40	39
Adjusted R^2	0.998	0.998		0.998
Short-run				
Δln(Consumption)	0.765***			
	(0.130)*			
Δln(Residential Iinvest)	0.259***			
	(0.061)***			
Δln(Government)	–0.003			
	(0.100)***			
Δln(Broad base)		1.040***	0.956***	1.017***
		(0.049)	(0.052)	(0.054)
Lagged LR residual	-1.015***	-0.917***	-0.888***	-0.694***
	(0.181)	(0.185)	(0.240)	(0.174)
Obs.	41	41	40	38
Adjusted R^2	0.906	0.896	0.868	0.915

Robust standard errors in parentheses. The *-symbol refers to the p-value of the test that the coefficient equals 0, with *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Similarly, the $\star$-symbol refers to the test that the elasticity equals 1.

Table 3: Asymmetric short-run VAT elasticities (1971-2008)

	Consumption		Broad base	
	LR residuals	Output gap	LR residuals	Output gap
Δln(Consumption)$^+$	1.186***	1.056***		
	(0.082)⋆⋆	(0.092)		
Δln(Consumption)$^-$	0.709***	0.826***		
	(0.076)⋆⋆⋆	(0.112)		
Δln(Broad base)$^+$			1.182***	1.086***
			(0.043)⋆⋆⋆	(0.058)
Δln(Broad base)$^-$			0.721***	0.792***
			(0.067)⋆⋆⋆	(0.093)⋆⋆
Lagged LR residual	-0.578***	-0.543**	-0.847***	-0.848***
	(0.188)	(0.241)	(0.125)	(0.167)
Obs.	19+19	20+18	20+18	20+18
Adjusted R^2	0.911	0.870	0.956	0.924
p-value Asymmetry	0.000	0.175	0.000	0.014

Robust standard errors in parentheses. The *-symbol refers to the p-value of the test that the coefficient equals 0, with *** p<0.01, ** p<0.05, * p<0.1. Similarly, the ⋆-symbol refers to the test that the elasticity equals 1. LR-residuals taken from column (3) in Table 1 and column (4) in Table 2. Number of observations gives the distribution between good and bad times.

3.3 Analysis of time-variation in VAT elasticities

In the literature, two standard approaches are used to analyse the stability of coefficients. The recursive approach starts by estimating on a subsample of the first T observations. Then the sample is subsequently extended by one year until the full sample is reached. A structural break is identified when the estimates significantly change after extending the sample by a single year. The second approach is labeled the rolling method. Following this approach, the size of the subsample is kept fixed but the time period is shifted every round by one year, meaning that the first observation of the previous round is dropped and a new last observation is added. We report the outcomes of the last approach to allow for large fluctuations in small samples of 20 years. The x-axis of the following Figures denote the mid year of the subsamples and also the 95%-confidence intervals are given (Results of the recursive approach support the same conclusions, as shown in Figures A.1 and A.2).

Figure 3 shows no significant trend in the LR and SR elasticities when consumption is taken as the tax base. Figure 4 provides evidence in favour of stable elasticities with respect to the broader base. Notice that the hypothesis that the SR elasticity equals one cannot be rejected in any of the subsamples for both bases.

3.4 VAT revenues over the business cycle

In a last step we discuss the implications for the elasticity of VAT revenues with respect to the output gap. This elasticity equals the product of the tax elasticity and the elasticity of the tax base to the output gap:

$$\frac{\Delta \ln(AT_t)}{\Delta \ln(gap_t)} = \frac{\Delta \ln(AT_t)}{\Delta \ln(B_t)} \frac{\Delta \ln(B_t)}{\Delta \ln(gap_t)} \tag{11}$$

where $gap = (Y - Y^*)/Y^*$; Y denotes output and Y^* potential output. The discussion so far addresses the estimation of the first elasticity at the right-hand side.[15] The second elasticity is given by the estimate of ν in the following equation (as described in the Appendix of Girouard and André (2005)):

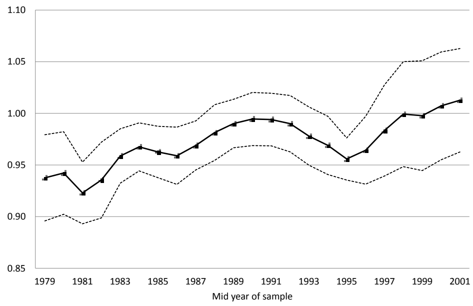
$$\Delta \ln(B_t/Y_t) = \mu + \nu \Delta \ln(Y_t/Y_t^*) \tag{12}$$

We apply the Generalised Least Square estimator to correct for first-order autocorrelation in the residuals. Results are presented in Table 4. In view of estimation problems, Girouard and André (2005) prefer to set both the elasticity of indirect tax revenues to private consumption and the elasticity of private consumption to the output gap to unity for all OECD countries. This choice implies that the elasticity of indirect taxes to the output gap equals unity. All our estimations in Tables 1 and 2 yield tax base elasticities around unity, irrespective of the definition of the tax base. Following Table 4, the elasticity of VAT revenues to the output gap then equals 0.7 when the base is measured by private consumption and 0.6 when the broader base is selected. VAT revenues change less than proportionately to GDP as its base lags behind GDP developments.

[15] In this subsection we do not consider that the tax elasticity might not be constant over the business cycle.

Figure 3: Rolling estimation of VAT elasticities to consumption

(a) LR elasticity



(b) SR elasticity

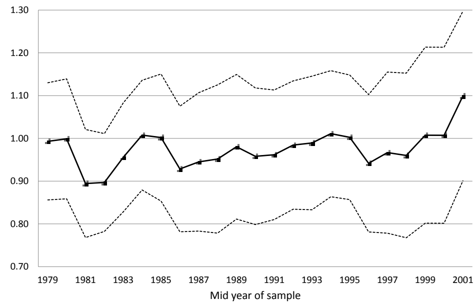
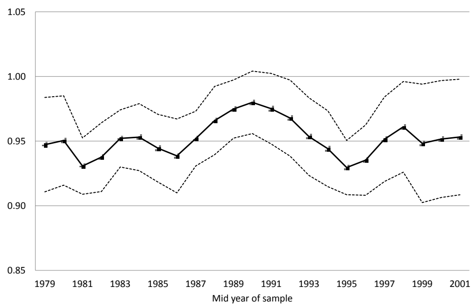


Figure 4: Rolling estimation of VAT elasticities to broad base

(a) LR elasticity



(b) SR elasticity

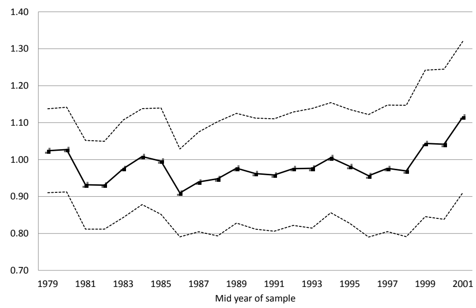


Table 4: Elasticities of VAT base to output gap (1971-2008)

	Consumption	Broad base
Output gap	0.714***	0.611***
	(0.165)	(0.144)
Constant	–0.004**	–0.003
	(0.002)	(0.002)
Obs.	38	38
Adjusted R^2	0.363	0.322

Robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$.

4 Personal income tax

4.1 Description of PIT data

In this section we analyse the sensitivity of PIT revenues, excluding social security contributions. Social security contributions cannot be incorporated due to the lack of series on the effects of discretionary measures. The PIT system is an individualized progressive tax system (with some exceptions). We discuss briefly two main reforms in our sample (1970-2011). The (*Oort*) reform in 1990 combined a broadening of the tax base (by eliminating the deductibility of general social security contributions and lowering personal exemptions) with a reduction and flattening of the tax rates. Microsimulations in Caminada and Goudswaard (1996) show that this reform reduced the revenue elasticity. In 2001 a large reform was implemented with three main elements (Bosch and van der Klaauw, 2012). First, the cut-off points of the tax brackets were shifted and the marginal rates were reduced, in particular for the highest two brackets (−8%-point). Second, tax allowances (reducing the base) were replaced by tax credits (reducing directly taxes to be paid). Third, before 2001, capital income was included in the tax base that was progressively taxed. After 2001, the value of wealth was taxed instead at a single rate of 1.2%.[16] Simulations of the tax system in CPB (2001) suggest that the reform slightly increased the tax elasticity.

In correcting the PIT revenues, we are confronted with a re-definition of discretionary

[16]Above a minimum value and excluding the value of the own house.

measures by the Ministry of Finance in 1990. Before 1972, the nominal figures of the tax schedule were not corrected for inflation (Caminada, 1996). Between 1972 and 1990, the tax system was not adjusted for inflation by rule, unless decided differently by law. In practice, complete indexation was seldom implemented, notwithstanding the high inflation rates during the 70's. In case it was decided explicitly to correct for inflation, the Ministry of Finance booked the revenue effects as discretionary tax reductions. The indexation rule was completely reversed in 1990. After 1990 the tax system is automatically and fully indexed, unless otherwise decided. Deviations from 100% indexation are considered as discretionary tax increases.

Clearly, revenues should be corrected for discretionary tax measures using a consistent series to ensure the same benchmark system over the whole sample. We take 100% inflation correction as general rule. We re-calculate the effects of discretionary measures before 1990 based on the costs of inflation indexations (reported in Appendix 1 of Caminada (1996)). Wolswijk (2007) neglects the inconsistent series, which leads to an upward bias of the elasticity estimate. The ultimate effects of correcting for discretionary measures are illustrated in Figure 5. During the first half of the sample, actual revenues exceed adjusted revenues, reflecting the effects of incomplete inflation indexation and the large Oort reform in 1990. Discretionary tax decreases start to dominate in 1995, but the difference between actual and endogenous revenues narrows during the last years.

We next look at the relationship between (adjusted) PIT revenues and alternative measures of the tax base. Gross wages are used as approximation of the tax base in most studies. Figure 6 suggests that revenues are well correlated with the wage share in GDP. We also use a proxy of the base that is standard calculated by CPB (starting in 1971). On the one hand, the base is extended with social benefits, private pensions and imputed rents. On the other hand, main deductions from the base are social insurance premiums (unemployment and disability), private pension contributions and interest payments on mortgages. After a similar development as the wage sum, the broad base is shown to increase strongly in the middle of the sample. After reaching a peak in 1993, the broad base sharply falls to the level of the wage share at the end of the sample.

Figure 5: Actual and adjusted PIT revenues (%GDP)

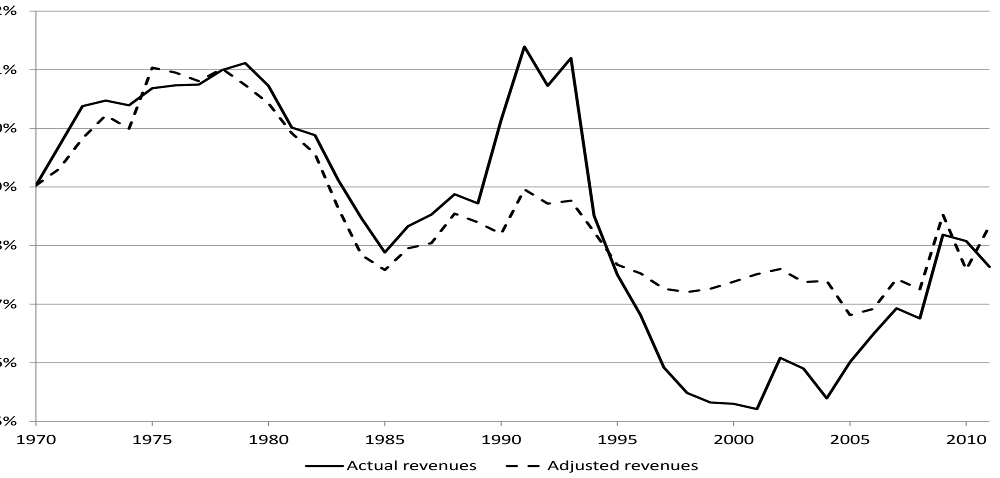
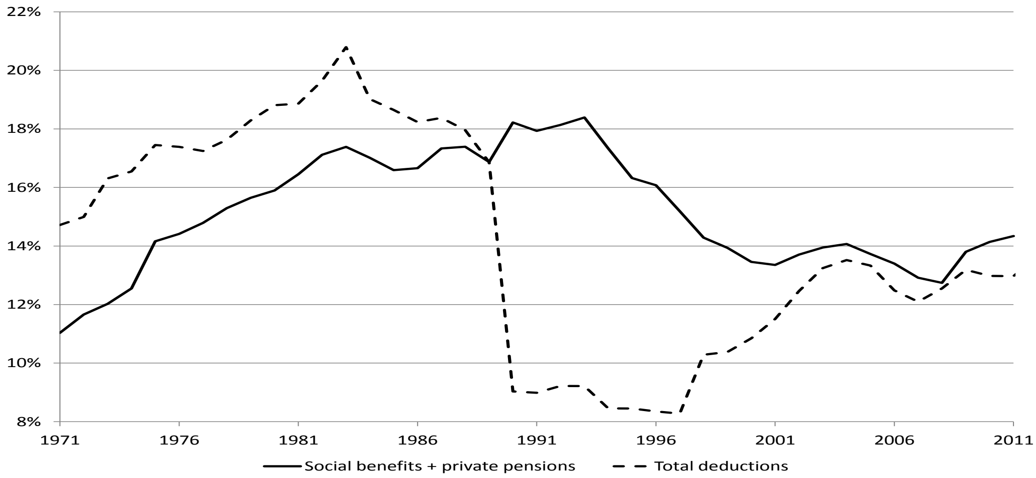


Figure 6: PIT tax bases (%GDP)

Figure 7: PIT base components (%GDP)



These developments are explained by plotting the other two components of the broad base in Figure 7.[17] Until 1983, the effect on the base of increasing social benefits is balanced by the rise in the financing social insurance premiums. The subsequent expansion of the base is mainly attributed to the fall in deductible social contributions arising from reforms of social security and the Oort reform in 1990. The erosion of the base as from 1993 is explained by both the reduction in social and pension benefits and the rise in total deductions. Total deductions during this period are mainly driven by increased pension contributions and mortgage interests (net of imputed rent). Finally, comparison of Figures 5 and 6 illustrates a drawback of using the broad base. Since the base is not corrected for the effect of discretionary changes, the base is stronger correlated with the observed revenues than with the adjusted revenues. In the next subsection we will estimate the elasticities with respect to both bases.

[17]The relationship between Figures 6 and 7 is as follows: "Broad base" equals "Wage sum" plus "Social benefits + private pensions" minus "Total deductions" (Imputed house rents are deducted from the last item).

4.2 Estimation results for PIT

We first present results in Table 5 using the nominal wage sum as the PIT base. We find in column (1) a long-run tax elasticity of 0.89, which is significantly below 1, and a short-run elasticity of 1.07, which is not significantly different from one. The finding of a higher short-run elasticity might reflect that employment in the short run is less flexible than in the long run. The low adjustment speed (0.24) indicates that revenues adjust slowly to deviations from the long-run level. The elasticities are low for a progressive tax, but notice we consider an inflation-neutral system as benchmark.[18] Elasticities are also low compared to estimates in other studies. Following a micro approach, Girouard and André (2005) calculate an income tax elasticity of 2.4 for the Netherlands in 2003. However, this calculation is only based on taxes due of a representative household, defined as a full-time, two-earner married couple with two children, with the secondary earner receiving 50% of the wage of the principal earner (see their footnote 8). Wolswijk (2007) finds a LR elasticity of 1.41 and a SR elasticity of 2.01 for the period 1975-2005. However, he uses the inconsistent series in correcting for discretionary measures and, as a consequence, it is not clear which benchmark tax system these elasticities represent.[19]

Applying the Dynamic OLS-estimator hardly changes the results in column (2) and dropping the special years 2009-2011 also gives similar findings in column (3). Adding a constant term to the SR equation results in general in a larger elasticity (with a larger standard error), while the adjustment speed hardly changes. For example, compared to the third column, the SR elasticity increases to 1.34 after including a (significant) constant term, but its 95%-confidence interval contains the estimate without constant term (1.06).[20]

[18]Based on simulations with a micro model, Caminada and Goudswaard (1996) assess the effect of inflation adjustments on the revenue elasticity for the total of income tax and social security contributions. Incorporating full adjustment for inflation is shown to reduce this elasticity from 1.22 to 1.07 in 1990.

[19]We have tried to reproduce the results of Wolswijk (2007) by using the inconsistent correction series and the same sample. Our estimates now become quite similar: 1.34 in the LR and 1.70 in the SR. As expected, this estimation suffers from a significant structural break in the coefficients in 1990.

[20]When revenues are not corrected for discretionary measures, estimates are slightly smaller: 0.78 in the long run and 1.03 in the short run. All results are available upon request.

Table 5: PIT elasticities using wage sum as tax base

	(1) OLS full sample	(2) DOLS full sample	(3) OLS w/o 2009-11	(4) OLS full sample
Long-run				
Constant	–0.552**	–0.376	–0.350	-0.640***
	(0.238)	(0.407)	(0.252)	(0.236)
ln(Wage sum)	0.891***	0.874***	0.873***	
	(0.020)⋆⋆⋆	(0.033)⋆⋆⋆	(0.021)⋆⋆⋆	
ln(Employment)				0.716***
				(0.204)
ln(Wage rate)				0.930***
				(0.048)
Obs.	42	39	39	42
Adjusted R^2	0.984		0.983	0.984
Short-run				
Δln(Wage sum)	1.069***	1.046***	1.058***	
	(0.072)	(0.072)	(0.070)	
Lagged LR residual	–0.240***	–0.304*	–0.233***	–0.262***
	(0.079)	(0.151)	(0.068)	(0.090)
Δln(Employment)				0.597
				(0.454)
Δln(Wage rate)				1.140***
				(0.086)
Obs.	41	39	38	41
Adjusted R^2	0.739	0.684	0.817	0.731

Robust standard errors in parentheses. The *-symbol refers to the p-value of the test that the coefficient equals 0, with *** p<0.01, ** p<0.05, * p<0.1. Similarly, the ⋆-symbol refers to the test that the elasticity equals 1.

To understand the low elasticities, we next decompose the effect of the wage sum into the effect of employment (in man-years) and the effect of the wage rate. An employment increase is commonly believed to have a much smaller effect than a wage increase (see e.g. Wolswijk, 2007). The last column supports this pattern in the long run but equality of the elasticities cannot be rejected. The change in employment has no significant effect in the short run, whereas the elasticity of the wage rate (insignificantly) exceeds one but the difference is again not significant. Therefore, we will only consider the wage sum in the remaining regressions.

The sensitivity of the outcomes to a broader tax base (as defined above) is shown in Table 6. Using a broader tax base leads to PIT elasticities that are similar to the estimates in Table 5. The adjustment speed gets smaller and less significant in all regressions.[21]

We finally allow for asymmetric elasticities in the short run in Table 7. We first define good (bad) years as years during which PIT revenues are above (below) the estimated long-run level. The first column shows that the elasticity to the wage base in the good regime (1.27) is larger than in the symmetric case (1.06) but a lower elasticity (0.65) is obtained in the bad regime. Wolswijk (2007) finds no evidence of asymmetric responses, following the same approach. The implications of asymmetric responses are illustrated by way of cumulative impulse response functions in Figure 8.[22] In the symmetric case revenues overshoot the long-run effect since the short-run elasticity exceeds the long-run elasticity. After year 1, the error correction term ensures that revenues converge to the new long-run equilibrium. In the asymmetric case, overshooting is larger after a positive shock, whereas the initial impact is lower (in absolute value) after a negative shock due to the smaller short-run elasticity. When the broad base is considered, also a significant, positive difference is found in column (3). In contrast, the hypothesis of asymmetric elasticities is strongly rejected when the impact of the growth in the base is split according to the sign of the output gap; columns (2) and (4). In other words, PIT revenues respond the same to base changes in expansionary and contractionary phases of the business cycle.

[21] The SR elasticity in the last column changes to 0.82 after including a (non-significant) constant term.

[22] The IRF is calculated as follows. We assume a long-run equilibrium in year 0, evaluated at the observed wage sum in 2008. In year 1 the wage sum is changed by 1%. We calculate the adjustment path of revenues using column (3) of Table 5 for the symmetric case and column (1) of Table 7 for the asymmetric case. For reasons of comparison, the responses to the negative shock are presented in absolute values.

Table 6: PIT elasticities using broad tax base

	(1) OLS full sample	(2) DOLS full sample	(3) OLS w/o 2009-11
Long-run			
Constant	0.351	0.597	0.676**
	(0.280)	(0.646)	(0.291)
ln(Broad base)	0.814***	0.791***	0.785***
	(0.024)⋆⋆⋆	(0.053)⋆⋆⋆	(0.025)⋆⋆⋆
Obs.	41	38	38
Adjusted R^2	0.968		0.970
Short-run			
Δln(Broad Base)	0.878***	0.799***	0.864***
	(0.198)	(0.207)	(0.193)
Lagged LR residual	–0.170*	–0.109	–0.204***
	(0.085)	(0.113)	(0.071)
Obs.	40	38	37
Adjusted R^2	0.589	0.492	0.668

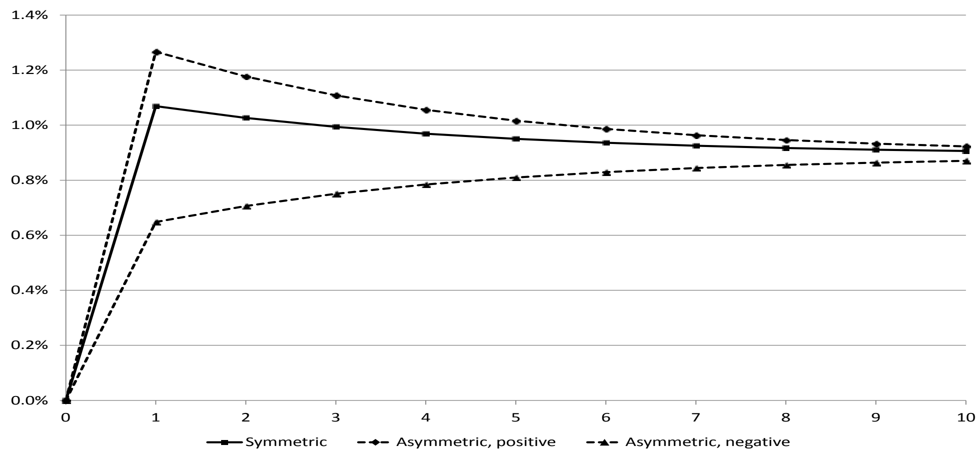
Robust standard errors in parentheses. The *-symbol refers to the p-value of the test that the coefficient equals 0, with *** p<0.01, ** p<0.05, * p<0.1. Similarly, the ⋆-symbol refers to the test that the elasticity equals 1.

Table 7: Asymmetric short-run PIT elasticities (1971-2008)

	Wage sum		Broad base	
	LR residuals	Output gap	LR residuals	Output gap
Δln(Wage sum)$^+$	1.267***	1.080***		
	(0.124)**	(0.069)		
Δln(Wage sum)$^-$	0.648***	0.942***		
	(0.139)**	(0.283)		
Δln(Broad base)$^+$			1.296***	0.851***
			(0.161)*	(0.233)
Δln(Broad base)$^-$			0.451**	0.892***
			(0.215)**	(0.258)
Lagged LR residual	-0.444***	-0.207***	-0.425***	-0.182**
	(0.101)	(0.069)	(0.104)	(0.073)
Obs.	19+19	20+18	20+17	19+18
Adjusted R^2	0.848	0.807	0.771	0.653
p-value Asymmetry	0.008	0.638	0.008	0.908

Robust standard errors in parentheses. The *-symbol refers to the p-value of the test that the coefficient equals 0, with *** p<0.01, ** p<0.05, * p<0.1. Similarly, the *-symbol refers to the test that the elasticity equals 1. LR-residuals are taken from column (3) in Tables 5 and 6. Number of observations gives the distribution between good and bad times.

Figure 8: Cumulative impulse response function after 1%-change in wage sum



Note: responses to negative shock are expressed in absolute value.

4.3 Analysis of time-variation in PIT elasticities

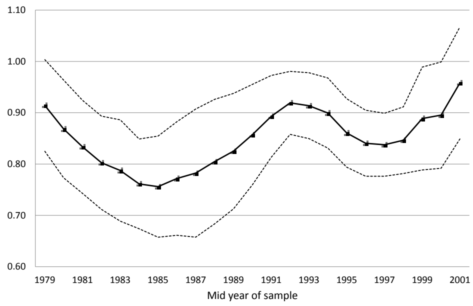
We examine the stability of the estimates by using rolling subsamples of 20 years (similar results of the recursive approach are presented in the Appendix). In case the base is measured by the wage sum, Figure 9 shows no clear trend in both the long-run and short-run elasticities. In addition, the long-run elasticity is significantly below one in most of the subsamples, whereas the short-run elasticity is never significantly different from one. In contrast, analysis with the broad base indicates a strong upwards trend in the long-run elasticity and an insignificant trend in the short-run elasticity (Figure 10).

The substantial reform of the tax structure in 2001 makes it hard to correct tax revenues for discretionary measures after 2001. In addition, endogenous responses might have changed due to the structural reform. Therefore, we test for a structural break in the coefficients in 2001. We define a dummy that equals one starting in 2001 and interact this dummy with the tax base variable. This means we estimate separate coefficients before and after 2001. We do not find significant changes in the short-run coefficients and therefore focus on the structural break in the long-run relation in Table 8. When the explanatory variable is the wage sum, the constant term and the elasticity are not significantly changed after 2001 (first column). However, when the broad base is considered, the long-run elasticity increases significantly from 0.73 before 2001 to 1.14 after 2001.[23] Using the residuals of this long-run equation hardly affects the short-run results, compared to the last column of Table 6. The finding that the long-run elasticity of (adjusted) PIT revenues is larger in the last decade seems to be in conflict with the perception expressed in e.g. Studiegroep Begrotingsruimte (2012). However, this perception relates more to the short-run elasticity of tax revenues with respect to GDP.

[23] After including the crisis years 2009-11, the post-2001 elasticity increases significantly by 0.435 and 0.623 when the wage sum and the broad base are used, respectively.

Figure 9: Rolling estimation of PIT elasticities to wage sum

(a) LR elasticity



(b) SR elasticity

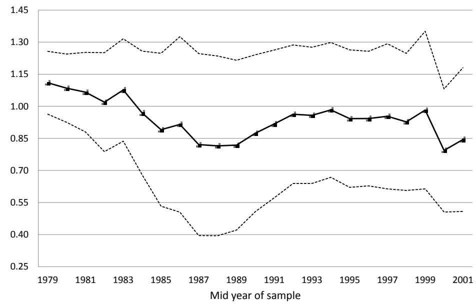
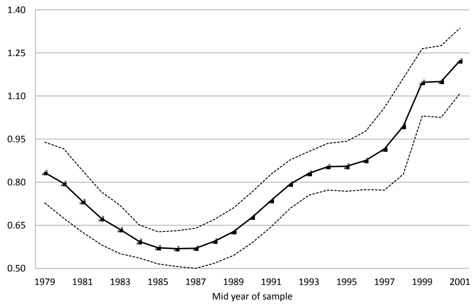


Figure 10: Rolling estimation of PIT elasticities to broad base

(a) LR elasticity



(b) SR elasticity

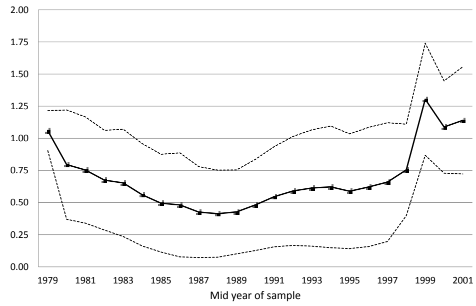


Table 8: Structural break in long-run PIT elasticities in 2001

	Wage sum	Broad base
Long-run		
Constant	–0.372	1.288***
	(0.364)	(0.433)
Dummy 2001	–1.900	–4.930***
	(1.396)	(1.264)
ln(Base)	0.875***	0.731***
	(0.031)⋆⋆⋆	(0.037)⋆⋆⋆
ln(Base)*Dummy 2001	0.152	0.405***
	(0.113)	(0.102)
Obs.	31+8	30+8
Adjusted R^2	0.982	0.976
Short-run		
Δln(Base)	1.059***	0.853***
	(0.070)	(0.181)
Lagged LR residual	–0.234***	–0.306***
	(0.068)	(0.083)
Obs.	38	37
Adjusted R^2	0.818	0.700

Robust standard errors in parentheses. The *-symbol refers to the p-value of the test that the coefficient equals 0, with *** p<0.01, ** p<0.05, * p<0.1. Similarly, the ⋆-symbol refers to the test that the elasticity equals 1.

4.4 PIT revenues over the business cycle

We finally describe the implications for the elasticity of PIT revenues to the output gap. Girouard and André (2005) combine a rather high elasticity of PIT revenues to earnings of 2.4 with an estimated elasticity of the wage bill to the output gap of 0.7[24], yielding an elasticity of revenues to the output gap of 1.7. Our estimation results of equation (12) can be found in Table 9. The estimate of both base elasticities to the output gap (0.61 and 0.76) is very similar to the value in the OECD-study. For the revenue elasticity to the tax bases, we consider the 95% upper bound of the short-run elasticity estimated over the period 1970-2008 (see the third column of Tables 5 and 6). The elasticity of PIT revenues to the output gap is then computed as $1.20 * 0.61 = 0.73$ when the wage sum measures the base, and similarly as $1.26 * 0.76 = 0.95$ with the broad base. In sum, according to OECD PIT revenues are much more elastic to the output gap than implied by our updates.

Table 9: Elasticities of PIT base to output gap (1971-2008)

	Wage sum	Broad base
Output gap	0.609***	0.756*
	(0.214)	(0.402)
Constant	–0.003	–0.001
	(0.003)	(0.006)
Obs.	38	37
Adjusted R^2	0.191	0.069

Robust standard errors in parentheses; *** $p < 0.01$, * $p < 0.1$.

[24] This value results from estimation on a pooled dataset with 5 countries. Estimating separately for the Netherlands results in an elasticity of 0.44.

5 Conclusions

We have estimated long-run and short-run elasticities of VAT and PIT revenues with respect to their bases, corrected for the effects of discretionary measures, for the Netherlands. We have experimented with tax bases for both types of taxes that are defined broader than in existing studies. We find VAT elasticities to private consumption around one in the long-run and short-run. Extending the base hardly affects these outcomes. The short-run elasticity exceeds one when VAT revenues exceed the estimated long-run level, while it is smaller than one in the other case. The evidence on asymmetric responses to changes in private consumption is weak when the definition of the regimes is based on the sign of the output gap. VAT elasticities are robust to the choice of the subperiod. Our estimate of the elasticity to private consumption implies an elasticity of VAT revenues to the output gap of 0.7, which is lower than the unitary value assumed by Girouard and André (2005).

We have considerably improved the correction of PIT revenues for the impact of discretionary measures, which leads to lower elasticities than those obtained by Wolswijk (2007). Outcomes are again robust to a broader definition of the tax base. Asymmetric responses are now strongly rejected when the output gap is considered to identify both regimes. Stability cannot be rejected for all elasticities, except for the long-run PIT elasticity to the broad base. The large 2001 reform has increased this elasticity significantly from 0.7 to 1.1. Finally, PIT revenues respond more than proportionally to the output gap according to the OECD-study. The upper bound of our elasticity estimate suggests that PIT revenues react much less elastically to the output gap.

For the estimation of PIT elasticities macro and micro approaches are applied in the literature. One might question whether estimating an average elasticity on aggregate variables is adequate to capture the complexities of the taxation system, including the regular structural reforms. Moreover, forecasting the dynamic effects of discretionary changes is much more demanding for PIT revenues than for VAT revenues. An older reform in 1990 is studied using a micro approach by Caminada and Goudswaard (1996) but an extensive analysis is still lacking for the larger reform in 2001. We plan to assess the impact of the 2001 reform on tax elasticities using an extensive microsimulation model developed at CPB and compare the results obtained with both approaches.

Finally, the recent debate on the size of fiscal multipliers clearly points at the bicausal relation between revenues and bases. We have applied two methods to alleviate the endogeneity problems in estimation. First, unexpected fluctuations in revenues might induce the implementation of measures that have an impact on the tax base. We therefore try to remove the effects of discretionary measures on tax revenues, keeping the benchmark tax structure unchanged. Second, applying the Dynamic OLS estimator eliminates the effects of regressor endogeneity (Bruce et al., 2006). The small differences between the OLS and DOLS estimates of the long-run elasticities suggest that the endogeneity bias is limited. Results might be further improved by estimating simultaneously tax elasticities and fiscal multipliers but this still looks like a daunting task.

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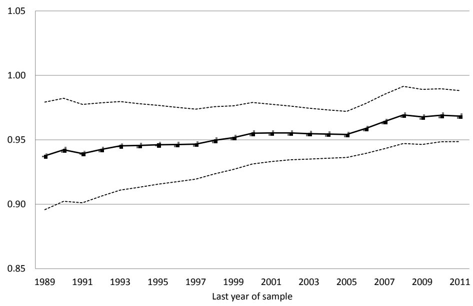
Appendix

Figure A.1: Recursive estimation of VAT elasticities to consumption

(a) LR elasticity



(b) SR elasticity

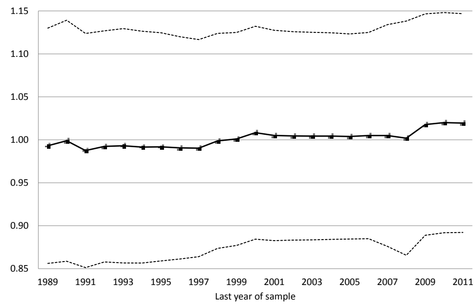
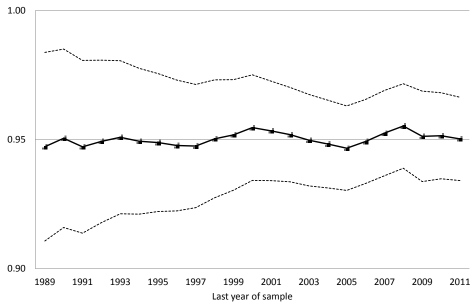


Figure A.2: Recursive estimation of VAT elasticities to broad base

(a) LR elasticity



(b) SR elasticity

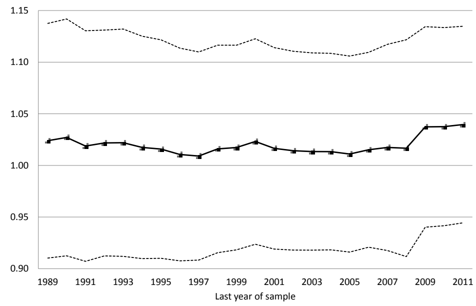
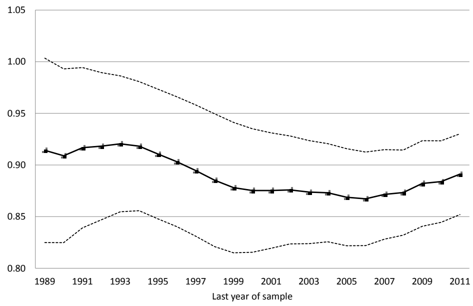


Figure A.3: Recursive estimation of PIT elasticities to wage sum

(a) LR elasticity



(b) SR elasticity

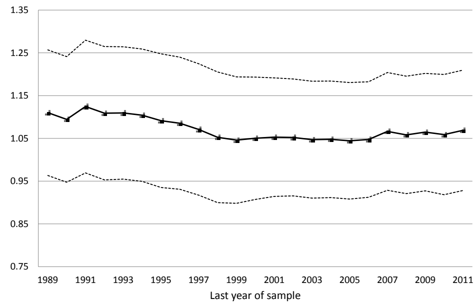
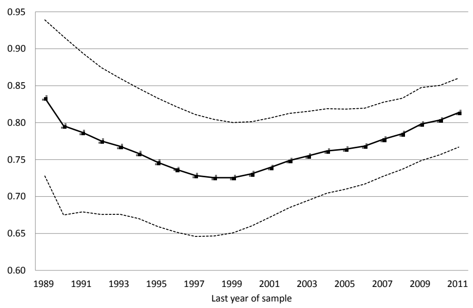
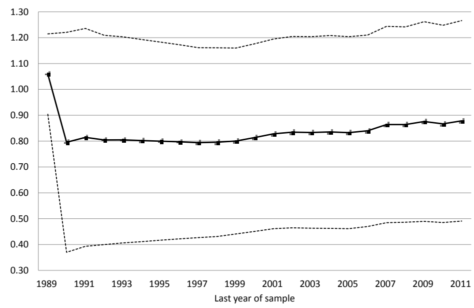


Figure A.4: Recursive estimation of PIT elasticities to broad base

(a) LR elasticity



(b) SR elasticity



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