The VAT Laffer Curve and the Business Cycle in the EU27: An Empirical Approach

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ABSTRACT

Value Added Tax (VAT) standard rate Laffer curves are estimated for the European Union of twenty seven countries (EU27) over the period 1995-2011, using a twice continuously differentiable VAT revenue quadratic flexible functional form. A business cycle effect on the Laffer curve is found. In recession years, VAT revenue is typically lower, the curve steeper, and the VAT standard rate that maximises VAT revenue slightly smaller than previously. These results can be explained with reference to changes in the composition of consumption and VAT collection enforcement. A countercyclical VAT standard rate policy (procyclical fiscal policy), observable in a few countries, not only increases the underlying business cycle volatility but may also result in long-term instability of VAT revenue. In 2011, the maximum VAT standard rates in expansion and recession were respectively 22.0 and 21.5 per cent. Most of the EU27 countries were operating in the non-prohibitive range of the curve; although Portugal, with a VAT standard rate of 23 per cent, along with several other countries with similar rates, was already operating in the prohibitive range of the curve. VAT standard rate Laffer curves shifted to the left and maximum VAT standard rates declined during the analysed period.

1. INTRODUCTION

THE WORLD FINANCIAL CRISIS, the eurozone crisis, and the Troika rescue programmes of the most indebted European Union (EU) countries have brought to the arena a discussion on fiscal policy and tax increases (e.g. Alesina and Ardagna 2010; Reinhart and Rogoff 2010; Krugman 2012; Blyth 2013). Rescued countries can face a Laffer effect: if tax rates keep increasing, tax revenues will decrease where they have not yet decreased, and hence fiscal deficits and debts will not be reduced.

The inverted U-shaped relation between tax rate and tax revenue — the so-called Laffer curve — has been discussed since at least the eighteenth cen-

tury. According to Blinder (1981), in 1774 Edmond Burke (1729-1797) opposed over-taxation of the American colonists in the British parliament. He argued that the scheme would end where it began; that is, with attempts to levy tax where no revenue is to be found. Still, according to Blinder (1981), the academic Dupuit wrote in 1884: 'If a tax is gradually increased from zero up to the point where it becomes prohibitive, its yield is at first nil, then increases by small changes until it reaches a maximum, after which it gradually declines until it becomes zero again' (Blinder 1981 p 83). The Laffer curve was rediscovered by Laffer himself in 1974, and named as such in a well-known paper by Wanniski (1978).

A wide range of empirical literature has estimated the Laffer curve for several different taxes. This literature has found peaks for the Laffer curve, conditions for the existence of the curve, or simply support for its existence. Papers have dealt with Laffer curves for overall taxation (Feige and McGee 1983; Dalamagas 1998, 2003; Hansson and Stuart 2003; Ioan 2012); for labour income tax (Yu 1996; Krause 2009); for corporate tax (Brill and Hasset 2007; Fève *et al* 2013) and also for VAT (Matthews 2003).

In particular, Matthews (2003) used unbalanced time-series data for the European Union of fourteen countries (EU14), covering the period 1970 to 1998. The author found the revenue-maximising VAT rate to be between 18.0 and 19.3 per cent, for given conditions of non-compliance. He argued that when the VAT rate increases: (i) people consume less (avoidance); and (ii) people escape paying VAT whenever possible (evasion). The latter effect is directly related to the size and characteristics of a country's informal economy. Thus, VAT avoidance and evasion are positively related to VAT rate.[2]

Similarly, Heijman and van Ophen (2005) claimed that the negative effect of an increase in tax rate on tax revenue has two main causes: (i) it leads to a decrease in activities (work, consumption, investment, etc.) in the formal economy (avoidance); and (ii) it leads to an increase in activities in the informal economy (evasion).

Trabandt and Uhlig (2011) calibrated Laffer curves for labour income, capital income, and consumption taxation for the United States (US), the EU14, and individual European countries, by comparing the balance-growth path of a neoclassical growth model featuring Constant Frisch Elasticity (CFE). They concluded that the EU14 is closer to its maximum than the US in terms of labour income and capital income taxation, and that the consumption tax Laffer curve does not peak. According to the authors, the latter result arises from the tax treatment of transfer income in the model. That is, it is a matter of 'accounting': tax revenue is used as transfer income and the latter is treated as income before consumption tax.

Other literature has addressed the effects of the business cycle on fiscal policy and tax revenues. The cyclicality of fiscal policy was addressed by Alesina *et al* (2008), Bilicka (2013) and Barseghyan *et al* (2013). The importance of the business cycle and its relevance to the decision-making process

was addressed by Sancak *et al* (2010) and by Végh and Vuletin (2012).[3] Ferede (2013), for example, studied the response of the tax base to the business cycle. The author argued that, in order to plan ahead, governments have to be able to predict revenues and expenses.

The above literature review leaves key important questions unanswered. Is there a VAT Laffer curve for the EU, and can we find its location so as to evaluate some of the policy choices that have been made recently? Is there a business cycle effect on this Laffer curve, and, if so, how does it work? To answer these questions, we estimate VAT Laffer curves for the EU27 countries over the period 1995-2011, and test for the impact of the business cycle on these curves. Our research aims to contribute to the empirical literature on the Laffer curve, on the effects of the business cycle on VAT revenue, and to the current discussion on fiscal policy choices in the EU.

The paper proceeds as follows. In section 2, we provide a number of theoretical underpinnings, which support the developed regression model. In section 3, we present and discuss the regression model (equation, data, and assumptions). Section 4 yields the estimation results and discussion. Section 5 concludes.

2. Theoretical underpinnings

Keynes (1936) outlined what today we can call micro-foundations of demand-driven business cycles, and provided a view of the business cycle as a self-perpetuating phenomenon, which is occasioned by a cyclical change in the marginal efficiency of capital.[4] Today's mainstream neoclassical macroeconomics considers the business cycle as an impulse-propagation mechanism: economies are subject to shocks or impulses that are converted into the business cycle through a transmission or propagation mechanism. However, it is divided concerning the primary source of these impulses (demand versus supply shocks) and on the transmission mechanism itself (price rigidity versus changes in the productivity of factors).

In this paper, we assume the business cycle as an impulse-propagation mechanism resulting from demand and supply shocks. Demand shocks result mainly from liquidity constraints imposed by financial markets and institutions on the real economy. These constraints are an outcome of global financial liberalisation and deregulation and/or financial-market failures, such as sudden changes in expectations driven by panic, asymmetrical information, and other traits of present global financial markets and institutions. The failures may lead to the bankruptcy of efficient and inefficient firms, long-term unemployment, emigration, etc.; that is, to negative permanent effects on supply or negative supply shocks. As suggested by Greenwald and Stiglitz (1998), we recognise the existence of price rigidities, and that price flexibility during a recession may work to exacerbate, instead of mitigate, the shocks.

Whether expectations are rational is an empirical question, with a negative answer in many instances (Greenwald and Stiglitz 1993). Given the recent financial crisis and the Great Recession, we look to long-run expectations of financial investors as not being rational; that is, as deviating from the fundamentals. Instead, we assume these expectations to work in line with Keynes's (1936) description. Financial investors are informed in their decisions by banks, brokers, rating agencies, and other financial agents and institutions whose focus is on short-term profits.

Regarding consumers, rational expectations demand time and other resources, as well as market efficiency. Most people lack the necessary time and other resources to provide rational expectations, and market inefficiency does little to help this situation. Even assuming that consumers are forward-looking, they may not be able fully to internalise the government's budget constraints when making consumption decisions, as a result of liquidity constraints imposed by the financial markets. Siddiki's (2008) empirical findings revealed finite time-horizon and liquidity constraints as the sources of deviation in Bangladesh from Barro's (1974) Ricardian Equivalence Hypothesis (REH). Thus, we expect the REH not to hold in the EU. That is, for a given pattern of government spending, the method of financing such spending does affect consumption decisions. *Ceteris paribus*, an increase in VAT rates does reduce consumption. According to the REH, unless consumers perceive a change in government spending and/or in their inter-temporal tax burden, they will not change their behaviour. The aim of this paper is to estimate an EU27 VAT Laffer curve, and not to test the REH hypothesis; nonetheless, we are aware of the implications of the REH, and we take into account forward-looking consumers in our estimation, as we explain in Section 3.[6]

In the last four decades, forward-looking agents, long-run general equilibrium, and dynamic programming have been used to address macroeconomic questions such as those pertaining to the Laffer curve. Usually, researchers establish a dynamic model of the economy, solve it for the steady state, calibrate the model using real data, and draw conclusions. Given the assumptions we have made on the business cycle, our strategy is different. Instead of calibrating a dynamic model of the Laffer curve, we estimate an approximation of the static (actual) VAT Laffer curve using a quadratic flexible functional form specification, and test for the business cycle effect on it. The dynamics of the VAT Laffer curve are provided by the sequence of (actual) VAT Laffer curves in time, and can be helpful in building a better theory of the Laffer curve and the business cycle.

Concerning the existence of the Laffer curve, Blinder (1981) argued that it is a result not of economics, but rather of mathematics: Rolle's Theorem (formally proven by Michel Rolle in 1691) stated that any real-valued differentiable function that attains equal values at two distinct points must have a stationary point somewhere between them; that is, a point at which the slope of the tangent line to the graph of the function is zero. Therefore, there is a tax

rate that maximises tax receipts, as long as the assumptions of Rolle's Theorem apply. In addition, it must be true that a zero tax rate yields no revenue and that there is an end-point tax rate that also yields no revenue (Blinder 1981).

The Laffer curve simply says that 'there are always two tax rates that yield the same revenue' (Wannisky 1978 p 3), except (we would add) for the tax rate that yields the maximum revenue possibly reached. Laffer (2004) himself stated that the Laffer curve translates the idea that a change in the tax rate has two opposing effects on tax revenue: (i) the arithmetic effect; and (ii) the economic effect. The former says that VAT revenue (*VATR*) increases with VAT rate (v), for a given VAT base (*VATB*).[7] The latter says that the *VATB* (and consequently *VATR*) decreases with v because, using Matthews' (2003) terminology, a higher v gives an incentive to reduce consumption and increase evasion; thus, to reduce the *VATB*. Therefore, the true VAT revenue function (*VATR**) can be expressed in the following way:

$$VATR^{*}(v) = v \times VATB(v) \tag{1}$$

Ceteris paribus, as long as the direct effect of v on *VATR* is larger than the indirect effect via the *VATB, VATR* will increase. This will happen up to a given point (the VAT rate v that yields the maximum *VATR*). From that point forward — Laffer (2004) calls it the 'prohibitive range' — any increase in v leads to a decrease in *VATR*.

3. The Regression Model

There is more than one VAT rate in the EU.[8] In addition to the VAT rates, other variables such as government debt, excise taxes, tax collection enforcement, culture, etc., may change consumption and/or the *VATB*, and consequently *VATR*. Let X be the set of variables affecting *VATR*. The true *VATR* function, *VATR*(X)*, is an unknown multivariable function or surface on X, which is assumed to be twice continuously differentiable. It can be approximated by the following twice continuously differentiable quadratic flexible functional form (FFF),[9] giving the regression equation:

$$\begin{aligned} VATR_{it} &= \beta_0 + \beta_{1i} D_i + \beta_2 x_{it} + \beta_3 t + \beta_4 \frac{x_{it}^2}{2} + \beta_5 \frac{t^2}{2} + \beta_6 x_{it} t \\ &+ \beta_7 D_{it}^e + \beta_8 D_{it}^e x_{it} + \beta_9 D_{it}^e \frac{x_{it}^2}{2} + \beta_{10} D_{it}^e x_{it} t + \beta_{11} y_{it} + \varepsilon_{it} \end{aligned} \tag{2}$$

where:

D_i Is the dummy variable that captures country i's specific fixed effects. This is equal to 1 if country i and 0 otherwise.

x_{it} Is the standard VAT rate in country *i*, year t

t Is the time variable, equal to 1 in 1995, 6 in 2000, ..., and 17 in 2011.

D_{it}^{e} Is the dummy variable for country *i*, year *t*, equal to 1 in a country expansion year and 0 in a country recession year.

y_{it} Is the reduced VAT rate in country *i*, year *t*.

ε_{it} Is the stochastic disturbance term.

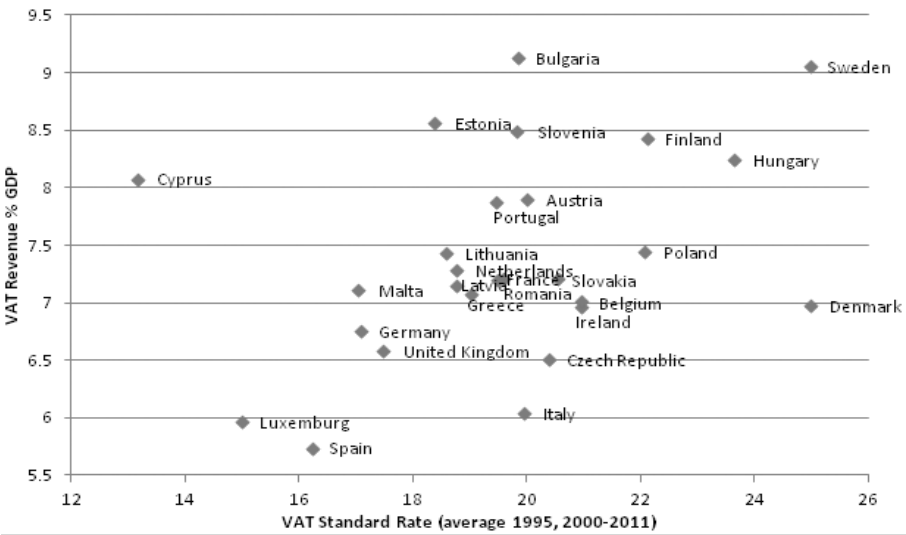
Given the expected shape of the VAT Laffer curve (see section 2), the twice continuously differentiable quadratic is an appropriated second-order FFF to approximate the true unknown actual VATR function, *VATR*(X)*.[10] Concerning the VAT Laffer curve in the standard rate (*x*), we expect the coefficient on x_{it} to be positive and the coefficient on $\frac{x_{it}^2}{2}$ to be negative.

We estimate equation (2) for the EU27 countries using an almost-balanced panel. The panel data cover the year 1995 and the years 2000 to 2011. It is almost balanced as Malta's 1995 Gross Domestic Product (GDP) at constant prices was unavailable. The data were obtained from a Eurostat report (*Eurostat Statistical Books* 2012) and from online Eurostat statistics. We have worked with GDP at constant prices of 2005. VATR is available as a percentage of nominal GDP for each country and time. By multiplying these percentages by GDP at constant prices as of 2005, we computed VATR at constant 2005 prices. Concerning the VAT rates, the standard rate (*x*) and the reduced rate (*y*) applicable in each country in each year have been considered (*Eurostat Statistical Books* 2012). In the period of analysis, the increased rate was zero and the variability of the parking rate was zero, or close to zero, in all countries. For several countries, more than one reduced rate was applicable. In these cases, we took the average reduced rate. Table 1 provides a summary of the data. Figure 1 yields a graph relating average VATR with average *x* for the EU27 countries in the years analysed.

Table 1: Data summary for the EU27 Member States, 1995 and 2000-2011

Variable	*Units*	*Mean*	*St. dev.*	*Max.*	*Min.*
VAT revenue (*VATR*)	10^5€	0.277	0.414	1.792	0.003
Standard VAT rate (*x*)	%	19.52	3.08	25.00	0.00
Reduced VAT rate (*y*)	%	6.51	2.96	16.50	0.00

Figure 1: VAT Revenue in percentage of GDP, Average 1995, 2000-2011



Source: authors

The variable x and time (t) enter the regression model in the quadratic form described in (2). In this way, and together with country-specific intercepts, we are able to capture demand and supply side effects impacting the shape, position, and even existence of the VAT Laffer curve in x. Thus, the specification allows controlling for the effects connected with forward-looking consumers.[11] Country-specific intercepts have been considered to capture the set of observable and non-observable factors that are specific to a given country. For instance, *ceteris paribus*, the scale of the country matters in terms of *VATR* collected and the same applies to cultural differences across countries in relation to tax evasion, and thus *VATR* collected. Given the difficulties with its measurement, y enters the regression model as a control.[12]

To separate the cyclical component of GDP, the Hodrick-Prescott (HP) filter (Hodrick and Prescott 1997) has been used over unbalanced panel data covering the EU27 countries' GDP at constant 2005 prices, over the period 1976-2012. Dummy variables were built to distinguish years of country expansion (with a positive HP GDP cyclical component) from years of country recession (otherwise). These dummy variables have been used to test for the effects of the business cycle on the EU27 VAT Laffer curves in x. They enter the regression in an additive and multiplicative way, affecting the intercept and the terms in x, and allowing the Laffer curves in x to shift up and down, left and right.

Robust estimation has been used. *VATR* never assumes negative values. The model used to reproduce *VATR* must therefore be limited to the same interval. Thus, truncated regressions have been estimated, imposing a lower limit of zero on *VATR*. Next, we present and discuss the estimation results.

4. Estimation results and discussion

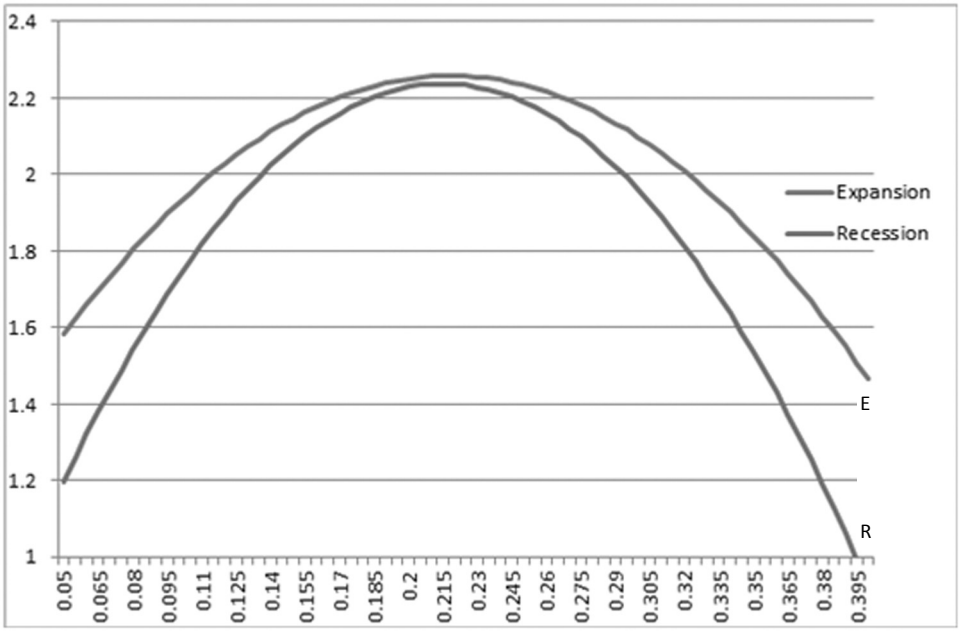
Table 2 provides estimation results for all EU27 countries over the period analysed (the intercept and country-specific intercept estimates are reported in Table 1A of the Appendix).[13] All the estimates reported in Table 2 are statistically significant at a level below 10 per cent. The quadratic function x_{it} and t estimates are significant at a level below 1 per cent and yield a VAT Laffer curve in x. The business cycle dummy estimates are significant at a level between 6.5 and 9.1 per cent. The variable y_{it} is significant at a level below 1 per cent and has a negative sign; that is, the EU27 countries seem to be operating in the prohibitive range of the VAT Laffer curve in y.

Table 2: Estimation results

	Equation (2)	
$VATR_{it}$	*Coefficient*	$P>\|z\|$
x_{it}	18.16643	0.002
t	0.0351321	0.000
$\frac{x_{it}^2}{2}$	-76.55003	0.005
$\frac{t^2}{2}$	-0.0008592	0.008
$x_{it}t$	- 0.101728	0.004
D_{it}^e	0.6475987	0.068
$D_{it}^e x_{it}$	-6.187066	0.065
$D_{it}^{er} \frac{x_{it}^2}{2}$	28.65893	0.067
$D_{it}^e x_{it} t$	0.0111675	0.091
y_{it}	-0.4903415	0.004
Lower limit	0	
Upper limit	+inf	
Log.pseudolikelihood	818.67522	
Number of obs	350	
Wald chi2 (38)	29946.77	
Prob >chi2	0.0000	

Figure 2 illustrates the EU27 2011 expansion and recession VAT Laffer curves in x.[14]

Figure 2: EU27 2011 VAT Laffer curves



Source: Authors. Horizontal axis: VAT standard tax rate. Vertical axis: VATR *scaled measure.*

The EU27 expansion VAT Laffer curve in x typically enclose the corresponding EU27 recession VAT Laffer curve in x. That is, for the same VAT standard rates, VATR is typically higher in expansion years than it is in recession years. More importantly, the curve is steeper in recession years (Figure 2).

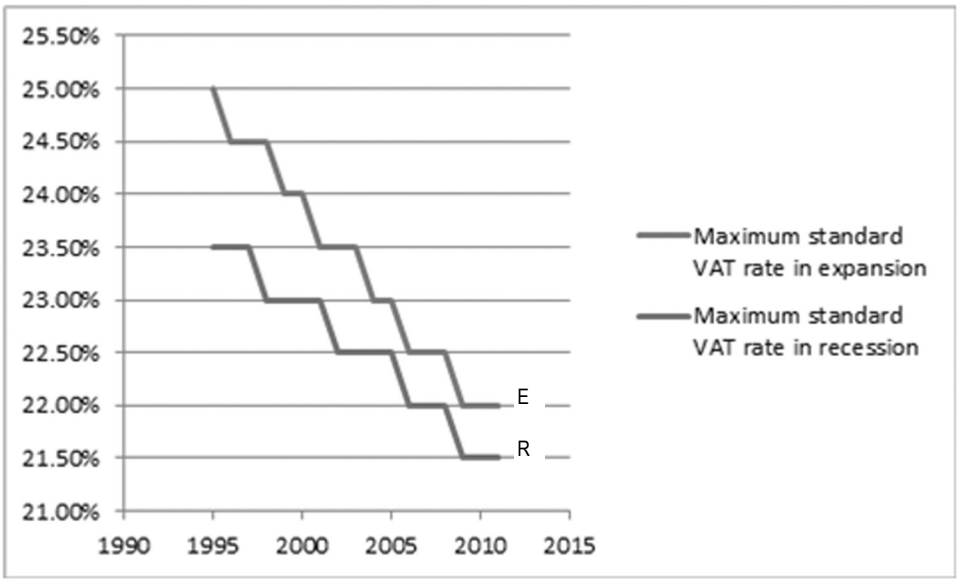
A procyclical fiscal policy is usually considered a pervasive phenomenon as it reinforces, rather than mitigates, underlying business-cycle volatility (Brzozowski and Siwinska-Gorzelak 2010; Végh and Vuletin 2012). In addition, in order to predict and plan based on tax revenues, long-term stability of tax revenues is desirable (Bilicka 2013; Sancak *et al* 2013). Countercyclical VAT standard rate policies (or procyclical fiscal policies) are being followed by a few countries, specifically Portugal. Our results show that any temporary increase in x during recessions must be followed by a more-than-proportional temporary decrease in x during expansions, for long-term stability of tax revenues. This is because the curve is steeper in recession years.

The value of x that maximises VATR is slightly higher in expansion years than it is in recession years (see Figure 2, along with Table 2A in the Appendix). In 2011, these rates were respectively 22 and 21.5 per cent. With an average x of 20.7 per cent in 2011, the EU27 countries were on average

operating in the non-prohibitive range of the curve. However, Portugal, with a value of *x* of 23 per cent, along with several other countries with similar rates, was already operating in the prohibitive range of the curve. The results are in line with those obtained by Matthews (2003) for the EU14 countries in the previous decade, although the maximum VAT tax rates obtained by Matthews (2003) were lower. The EU now has more member states and the structure of the VAT tax rates has changed substantially in the last decade for most EU countries.

Finally, the peaks of the curves (maximum *x*) have declined over time. That is, the curves have been shifting to the left. Figure 3, along with Table 2A in the Appendix, illustrate the decline. Buchanan and Lee (1982) have already made a distinction between short- and long-run Laffer effects. This result implies a reduction in *VATB* in time. There are several possible explanations for this. For instance, inequality is increasing in the Organisation for Economic Co-operation and Development (OECD) countries (Blyth 2013; Gornick 2014; Piketty 2014), which reduces consumption (Keynes 1936; Martins 2011) and the *VATB*. The result has policy implications and demands further study.

Figure 3: Maximum VAT standard rates by year



Source: authors

5. Conclusions

The EU is still finding the best way to deal with the impacts of the world financial crisis and Great Recession. The rescue programmes of the most indebted EU countries, such as Portugal, have brought to the arena a discussion on fiscal policy and tax increases.

Using panel data for the EU27 countries in the years 1995 and 2000-2011 and a twice continuously differentiable quadratic multivariable function, we have estimated VAT standard rate Laffer curves for the EU27 countries in the analysed period and found evidence to support business-cycle effects.

For the same VAT standard rate, *VATR* is typically higher in expansion years than it is in recession years. More important, the curve is steeper in recession years. Owing to liquidity constraints, it is expected that consumers' bundles will include fewer luxury and/or non-essential goods in recession years than in expansion years. In contraction years, consumers spend a higher share of their income on necessity goods (Sancak *et al* 2010). That is, in recession years it is less likely that consumers can achieve tax avoidance by lowering their consumption. In addition, VAT collection enforcement is likely to be stronger in recession years, when government need for VATR is more urgent. Consequently, tax evasion is harder to achieve in recession years.

A countercyclical VAT standard rate policy (procyclical fiscal policy) increases, rather than mitigates, the underlying business-cycle volatility. Increases in x in recession years require more than proportional decreases in x in expansion years for VATR stability. It has been argued in the literature that fiscal policy should not be procyclical. We make the same conclusion. However, procyclicality has been exposed in several studies (Lane 2003).

The VAT standard rate that maximises VATR is slightly higher in expansion years than it is in recession years. In 2011, these rates were respectively 22 and 21.5 per cent. With an average x of 20.7 per cent in 2011, most of the EU27 countries were operating in the non-prohibitive range of the curve; although Portugal, with x equal to 23 per cent, along with several other countries with similar standard rates, was already operating in the prohibitive range of the curve.

Finally, maximum VAT standard rates have declined as the VAT Laffer curves in x have shifted to the left over the period analysed. This result implies a reduction in *VATB* in time, which (we speculate) can be explained by the increasing inequality in the EU27 countries. The result has policy implications and is an important topic for future research.

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APPENDIX

Table 1A: Intercept (PT) and other than Portugal countries' specific intercepts

$VATR_{it}$	Equation (2)	
	Coeff.	$P > \|z\|$
Intercept (PT)	-2.039022	0.001
AT	0.0623205	0.000
BE	0.075392	0.000
BG	-0.2284	0.000
CY	-0.1271289	0.059
CZ	-0.1084504	0.000
DE	1.469396	0.000
DK	-0.0535383	0.063
EE	-0.3291726	0.000
EL	0.035038	0.091
ES	0.4582257	0.000
FI	-0.0221009	0.214
FR	1.064487	0.000
HU	-0.0874046	0.000
IE	-0.0517413	0.002
IT	0.7294865	0.000
LT	-0.2315768	0.000
LU	-0.1127073	0.063
LV	-0.3297822	0.000
MT	-0.5700082	0.000
NL	0.2414607	0.000
PL	0.0064204	0.721
RO	-0.1119567	0.000
SE	0.1215936	0.000
SI	-0.1907492	0.000
SK	-0.1755064	0.000
UK	1.085132	0.000

Source: Authors

Table 2A: VAT maximum standard rate, in expansion and recession (1995-2011)

Year	*Maximum standard VAT rate in expansion (%)*	*Maximum standard VAT rate in recession (%)*
1995	25.0	23.5
1996	24.5	23.5
1997	24.5	23.5
1998	24.5	23.0
1999	24.0	23.0
2000	24.0	23.0
2001	23.5	23.0
2002	23.5	22.5
2003	23.5	22.5
2004	23.0	22.5
2005	23.0	22.5
2006	22.5	22.0
2007	22.5	22.0
2008	22.5	22.0
2009	22.0	21.5
2010	22.0	21.5
2011	22.0	21.5

Source: Authors

ENDNOTES

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2. Indirect taxes tend to be more distortionary than direct taxes. Therefore, tax avoidance and evasion is an important matter of indirect taxation.

3. The authors claimed that tax revenue is endogenous by nature and that little has been said about the cyclical nature of policy.

4. See Chapter 22 ('Notes on the Trade Cycle'), Book VI ('Short Notes Suggested by *The General Theory*') of Keynes (1936).

5. See Chapter 12 ('The State of Long-term Expectation'), Book IV ('The Inducement to Invest') of Keynes (1936).

6. Forward-looking consumers who are impressed by government austerity and/or enthusiasm for cutting spending, believing in a lower inter-temporal tax burden, may feel richer, and spend more right away (Alesina and Ardagna 2010).

7. The *VATB* is the measure upon which VAT tax liability is based. For instance, taxable income is the tax base for the income tax. The tax base for VAT (*VATB*) is VAT-rated final consumer spending.

8. In the estimation period, VAT tax rates were classified into four categories in the EU: standard, reduced, parking, and increased. Not all countries had the four categories; in addition, the rates differed among countries.

9. According to Diewert (2008 p 2), 'a flexible functional form (FFF) *f* is a functional form that has enough parameters in it so that *f* can approximate an arbitrary twice continuously differentiable function *f** to the second order at an arbitrary point *X** in the domain of definition of *f* and *f** '. It can be seen that the function in equation (2) fulfils the requirements.

10. For more than 30 years, it has become standard in economics to use second-order FFFs for empirical analyses (Wolff *et al* 2010).

11. We tried several specifications of the model, including considering government debt as a proxy for the inter-temporal tax burden. Estimation results of the VAT Laffer curve in x did not change significantly. The chosen specification is the one with the greater explanatory power. The country specific-intercepts and the quadratic specification of time allow for capture of the effects connected with government debt.

12. Matthews (2003) used the VAT standard rate as a proxy for the representative VAT rate.

13. The intercept is for Portugal; however, it could be for any country. Country-specific intercepts have been estimated as deviations from Portugal's intercept.

14. Apart from the constant term, the country-specific intercept and variable *y*, the expansion and recession Laffer curves in *x* are the same for every country in a given year. In a given year, the country specific-intercept and variable *y* move both Laffer curves vertically, without changing their shape. In Figure 1 we are considering a scaled measure of *VATR* without taking into account the constant term, the country-specific intercept, and variable *y*.

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