Essays on Value-Added Taxation

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ESSAYS ON VALUE-ADDED TAXATION

BY

ASMAA EL-GANAINY

A Dissertation Submitted in Partial Fulfillment
of the Requirements for the Degree
of
Doctor of Philosophy
in the
Andrew Young School of Policy Studies
of
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ACCEPTANCE

This dissertation was prepared under the direction of the candidate's Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Economics in the Andrew Young School of Policy Studies of Georgia State University.

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ABSTRACT

ESSAYS ON VALUE-ADDED TAXATION

By

ASMAA EL-GANAINY

May 2006

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This dissertation evaluates the empirical relation between the value-added tax (VAT) and the level of aggregate consumption. Furthermore, it develops a theoretical framework and an empirical analysis to study the impact of the VAT, as a form of taxing consumption, on capital accumulation, productivity growth, and overall economic growth.

While recent theoretical work shows that the VAT may boost capital accumulation and growth by encouraging more savings, we find that the net impact of consumption taxes on growth and its sources is theoretically ambiguous, and depends on the interaction between utility parameters, the interest rate, and the tax structure.

Moreover, we develop a theoretical model to study the tax design problem in order to rationalize the observed variation in effective VAT rates over time in our sample. This framework considers both equity and efficiency as important factors determining optimal tax structure, and we identify conditions under which taxes could be evolving or constant over time.

Empirically, we use a panel of 15 European Union countries and employ the recently developed GMM dynamic panel techniques. After controlling for the potential biases associated with persistence, endogeneity, simultaneity, measurement error, omitted variables, and unobserved country-specific effects, we find that (i) the VAT exerts a negative impact on the level of aggregate consumption, (ii) the VAT affects physical capital accumulation positively, which feeds through to overall GDP growth, and (iii) productivity growth seems to be a less relevant channel for the VAT to influence economic growth.

Essay One: Value-Added Taxation and Consumer Behavior: A Dynamic Analysis

Introduction

This study develops an empirical framework of the consumption decision of economic agents that incorporates the effects of value-added taxes (VAT) as a comprehensive broad-based consumption tax. It is well-known that consumption decision is crucial for both short-run and long-run analyses. While in the short-run it plays a significant role in determining aggregate demand and its fluctuations, in the long-run it has a central function in economic growth and welfare. Indeed, aggregate consumption is the biggest component of aggregate demand in any nation, constituting about two-thirds of Gross Domestic Product (GDP) in most countries. Therefore, accurate inspection of consumption decisions has been at the heart of economic research for several decades.

The vast theoretical literature on consumption and savings started early with Fisher's (1930) *Theory of Interest*, Keynes's (1936) *Absolute Income Hypothesis*, Duesenberry's (1949) *Relative Income Hypothesis*, Friedman's (1957) *Permanent Income Hypothesis (PIH)*, and Ando and Modigliani's (1963) *Life-Cycle Hypothesis (LCH)*. More recently, researchers incorporated different views and components to consumption theories, For instance, Dynan (1993) and Skinner (1988) looked at precautionary saving motives; whereas Hall (1978) and Shea (1995) studied aspects related to uncertainty and the random walk hypothesis. On the empirical side, Boskin (1978) and Feldstein (1996a) investigated the determinants of consumption; while Aschauer (1985), Feldstein (1980), and Lewis and Siedman (1998) tackled the estimation problems and examined the influence of different fiscal and monetary policy variables. Yet, it is surprising that this steady flow of research is still largely inconclusive, both theoretically and empirically.

However, the literature on the VAT is small relative to its rapid and seemingly attractive spread all over the globe.[1] In more than 120 countries, the VAT - as a major source of governments' revenue - affects about four billion people (i.e., about 70 percent of the world's population). Thus, exploring its influence on major economic indicators, such as consumer spending, is of interest to practitioners and academics, as well as to policymakers.

Recently, the effect of tax policy on economic behavior, particularly on saving and consumption, has gained a lot of attention with the increase in the number of tax reform proposals in many countries including the United States (U.S.). The majority of these tax reform proposals advocate the replacement of the income-based tax with a comprehensive consumption-based tax. The argument in favor of consumption-based taxes is that it exempts savings and capital income from the tax base, and hence it boosts household saving.[2] More saving would lead to higher investment, and ultimately stimulate economic activity, growth, and the future standard of living. As such, there is an apparent need to understand and evaluate the mechanism through which such reforms can influence the behavior of economic agents with respect to their consumption/saving decision. In fact, Summers (1981) and more recently Lewis and Seidman (1999) have studied the theoretical relationship between consumption tax on one hand, and savings and capital accumulation on the other. Nonetheless, not much emphasis has been put into its impact on consumer behavior, specifically from an empirical point of view. Therefore,

[1] Much of the VAT literature has been concerned with its design, implementation, administration, efficiency, and revenue performance. See, for example, Ebrill et al. (2001) for a detailed discussion of these issues.

[2] Eliminating taxes on new savings would reduce the price of future consumption compared with current consumption. This change in the relative prices induces people to reduce current consumption and save more for the future.

this study is considered a first step towards examining empirically the impact of the VAT - as a broad-based consumption tax - on consumer behavior. As a result, the empirical evidence of this study is expected to provide some guidance and insight for policymakers when considering different tax reform proposals. In effect, in consumption-driven economies such as that of the U.S., it is equally important to investigate the response of consumer spending to changes in the VAT rate, as well as to provide policymakers with a policy prescription to be taken into account when evaluating different tax reform proposals.

The goal of this study is to empirically investigate the effect of an increase in the effective VAT rate on the level of per capita aggregate household consumption. Since household consumption and saving are considered two faces of the same coin, evaluating the impact of the VAT on consumption would provide us with a good approximation of its impact on private saving. Empirical stylized facts show that the effective VAT rate varies over time within each country in our sample. This fact, in turn, implies that the VAT generates an intertemporal effect which affects the relative prices of current consumption vs. future consumption. In other words, the tax shock generates substitution and income effects.[3] Theoretically, the net impact of these two forces on the level of aggregate private consumption is ambiguous. This raises the urge to provide empirical evidence on the direction of the relation between the VAT and the level of household consumption.

This study contributes to the existing literature along three dimensions. First, the idea linking consumption taxes in general, and the VAT specifically, to consumer

[3] If current VAT rate is higher than that of the future, then current consumption is relatively more expensive, and hence the substitution effect results in a decline in current consumption. The income effect reduces consumption in all periods as it leads to a reduction in individuals' life-time resources.

behavior is innovative in the field. Second, the use of panel data analysis is an addition to the current literature, which primarily uses time series approach.[4] Finally, the use of the recently developed dynamic panel generalized method of moments (GMM) system estimator as our main econometric methodology is unique in the consumption literature. Conditional on a specific set of assumptions, this estimator produces estimates that have superior finite sample properties and do not suffer from biases induced by endogeneity, simultaneity, omitted variables, or measurement error, which are typically present when estimating aggregate consumption functions using macro-level data.

Our empirical analysis is based on data from fifteen European Union (EU) countries over the period 1961-2000. In addressing the issue, the study draws on the European experience for several reasons. First, the VAT traces back to the writing of Von Siemens, a German businessman in the 1920s, which implies that this system is not only a European invention but it was first implemented in Europe. Consequently, it is safe to assume that this system is a "well-established" one in Europe and that enables us to depict some credible conclusions from the analyses. Second, the EU economies are developed and hence they resemble many features of the U.S. economy. Therefore, performing the study on these economies would be helpful for policymakers in the U.S. to foresee the possible impacts of such tax regime on aggregate consumption and economic performance in the U.S. Finally, lack of systematic accessible data on the VAT in most developing and transitional economies is an obstacle to performing the analysis on these countries. However, it can easily be extended, with some qualifications, to include these countries in the future as data becomes available.

[4] In fact, panel data models have several advantages. For instance, it allows controlling for individual fixed effects (and hence omitted variable bias), it is better suited to understand the dynamics of adjustments in the economy, it provides more informative data, and allows for more variability and efficiency.

Using a reduced form aggregate consumption function, which allows us to use a wide range of consumption determinants; we found that the VAT is negatively related to the level of per capita private consumption. More specifically, a one percentage point increase in the VAT rate leads to *about* a one percent reduction in the level of aggregate consumption, *ceteris paribus*.

The rest of the paper is organized as follows. Section two surveys the theoretical and empirical literature on consumption taxes and consumer behavior. In addition, it provides a brief review of the existing VAT literature. Section three presents the theoretical model, and the results of the comparative static analysis. Section four presents the empirical analysis with emphasis on the empirical strategy which provides an overview of the dataset and the empirical specification. Furthermore, it addresses the econometric issues and describes the estimation methodology, and finally, it presents our basic results, as well as the results of the sensitivity analysis. Section five concludes the study with an emphasis on the policy implications of its empirical results, and possible future research directions.

Literature Review

Introduction

A substantial number of studies have attempted to develop theoretical and empirical works to understand households' consumption and saving patterns. Furthermore, a number of studies have examined the various theoretical and empirical aspects of conversion from an income-based tax system to a consumption-based tax system including the response of the savings elasticity, the transitional issues, and the welfare effects. This section reviews the literature, with a particular emphasis on the impact of consumption tax on consumption behavior. The section is divided into three main parts corresponding to theoretical and empirical studies of the effects of consumption tax on consumption with a brief survey of the VAT literature. The final part concludes the literature survey.

Theoretical Literature on Consumption Taxes and Consumption Behavior

Few studies have looked at the theoretical linkage between consumption taxes and consumer behavior, mostly focusing on the outcome of a tax reform that aims at replacing the income tax with a tax on consumption. For instance, Batina (1999) studies the effects of converting from an income tax to a consumption tax in the presence of bequests. Using an overlapping generation model, the author finds that taxing bequests at the consumption tax rate repels the benefits of the tax reform as saving and capital accumulation will no longer increase. In this case, the bequest decision will be distorted, as bequests will then suffer from being taxed twice, and this may lead to a reduction in capital accumulation when the reform takes place, as there will be less incentive to save for bequests.

Another study by Lewis and Seidman (1999) has examined the influence of converting the income tax to a consumption tax on the elasticity of saving. Using a standard isoelastic intertemporal utility function and a Cobb-Douglas production function, with other assumptions regarding inelastic labor supply, zero depreciation rate of capital, zero government debt, and an annual balanced budget in which government consumption expenditures are financed by tax revenues and tax revenues per unit of effective labor is the same under all taxes in every year, the authors concluded that conversion from an income tax to a consumption tax always increases the steady-state capital/labor ratio regardless of the elasticity of saving. They also show that consumption tax is not equivalent to wage tax because they yield different steady-state results regarding capital/labor ratio. For instance, conversion to a wage tax may increase or lower capital/labor ratio, while consumption tax always raises it. The results also imply that the saving elasticity is irrelevant to the steady-state effect of conversion because the after-tax interest rate is the same in the two steady-states; however, the saving elasticity does affect the speed of convergence to the consumption tax steady-state, in particular, higher elasticity results in higher speed.

Matsuzaki (2003) studies the effects of consumption tax on effective demand under stagnation. Using a two-class model with uneven wealth distribution, the author found that under stagnation, an increase in the consumption tax rate decreases (increases) effective demand in the case of heterogeneous households (when the ratio of poorer households is large (small) relative to the total population). The author reasons this finding as follows. Increasing the consumption tax rate on richer households does not affect their consumption because in this case the marginal utility of money reaches its lower bound. However, when the consumption tax rate is increased on poorer households, it generates two effects: the pure consumption tax effect which increases the household's marginal utility of money and thus this effect always decrease consumption; and the redistribution effect (the government rebates the consumption tax revenue in a lump sum manner to all households) which increases poorer household's consumption. Furthermore, the redistribution effect is less effective as the ratio of poorer households is larger relative to total population. Therefore, the net effect of consumption tax on poorer households depends on which of these two effects dominates.

Empirical Literature on Consumption Taxes and Consumption Behavior

Among the empirical studies relating fiscal policy variables to consumption behavior are Feldstein (1987), Kormendi (1983), Aschauer (1985), Graham (1993), Darby and Malley (1996), and others. These studies have looked at the impact of various fiscal variables, such as tax revenues, government transfers, government net debt, and government spending (crowding-out effect), on consumer behavior. Furthermore, a large number of empirical studies linking taxes and consumption behavior focused on testing the Ricardian Equivalence Theorem (RET).[5] Several studies have attempted to test the RET for the U.S., reaching inconclusive evidence. For instance, Seater and Mariano (1985) found no empirical support for the RET, whereas, Bernheim (1987) findings supports the existence of simulative effect of government fiscal policy on private consumption. Other studies conducted cross-country comparative studies to evaluate the

[5] The RET suggests that, given government expenditures and population growth, the shift between bond financing and taxation have no effect on the allocation of resources between private consumption and saving. Thus, taxes fail to change private consumption levels because consumers have rational expectations.

existence of the RET in developed countries, such as Evans (1993), Masson et al. (1995), Brunila (1997), and Giavazzi et al. (2000) have all reached conflicting results.[6]

Nonetheless, empirical literature tying consumption taxes and consumer behavior is substantially scarce relative to those studies that use other measures of taxes and to its theoretical counterpart.[7] An exception is a study by Summers (1981) shows by simulating his model into U.S. data that for a wide variety of plausible parameter values, saving is very interest elastic implying that shifting away from capital income taxation would significantly increase capital formation, making possible long-run increases in consumption. As alternatives to capital income taxation, both wage and consumption taxes are compared in the steady-state in a general equilibrium framework. The author found that the annual welfare gain from a shift to consumption taxation is estimated at 10 percent of GNP.

Furthermore, Fullerton et al. (1983) used a dynamic general equilibrium model of the U.S. economy and tax system to evaluate the welfare consequences of a change from the current U.S. income tax to a progressive consumption tax. The model endogenizes households' saving behavior and assumes that the U.S. economy is on a balanced growth path in the presence of existing income taxes. The change results in more savings and less consumption but only initially. Consumption ultimately increases as capital stock grows, and the economy approaches the new balanced growth path with higher consumption and larger capital stock. The authors calculated the discounted present value of the stream of welfare gain from this change to about $650 billion in 1973 dollars, which represents about one percent of the discounted present value of national income.

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[6] For a comprehensive survey of the literature on the Ricardian Equivalence Theorem see Ricciuti (2003).

[7] Most studies that incorporate taxes when estimating consumption functions use either tax revenue as a percent of GDP or a measure of the marginal tax rate to capture the effect of taxes on private consumption.

Finally, Lewis and Seidman (1998) assessed the impact of household heterogeneity with saving propensities on aggregate saving when converting an income tax to an equally-progressive consumption tax. The authors used a graduated schedule which ensures that households with the same consumption level are subject to the same consumption tax rate despite their income levels. The authors carried out simulations using U.S. data and found that household heterogeneity may increase aggregate saving by 11 percent when an income tax is converted to an equal yield consumption tax.

While a study by Poterba (1988) looked at how changes in income taxes affect consumer spending,[8] no study, to our knowledge, has looked at how these expenditures are affected by changes in consumption taxes. Nonetheless, Freebairn (1991) investigated the effects of a consumption tax on the level and composition of Australian saving and investment. The author shows that the short run effects are small, though positive, on aggregate saving due to three reasons: (1) the reduction in marginal tax rates that can be financed with a consumption tax will be small; (2) given the continuation of Australia's hybrid income tax system, lower marginal income tax rates on personal income will increase the incentive to save on less than a half of household saving; (3) some household will not respond to the increased after-tax return from some saving options because their behavior is affected by habit or precautionary motives, or because of the presence of liquidity constraints. However, the impact on the composition of saving and investment is stronger due to heterogeneity in the mix of Australia's saving and investment, along with its hybrid tax system. Therefore, he concludes that the main benefit from the introduction

[8] Other studies along the same line include Hubbard et al. (1986), Watanabe et al. (1999) and Steindel (2001).

of a consumption tax as part of a tax mix change lies in improving the *quality* of investment rather than increasing in the aggregate *quantity* of saving and investment.

With regard to the impact of VAT on consumption behavior, Andrikopoulos et al. (1993) assessed the short run effects of the VAT on consumption patterns in Greece. The study aimed at evaluating the effect a VAT could have on individual commodity prices, consumer price index, shares and the allocation patterns of total consumption expenditures among groups of commodities. Using time series data from 1958-1986 for thirteen commodity groups in Greece, and by utilizing the full information maximum likelihood (FIML) approach to estimate and test the static almost ideal demand system (AIDS) model, the major empirical findings are: (1) the VAT has affected at different rates (positively or negatively) the structure of commodity prices. Indeed, the VAT has increased the consumer price index by 4.7 percent above the rate expected to prevail without it; and (2) the VAT has altered consumption patterns or the allocation of total consumption expenditures among the groups of goods and services under investigation. This result is due to the considerable divergence between the actual and the predicted budget shares, as well as the substantial change of both the compensated and uncompensated demands.

Other studies used computable general equilibrium (CGE) models to assess the impact of either introducing the VAT or increasing its rate on the economy, i.e., on consumer prices, consumption, investment, and welfare. Most of these studies were conducted on developing countries. For example, Rege (2002) found that instant implementation of the VAT in India (as to replace other indirect taxes) reduces welfare more than if its implementation was gradual because it causes an increase in the price of necessary goods. Therefore, he found that when the essentials are exempt from the tax base, i.e., agriculture, food, and textiles, the welfare loss is reduced by about half.

In a similar study on the Fiji economy, Narayan (2003) found that a 25 percent increase in Fiji's VAT rate led to about 4 percent increase in government revenue, assuming 100 percent collection rate, and about 0.6 percent increase in real GDP; however, it led to a decline in real consumption, investment, and national welfare.

Few more studies have examined the various issues involved when implementing a VAT in developing and developed countries. For instance, Metcalf (1995) studied the issues to be considered when designing a VAT, its mechanism, administration, and compliance costs, its economic impact on savings and labor supply, and its distributional and transitional concerns if implemented in the U.S. Regarding its impact on saving, the author argues that the VAT eliminates the intertemporal consumption distortions caused by taxing savings, and if the elasticity of saving with respect to the rate of interest is positive, then the VAT will raise the amount of saving via increasing the after-tax rate of return on savings. However, he emphasizes that a clear cut answer on whether implementing the VAT would increase savings rate is far from being answered.

Similarly, Bird (2005) discusses the major lessons when introducing a VAT in developing and transitional economies (DTE). First, the VAT works well in most DTE and better than any other forms of general sales taxes. Second, implementation of the VAT depends on "self-assessment," which is still a problem for many DTE. Third, when designing a VAT, it is important to be aware of countries' situations, which can vary substantially across countries and over time within each country. Finally, the main lesson lies in the ability of grasping the political economy dimension of the VAT policy and administration. Furthermore, the author asserts that the main challenge facing empirical studies on the VAT in DTE is lack of systematic, consistent, and accessible data on the VAT in these countries.

Concluding Remarks

In this section we presented the current literature on consumption taxes and consumer behavior. The results of the review show that the existing literature does not provide formal empirical evidence on the relationship between consumption taxes, in general, and the VAT, in particular, on consumer spending. Therefore, this study tries to fill this void in the literature by providing a thorough treatment of the empirical linkage between the VAT and consumption behavior using actual data and proper econometric techniques that deal with the standard econometric issues arising in these cases, such as the dynamic nature of the model, endogeneity, persistence, simultaneity bias, and omitted variable bias.

Theoretical Model

This section aims at developing a theoretical model in which the impact of consumption taxes on the level of consumption can be evaluated. In pursuing our goal, we follow two steps. First, we derive an aggregate consumption function based on the LCH. The model is an application of the model developed by Ando and Modigliani (1963) in which we extend the literature by incorporating consumption tax as an additional parameter to assess the outcome. Second, we perform some comparative static analysis to isolate the influence of consumption tax on consumption.

Derivation of Aggregate Consumption Function

The LCH visualized consumption decisions as integrated in an intertemporal optimization for a representative consumer. In other words, households were faced with a forecasted "income stream" which they attempted to allocate over their lifetime. Therefore, agents choose a consumption path over their lifetime which maximizes their intertemporal lifetime utility function weighted by a subjective discount rate, subject to an intertemporal budget constraint which is governed by a discounted stream of future income and the wealth they are born with.

Assumptions of the Model:

1) Individuals are unrestricted to access capital markets.
2) Each person works from $i = 1$ to $i = R$ and retires from $i = (R+1)$ to $i = J$.
3) All workers at any point in time receive the same real wage.
4) The government has a balanced budget (cash flow budget constraint).
5) Consumption is a normal good in all periods.
6) Utility is derived from consumption in all periods.

7) Individuals' utility function is concave and time-invariant to insure smoothness of consumption in both periods, that is, $U(.)' > 0$ *and* $U(.)'' < 0$.

8) The tax on consumption is imposed on consumption in all periods.

Following Lewis and Seidman (1999) and Bakhshi (2000), we assume that each individual maximizes his/her lifetime utility by choosing the stream of consumption from ($c_1, c_2, \ldots, c_J$) subject to his/her lifetime budget constraint as follows:

$$Max_{\{c_t\}} U \equiv \sum_{i=0}^{J} \frac{U(c_{t+i})}{(1+\rho)^i} \tag{1}$$

where:

c_{t+i}: Consumption in different periods.

J: Certain date of death.

ρ : Subjective discount rate.

i: represents time index

s.t.

$$\sum_{i=0}^{J} \left(\frac{c_{t+i}}{1-\tau_{t+i}}\right)\left(\frac{1}{1+r}\right)^i = a_t + Z \sum_{i=0}^{R} w_{t+i} \left(\frac{1}{1+r}\right)^i \tag{2}$$

where:

τ_{t+i} : consumption tax rate in different periods, which equals $\left(T^c_{t+i}/c_{t+i}\right)$, where T^c_{t+i} represents tax revenues from the consumption tax in different periods and c_{t+i} represents the tax base which is consumption in different periods. Therefore, the tax rate represents the effective rate.

r: real interest rate

$$Z = \begin{cases} 1 & if\ t \leq R \\ 0 & if\ t \geq (R+1) \end{cases}$$

a_t: individual's initial holdings of wealth or assets.

w_{t+i}: wage rate in different periods which grows at rate $g \Rightarrow w_t = w_0(1+g)^t$

The first-order conditions (F.O.Cs) of the maximization problem are given by:

$$U'(c_{t+i})(1-\tau_{t+i}) = \lambda\left(\frac{1+\rho}{1+r}\right)^i \tag{3}$$

Therefore,

$$\text{if } i = 0 \Rightarrow U'(c_t)(1-\tau_t) = \lambda \tag{4}$$

Put (4) in (3) to obtain the *Euler equation*:

$$\frac{U'(c_{t+i})}{U'(c_t)} = \left(\frac{1-\tau_t}{1-\tau_{t+i}}\right)\left(\frac{1+\rho}{1+r}\right)^i \tag{5}$$

Note that according to (5), the consumer can not improve his/her utility by reducing consumption in one period, say *(t)*, and then increasing it in another period, say *(t+1)*.

Now, let us assume a specific form for the utility function to get a closed-form solution. In fact, Bakhshi (2000) mentioned that a closed-form solution is obtainable if the utility function takes one of the following forms:

i) Constant relative risk aversion (CRRA).

ii) Constant absolute risk aversion (CARA).

iii) Quadratic utility function.

For our purpose here, let's assume a CRRA or CES or isolelastic utility function:

$$U(c_{t+i}) = \begin{cases} \dfrac{c_{t+i}^{1-\gamma} - 1}{1-\gamma} & if\ \gamma \neq 1 \\ \ln c_{t+i} & if\ \gamma = 1 \end{cases} \quad , \ \gamma > 0 \tag{6}$$

where: $\gamma = \dfrac{1}{\sigma}$, and σ is the intertemporal elasticity of substitution.

Put (6) in (5) and with some algebraic manipulation we get the following:

$$\frac{U'(c_{t+i})}{U'(c_t)} \equiv \left(\frac{c_t}{c_{t+i}}\right)^{\gamma} = \left(\frac{1-\tau_t}{1-\tau_{t+i}}\right)\left(\frac{1+\rho}{1+r}\right)^{i} \tag{7}$$

Put (7) into the budget constraint (2) for c_{t+i} to get:

$$\sum_{i=0}^{J}\left(\frac{c_t}{1-\tau_{t+i}}\right)\left(\frac{1-\tau_{t+i}}{1-\tau_t}\right)^{\frac{1}{\gamma}}\left(\frac{1+r}{1+\rho}\right)^{\frac{i}{\gamma}}\left(\frac{1}{1+r}\right)^{i} = a_t + h_t$$

where: h_t (human wealth) = $Z \sum_{i=0}^{R} w_{t+i}\left(\dfrac{1}{1+r}\right)$, and $(a_t + h_t)$ = total lifetime wealth.

Therefore,

$$c_t = \frac{1}{\beta}(a_t + h_t) \tag{8}$$

Where β is a proportionality factor which is a function of the interest rate, tastes (utility function parameters, γ *and* ρ), age of the individual and the length of his/her life, and consumption tax rates, that is:

$$\beta = \left(\frac{(1-\tau_{t+i})^{1-\gamma}}{(1-\tau_t)}\right)^{\frac{1}{\gamma}}\left(\frac{1+r}{1+\rho}\right)^{\frac{i}{\gamma}}\left(\frac{1}{1+r}\right)^{i}$$

Equation (8) is similar to the one obtained by Ando and Modigliani (1963), where *(1/β)* is equivalent to Ω in their notation.

Assuming that all consumers behave like a representative one at a particular economic age, then (8) can be interpreted as representing aggregate consumption function when the population has a specific age and income distribution; therefore our aggregate consumption function is given by:

$$C_t = \frac{1}{\beta}(A_t + H_t) \quad (9)$$

Comparative Static Analysis

In this section we perform a comparative static analysis to isolate the impact of a change in consumption tax rate on consumption. Since optimality conditions require a uniform characterization of the Euler equations for any two periods, we focus on a tax shock between periods *(t)* and *(t+1)*, which generalizes to any number of periods.

Recall the F.O.Cs, (with the assumption that tax rates are not equal in the two periods):

$$c_t : U_t - \lambda(1+\tau_t) = 0 \quad (10)$$

$$c_{t+1} : U_{t+1} - \lambda\left(\frac{(1+\tau_{t+1})}{(1+r)}\right) = 0 \quad (11)$$

$$\lambda : a_t + Z \sum_{i=0}^{R}\left(\frac{w_{t+i}}{(1+r)^i}\right) - \sum_{i=0}^{J}(c_{t+i})\left(\frac{1+\tau_{t+i}}{(1+r)^i}\right) = 0 \quad (12)$$

where (U_t) refers to the first derivative of the utility function with respect to period's *(t)* consumption (c_t), or $U_t = \frac{\partial U}{\partial c_t}$, and similarly, $U_{t+1} = \frac{\partial U}{\partial c_{t+1}}$.

Totally Differentiating F.O.Cs yield:[9]

$$U_{t,t}\, dc_t + U_{t,t+1}\, dc_{t+1} - (1+\tau_t)\, d\lambda - \lambda\, d\tau_t = 0 \quad (13)$$

[9] In this experiment, we hold all variables, such as interest rate, and income in all periods constant while varying only consumption tax rates.

$$U_{t+1,t}\, dc_t + U_{t+1,t+1}\, dc_{t+1} - \left(\frac{(1+\tau_{t+1})}{(1+r)}\right) d\lambda - \frac{\lambda}{(1+r)} d\tau_{t+1} = 0 \tag{14}$$

$$-(1+\tau_t)\, dc_t - \left(\frac{(1+\tau_{t+1})}{(1+r)}\right) dc_{t+1} - c_t d\tau_t - \left(\frac{(c_{t+1})}{(1+r)}\right) d\tau_{t+1} = 0 \tag{15}$$

where: $U_{t,t} = \dfrac{\partial^2 U}{\partial c_t^2}$, $U_{t,t+1} = U_{t+1,t} = \dfrac{\partial^2 U}{\partial c_t \partial c_{t+1}}$ (by symmetry), and $U_{t+1,t+1} = \dfrac{\partial^2 U}{\partial c_{t+1}^2}$.

The Boardered Hessian is given by:

$$|D| = \begin{bmatrix} U_{t,t} & U_{t,t+1} & -(1+\tau_t) \\ U_{t+1,t} & U_{t+1,t+1} & -\dfrac{(1+\tau_{t+1})}{(1+r)} \\ -(1+\tau_t) & -\dfrac{(1+\tau_{t+1})}{(1+r)} & 0 \end{bmatrix} \tag{16}$$

The second-order conditions (S.O.Cs) imply that $|D|$ is positive, since, by assumption, U_t and U_{t+1} are positive, whereas $U_{t,t}$ and $U_{t+1,t+1}$ are negative, and $U_{t,t+1} = U_{t+1,t}$ by symmetry.

Therefore, we have a system of three equations with three unknowns:

$$\begin{bmatrix} U_{t,t} & U_{t,t+1} & -(1+\tau_t) \\ U_{t+1,t} & U_{t+1,t+1} & -\dfrac{(1+\tau_{t+1})}{(1+r)} \\ -(1+\tau_t) & -\dfrac{(1+\tau_{t+1})}{(1+r)} & 0 \end{bmatrix} \begin{bmatrix} dc_t \\ dc_{t+1} \\ d\lambda \end{bmatrix} = \begin{bmatrix} \lambda\, d\tau_t \\ \dfrac{\lambda}{(1+r)} d\tau_{t+1} \\ c_t\, d\tau_t + \dfrac{(c_{t+1})}{(1+r)} d\tau_{t+1} \end{bmatrix} \tag{17}$$

Using Cramer's rule, we can solve for $\left(\dfrac{dc_t}{d\tau_t}\right)$ and $\left(\dfrac{dc_t}{d\tau_{t+1}}\right)$ as follows:

$$dc_t = \begin{bmatrix} \lambda\, d\tau_t & U_{t,t+1} & -(1+\tau_t) \\ \frac{\lambda}{(1+r)} d\tau_{t+1} & U_{t+1,t+1} & -\frac{(1+\tau_{t+1})}{(1+r)} \\ c_t\, d\tau_t + \frac{(c_{t+1})}{(1+r)} d\tau_{t+1} & -\frac{(1+\tau_{t+1})}{(1+r)} & 0 \end{bmatrix} |D|^{-1} \tag{18}$$

$$dc_t = \frac{d\tau_{t+1}\left(\frac{(1+\tau_{t+1})}{(1+r)^2}\left[c_{t+1}\left\{\frac{(1+\tau_t)}{(1+r)}U_{t+1,t+1} - U_{t,t+1}\right\} + (1+\tau_t)\lambda\right]\right)}{|D|} + \frac{d\tau_t\left(c_t\left[(1+\tau_t)U_{t+1,t+1} - \frac{(1+\tau_{t+1})}{(1+r)}U_{t,t+1}\right] - \frac{(1+\tau_{t+1})^2\lambda}{(1+r)^2}\right)}{|D|} \tag{19}$$

If we assume that $(d\tau_{t+1} = 0)$ then:

$$\frac{dc_t}{d\tau_t} = \left(c_t\left[(1+\tau_t)U_{t+1,t+1} - \frac{(1+\tau_{t+1})}{(1+r)}U_{t,t+1}\right] - \frac{(1+\tau_{t+1})^2\lambda}{(1+r)^2}\right)|D|^{-1} \tag{20}$$

If however, $(d\tau_t = 0)$ then:

$$\frac{dc_t}{d\tau_{t+1}} = \left(\frac{(1+\tau_{t+1})}{(1+r)^2}\left[c_{t+1}\left\{\frac{(1+\tau_t)}{(1+r)}U_{t+1,t+1} - U_{t,t+1}\right\} + (1+\tau_t)\lambda\right]\right)|D|^{-1} \tag{21}$$

Equations (20) and (21) show the impact of a change in current and future tax rates on current consumption, respectively. Clearly, the impact of current consumption taxes on current consumption is theoretically ambiguous.[10] The reason is that there are two competing effects, i.e., the substitution effect given by the term $\left[\left(\frac{(1+\tau_{t+1})^2\lambda}{(1+r)^2}\right)|D|^{-1}\right]$ which always reduces current consumption as the current tax rate

[10] Recall that *(C_t), (C_{t+1}), (τ_t), (τ_{t+1}), (r), (λ),* and *[D]* are all positive, whereas, *$(U_{t+1,\,t+1})$* is negative, and *$(U_{t,,t+1})$* is indeterminate.

increases.[11] The reason is that, when current tax rate increases, individuals anticipate that future one will decline. This change in the relative price of consumption today vs. tomorrow leads to lower levels of current consumption as current tax rates climbs.

However, the second effect is the income effect which leads to an ambiguous impact on current consumption. The reason is that the sign of $(U_{t,t+1})$ is indeterminate. If it is positive then the term $\left(c_t \left[(1+\tau_t) U_{t+1,t+1} - \frac{(1+\tau_{t+1})}{(1+r)} U_{t,t+1} \right] |D|^{-1} \right)$ which represents the income effect has a negative sign. In that case, both effects work in the same direction enforcing each others, and an increase in the current consumption tax rate reduces current consumption. If, however, $(U_{t,t+1})$ is negative, the sign of the term representing the income effect is indeterminate and, hence, the total impact of an increase in current tax rate on current consumption is ambiguous.

For the impact of an increase in future taxes on current consumption, the substitution effect in this case {given by the term $\left(\left[\frac{(1+\tau_{t+1})(1+\tau_t)\lambda}{(1+r)^2} \right] |D|^{-1} \right)$} is always positive and, hence current consumption increases as future tax rate increases.[12] This is logical; because it implies that current consumption is cheaper relative to future one, and therefore it is expected to be positive (it is exactly the opposite of the previous case).

Similar arguments hold for the ambiguous impact of the income effect due to the presence of the term $(U_{t,t+1})$, as discussed. If it is positive the income effect has a negative sign and the two forces work in opposite directions. If, however, it is negative,

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[11] Note the negative sign preceding the term representing the substitution effect in equation (20).
[12] Note the positive sign preceding the term representing the substitution effect in equation (21).

the sign of the term representing the income effect is indeterminate and the overall impact of an increase in future taxes on current consumption is theoretically unclear.

Concluding Remarks

In this section we derived an aggregate consumption function that incorporates consumption taxes. We showed that consumption is proportional to life-time income. The proportionality parameter is similar to the one derived by Ando and Modigliani (1963), with tax structure included as an additional parameter. The results of the comparative static analysis show that the impact of present consumption tax on present consumption is theoretically ambiguous due to the presence of two competing effects, i.e., the substitution effect and the income effect.

Empirical Analysis

Empirical Strategy

While previous empirical studies capture a number of factors relevant to consumption decision, they vary considerably in the data coverage, empirical specification, and econometric procedure. Our primary objective here is to extend the literature by providing a comprehensive characterization of the empirical association between the level of per capita private consumption and the VAT rate, as well as a broad range of potentially important consumption determinants using the best available data. To do that, we complement and extend previous work along two dimensions. First, we adopt a reduced form approach which includes a variety of consumption determinants identified in the literature, rather than adhering to one particular, narrow, structural model. Second, we employ a variety of estimation methods but focus our attention on estimators that attempt to control for endogeneity, omitted variable bias, simultaneity, and measurement error.

The data. The dataset includes 15 European Union (EU) countries over the period 1961-2000. Annual data on household (private) consumption expenditures (constant 1995 $U.S.), household (private) consumption expenditures per capita (constant 1995 $U.S.), GDP (constant 1995 $U.S.), GDP per capita (constant 1995 $U.S.), inflation - consumer prices (annual %), total population, old population, and consumer price index (CPI) (1995 = 100) are drawn from the World Development Indicators CD-ROM (2004) of the World Bank. Data on unemployment rate (annual percent, monthly averages), and long-term interest rates (annual percent, average) are obtained from the OECD Economic

Outlook, No. 75.[13] Due to difficulty in obtaining data on household wealth, we use financial system deposits to proxy for households' wealth. This variable is drawn from the Financial Structure and Economic Development Database of the World Bank (2000).[14] Data on different tax revenues, i.e., the VAT ($U.S.), taxes on goods and services ($U.S.), taxes on income, profits and capital gains ($U.S.), taxes on payroll and workforce ($U.S.), and total tax revenues ($U.S.) are drawn from the OECD Revenue Statistics CD-ROM 1965-2001 (2002).[15]

We generated three tax variables from the collected data:

$$\text{(a) VATRate}_t = \left\{ \frac{\text{VAT Revenue (constant 1995 \$US)}}{\begin{array}{c}\text{Total household (private) final consumption expenditures} \\ \text{(constant 1995 \$US)}\end{array}} \right\} * (100)$$

(b) TotConsTax_VAT_t = {Taxes on goods and service revenue ($U.S.) – VAT revenues ($U.S.)}

(c) TotIncomeTax_t = {Taxes on income, profit and capital gain ($U.S.) + payroll taxes ($U.S.)}.

Consumption, income, wealth and the two tax revenue data are in real terms;[16] and have been transformed into their natural logarithm equivalent.[17]

A complete and detailed discussion of the variables' definition and sources is provided in Table A1 of Appendix A. We generated five-year averages for all the variables for two reasons. First, as we are more interested in the long-run effects of the VAT on consumption, we followed the common practice in the literature in such cases and generated these averages to remove the cyclical effects of business cycle fluctuations.

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[13] Also available online at: http://ceres.sourceoecd.org/vl=617395/cl=91/nw=1/rpsv/ij/oecdstats/16081153/v115n1/s1/p1
[14] Available online at: http://www.worldbank.org/research/projects/finstructure/database.htm
[15] Also available online at: http://thesius.sourceoecd.org/vl=2303064/cl=27/nw=1/rpsv/ij/oecdstats/16081099/v55n1/s5/p1
[16] The real series are obtained by deflating the nominal ones using the consumer price index (CPI 1995=100).
[17] The main advantage of such transformation is to stabilize the variance.

Second, because our preferred econometric technique; i.e., the GMM-System estimator, which will be discussed as we proceed, is better suited for samples with small number of time observations (i.e., when T is small and N is large).[18] Nonetheless, we provide estimation results based on the annual data. Consequently, we have two different "sub" datasets, namely the five-year averaged data and the annual data.

Tables A2 and A3 of Appendix A provide descriptive statistics of the five-year averaged and the annual datasets, respectively. Descriptive statistics of the averaged dataset show that the effective VAT rate ranges between zero and 17.36 percent – which is achieved in Denmark in 2000 - with a sample mean of 5.39 percent, whereas it varies between zero and 19.25 percent – which is achieved in Sweden in 1995 - with the same sample mean in the annual dataset.[19] Moreover, the sample mean of the dependent variable, i.e. per capita household final consumption expenditures (in constant 1995 $U.S. and in natural logs) is about 9.2 $U.S. in both samples.[20]

Major empirical determinants of household consumption. Before addressing the various determinants of household consumption and the logic behind including each of them in our set of explanatory variables, we want to emphasize that our *dependent variable* is the (ln) level of per capita household final (private) consumption expenditures (Ln C_t). We chose this variable as our dependent variable, because we are interested in examining the response of the per capita level of private (household) aggregate consumption to changes in the effective VAT rate.

[18] The reasons will be discussed in more detail as we proceed.

[19] The minimum value is zero because we included observations in years in which the VAT was not yet introduced in some countries. If however, we drop the zeros from the sample, the number of observations drops from 118 to 90 in the averaged dataset, and in that case the minimum effective VAT rate is 0.19 percent in 1970 in Luxembourg. If the zeros are dropped from the annual dataset, the number of observations falls from 590 to 419, and in that case the minimum effective VAT rate is 0.43 percent in 1972 in Ireland.

[20] For further details on data description see tables A2 and A3 of Appendix A.

The set of regressors includes the following:

Lagged household final consumption expenditures (Ln C_{t-1}). This variable is included to represent the influence of habits acquired in the past on current consumption behavior (i.e., habit persistence). We expect a positive sign on this estimate, and the magnitude, according to the partial adjustment model, should lie be between zero and one.[21] Since any level of actual consumption represents the accumulation of all past experience, and we assume, reasonably, that the "habit persistence" effect induced by past consumption on current behavior would be strongest when *t* is small and gradually die away as *t* becomes larger, we include only a single lag of only one time period.

Income (Ln Y_t). Income is measured by the (ln) level of GDP per capita (constant 1995 $U.S.). According to the PIH agents will base their consumption decision not on their current income but on a measure of their permanent income or their average income over their life-cycle. Since this measure of income will vary much less from year to year than does current income, current consumption will also vary less than current income, therefore, the relationship is not one-to-one. This means that we would expect a positive marginal propensity to consume out of current income and the magnitude should be somewhere between zero and one.

Income growth (Growth Y). We follow adaptive expectations model, this means that consumers look forward in time using past expectations. In that case, we use the conventional practice in the literature to proxy for life-cycle income employing, in addition to the current level of income, a measure for the growth of income. Since expected future income can be projected by past change in income (i.e., income growth), then a positive growth of income implies that expected future income is affected

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[21] See Brown (1952) for more details on habit persistence model of the aggregate consumption function.

positively, and hence current consumption increases. As such, the level of income represents the anticipated/planned component of life-cycle income, whereas income growth represents the unanticipated/windfall element.

Household wealth (Ln W_t*).* We use the (ln) level of per capita financial system deposits (real $U.S.) as a proxy for households' wealth. According to the PI/LC hypotheses, current consumption depends on human and non-human wealth. While human wealth (i.e., wage income) is measured by life-time income (as described above), non-human wealth (i.e., non-wage income) can be proxied by some measure of financial assets holding. Given that the association between wealth and consumption is, theoretically, positive; we expect a positive sign on this variable. Since one of the LCH predictions is that the marginal propensity to consume out of wage income is much larger than that out of non-wage income, we would expect that the estimated wealth elasticities will be smaller than those of income elasticities, if our results are in line with the LCH.

Unemployment rate ($URate_t$*).* The unemployment rate (measured by the ratio between the number of unemployed and total labor force) is generally included to proxy either for the effects of liquidity constraints and/or uncertainty regarding future income (short-run fluctuations of income). Therefore, higher unemployment rate is associated with lower levels of current consumption.

Inflation rate ($Inflation_t$*).* Inflation rate is measured by the annual change in consumer prices (annual percent). The inclusion of the rate of inflation is logical since it can be used to proxy for macroeconomic uncertainty regarding economic performance, nominal incomes, future policies, and consumer confidence. In that case, higher inflation rates affect real incomes adversely, leading to lower levels of consumption. Moreover, to the extent that the increase in inflation is unanticipated, confusing the increase in the overall price level with a rise in the relative prices of certain goods, leads to a reduction in consumption.

Old dependency ratio (Old_t). Since we rely on the PI/LC hypotheses as a theoretical foundation for our empirical estimation, we use the old dependency ratio, defined as the ratio of population over 65 year of age to total population, to capture life-cycle effects. The LCH predicts a positive effect of old dependency ratio on consumption, whereas the PIH predicts that its influence on consumer behavior is insignificant.

Long-term interest rate (LTR_t).[22] The interest rate is typically included to capture three effects. First, the intertemporal substitution effect associated with changes in the relative price of current versus future consumption, because higher interest rates increase the cost of current consumption relative to future one which motivates people to shift consumption from the present to the future. Second, the income effect that tends to raise consumption at all dates. Third the human wealth effect which reduces consumption in all periods, because higher interest rates reduces the present discounted value of future income. In principle, the effect of the interest rate is, theoretically, ambiguous, because the net effect of an increase in the interest rate depends on which of these forces dominates.[23] However, the usual presumption is that it is negative.[24]

We use long-term interest rates for two reasons. First, since our focus is on the long-run effects of the VAT on consumption, the long-term rates of interest are more

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[22] In principal, long-term interest rate is broadly defined as a 10-year average government bond yield. A full definition of LTR is provided in Table A1 of Appendix A.

[23] It depends also on whether the individual is a saver or dissaver.

[24] In principal, we assume that the sum of the substitution and wealth effects outweighs the income effect.

relevant. Second, lack of relatively longer data series on short-run interest rates is another motive to use long-term rates.

The effective value-added tax rate ($VATRate_t$). This variable is our key variable, which is calculated using the formula explained earlier. We choose to include the VAT in our equation in the form of effective rate, rather than as a revenue measure for two reasons. First, since we are interested in the intertemporal effect generated by the VAT as a tax on consumption, the effective rate is more capable of capturing that effect than a revenue measure, as it is easier to perceive altering relative prices of consumption today vs. consumption tomorrow.[25] Second, to control for variations in the VAT's statutory rates, exemptions …etc. across the EU countries and within each country, a measure of effective rate is more appropriate for comparability purposes. According to our hypothesis, the VAT is negatively related to the level of per capita private consumption; hence it should appear with a negative sign.

Total consumption tax revenues excluding VAT revenue ($Ln\ TotConsTax\_VAT_t$). We control for the possible impact of other consumption taxes in our equation by including a measure for other consumption tax revenues excluding those from the VAT. We calculated this variable as explained earlier. As this tax measure includes taxes levied on imports and exports (as part of the taxes on goods and services), its definite sign is largely uncertain. It depends on several factors. First, the proportion of import and export taxes relative to the total tax revenue on goods and services. Smaller fraction of trade taxes implies that these two taxes are relatively less important source of tax revenue in

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[25] If the tax increases the relative price of current consumption in terms of future consumption, then the intertemporal effect generated by the tax shock may lead to a reduction in consumption.

the EU countries, and hence their qualitative effect can be ignored.[26] Second, the relative size of these two trade tax variables to each others. If more taxes are levied on imports than on exports, then most of the tax burden is borne by "home" residents. In that case, consumption will decline as a result of a relatively larger import taxes (at least for those imported goods). If however, more taxes are collected from exports, then consumption level at "home" should not be affected. This means that either a negative sign or an insignificant result is expected.

Total income tax revenue (Ln $TotIncomeTax_t$). To control for the potential influence of income taxes on current consumption, we include a measure of income tax revenue in our estimated function. This variable is calculated from the collected tax data as explained previously. The base of an income tax includes income from both labor (earnings) and capital (such as rent, interest, dividends, or capital gain). Taxing the return from capital has two competing effects: (1) the substitution effect which tends to tilt prices in favor of current consumption and against future consumption, as it makes future consumption more expensive; and (2) the income effect which reduces total life time resources, and induces individuals to consume less in all periods. The net effect of these two forces is, theoretically, ambiguous. Therefore, a range of outcomes is possible. While a positive sign implies that the substitution effect is greater than the income effect, a negative coefficient means that the income effect is the dominant force. Finally, an insignificant result probably implies that these two effects cancel each others.

Empirical specification. We employ a reduced form linear equation, which allows us to include a broad range of consumption determinants. We focus our attention on a "core" set of regressors selected based on theoretical connection and analytical

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[26] Total trade taxes are the sum of tax revenues collected from import and export taxes.

relevance; however, we also examine the empirical role of a number of less-standard consumption determinants.

Following previous literature, our core regressors include a standard group of income-related variables, namely the (ln) level and the rate of growth of real per capita income, and (ln) level of per capita real household (private) wealth; other variables include real long-term interest rate, old dependency ratio, two tax control variables, namely (ln) level of per capita total consumption tax revenue excluding the VAT revenue, and (ln) level of per capita total income tax revenue, and finally our variable of interest, the effective VAT rate.

We perform additional empirical experiments using two measures of macroeconomic uncertainty, namely inflation rate and unemployment rate. These variables capture precautionary saving effects. More specifically, inflation rate has been used in the literature as a proxy for price uncertainty; whereas unemployment rate has been used, more generally, to proxy for macroeconomic instability.[27]

Econometric Issues and Methodology[28]

We are interested in estimating the following simple AR(1) consumption model with unobserved country-specific effect:

$$C_{i,t} = \alpha C_{i,t-1} + \beta' X_{i,t} + \mu_{i,t} \qquad |\alpha| < 1 \qquad (22)$$

$$for\ i = 1,...,N \qquad and \qquad t = 2,...,T$$

where:

$C_{i,t}$ Observable dependent variable.

[27] See for instance, Deaton (1977) and Fischer (1993).
[28] This section borrows heavily from Arellano and Bond (1991), Loayza et al. (2000) and Bond et al. (2001).

$X_{i,t}$ $K \times 1$ vector of observable independent variables.

β $K \times 1$ vector of parameters.

$\mu_{i,t}$ Random disturbance term satisfying the following assumptions:

$$E(\mu_{i,t})=0,\ E(\mu_{i,t}^2)=\sigma_\mu^2,\quad and\ \ E(\mu_{i,t}\,\mu_{j,s})=0\quad if\quad i\neq j\quad and/or\ \ t\neq s$$

N Number of cross-sectional units (countries)

T Number of time periods (years)

To estimate this model, we consider four estimators. While we realize the dynamic nature of our equation and that one or more of the right hand side variables is/are endogenous, which implies the necessity for an appropriate estimator that deals with these problems; we present regression results based on estimators that do not confront these problems to provide comparisons.[29] The reason is that our preferred dynamic panel estimator, which incorporates these issues, is sometimes criticized based on the fact that it is very sensitive to any small changes in the instrument set and/or the set of explanatory variables. Therefore, our first estimator is the basic pooled OLS (POLS) estimator using the White (1980) covariance estimator to produce consistent covariance matrix estimates when heteroskedasticity is an issue.[30] However, the POLS estimator suffers from several problems in our context. First, it ignores the panel nature of the data. Second, it assumes that the errors are serially uncorrelated for a given country.[31] Third, it does not account for the country-specific effect. Fourth, it neither

[29] The dynamic model is a regression in which the lagged value of the dependent variable is one of the explanatory variables. As pointed out by Bond (2002), even if we are not directly interested in the coefficient on lagged dependent variable, allowing for dynamics in the underlying process may be crucial for recovering consistent estimates of other parameters.
[30] Panel-level Heteroskedasticity has been tested using the likelihood ratio test (LR). The significant *p-value* reveals that the null hypothesis of homoskedastic errors has been rejected.
[31] We have tested for panel-level autocorrelation using Wooldrige (2002) test. The significant test-statistics indicates the presence of autocorrelation.

confronts the endogeneity problem of the regressors nor the effect of including lagged dependent variable among the explanatory variables in the model, i.e., the dynamic nature of our equation. Therefore, the simple OLS estimator on the pooled data turns out to be biased and inefficient. Furthermore, the estimated standard errors are wrong as they do not take into account the dependence of the error term within country over time.

Given the limitations of the POLS estimator in our context, as well as the previously discussed advantages of panel data models, we employ a two-way error component model, in which we include year dummies to account for time-specific effects.[32] In that case, we decompose the error term (μ_{it}) as follows:

$$\mu_{i,t} = \eta_i + \lambda_t + \varepsilon_{i,t}$$

where:

η_i Unobservable country-specific effect

λ_t Unobservable time-specific effect

$\varepsilon_{i,t}$ Stochastic error term that is identically, independently distributed *(IID)* with zero mean and constant variance $\varepsilon_{i,t} \sim IID(0,\sigma^2)$.

If (η_i) *and* (λ_t) are fixed parameters, then the fixed effect error component specification has been specified. If, however, (η_i) *and* (λ_t) are random parameters, then the random effect error component specification has been specified. The Hausman (1987) specification test is used to test whether the fixed or random effects model provides a better fit. Results from the Hausman test reject the null hypothesis; therefore, the fixed

[32] See Baltagi (2001) for a detailed discussion of the two-way error component models.

effect model is chosen. As a result, we estimate equation (22) using two-way fixed effect model (FE) as our second estimator (also known as the within estimator).

Although the fixed effect estimator controls for the unobserved country-specific effect, it fails to account for the other problems in our model. More specifically, it does not deal with the issues raised by endogeneity of the regressors, measurement error, and simultaneity bias which renders the within estimator biased and inconsistent. This discussion convinces us that the estimation procedure needs to tackle several issues. First, we must allow for the possible endogeneity of one or more of the explanatory variables.[33] Second, we must address the potential problem of measurement error in measures of the dependent and independent variables, which is a typical problem for macro-level data. Third, we must tackle the problem of omitted variable bias. Fourth and finally, our estimator must take into account the possibility of simultaneity bias.

To address these issues our "main" econometric technique is based on generalized method of moments (GMM) estimators applied to dynamic models using panel data. If a specific set of assumptions is met – which will be discussed as we proceed, the dynamic GMM estimator allows us to control for all the problems discussed previously.

At this point, we must clarify the extent to which we control for joint endogeneity. For that purpose, our panel estimator uses "internal instruments," that is, instruments based on lagged values of the explanatory variables. Through this method, we can relax the assumption that the independent variables are strictly exogenous; however we cannot allow for full endogeneity of the explanatory variables. To be precise, we must assume that the explanatory variables are *weakly* exogenous, which means that they can be

[33] In fact, the presence of lagged dependent variable among the regressors implies that it is - by construction - correlated with the country-specific component of the error term.

affected by current and past realizations of the error term, but uncorrelated with future realizations of the error term.[34] Conceptually, weak exogeneity does not mean that future levels of consumption cannot be correlated with current realizations of variables such as income growth or the interest rate (as would be predicted by forward-looking consumers). Rather, weak exogeneity means that future innovations (or unforeseen changes) to the level of consumption do not influence previous realizations of consumption determinants. Relaxing the strict exogeneity assumption of the explanatory variables allows for the possibility of simultaneity and reverse causality, which are very likely to be present in consumption equation. We believe that this assumption is not particularly restrictive; furthermore, we can statistically examine its validity through several specification tests, as explained below.

Recall that we are interested in estimating equation (22) with unobserved country-specific effect; where $\mu_{i,t} = \eta_i + \varepsilon_{i,t}$ is the usual "fixed effects" decomposition of the error term. Following Arellano and Bond (1991), Ahn and Schmidt (1995), and Blundell and Bond (1998) we assume that η_i *and* ε_{it} have the standard error components structure:

$$E(\eta_i)=0, E(\varepsilon_{i,t})=0, E(\varepsilon_{i,t}\eta_i)=0 \quad for \quad i=1,...,N \quad and \quad t=2,...,T \tag{23}$$

In addition, we assume that the transient errors are serially uncorrelated:

$$E(\varepsilon_{i,t}\varepsilon_{i,s})=0 \quad for \quad i=1,...,N \quad and \quad \forall\, t \neq s \tag{24}$$

And finally, we assume that the initial conditions C_{i1} are predetermined:

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[34] See Chamberlain (1984) for more details. Note, however, that if $x_{i,t}$ is endogenous then $E(x_{i,t}\varepsilon_{i,t}) \neq 0$ *and* $E(x_{i,t-1}\varepsilon_{i,t-1}) \neq 0$, and in that case valid instruments are $x_{i,s}$ with *s = 1, ..., t-2*, as $E(x_{i,t-2}\varepsilon_{i,t}) = 0$. If, however, $x_{i,t}$ is predetermined (weakly exogenous), then $E(x_{i,t}\varepsilon_{i,t-1}) \neq 0$ *but* $E(x_{i,t-1}v_{i,t-1}) = 0$, and in that case valid instruments are $x_{i,s}$ with *s = 1, ..., t-1*.

$$E(C_{i,1}\varepsilon_{i,t})=0 \quad for\, i=1,...,N \quad and \quad t=2,...,T \tag{25}$$

In specification (22), as lagged dependent variable is one of the explanatory variables, it is expected to be correlated with the country-specific component of the error term (η_i). The suggested solution to resolve this problem is to first-difference equation (22) to eliminate the country-specific effect:

$$C_{i,t}-C_{i,t-1}=\alpha(C_{i,t-1}-C_{i,t-2})+\beta'(X_{i,t}-X_{i,t-1})+(\varepsilon_{i,t}-\varepsilon_{i,t-1}) \tag{26}$$

Clearly, the use of instruments is necessary to deal with several problems. First, the problem imposed by the existence of lagged difference of the dependent variable $(C_{i,t-1}-C_{i,t-2})$ among the regressors. This means that it is correlated with the error term $(\varepsilon_{i,t}-\varepsilon_{i,t-1})$. Second, the possible endogeneity of the other explanatory variables *X*.

Assumptions (23), (24), and (25) imply the following moment restrictions:

$$E[C_{i,t-s}(\varepsilon_{i,t}-\varepsilon_{i,t-1})]=0 \quad for \quad t=3,...,T \quad and \quad s\geq 2 \tag{27}$$

$$E[X_{i,t-s}(\varepsilon_{i,t}-\varepsilon_{i,t-1})]=0 \quad for \quad t=3,...,T \quad and \quad s\geq 2 \tag{28}$$

Moment conditions (27) and (28) are then used to calculate the dynamic panel GMM-*Difference* estimator, under the assumptions that the error term is serially uncorrelated and that the lagged levels of the explanatory variables *X* are weakly exogenous, as explained above.[35]

Nonetheless, Blundell and Bond (1998) pointed out that when the time series are *persistent* (like consumption and GDP) and the number of time series observations is

[35] As pointed out by Arellano and Bond (1991), the moment conditions of the GMM-*Difference* estimator imply the use the lagged levels of the explanatory variables dated *(t – 2)* and earlier as instruments for the equation in first-differences.

small, the GMM-*Difference* estimator has been found to have poor finite sample properties, in terms of bias and imprecision. The reason is that, under these conditions, lagged levels of the series are only weakly correlated with subsequent first-differences. Therefore, the available instruments for the first-differenced equations are weak.[36] Asymptotically, the coefficients' variance of the GMM-*Difference* estimator rises in the presence of weak instruments. In small samples, instrument weakness results in biased coefficient estimates of the GMM-*Difference* estimator as shown in Monte Carlo experiments. Furthermore, by first-differencing the cross-country dimension of the data is lost. Finally, Griliches and Hausman (1986) argued that differencing may decrease the signal-to-noise ratio, thus worsening the degree of biases resulting from measurement error.

Arellano and Bover (1995) and Blundell and Bond (1998) proposed an alternative approach to deal with these problems. This alternative method estimates the regression in differences jointly with the regression in levels to produce a GMM-*System* estimator. The main advantage of the *system* estimator over the *difference* estimator is that the former exploits an assumption about the initial conditions to obtain moment restrictions that continue to be useful even for persistent series. Therefore, it is shown that this estimator have superior finite sample properties in terms of potential biases of the coefficient estimates, in addition it reduces the asymptotic imprecision associated with the difference estimator. The reason behind this result is that the inclusion of the regression in levels does not eliminate cross-country variation nor does it strengthen the degree of measurement error. Moreover, the variables in levels, obviously, are more serially correlated than in differences, this implies that they sustain a stronger correlation with

[36] See Blundell and Bond (1998) and Bond et al. (2001) for further details.

their instruments. However, the inclusion of the regression in levels requires appropriate instruments to be used to control for country-specific effect. More specifically, lagged differences of the explanatory variables are used as instruments. These are considered valid instruments if the following two assumptions are met: (1) the error term is serially uncorrelated; and (2) although there may be correlation between the country-specific component of the error term (η_i) and the levels of the explanatory variables, there is no correlation between the error term and the differences in these explanatory variables. This assumption is drawn from the following stationarity properties:

$$E[C_{i,t+p}\eta_i] = E[C_{i,t+q}\eta_i] \quad and \quad E[X_{i,t+p}\eta_i] = E[X_{i,t+q}\eta_i] \quad for\ all\ p\ and\ q \tag{29}$$

The additional moment conditions for the regression in levels (the second part of the system) are given by:

$$E[(C_{i,t-s} - C_{i,t-s-1})(\eta_i + \varepsilon_{i,t})] = 0 \qquad for \quad s = 1 \tag{30}$$

$$E[(X_{i,t-s} - X_{i,t-s-1})(\eta_i + \varepsilon_{i,t})] = 0 \qquad for \quad s = 1 \tag{31}$$

Using the moment conditions in equations (27), (28), (30), and (31) produces the GMM-*System* estimator, in which the difference equation uses lagged levels as instruments, while the equation in levels uses lagged differences as instruments.[37]

Specification tests. Consistency of the GMM-System estimator depends on the validity of the assumption that the error term, $(\varepsilon_{i,t})$, is serially uncorrelated; and on the validity of the instruments. Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998) suggested two specification tests. The first one considers the assumption of serially uncorrelated errors. It is applied to the first-difference equation

[37] Arellano and Bover (1995) pointed out that since lagged levels are used as instruments in the differenced equation, only the most recent difference should be used as instrument in the levels equation. Redundant moment conditions would result by using other lagged differences.

residuals in order to purge the unobserved and perfectly autocorrelated (η_i). By construction, we would expect the differenced error term to be first-order serially correlated even if the original error term is not, because $(\varepsilon_{i,t} - \varepsilon_{i,t-1})$ is correlated with $(\varepsilon_{i,t-1} - \varepsilon_{i,t-2})$ since they share the term $(\varepsilon_{i,t-1})$. Therefore, the test tests whether the differenced error term is second-order serially correlated.[38] Under the null hypothesis of no second-order correlation, this test has a standard normal distribution. If we do not fail to reject the null of no second-order correlation, it indicates that some lags of the dependent variable, which might be used as instruments, are in fact endogenous, thus considered "bad" instruments.

The second test is the *Hansen* test of over-identifying restrictions (which is the minimized value of the two-step GMM criterion function). This test tests for the overall validity of the instruments. Under the null hypothesis of the validity of the instruments (i.e., the instruments used are uncorrelated with the residuals, or whether the instruments, as a group, appear exogenous), this test has a χ^2 distribution with *(J-K)* degrees of freedom, where *J* is the number of instruments, and *K* is the number of regressors. The *Hansen J-Statistic* is robust to heteroskedasticity and autocorrelation.[39] Failure to reject the null hypotheses of both tests provides support to our model.

We estimate the following aggregate level equation of *per capita* private consumption:[40]

$$C_{i,t} = \beta_1 C_{i,t-1} + \beta_2 VATRate_{i,t} + \beta_3 Z_{i,t} + \eta_i + \varepsilon_{i,t} \qquad i = 1,...N; t = 1,...T \qquad (32)$$

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[38] Note here that since the error terms from the regression in levels include the country-specific effect (η_i), we cannot use these error terms (from the level regression) to perform our test of serial correlation.

[39] Note that the Hansen test is the heteroskedasticity-robust version of the Sargan test.

[40] We chose to estimate the per capita equation because it is more comparable across different units.

where i refers to countries, t to time, and $(\eta_i + \varepsilon_{i,t})$ to the composite error term that includes the country-specific time-invariant unobservable effect (η_i).

The (ln) level of per capita private final consumption (constant 1995 $U.S.) is given by $(C_{i,t})$, $(VATRate_{i,t})$ is our variable of interest, the set of control variables is given by $(Z_{i,t})$, which includes (ln) level of income, income growth rate, (ln) level of wealth, interest rate, (ln) level of per capita income tax revenue, (ln) level of per capita other consumption taxes revenue (excluding the VAT revenue), old dependency ratio, inflation rate, and unemployment rate.

While this presentation of the methodology treats all variables as weakly exogenous (with respect to $\varepsilon_{i,t}$), practically, however, we treat some variables as strictly exogenous (with respect to $\varepsilon_{i,t}$). These variables include households' wealth, inflation rate, unemployment rate, old dependency ratio, and the two tax control variables (i.e., income tax and other consumption taxes).

As a linear GMM estimator, the GMM-System estimator has one-step and two-step variants. Arellano and Bond (1991) and Blundell and Bond (1998) pointed out that although asymptotically more efficient, the two-step estimates of the standard errors tend to be severely downward biased, though in theory the standard covariance matrix is already robust. To compensate – for the downward biasness, our GMM-System estimator employs a finite-sample correction to the two-step covariance matrix derived by Windmeijer (2005), which dramatically improved accuracy in his Monte Carlo Simulations. For our purpose here, we specify that the robust estimator of the covariance matrix of the parameter estimates be calculated. The resulting standard errors are consistent in the presence of any pattern of heteroskedasticity and/or autocorrelation within panels. This makes the two-step robust more efficient than one-step robust, especially for system GMM. Nevertheless, for completeness and as a robustness check, we employ both one-step and two-step robust estimators as our third and fourth estimators, respectively.

Estimation Results

We now present the estimation results for private consumption function. We organize our discussion around the "core" empirical specification presented earlier (it is shown in Table B1 of Appendix B).

We note from the results presented in tables B1 through B14 of Appendix B that the specification tests generally support our dynamic GMM estimates (as shown in columns (3) and (4) of Table B1). The Hansen test of overidentifying restrictions fails to reject the null hypothesis that the instruments are uncorrelated with the error term (*p-value* = 0.49 and 0.69 for the one-step and two-step GMM-System estimators, respectively). Similarly, the tests of serial correlation reject the hypothesis that the error term is second-order serially correlated, providing additional support to the use of appropriate lags of the explanatory variables as instruments for the estimation.

Basic results. Table B1 of Appendix B reports the results of private consumption regression using alternative estimators on the five-year averaged data and utilizing the core specification. Our preferred estimation method uses the two-step GMM-System estimator. Therefore, we first discuss the results obtained with this estimator (columns (4) of Table B1) and then compare them with those obtained with alternative estimation methods.

Before presenting the results in more detail, we must clarify their interpretation. Our econometric methodology is designed to isolate the effect of the exogenous component of each of the explanatory variables on aggregate consumption. To the extent that our assumptions regarding the instruments utilized in the GMM procedure are correct, we isolate the causal effects of the explanatory variables on aggregate private consumption. As mentioned, the specification tests presented in our results support the validity of our instruments and hence, allow us to draw inferences regarding the connection between the exogenous component of policy and non-policy variables and the level of household private consumption. Therefore, when we point out to the effect of a given variable on consumption, we are referring to the correlation between the exogenous component of that variable and consumption.

The results show a statistically significant relation between the exogenous component of the effective VAT rate and the level of private aggregate consumption. As expected, the direction of the relation is negative, implying that consumption declines by more than one percent when the VAT rate is increased by one percentage point. The results are statistically significant at the 1 percent level. The economic weight of the results can be shown by a simple example. Consider, for example, Italy's median value for effective VAT rate over the period 1961-2000 was 3.62 percent. An exogenous increase in VAT rate that brought it to the sample median of 5.09 percent would result in a 1.63 percent lower consumption over five-year period.[41] This latter value translates roughly to 0.33 percent lower consumption per year. This negative link between the VAT

[41] This result follows from 5.09 – 3.62 = 1.47, and (1.47)*(1.11) = 1.63, where 1.11 is the point estimate of VATRate in column (4) of Table B1 of Appendix B.

rate and private consumption is not due to simultaneity bias, omitted variables, or measurement error.

We now turn to a detailed discussion of the results obtained in column (4) of Table B1:

Habit persistence. As expected, (ln) level of lagged consumption has a positive and significant coefficient (at the 10 percent level) whose size (0.37) indicates the presences of habit persistence in consumer behavior.[42]

Income. Both the (ln) level of real per capita income and its growth rate have a positive and significant effect (at the 5 percent, and 10 percent levels of significance, respectively) on private consumption. The point estimate reveals that the elasticity of consumption with respect to income equals 0.45.[43] In turn, the estimated growth coefficient indicates that an increase in the growth rate of income by one percentage point leads to about 0.82 percent increase in private consumption. This result is consistent with consumption smoothing by forward-looking agents.

Wealth. The estimated wealth elasticity equals 0.05, with a positive but insignificant coefficient. This result shows that the marginal propensity to consume out of income is much larger than that out of wealth.

Interest rate. The rate of interest has a negative and significant impact, at the 5 percent significance level, on private consumption; suggesting that the sum of its substitution and human wealth effects outweighs its income effect. The magnitude of the

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[42] The best way to interpret the coefficient of lagged consumption is in terms of the "speed of adjustment" in consumer behavior. For example, with the point estimate of lagged consumption equal to 0.37, the adjustment rate is equal to 0.63. The latter value means that 0.63 of the difference between desired and actual consumption is eliminated in five years.

[43] To put it differently, it means that an increase in income of 10 percent raises private consumption by about 4.5 percent, on average.

estimated coefficient indicates that an increase of one percentage point in the rate of interest drives private consumption down by about 0.84 percent.

Fiscal policy. We included three variables under this category:

i. *VAT Rate.* The effective VAT rate is our key variable. It appears with a negative and significant coefficient. The 1 percent level of significance implies the existence of a strong statistical correlation. Furthermore, the economic significance is sizable since the point estimate of the coefficient indicates that, on average, a one percentage point increase in the VAT rate will lead to 1.11 percent decline in the level of private consumption. Therefore, our result provides support to our hypothesis.

ii. *Total consumption tax revenue excluding VAT revenue.* The results on our first tax control variable show that its influence on private consumption is statistically insignificant, with a positive sign and very small magnitude (almost zero). As we discussed earlier, the positive coefficient can possibly indicate that a larger proportion of trade taxes is collected from exports, however, the insignificant results might imply that trade taxes, on average, do not constitute a large fraction of the total taxes collected from goods and services. Indeed, total trade taxes constitutes only 4.4 percent of total taxes on goods and services, hence their impact on consumption is trivial.

iii. *Total income tax revenue.* The results indicate that the correlation between total income tax revenue and aggregate level of per capita private consumption is statistically insignificant. Since income taxes generate substitution and income effects, which typically work in opposite directions; thus one possible explanation of the insignificant result is that these two forces cancel out each others leaving an insignificant impact on the level of aggregate consumption. The small magnitude of 0.04 implies that the economic significance of this variable is negligible.

Old dependency ratio. Our demographic variable appears with an unexpected positive sign, though it is statistically insignificant. This insignificant result implies that consumers base their consumption decisions on the PIH.

Sensitivity analysis. In order to test for the robustness of the basic results and to enlighten their interpretation, we also conduct a sensitivity analysis along three dimensions. First, we utilize alternative econometric techniques. Second, we work with two data sets based on the relevant time interval; i.e., with five-year averaged data and annual data. Third and finally, we bring in the importance of other explanatory variables.

Alternative estimators. Table B1 of Appendix B also presents results obtained with alternative estimation techniques. The first estimator, shown in column (1), represents the static OLS estimates using pooled data. As explained above, POLS is likely to be biased and inconsistent because it ignores unobserved country-specific effects and joint endogeneity of the explanatory variables. To control for country-specific effects, we use the two-way fixed effect estimator as our second estimator. However, the within estimator does not solve the joint endogeneity problem. An additional problem already noted earlier is that the presence of a lagged dependent variable renders the within estimator biased and inconsistent. Finally, column (3) presents the results obtained with the one-step GMM-System estimator which deals with country-specific effects, joint endogeneity, and the inclusion of lagged dependent variable as one of the regressor. Nevertheless, the one-step GMM-System estimator is less efficient than the two-step estimator as indicated previously.

In many cases, the results obtained with our preferred two-step GMM-System estimator are qualitatively similar to those obtained with alternative estimators. All estimators yield positive effects of the (ln) level of income, growth rate of income, (ln) level of wealth, and negative effects of interest rate, although, the coefficients vary in size and statistical significance. Most interestingly, the VAT Rate appears with a negative and statistically significant coefficient in all estimators, though with varying magnitude and level of significance. There are, however, some prominent exceptions. For example, the sign of the coefficients on old dependency ratio and total consumption tax revenue excluding VAT revenue do not show a clear pattern across alternative estimators, though they appear to be insignificant in all cases. Likewise, total income tax revenue is obviously positive and insignificant across alternative estimators; nonetheless, it is significant in our third estimator, i.e., one-step GMM-System estimator.

Alternative time units. In Tables B8 through B14 of Appendix B we employ the annual dataset to perform our analysis. The results indicate that the specification tests generally do *not* support our dynamic GMM estimates (as shown in columns (3) and (4) of Table B8). The *p-value* of the Hansen test is consistently equal to 1.00, indicating that our model is heavily over-identified which leaves our instruments invalid. The reason for that is because of the large time dimension (i.e., T = 40) in the annual regressions, which simply means that there are many more moment conditions than parameters to estimate.[44] However, we present these results for completeness. Several conclusions emerge from these results. First, most of the explanatory variables appear with the expected sign, though with varying size and level of significance. Second, the VAT Rate appears with the expected negative sign and is significant across alternative estimators. Third, unlike the case with the five-year averaged data, old dependency ratio appears to influence the level of per capita private consumption significantly in the case of POLS estimator. Fourth, income growth seems to be more relevant in this case (note the high level of significance in all estimators). Fifth, wealth seems to be important in the case of POLS and the FE estimators, but continues to appear with an insignificant coefficient in the two GMM estimators. Sixth, there is no clear pattern regarding the influence of total consumption tax revenue excluding VAT revenue in terms of its sign and level of significance across the two samples for all four estimators. Finally, there are some similarities between both samples, for instance lagged consumption, (ln) level and growth rate of income are consistently positive while the rate of interest is constantly negative, despite the fact that there are notable differences in terms of their size and level of significance.

Additional explanatory variables. We added other potential determinants of private consumption which are excluded from the core set of explanatory variables because they are either less commonly used in the literature or because they are less relevant for our purpose here as we are more interested in examining long-run behavior. Furthermore, we tested the sensitivity of our results by dropping some variables from the

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[44] Recall that consistency of GMM estimates is established under the assumptions that T is small and N is large. In this case we have 40 annual observations for 15 countries, which means that $T > N$, and that invalidates this main assumption.

core specification. In the latter case, we focused on only two variables, namely the growth rate of income and the old dependency ratio. Tables B2 through B4 of Appendix B present the sensitivity of the core results to dropping one or more of these variables using the five-year averaged data. Generally, the core results are not sensitive to dropping income growth and/or old dependency ratio. The coefficients of lagged consumption, (ln) level of income, and (ln) level of wealth preserve their expected positive sign with relatively comparable size and level of significance across alternative estimators. An important observation in this case is the significant impact of wealth on consumption level when one of the variables (or both) is (are) dropped from the core specification. Similarly, the rate of interest and our variable of interest, the VAT Rate, are consistently negative and significant at various levels of significance with analogous magnitude. These results imply that our core results are not sensitive to changes in the core specification, which provides further support to our model and hypothesis.

In addition, we included two macroeconomic uncertainty variables, namely inflation rate and unemployment rate. These variables are included in Tables B5 through B7 of Appendix B. Using the five-year averaged data, we find that both of these variables are statistically not different from zero, with the exception of the POLS estimates in which unemployment rate is significant at 10 percent level. Furthermore, their small magnitude implies the absence of economic significance as well. Both variables appear with an unexpected positive sign in most cases. A possible explanation for this result is that these two variables are “more” relevant in the short-run and when studying business cycles’ behavior. Since we have controlled for the effect of business cycle fluctuations by averaging our data, there is a chance that the effects of these variables have vanished, leaving an insignificant impact on consumption.

When we turn to the annual data regressions in Tables B12 through B14 of Appendix B, we note that in Tables B12 and B14 the POLS and FE estimators show that inflation rate has a negative and significant impact on the level of aggregate consumption. However, these results are reversed in terms of the sign and level of significance in the two GMM-System estimators, with a very small magnitude (almost zero). Tables B13 and B14 show that unemployment rate appears with a negative coefficient in all estimators, except in the POLS estimates of Table B13. The rate of unemployment seems to affect the level of aggregate consumption significantly in the POLS and the one-step GMM-System estimates. These results confirm our predictions regarding the insignificant influence of the business cycle variables on the long-run level of aggregate consumption.

Concluding Remarks

As indicated earlier, the purpose of this study is to empirically examine the correlation between the VAT and the level of per capita private consumption. Using a sample of fifteen EU countries over the period 1961-2000 and the recently developed dynamic panel GMM-system estimator, we find that the VAT is negatively correlated with the level of aggregate consumption. More specifically, a one percentage point increase in the VAT rate leads to *about* a one percent reduction in the level of per capita aggregate consumption, *ceteris paribus*. Furthermore, the results of the sensitivity analysis, using various estimators, alternative time units, and additional explanatory variables confirm our basic results.

Conclusions, Policy Implications, and Future research

This essay has attempted to expand our understanding of the relationship between consumption taxes, in general, and the VAT, in particular, and consumption behavior. The first section presented the motivation and the goals of the essay. The second section provided a survey of the existing theoretical and empirical literature on this subject, with a conclusion that pointed out to what has been done and what is needed.

In section three, we developed a theoretical framework of consumer spending. The model is an extension of the model developed by Ando and Modigliani (1963), in which we derived an aggregate consumption function that explicitly incorporates consumption taxes as an additional parameter. Furthermore, we provided comparative static analysis to isolate the effect of consumption taxes on the level of consumption. We found that the effect of an increase in the current consumption tax rate on the level of aggregate consumption is theoretically ambiguous due to the presence of two competing effects, i.e., the substitution effect and the income effect.

Section four presented the empirical model to estimate the impact of the VAT on consumer spending. The model is considered a first attempt to explicitly include and estimate the effects of the VAT on consumption behavior. Unlike almost all previous literature which is based on structural models that use single-country, time-series approach, we used a panel dataset that includes 15 EU countries and spans the years 1961-2000. We adopted a reduced form approach which allowed us to include a variety of consumption determinants identified in the literature. Our model is estimated using estimation methods that allow controlling for endogeneity of the regressors and country heterogeneity using internal instruments, i.e., the dynamic panel GMM estimators. Our benchmark results are further confirmed with the results of the sensitivity analysis, using various estimators – namely, pooled OLS, two-way fixed effect, and one-step GMM-System; alternative time units; and additional explanatory variables. Overall, our estimation results are satisfactory and pass the Hansen and the serial correlation specification tests of the one-step and two-step GMM-System estimators. In particular, we found a negative and robust correlation between the VAT rate and the level of per capita aggregates household consumption. More specifically, a one percentage point increase in the VAT rate leads to *about* a one percent reduction in the level of per capita aggregate consumption, *ceteris paribus*.

The results of this study are valuable because they provide us with more precise marginal effects, as well as because of its policy implication. Since aggregate consumption is an important element in evaluating society's welfare and it feeds through to savings, capital accumulation and growth, which in turn affects future welfare and standard of living; policymaker should take into account the potential impact of the VAT on households' consumption decision when designing a VAT-type consumption tax proposal, as it seems to influence current and future consumption and welfare.

While this study serves as a first attempt to provide empirical evidence on the relationship between the VAT and consumer spending, there remains much to be done. For instance, an interesting extension would be to develop a formal theoretical model of consumption behavior that incorporates, along with consumption taxes, other views of consumption such as liquidity constraints, uncertainty regarding future income or future taxes, and administration and compliance costs. The last view is of significant relevance if future research is to be directed to establish the relationship between the VAT and consumer spending in developing countries. Other possibilities include conducting an empirical study that compares the effect of the VAT on consumption across developing and industrial countries, which is likely to be different, given the limited administrative capacity of taxpayers and tax authorities in these countries.

Essay Two: Value-Added Taxation, Economic Growth and the Sources of Growth: Theory and Evidence

Introduction

Economic growth is the basis of increased prosperity in any nation. Investment in new capital (both human and physical), the implementation of both new production techniques and new products are the foundations of the growth process. Taxation, through its effect on the net rates of return to investment, savings, labor supply, the expected profitability of research and development, the cost of capital, and the possibility of transferring income between household with different consumption-savings patterns, can affect what choices are made, and ultimately, the growth rate of the economy.[45] Several empirical papers have tested for the effects of fiscal policy, in general, and taxes, in particular, on growth in various ways. Most of these studies found a significant negative impact.[46]

The recently growing number of proposals for fundamental tax reform in many countries including the United States (U.S.) ends up in many cases at proposing a shift from the current income tax regime to a broad-based consumption tax regime, such as the value-added tax (VAT). The purpose of such a change, as articulated by its proponents, is to stimulate economic activity and promote efficiency in resource allocation. Therefore, understanding the channels through which such reforms can influence economic growth

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[45] For a detailed presentation of the theoretical connection between tax policies and the economy's level of income and its endogenous growth rate see Barro (1990), Rebelo (1991), Barro and Sala-i-Martin (1995), Pecorino (1993), Xu (1994), Milesi-Ferretti and Roubini (1998), Judd (1999), and Turnovsky (2000), among others.

[46] The empirical literature includes Levine and Renelt (1991), Plosser (1992), Engen and Skinner (1992), Cashin (1995), Barro (1996), Agell et al. (1997), Leibfritz et al. (1997), Miller and Russek (1997), Kneller et al. (1999), Fölster and Henrekson (2000), Myles (2000), and Leach (2003), among others.

and its sources, namely capital accumulation and productivity growth is becoming crucial for academics and policymakers.

The principal argument for the consumption tax as growth enhancer is straightforward. Proponents of consumption-based taxes argue in its favor because of its potentially positive impact on household saving, since savings are exempted from the tax base which implies that the after-tax rate of return on savings is higher. More saving would lead to: (i) higher investment in physical capital – since the cost of capital is lower because consumption-based taxes remove the tax on capital income; (ii) greater productivity – if tax reform sufficiently broadens the tax base by eliminating various tax preferences, then it might lead to an increase labor supply, and hence productivity, because it allows for a reduction in the marginal tax rate on labor income;[47] and (iii) more output in the long-run.

While few studies, such as Summers (1981) and more recently Petrucci (2002) have looked at the effect of consumption tax on capital accumulation, no study to our knowledge has examined its impact on productivity growth. Furthermore, to our knowledge no formal argument has been provided to examine in a unified fashion, that includes a theoretical treatment as well as an empirical analysis, the potential influence of consumption taxes on the sources of growth.

Therefore, the goals of this study are: (i) to develop a theoretical framework that incorporates consumption taxes to assess their impact on per capita physical capital growth, per capita productivity growth and overall per capita income growth; (ii) to

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[47] However, if the reform does not broaden the tax base, then taxes on earnings must climb to maintain the same amount of revenues and in that case tax reform might lead to a reduction in labor supply. The reason is that the tax base for a consumption tax is smaller than that of an income tax, with saving being the difference.

empirically test how the VAT, as a broad-based consumption tax, affects growth and its sources. In other words, as predicted by most tax reform proposals, does an increase in the effective VAT rate lead to: (1) an increase in the economy's per capita income growth rate ?; (2) an increase in the rate of per capita physical capital growth rate ?; and finally, (3) an increase in the per capita productivity growth rate ?; and (iii) to develop a theoretical framework to explain the observed variation in effective VAT rates over time in our sample by studying the tax design problem.

This study contributes to the existing literature in several directions. First, it provides a formal and unified theoretical framework to address the connection between consumption taxes on one hand, and growth and its sources on the other. Second, with the observed variation in effective VAT rates over time, the study develops a theoretical model, which incorporates both equity and efficiency considerations as they are considered important factors determining tax structure, to identify conditions under which differential taxation, as well as uniform taxation over time is optimal. Finally, the use of the recently developed dynamic panel generalized method of moments (GMM) system estimator as our main econometric methodology adds an additional layer of originality to the study. If a particular set of assumptions is met, the finite sample properties of these estimates are better in the sense that they do not bear biases induced by endogeneity, simultaneity, omitted variables, or measurement error, which are typical issues to deal with when estimating growth equation using macro-level data. Hence, the theoretical piece as well as the empirical evidence of this study is expected to provide some guidance and insight for policymakers when considering different tax reform proposals, as they may yield serious long-run consequences with respect to the economy's performance, and hence the future standard of living.

Our theoretical model relies on Diamond's (1965) overlapping generation model in order to include both efficiency and equity considerations in our analysis as it allows for heterogeneity among individuals. The results show that consumption taxes affect growth and its sources through the savings channel; nonetheless their net effect is theoretically ambiguous and depends on the interaction between utility parameters, interest rate, and the tax structure. Furthermore, the results of the tax design problem show that if the change in taxes that keeps the economy at the same social welfare level is not equal (equal) to the change in taxes that keeps the economy at the same revenue set, evaluated at proportional taxation, then differential (uniform) taxation over time is optimal.

With respect to the empirical analysis, we use the same dataset used by Beck et al. (2000) and added to that our variable of interest (i.e., the effective VAT Rate), as well as the other two tax control variables we employed in the first essay (i.e., total consumption tax revenue excluding VAT revenue and total income tax revenue). However, the dataset includes only fourteen EU countries and spans over the period 1961-1995.[48] We employ the same four estimators used in the first essay, namely, pooled OLS, two-way fixed effect error component, one-step GMM-system, and two-step GMM-system estimators. Our empirical results indicate that the effective VAT rate is positively and significantly correlated with growth and capital accumulation. The correlation is found to be robust across various estimators and model specifications. However, the VAT appears to have

[48] The dataset includes only 14 countries, rather than 15, because data on educational attainment are not available for Luxembourg. Furthermore, data on capital accumulation and productivity growth is available only up to 1995.

an insignificant, though positive, effect on per capita productivity growth. More specifically, using the simple conditioning information set, which includes in addition to our variable of interest, two other tax control variables, initial income to control for convergence, and schooling to control for the level of human capital, we find that a one percentage point increase in the VAT rate would lead to a 0.23 percentage point increase in the growth rate, and to a 0.28 percentage point increase in the capital growth rate, *ceteris paribus*.

The rest of the paper is structured as follows. Section two surveys the existing theoretical and empirical literature on growth and its sources on one hand and consumption taxes on the other. Section three presents the theoretical model, and provides a treatment for the tax design problem. Section four presents the empirical analysis with an emphasis on the empirical strategy which provides an overview of the dataset and the empirical specification. The section also discusses the econometric issues, the estimation methodology, presents the basic results, as well as the results of the sensitivity analysis. Conclusions, policy implications, and possible future research are presented in section five.

Literature Review

Introduction

A substantial number of studies have attempted to develop a theoretical linkage, as well as an empirical investigation of the relationship between taxes and economic growth. In fact, neoclassical and endogenous growth theories have substantially different implications about how changes in certain variables, such as the saving rate, the population growth rate, and several government-policy variables, including taxes, affect long-term growth rate. In particular, the exogenous growth theory, developed by Ramsey (1928), and typified by Solow (1956), Swan (1956), Cass (1965), and Koopmans (1965) predicts that such changes, while permanently affect the steady-state *level* of output per capita, will alter its growth rate only temporarily during the transition period, and have no permanent effect on the economy's steady-state *growth rate*. In contrast, endogenous growth theories, pioneered by Romer (1986), Lucas (1988), and Rebelo (1991), among others, predict that such changes will permanently change the growth rate of per capita output in the long-run.[49]

While the link between taxes on one hand and growth and its sources on the other occurs through a straightforward channel – taxes reduce private returns to accumulation in human and physical capital, which leads to lower growth rates of output, capital, and productivity, the empirical literature is inconclusive regarding the magnitude of the effect.[50] For instance, the recent theoretical contributions of Lucas (1990), Stockey and

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[49] Since neoclassical growth theories do not provide persuasive answers to the central questions about economic growth, this leads us to concentrate on the other group of economic growth theories, i.e., endogenous growth theories.

[50] In fact, the magnitude of the influence depends on several factors, such as the degree of labor elasticity, the intertemporal elasticity of substitution in the utility, the rate of depreciation of human and physical capital, and factor shares in the production of human capital and physical output. Other factors may include the extent of substitutability between physical and human capital in production, the time-horizon of

Rebelo (1995), and Hendricks (1999), among others concluded that the growth effects of taxes are limited. On the contrary, King and Rebelo (1990), Jones et al. (1993), Razin and Yuen (1996), and Yakita (2003), among others concluded that tax policies have moderate to large growth effects.

On the empirical front, even with the substantial number of empirical studies exploring the impact of taxation on economic growth, no single conclusive answer has been provided on the direction and/or the size of the influence. For instance, the contributions of Koester and Kormendi (1989), Barro (1991), Easterly and Rebelo (1993), Engen and Skinner (1996), and Padovano and Galli (2001) among others have found significant negative effect of the marginal tax rates on the growth rate and/or the level of real GDP per capita. In contrast, Levine and Renelt (1992), Slemrod (1995), Kneller et al. (1998), and Myles (2000), among many others have concluded that the impact of taxation on growth and/or the level of income are either negligible, difficult to isolate and measure, not robust, and/or undetermined.

To summarize, there is a general consensus among most researchers that taxes, at least theoretically, have permanent negative real effects on growth rates in an endogenous growth model. Nonetheless, there is much controversy regarding the magnitude of the effect ranging from zero to as much as eight percentage points.

The aim of this section is to provide a survey of the literature, placing emphasis on the studies that have focused, in particular, on the impact of consumption taxes on growth and its sources. The section is divided into three main parts as follows. Part one reviews the theoretical literature relating consumption taxes on one hand and growth and

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households, the degree of openness in the economy, and uncertainty regarding future rate of return. See Myles (2000) for a detailed discussion of these issues.

its sources on the other; whereas, part two reviews the empirical literature on the same subject. The final part presents the conclusions drawn from the literature review.

Theoretical Literature on Growth, Sources of Growth and Consumption Taxes

Most taxation and growth studies examined the consequences of capital and/or income taxation on the economy's growth rate. However, one of the few studies that looked at consumption tax and growth is conducted by Turnovsky (1996). He considered the role of consumption taxes in enhancing economic growth. The author demonstrated that the trade-off between the optimal income tax and consumption tax depends crucially on the externalities generated by government expenditures on the returns to capital, which in turn depend upon two factors: (1) the level of government expenditure relative to its social optimum; and (2) the degree of congestion. He found that an increase in the taxation of capital offset by either a reduction in debt or in the consumption tax will lower the equilibrium growth rate, yet an increase in the consumption tax which is offset by a reduction in debt has no effect on the equilibrium growth rate, but if it is offset by a reduction in the taxation of capital it will increase the growth rate.

Another study by Milesi-Ferretti and Roubini (1998) examines the macroeconomic effects of consumption and factor income taxation on resource allocation, economic growth, and welfare. These effects are studies in the context of models in which growth is driven by human and physical capital accumulation. The study showed that the effects of labor, capital, and consumption taxes on growth depend on the role played by human capital accumulation, technology, and the nature of leisure activity. In particular, the authors showed that the elasticity of labor supply plays a crucial role in determining the effects of consumption taxes on growth. The results indicate that consumption tax distorts the labor (or education) – leisure decision, and hence it reduces the economy's growth rate. However, it does not affect the capital-labor ratio, and hence it does not reduce capital accumulation. Therefore, the authors suggest that a heavier reliance on consumption taxes relative to income taxes in the transition to the balanced growth path is an appropriate feature of an optimal tax policy plan.

Finally, Petrucci (2002) explored the consequences of a consumption tax on capital formation and economic development by utilizing a simple one-sector endogenous growth model with finite horizons. In order to be able to focus exclusively on the effect of the consumption tax on the relative price of consumption today and tomorrow, the author assumed inelastic labor supply to eliminate the intertemporal consumption-leisure distortion brought about by the consumption tax. He found that, in the endogenous growth model with new generations continuously entering the economy, consumption taxation reduces aggregate consumption and raises savings, stimulating capital accumulation and economic growth, under two scenarios. First, when currently living consumers are lump-sum rebated for the tax; and second when the increase in the consumption tax is accompanied by a reduction in public debt. The author asserts that under the first scenario, consumption taxes affect aggregate saving through the intergenerational redistribution of income, as young consumers save relatively more than old ones, which is carried out by the allocation of tax revenues. Therefore, the positive effect of consumption tax on saving and economic growth is due to demographic heterogeneity of households. In the second scenario, however, the reduction in public debt that accompanies the increase in consumption tax reduces the share of consumption in national income, spurs capital accumulation and long-run economic growth as the change in public debt redistributes wealth among generations, while consumption taxation *per se* is neutral. However, if income is not intergenerationally redistributed between living generations and generations that are still unborn because the resources from taxation were used to finance unproductive public spending, the net effect of consumption tax on growth rate would vanish. This result creates a transitional adjustment of the economy, in which the short-run effects of consumption taxation on real growth and the ratio of private consumption to national income are smaller than the long-run outcomes. Ultimately, the author concluded by a policy recommendation which supports revenue-neutral tax proposals that seek to reduce output tax in favor of expenditure tax, since the latter creates less distortion; and hence, it boosts capital accumulation and growth.

With respect to productivity growth, only few studies have looked at the influence of income tax on productivity growth.[51] For instance, Nerlove et al. (1990) provide some theoretical foundation of the possible channels through which income taxes might affect the overall productivity level of the economy. More specifically, the authors showed that a comprehensive income tax which is applied to both labor and capital incomes generates a bias against investment in human capital relative to investment in physical capital; therefore, it has a negative effect on human capital accumulation, and in turn on overall productivity level. Moreover, Cassou and Lansing (1998) develop a quantitative theoretical model to show that the trend of increasing tax rates in the U.S. economy offers a good explanation for the post-1970 productivity slowdown.

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[51] To our knowledge, no formal argument has been provided to show the theoretical or the empirical connection between consumption taxes and productivity growth.

Empirical Literature on Growth, Sources of Growth and Consumption Taxes

Few papers examined the empirical correlation between consumption taxes on one hand, and growth and its sources on the other. Most of these studies conduct numerical simulations; for instance, Pecorino (1994) uses the U.S. economy in 1985 as a basis for his benchmark parametrization to facilitate comparison with the results obtained by Lucas (1990). The simulation results show that replacing the income tax with a consumption tax leads to an increase in the growth rate of the order 1 percent per capita per year.

Mendoza et al. (1997) consider the role of consumption taxes, as well as other taxes in altering long-run growth rates. Their model predicts that assumptions regarding households' rate of time preference, the available technologies for physical and human capital accumulation, as well as the incidence of income tax play crucial role concerning the effects of direct and indirect taxes with respect to growth and capital accumulation. Nevertheless, the general result is that income taxes are growth-reducing, while growth effects of consumption taxes are ambiguous and depend in particular on the elasticity of labor supply. They conduct numerical simulations which supports the Harbergr's supernuetrality conjecture in the light of endogenous growth theory. They showed that a 10 percentage points change in tax rates result in about 0.5 to 1.5 percentage points change in the long-run investment rate, and in about 0.1 to 0.2 of a percentage point change in the long-run growth rate of output. In addition, the authors found that investment and growth effects of changes in labor income taxes are stronger relative to those resulting from changes in capital income and consumption taxes. This result is further supported by an empirical estimation in which they employed panel data from 18 countries (G7 and 11 OECD countries), over the period 1965 – 1991. The authors found that a cut of 10 percentage points in labor and capital income taxes increases investment rate by about 1 to 2 percentage points, whereas an increase of similar magnitude in consumption taxes increases the long-run investment rate by about the same magnitude. The authors conclude that tax rates are not statistically-significant determinants of growth.

Altig et al. (2001) simulate fundamental tax reform in the U.S. using a large-scale dynamic life-cycle computable general equilibrium model. The model compares the welfare and macroeconomic effects of transitions to five fundamental alternatives to the current U.S. federal income tax, including a proportional income tax, a proportional consumption tax, the flat tax, the flat tax with transition relief, and the X tax.[52] The numerical results show that long-run output increases significantly by replacing the current U.S. federal income tax with a proportional consumption tax. In fact, the authors found that in the long-run, capital stock exceeds its initial value by 25.4 percent, and output would increase eventually by 9.4 percent. However, these gains come at a high welfare cost as lower life-time income groups are hurt by the reform. Under a flat tax, the welfare of the lower-income individuals is improved but at the expense of lowering the increase in the long-run capital stock and output to only 15 and 4.5 percent, respectively.

Concluding Remarks

This section has shed light on the current literature on consumption taxes on one hand, and growth and its sources on the other. The results of the survey reveal that while the existing literature provides a formal treatment of the theoretical connection between

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[52] All these taxes, except the proportional income tax, are different alternatives of taxing consumption. Under the X tax, high-wage earners are placed in a higher tax bracket than low-wage earners. A detailed description of these taxes is provided in table (3) on p. 586 of the original paper.

consumption taxes and growth, it does not provide an answer for its correlation with the sources of growth. Furthermore, the scarcity of empirical literature that addresses the same issue using actual data and appropriate econometric techniques is an additional indication for the need for a formal and comprehensive treatment of the relationship between consumption taxes and growth and its sources both theoretically and empirically.

Theoretical Model

This section develops a theoretical model in which we examine the growth, capital accumulation, and productivity growth effects of changes in the consumption tax rates in a two-sector endogenous growth model. We tackle the issue by deriving all three equations based on Diamond's (1965) overlapping generation model. As such, the model allows us to account for heterogeneity in order to be able to assess both equity and efficiency considerations. Furthermore, we expand the analysis by incorporating the tax design problem, in order to provide a theoretical framework to explain the observed variation in effective VAT rates over time in the EU countries.

Consumption Taxes and Endogenous Growth in an Overlapping Generation Model

The model developed in this section is a simplified adaptation of the R&D and growth models developed by Romer (1990), Grossman and Helpman (1991), and Aghion and Howitt (1992). We extend the basic model to incorporate consumption taxes and then assess their effects on growth and its sources.

The economy consists of finitely-lived individuals, competitive firms, and the government. The main assumptions are:

1. Time is discrete.
2. Each individual lives for two periods only.
3. L_t individuals are born in period t.
4. Population grows at rate n, i.e., $L_t = (1+n) L_{t-1}$.
5. Each individual supplies one unit of labor when he or she is young, and divides the resulting labor income between first period consumption and saving; in the

second period, the individual consumes the saving and any interest he or she earns.

6. We assume a constant-relative-risk-aversion utility.

Household behavior. The representative consumer maximizes his/her life-time utility by choosing the stream of consumption $(C_{1,t}\ and\ C_{2,t+1})$ subject to its life-time budget constraint, in which he or she takes the paths of interest rate, real wage and taxes as given.

Formally,

$$Max_{\{c_{1,t},c_{2,t+1}\}}\ U_t = \frac{c_{1,t}^{1-\theta}}{(1-\theta)} + \frac{1}{1+\rho}\frac{c_{2,t+1}^{1-\theta}}{(1-\theta)} \qquad and \qquad \theta > 0,\ \rho > -1 \qquad (33)$$

Subject to

$$c_{1,t}(1+\tau_t) + \frac{1}{1+r_{t+1}} c_{2,t+1}(1+\tau_{t+1}) = A_t w_t \qquad (34)$$

where:

$c_{1,t}$ is consumption of young in period *t*.

$c_{2,t+1}$ is consumption of old in period *t+1*.

r_{t+1} is the interest rate.

τ_t is the consumption tax rate in period *t*.

τ_{t+1} is the consumption tax rate in period *t+1*.

$A_t w_t$ is labor income.

θ is the intertemporal elasticity of substitution.[53]

ρ is the exogenous rate of time preference (discount rate).[54]

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[53] The smaller is θ, the more willing the household is to allow its consumption to vary over time.

The budget constraint states that the present value of life-time consumption equals the present value of life-time labor income.

The lagrangian function is given by:

$$L_H = \frac{c_{1,t}^{1-\theta}}{(1-\theta)} + \frac{1}{(1+\rho)}\frac{c_{2,t+1}^{1-\theta}}{(1-\theta)} + \lambda_H\left[A_t w_t - c_{1,t}(1+\tau_t) - \frac{c_{2,t+1}(1+\tau_{t+1})}{(1+r_{t+1})}\right] \quad (35)$$

The first-order conditions of the maximization problem are obtained by differentiating (35) with respect to $c_{1,t}, c_{2,t+1}, and\ \lambda$:

$$c_{1t}: \quad \lambda = \frac{c_{1,t}^{-\theta}}{(1+\tau_t)} \quad (36)$$

$$c_{2t+1}: \quad \lambda = \frac{c_{2,t+1}^{-\theta}(1+r_{t+1})}{(1+\rho)(1+\tau_{t+1})} \quad (37)$$

$$\lambda: \quad A_t w_t - c_{1,t}(1+\tau_t) - \frac{c_{2,t+1}(1+\tau_{t+1})}{(1+r_{t+1})} = 0 \quad (38)$$

From (36) and (37) we get the following Euler equation:[55]

$$\frac{c_{2,t+1}}{c_{1,t}} = \left[\left(\frac{1+r_{t+1}}{1+\rho}\right)\left(\frac{1+\tau_t}{1+\tau_{t+1}}\right)\right]^{\frac{1}{\theta}} \quad (39)$$

Substituting (39) into (38) and solving for $c_{1,t}$:

[54] If $\rho > 0$, individuals place greater weight on first-period than second-period consumption, and *vice versa*. The assumption that $\rho > -1$ ensures positive weight on second-period's consumption.

[55] Note that if $(\tau_t = \tau_{t+1})$, the Euler equation reduces to $\left(c_{2,t+1}/c_{1,t}\right) = \left(1 + r_{t+1}/1+\rho\right)^{\frac{1}{\theta}}$.

$$c_{1,t} = \left\{ \frac{A_t w_t}{(1+\tau_t)\left(1-\left[\dfrac{1+\tau_t}{1+\tau_{t+1}}\right]^{\frac{1-\theta}{\theta}}\left[\dfrac{1+r_{t+1}}{1+\rho}\right]^{\frac{1}{\theta}}\left[\dfrac{1}{1+r_{t+1}}\right]\right)} \right\} \tag{40}$$

Equation (40) shows that the interest rate and the consumption tax rates determine the fraction of income the individual consumes in the first period.

From (39) and (40), we can solve for c_{2t+1}:

$$c_{2,t+1} = \left\{ \frac{A_t w_t \left(\left[\dfrac{1+\tau_t}{1+\tau_{t+1}}\right]^{\frac{1-\theta}{\theta}}\left[\dfrac{1+r_{t+1}}{1+\rho}\right]^{\frac{1}{\theta}}\right)}{(1+\tau_{t+1})\left(1-\left[\dfrac{1+\tau_t}{1+\tau_{t+1}}\right]^{\frac{1-\theta}{\theta}}\left[\dfrac{1+r_{t+1}}{1+\rho}\right]^{\frac{1}{\theta}}\left[\dfrac{1}{1+r_{t+1}}\right]\right)} \right\} \tag{41}$$

Let $s(r_{t+1}, \tau_t, \tau_{t+1})$ denote the fraction of income saved, then (40) implies:

$$c_{1,t} = [1 - s(r_{t+1}, \tau_t, \tau_{t+1})]\, A_t w_t \tag{42}$$

Substituting for $c_{1,t}$ from (40) and solving for $s(r_{t+1}, \tau_t, \tau_{t+1})$ we get:

$$s(r_{t+1}, \tau_t, \tau_{t+1}) = 1 - \left\{ (1+\tau_t)\left(1-\left[\frac{1+\tau_t}{1+\tau_{t+1}}\right]^{\frac{1-\theta}{\theta}}\left[\frac{1+r_{t+1}}{1+\rho}\right]^{\frac{1}{\theta}}\left[\frac{1}{1+r_{t+1}}\right]\right) \right\}^{-1} \tag{43}$$

The impact of current and future consumption taxes on private savings rate is given by equations (44) and (45), respectively:

$$\frac{\partial s(.)}{\partial \tau_t} = \frac{\frac{1}{\theta}\left[(\theta-1)(1+\rho)^{\frac{-1}{\theta}}\left(1+r_{t+1}\right)\left(1+\tau_t\right)\left(\frac{1+\tau_t}{1+\tau_{t+1}}\right)^{\frac{1-\theta}{\theta}}\right]}{\left(1+\tau_t\right)^3\left[-1+(1+\rho)^{\frac{-1}{\theta}}\left(1+r_{t+1}\right)^{\frac{1-\theta}{\theta}}\left(\frac{1+\tau_t}{1+\tau_{t+1}}\right)^{\frac{1-\theta}{\theta}}\right]^2}$$

$$+\frac{\left(1+\tau_t\right)\left[1-(1+\rho)^{\frac{-1}{\theta}}\left(1+r_{t+1}\right)^{\frac{1-\theta}{\theta}}\left(\frac{1+\tau_t}{1+\tau_{t+1}}\right)^{\frac{1-\theta}{\theta}}\right]}{\left(1+\tau_t\right)^3\left[-1+(1+\rho)^{\frac{-1}{\theta}}\left(1+r_{t+1}\right)^{\frac{1-\theta}{\theta}}\left(\frac{1+\tau_t}{1+\tau_{t+1}}\right)^{\frac{1-\theta}{\theta}}\right]^2} \tag{44}$$

$$\frac{\partial s(.)}{\partial \tau_{t+1}} = \frac{\left\{(1-\theta)\,(1+\rho)^{\frac{-1}{\theta}}\left(1+r_{t+1}\right)^{\frac{1-\theta}{\theta}}\left(\frac{1+\tau_t}{1+\tau_{t+1}}\right)^{\frac{1}{\theta}-2}\right\}}{\left\{\theta\left(1+\tau_{t+1}\right)^2\left[-1+(1+\rho)^{\frac{-1}{\theta}}\left(1+r_{t+1}\right)^{\frac{1-\theta}{\theta}}\left(\frac{1+\tau_t}{1+\tau_{t+1}}\right)^{\frac{1-\theta}{\theta}}\right]^2\right\}} \tag{45}$$

Equation (44) implies that, theoretically, current consumption taxes have an ambiguous effect on private savings rate. Indeed, the effect is determined by the interaction between utility parameters $(\rho \, and \, \theta)$, the interest rate (r_{t+1}) and the tax structure $\left(\tau_t / \tau_{t+1}\right)$ (which measures the relative price of consumption today versus tomorrow).

Firms. The production side of the economy is composed of many identical competitive firms. There are two sectors in the economy, a goods-producing sector (which is modeled according to equation (46)), and a R&D sector in which additions to the stock of knowledge is made (modeled according to equation (47)) as follows:

$$Y_t = [(1-a_K)K_t]^{\alpha}[A_t(1-a_L)L_t]^{1-\alpha} \qquad 0<\alpha<1 \tag{46}$$

$$A_t = G(a_K K_t, a_L L_t, A_0) \tag{47}$$

where:[56]

Y_t is output.

K_t is capital.

L_t is labor.

A_t is technology.

A_0 is initial level of knowledge.

$(1-a_K)$ is the fraction of capital stock used in producing goods.

a_K is the fraction of capital stock used in R&D.

$(1-a_L)$ the fraction of labor force used in producing goods.

a_L the fraction of labor force used in R&D.

Production function (46) is assumed to have CRS and to satisfy the Inada conditions.

Divide both sides of (46) by L_t and take logs to obtain:

$$\ln(y_t) = \alpha\ln(1-a_K) + (1-\alpha)\ln(1-a_L) + \alpha\ln k_t + (1-\alpha)\ln a_t \tag{48}$$

where $y_t, k_t, and\ a_t$ represent output per labor, capital per labor and technology per labor, respectively.

Since we know that:

[56] Equation (47) is similar to the one used in Romer (1996) for given levels of knowledge in the initial period.

$$\frac{d\ln y_t}{dt}=\frac{\dot{y}_t}{y_t} \quad , \quad \frac{d\ln k_t}{dt}=\frac{\dot{k}_t}{k_t} \quad and \quad \frac{d\ln a_t}{dt}=\frac{\dot{a}_t}{a_t}$$

Differentiate (48) with respect to time:

$$\frac{\dot{y}_t}{y_t}=\alpha\frac{\dot{k}_t}{k_t}+(1-\alpha)\frac{\dot{a}_t}{a_t} \tag{49}$$

The Dynamics of the Economy

Let (s_k) denote the fraction of savings devoted to capital accumulation, and (s_a) the fraction of savings devoted to knowledge accumulation. For simplicity, suppose these fractions are given such that:

$$s_k=\varphi_k\, s(r_{t+1},\tau_t,\tau_{t+1}) \qquad where \qquad \varphi_k\in[0,1] \tag{50}$$

$$s_a=\varphi_a\, s(r_{t+1},\tau_t,\tau_{t+1}) \qquad where \qquad \varphi_a\in[0,1] \tag{51}$$

$$\varphi_k+\varphi_a=1 \tag{52}$$

$$s_k+s_a=s(r_{t+1},\tau_t,\tau_{t+1}) \tag{53}$$

where $s(r_{t+1},\tau_t,\tau_{t+1})$ is defined in equation (43) and refers to overall income devoted to savings.

The equation of motion of (k). The capital stock per unit of labor in period (*t+1*) is given by a fraction (s_k) of the amount saved by young individuals in period (*t*); that is:

$$\frac{K_{t+1}}{L_{t+1}}=\frac{s_k\, w_t\, A_t\, L_t}{L_{t+1}}, \tag{54}$$

where (s_k) is defined in equation (50). Note that the population growth rate is given by $\frac{L_t}{L_{t+1}}=\frac{1}{1+n}$. Re-write equation (54) as follows:

$$k_{t+1} = \frac{\varphi_k \, s(r_{t+1}, \tau_t, \tau_{t+1}) \, w_t \, A_t}{(1+n)} . \tag{55}$$

Substituting for $s(r_{t+1}, \tau_t, \tau_{t+1})$ from equation (43), the per capita capital accumulation equation is given by:

$$k_{t+1} = \frac{\varphi_k \, w_t \, A_t}{(1+n)} \left\{ 1 - \left[(1+\tau_t) \left(1 - \left[\frac{1+\tau_t}{1+\tau_{t+1}} \right]^{\frac{1-\theta}{\theta}} \left[\frac{1+r_{t+1}}{1+\rho} \right]^{\frac{1}{\theta}} \left[\frac{1}{1+r_{t+1}} \right] \right) \right]^{-1} \right\} . \tag{56}$$

Since markets are competitive, the following must hold:

$$r_{t+1} = f'(k_{t+1}) . \tag{57}$$

$$w_t = f(k_t) - k_t f'(k_t) . \tag{58}$$

Substituting equation (58) in (56) yields:

$$k_{t+1} = \frac{\varphi_k \, A_t [f(k_t) - k_t f'(k_t)]}{(1+n)} \times \left\{ 1 - \left[(1+\tau_t) \left(1 - \left[\frac{1+\tau_t}{1+\tau_{t+1}} \right]^{\frac{1-\theta}{\theta}} \left[\frac{1+r_{t+1}}{1+\rho} \right]^{\frac{1}{\theta}} \left[\frac{1}{1+r_{t+1}} \right] \right) \right]^{-1} \right\} . \tag{59}$$

Note that in equation (59) the evolution of k is determined given its initial value.

The impact of consumption taxes on per capita physical capital can be assessed from equation (59). However, the equation shows that taxes affect per capita capital (and per capita productivity as shown below) in the same way as they affect saving. The only difference is that the impact is scaled by a constant factor as follows:

$$\frac{\partial k_{t+1}}{\partial \tau_t} = \frac{\varphi_k\ A_t[f(k_t) - k_t f'(k_t)]}{(1+n)} \left(\partial s(.) \big/ \partial \tau_t\right) \tag{60}$$

and,

$$\frac{\partial k_{t+1}}{\partial \tau_{t+1}} = \frac{\varphi_k\ A_t[f(k_t) - k_t f'(k_t)]}{(1+n)} \left(\partial s(.) \big/ \partial \tau_{t+1}\right), \tag{61}$$

where $\left(\partial s(.) \big/ \partial \tau_t\right)$ and $\left(\partial s(.) \big/ \partial \tau_{t+1}\right)$ are derived in equations (44) and (45). Therefore, the impact of consumption taxes on per capita capital accumulation is theoretically ambiguous and depends on the interaction between utility parameters, the interest rate and the tax structure.

The equation of motion of (a). The technology per unit of labor in period (*t+1*) is given by a fraction (s_a) of the amount saved by young individuals in period (*t*):

$$\frac{A_{t+1}}{L_{t+1}} = \frac{s_a\ w_t\ A_t\ L_t}{L_{t+1}}\ , \tag{62}$$

where (s_a) is defined in equation (51). Therefore,

$$a_{t+1} = \frac{\varphi_a\ s(r_{t+1}, \tau_t, \tau_{t+1})\, w_t A_t}{(1+n)}\ . \tag{63}$$

Substituting for $s(r_{t+1}, \tau_t, \tau_{t+1})$ *and* w_t from equations (43) and (58) respectively, the per capita productivity equation is given by:

$$a_{t+1} = \frac{\varphi_a\ A_t[f(k_t) - k_t f'(k_t)]}{(1+n)} \times \left\{ 1 - \left[(1+\tau_t) \left(1 - \left[\frac{1+\tau_t}{1+\tau_{t+1}} \right]^{\frac{1-\theta}{\theta}} \left[\frac{1+r_{t+1}}{1+\rho} \right]^{\frac{1}{\theta}} \left[\frac{1}{1+r_{t+1}} \right] \right) \right]^{-1} \right\}. \tag{64}$$

Note the close similarity between (59) and (64).

Therefore, the impact of consumption taxes on per capita productivity is given by:

$$\frac{\partial a_{t+1}}{\partial \tau_t} = \frac{\varphi_a A_t[f(k_t) - k_t f'(k_t)]}{(1+n)} \left(\partial s(.) / \partial \tau_t \right) \quad (65)$$

and,

$$\frac{\partial a_{t+1}}{\partial \tau_{t+1}} = \frac{\varphi_a A_t[f(k_t) - k_t f'(k_t)]}{(1+n)} \left(\partial s(.) / \partial \tau_{t+1} \right), \quad (66)$$

where $\left(\partial s(.) / \partial \tau_t \right)$ and $\left(\partial s(.) / \partial \tau_{t+1} \right)$ are derived in equations (44) and (45). Therefore, the impact of consumption taxes on per capita productivity growth is theoretically ambiguous and depends on the interaction between utility parameters, the interest rate and the tax structure.

The impact of consumption taxes on growth. Obviously, the impact of consumption taxes on growth feeds through capital accumulation and productivity growth. Consider the following:

By definition, we know that at time *(t+1)* the following holds:

$$\dot{k}_t = k_{t+1} - \bar{k}_t \quad (67)$$

where:

$\bar{k}_t$ is initial endowment of capital.

k_{t+1} is defined in equation (59).

Divide (35) by $\bar{k}_t$:

$$\frac{\dot{k}_t}{\bar{k}_t} = \frac{k_{t+1} - \bar{k}_t}{\bar{k}_t} \quad (68)$$

Thus, the impact of current and future consumption taxes $(\tau_t, \tau_{t+1}, \textit{respectively})$ on capital accumulation is given by equations (69) and (70):

$$\left(\frac{\partial\left(\dot{k}_t/\bar{k}_t\right)}{\partial\tau_t}\right)=\frac{1}{\bar{k}_t}\left(\partial k_{t+1}/\partial\tau_t\right) \tag{69}$$

and,

$$\left(\frac{\partial\left(\dot{k}_t/\bar{k}_t\right)}{\partial\tau_{t+1}}\right)=\frac{1}{\bar{k}_t}\left(\partial k_{t+1}/\partial\tau_{t+1}\right), \tag{70}$$

where $\left(\partial k_{t+1}/\partial\tau_t\right) \textit{and} \left(\partial k_{t+1}/\partial\tau_{t+1}\right)$ are given in equations (60) and (61), respectively. Equations (69) and (70) indicate that the sign of $\left(\partial\left(\dot{k}_t/\bar{k}_t\right)/\partial\tau_t\right)$ is the same as the sign of $\left(\partial k_{t+1}/\partial\tau_t\right)$, and the sign of $\left(\partial\left(\dot{k}_t/\bar{k}_t\right)/\partial\tau_{t+1}\right)$ is the same as the sign of $\left(\partial k_{t+1}/\partial\tau_{t+1}\right)$.

By similar steps, the impact of consumption taxes (τ_t, τ_{t+1}) on productivity growth is given by equations (71) and (72):[57]

$$\left(\frac{\partial\left(\dot{a}_t/\bar{a}_t\right)}{\partial\tau_t}\right)=\frac{1}{\bar{a}_t}\left(\partial a_{t+1}/\partial\tau_t\right) \tag{71}$$

and,

$$\left(\frac{\partial\left(\dot{a}_t/\bar{a}_t\right)}{\partial\tau_{t+1}}\right)=\frac{1}{\bar{a}_t}\left(\partial a_{t+1}/\partial\tau_{t+1}\right), \tag{72}$$

where $\left(\partial a_{t+1}/\partial\tau_t\right) \textit{and} \left(\partial a_{t+1}/\partial\tau_{t+1}\right)$are given in equation (65) and (66), respectively. Equations (71) and (72) indicate that the sign of $\left(\partial\left(\dot{a}_t/\bar{a}_t\right)/\partial\tau_t\right)$ is the same as the sign of $\left(\partial a_{t+1}/\partial\tau_t\right)$, and the sign of $\left(\partial\left(\dot{a}_t/\bar{a}_t\right)/\partial\tau_{t+1}\right)$ is the same as the sign of $\left(\partial a_{t+1}/\partial\tau_{t+1}\right)$.

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[57] Since by definition, at period *(t+1)*, $\dot{a}_t = a_{t+1} - \bar{a}_t$, where $\bar{a}_t$ is initial endowment of technology and a_{t+1} is defined in equation (64).

Applying the partial derivatives with respect to $(\tau_t \ and \ \tau_{t+1})$ to equation (49) gives:

$$\left(\frac{\partial\left(\dot{y}_t/y_t\right)}{\partial\tau_t}\right)=\alpha\left(\frac{\partial\left(\dot{k}_t/k_t\right)}{\partial\tau_t}\right)+(1-\alpha)\left(\frac{\partial\left(\dot{a}_t/a_t\right)}{\partial\tau_t}\right) \tag{73}$$

and,

$$\left(\frac{\partial\left(\dot{y}_t/y_t\right)}{\partial\tau_{t+1}}\right)=\alpha\left(\frac{\partial\left(\dot{k}_t/k_t\right)}{\partial\tau_{t+1}}\right)+(1-\alpha)\left(\frac{\partial\left(\dot{a}_t/a_t\right)}{\partial\tau_{t+1}}\right), \tag{74}$$

where $\left(\frac{\partial\left(\dot{k}_t/k_t\right)}{\partial\tau_t}\right),\left(\frac{\partial\left(\dot{k}_t/k_t\right)}{\partial\tau_{t+1}}\right),\left(\frac{\partial\left(\dot{a}_t/a_t\right)}{\partial\tau_t}\right), and \left(\frac{\partial\left(\dot{a}_t/a_t\right)}{\partial\tau_{t+1}}\right)$ represent the effects of present and future taxes on capital accumulation and on productivity growth, respectively. These expressions are defined in equations (69), (70), (71), and (72), respectively.

Interpretation of the results. Equations (73) and (74) show the channels through which consumptions taxes affect per capita growth. More specifically, these channels are given by the effect of taxes on per capita capital accumulation and on per capita productivity growth. The interesting issue here is that taxes in this model affect both channels, and hence, growth in the same manner. The reason is that the impact of consumption taxes on both capital accumulation and productivity growth is mainly feeding through their respective impacts on the savings rate. However, equation (44) shows that the net effect of these taxes on savings, and hence on growth and its sources is theoretically ambiguous. Therefore, while the model provides a framework in which the effect of consumption taxes on growth and its sources might be addressed, it does not provide a clear-cut answer on the direction of the influence, from a theoretical point of view. This by itself provides an incentive for further investigation at the empirical front to get empirical evidence on how these variables react in the real world, if at all, to changes in consumption tax rates.

The Tax Design Problem

This section aims at studying the government's tax design problem. While the above analysis is sufficient for our purpose in this study as it provides the effects of consumption taxes on growth and its sources, we believe a closer look at the government's problem might be interesting. The reason in that belief is that empirical stylized facts show variations of effective VAT rates across countries and within each country in our sample over time. For illustration purposes, Figures C1 through C30 of Appendix C provide a graphical representation of the annual, as well as the averaged effective VAT rates over the period 1961-2000 for individual countries. Furthermore, the same information is provided in Figures C31 and C32 of Appendix C but for the averaged sample (i.e., all countries) at both annual and averaged levels, respectively. The figures show variation of effective VAT rate over time and across countries. The variation is more volatile with the annual data; nonetheless, it is still present with the averaged data. Moreover, the volatility is stronger in recent years from around 1986 to 2000 with the annual data; however, the pattern for Belgium and Spain show some stability of the VAT rate recently (1995-2000) with the averaged data. In fact, using annual data over the studied period for the years in which the VAT was introduced, the highest rate was implemented in Sweden in 1995 (19.25 percent), whereas the lowest rate was applied in Ireland in 1972 (0.43 percent), with a sample variance equal to 17.47.[58] With averaged data, the results are slightly different. For instance, Denmark scored the highest rate (17.36 percent), while Luxembourg had the lowest rate (0.19 percent) over

[58] The highest variance is equal to 35.93 in Denmark, and the lowest is 2.52 in Spain.

the studied period, with a sample variance of 19.08.[59] Therefore, we believe that studying the tax design problem will enable us to provide rationale for these facts, and to understand the reasons behind such variation and pattern of the VAT rates in our sample over the studied period.

In this analysis we follow Barro (1979), in which the government achieves its objective function subject to its overall intertemporal budget constraint. Our formulation is different though in the sense that Barro's objective function is to minimize the present value of revenue-raising costs, while our objective is to maximize the social welfare function (SWF).Therefore, the government's problem is to maximize SWF, which includes utilities of all individuals (young and old) in all periods by choosing current and future consumption tax rates, subject to its revenue constraint and given individuals' optimal responses (young and old) in all periods. For simplicity, we abstract from the government's ability to issue public debt.

The government's optimization problem is:[60]

$$Max_{\{\tau_t, \tau_{t+1}\}} \overline{V} = V(C^*_{1,t}, C^*_{2,t}, C^*_{1,t+1}, C^*_{2,t+1}) \quad (75)$$

s.t.

$$\overline{R} = R(\tau_t, \tau_{t+1}) = \tau_t C^*_t + \tau_{t+1} C^*_{t+1} \quad (76)$$

$$C^*_{kt} \text{ Where } k = \{1, 2\} \quad (77)$$

$$C^*_t = C^*_{1,t} + C^*_{2,t} \qquad \forall t \quad (78)$$

where:

Index (1) refers to young.

---

[59] The highest variance is equal to 40.39 in Sweden, and the lowest is 2.11 in Spain.

[60] We employ a (SWF) which includes individuals' utilities of the form:
$\overline{V} = V(v^1(C_{1,t}, C_{2,t}) \ldots v^m(C_{1,t}, C_{2,t}))$. Nevertheless, we use the notation in (75) for simplicity.

Index (2) refers to old.

$\overline{V}$ is an indirect utility function which represents the life-time SWF.

$C^*_{1,t}$ is the optimal consumption of young in period *t*.

$C^*_{2,t}$ is the optimal consumption of old in period *t*.

$C^*_{1,t+1}$ is the optimal consumption of young in period *t+1*.

$C^*_{2,t+1}$ is the optimal consumption of old in period *t+1*.

Condition (76) assumes that the overall collected public revenue $(\overline{R})$ is fixed, while $R(\tau_t, \tau_{t+1})$ is a function which reflect the taxes that satisfy the public revenue constraint. Condition (77) implies that the government takes into account all individuals' (young and old) optimal responses in all periods. Condition (78) is an aggregate condition that must be satisfied in all periods. It implies that aggregate consumption in each period is the sum of young individuals' consumption and old individuals' consumption.

The government lagrangian function is then given by:

$$L_G = V(C^*_{1,t}, C^*_{2,t}, C^*_{1,t+1}, C^*_{2,t+1}) + \lambda_G[\overline{R} - \tau_t C^*_t - \tau_{t+1} C^*_{t+1}] \quad (79)$$

The F.O.Cs are:[61]

$$\begin{aligned}\frac{\partial L_G}{\partial \tau_t} &= \frac{\partial V}{\partial C^*_{1,t}}\frac{\partial C^*_{1,t}}{\partial \tau_t} + \frac{\partial V}{\partial C^*_{2,t}}\frac{\partial C^*_{2,t}}{\partial \tau_t} + \frac{\partial V}{\partial C^*_{1,t+1}}\frac{\partial C^*_{1,t+1}}{\partial \tau_t} \\ &\quad + \frac{\partial V}{\partial C^*_{2,t+1}}\frac{\partial C^*_{2,t+1}}{\partial \tau_t} - \lambda_G\left[C^*_t + \sum_{j \neq t} \tau_j \frac{\partial C^*_j}{\partial \tau_t}\right] = 0\end{aligned} \quad (80)$$

[61] As noted earlier, the (SWF) is a function of individuals' utilities, that is: $\overline{V} = V(v^1(C_{1,t}, C_{2,t})...v^m(C_{1,t}, C_{2,t}))$, therefore, the F.O.Cs imply $(\partial V / \partial C_{i,t}) = (\partial V / \partial v^h)(\partial v^h / \partial C_{i,t})$.

$$\frac{\partial L_G}{\partial \tau_{t+1}} = \frac{\partial V}{\partial C^*_{1,t}} \frac{\partial C^*_{1,t}}{\partial \tau_{t+1}} + \frac{\partial V}{\partial C^*_{2,t}} \frac{\partial C^*_{2,t}}{\partial \tau_{t+1}} + \frac{\partial V}{\partial C^*_{1,t+1}} \frac{\partial C^*_{1,t+1}}{\partial \tau_{t+1}}$$
$$+ \frac{\partial V}{\partial C^*_{2,t+1}} \frac{\partial C^*_{2,t+1}}{\partial \tau_{t+1}} - \lambda_G \left[C^*_{t+1} + \sum_{j \neq t} \tau_j \frac{\partial C^*_j}{\partial \tau_{t+1}} \right] = 0 \qquad (81)$$

To solve for (τ^*_t) from (80), let $\phi^\tau_t = \lambda_G \left[C^*_t + \sum_{j \neq t} \tau_j \frac{\partial C^*_j}{\partial \tau_t} \right]$

where $\phi^\tau_t = \frac{\partial V}{\partial C^*_{1,t}} \frac{\partial C^*_{1,t}}{\partial \tau_t} + \frac{\partial V}{\partial C^*_{2,t}} \frac{\partial C^*_{2,t}}{\partial \tau_t} + \frac{\partial V}{\partial C^*_{1,t+1}} \frac{\partial C^*_{1,t+1}}{\partial \tau_t} + \frac{\partial V}{\partial C^*_{2,t+1}} \frac{\partial C^*_{2,t+1}}{\partial \tau_t}$

and,

$$\sum_{j \neq t} \tau_j \frac{\partial C^*_j}{\partial \tau_t} = \tau_t \frac{\partial C^*_t}{\partial \tau_t} + \tau_{t+1} \frac{\partial C^*_{t+1}}{\partial \tau_t}.$$

Therefore,

$$\tau^*_t = \left[\frac{\phi^\tau_t}{\lambda_G \left[\partial C^*_t \big/ \partial \tau_t \right]} \right] - \left[\frac{C^*_t}{\partial C^*_t \big/ \partial \tau_t} \right] - \left[\tau_{t+1} \left(\partial c^*_{t+1} \big/ \partial C^*_t \right) \right]. \qquad (82)$$

But we know that: $\frac{C^*_t}{\left(\partial C^*_t / \partial \tau_t \right)} = \frac{1}{\left(\partial C^*_t / \partial \tau_t \right) \left(\tau^*_t / C^*_t \right) \left(1 / \tau^*_t \right)}$.

Since $\varepsilon_{C^*_t, \tau^*_t} = \left(\partial C^*_t \big/ \partial \tau_t \right) \left(\tau^*_t \big/ C^*_t \right)$ where $\varepsilon_{C^*_t, \tau^*_t}$ refers to the elasticity of (C^*_t) with respect to (τ^*_t), then:

$$\frac{C^*_t}{\left(\partial C^*_t / \partial \tau_t \right)} = \frac{\tau^*_t}{\varepsilon_{C^*_t, \tau^*_t}}. \qquad (83)$$

Substituting (83) into (82), yields:

$$\tau_t^* = \frac{\left[\dfrac{\phi_t^\tau}{\lambda_G\left(\partial C_t^* / \partial \tau_t\right)}\right] - \left[\tau_{t+1}\left(\partial C_{t+1}^* / \partial C_t^*\right)\right]}{\left[1 + 1/\varepsilon_{C_t^*, \tau_t^*}\right]}. \tag{84}$$

Similarly, we can solve for (τ_{t+1}^*):

$$\tau_{t+1}^* = \frac{\left[\dfrac{\phi_{t+1}^\tau}{\lambda_G\left(\partial C_{t+1}^* / \partial \tau_{t+1}\right)}\right] - \left[\tau_t\left(\partial C_t^* / \partial C_{t+1}^*\right)\right]}{\left[1 + 1/\varepsilon_{C_{t+1}^*, \tau_{t+1}^*}\right]}, \tag{85}$$

where $\varepsilon_{C_{t+1}^*, \tau_{t+1}^*}$ is the elasticity of (C_{t+1}^*) with respect to (τ_{t+1}^*).

The elasticity terms $(\varepsilon_{C_t^*, \tau_t^*})$ and $(\varepsilon_{C_{t+1}^*, \tau_{t+1}^*})$, as well as the terms $\left(\partial C_{t+1}^* / \partial C_t^*\right)$ and $\left(\partial C_t^* / \partial C_{t+1}^*\right)$, are related to efficiency, whereas the terms (ϕ_t^τ) and (ϕ_{t+1}^τ) are related to equity.[62] The expressions derived in (84) and (85) show the trade offs between them. For instance, in equation (84), if (ϕ_t^τ) declines (this might be due to an increase in the sensitivity of consumption of the young generation at period *(t)* to taxes in the same period), then the welfare cost of taxes for this generation is higher. This gives an incentive for the government to reduce (τ_t). Therefore, the presence

[62] More specifically, the terms $\left(\partial C_{t+1}^* / \partial C_t^*\right)$ and $\left(\partial C_t^* / \partial C_{t+1}^*\right)$ represent the dynamic inefficiency from taxation, whereas the terms (ϕ_t^τ) and (ϕ_{t+1}^τ) include the weights the government places on different generations, as explained in the model.

of equity concerns (measured by (ϕ_t^{τ})) leads to a reduction in taxes in period *(t)*. If we assume that the good consumed in period *(t)* is inelastic and that the effect of present taxes on present consumption is negative (i.e., $(\varepsilon_{C_t^*,\tau_t^*})$ < 0, this is the case in which the substitution effect dominates the income effect), then efficiency considerations dictate that (τ_t) should be higher. However, if equity considerations are taken into account, a lower (ϕ_t^{τ}) will tend to reduce (τ_t), as explained above. This discussion shows the trade offs between equity and efficiency.

We provide graphical illustration of the optimal tax system for different assumptions regarding the properties of the SW and the revenue functions. For the purpose of illustration, let us assume that the SWF is strictly concave on taxes. Assume further that the slope of the welfare level set is negative.[63] Regarding the revenue level set, we assume that it is quasi-concave on taxes. Therefore, for a given tax structure $\{(\tau_t^R),(\tau_{t+1}^R)\}$ such that $(\partial R/\partial\tau_t^R)\geq 0$ and $(\partial R/\partial\tau_{t+1}^R)\geq 0$, which imply $(\partial\tau_{t+1}^R/\partial\tau_t^R)\leq 0$, the slope along the tax revenue level set is negative. Our quasi-concavity assumption also ensures that $(\partial^2\tau_{t+1}^R/\partial^2\tau_t^R)\geq 0$ holds. By these assumptions, the SWF and the tax possibility set are downward sloping; therefore, depending on the relative slopes of the $(\overline{V})$ curve and the $(\overline{R})$ curve we can get a wide range of outcomes as illustrated in figures A – C:

In Figure A, we assume that the government places a higher weight on the welfare of the current generation such that the slope of the SWF is larger (steeper) relative to the slope of the revenue curve. As such, if the economy starts at point A, the government can

[63] We acknowledge that strict concavity of the SWF is not a sufficient condition to guarantee that the slope is negative due to the ambiguity of the sign and the magnitude of $(\partial C_t/\partial\tau_t)$ and $(\partial C_{t+1}/\partial\tau_{t+1})$.

maximize society's welfare by lowering (τ_t) and increasing (τ_{t+1}) while still maintaining its revenue requirement. In this case, the economy moves from point A to point B in which differential taxation is optimal as it results in the social welfare optimum and the society as a whole is made better off.

In this context, it is appropriate to note that the introduction of public debt into this framework will not affect the main results of the model. Even in the presence of debt, lower tax revenues in the present call for higher revenues in the future in order to satisfy the government intertemporal budget constraint and the differential tax burdens over time which maximizes the social welfare.

Figure A. The slope of the SWF is *big* relative to the slope of the $(\overline{R})$ curve

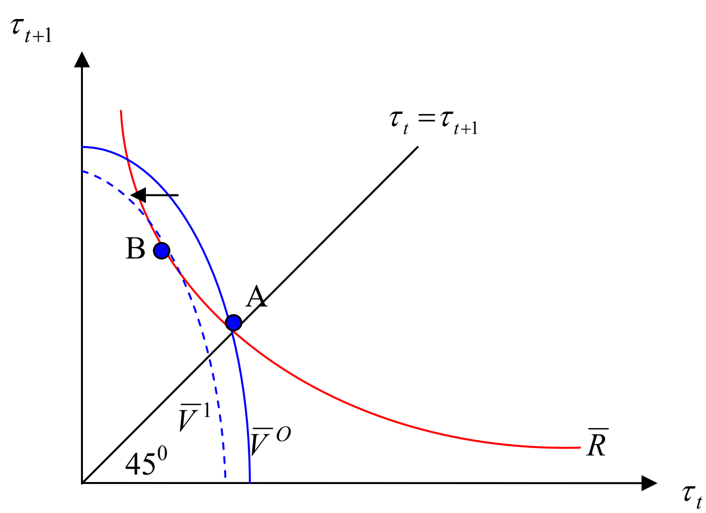

Figure B. The slope of the SWF is *small* relative to the slope of the $(\bar{R})$ curve

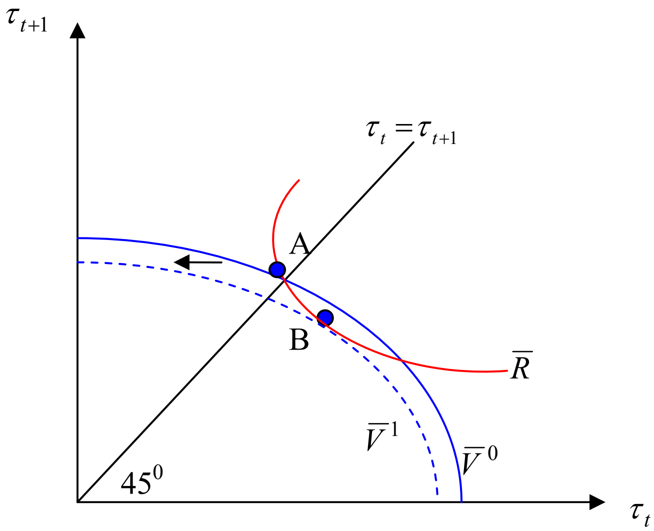

Figure B illustrates the opposite case of Figure A. The government in this case is assumed to place a higher weight on the welfare of the future generation such that the slope of the SWF is smaller (flatter) relative to the slope of the revenue curve. Therefore, the social welfare optimum which results in an improvement in society's welfare can be achieved if the government increases (τ_t) and lowers (τ_{t+1}) without altering its revenue requirement. Thus, the economy moves from point A to point B which achieves the highest level of welfare for the society. Therefore, in these two cases differential taxation is optimal as it results in an improvement in society's welfare.

Next, we provide a formal analysis of the optimal tax system:

Let $\bar{V}$ be the indirect preferences over the tax structure such that:

$$\bar{V} = V(\tau_t, \tau_{t+1}) \tag{86}$$

Totally differentiating (86) gives:

$$\Delta \bar{V} = \frac{\partial V}{\partial \tau_t^V} d\tau_t^V + \frac{\partial V}{\partial \tau_{t+1}^V} d\tau_{t+1}^V = 0, \tag{87}$$

where:

$\frac{\partial V}{\partial \tau_t^V}$ represents the change in SWF due to marginal change in the tax rate in period *t*.

$d\tau_t^V$ represents the size of the marginal change in tax in period *t* along the SWF level set *V*.

$\frac{\partial V}{\partial \tau_t^V} d\tau_t^V$ represents the total change in SWF due to change in the tax rate in period *t*.

We can re-write (87) as:

$$\nabla V\, d\tau^V = 0, \tag{88}$$

where $\nabla V = \left[\frac{\partial V}{\partial \tau_t^V}, \frac{\partial V}{\partial \tau_{t+1}^V} \right]$ and $d\tau^V = \begin{bmatrix} d\tau_t^V \\ d\tau_{t+1}^V \end{bmatrix}$

The slope of the SWF = $\frac{d\tau_{t+1}^V}{d\tau_t^V} = -\frac{\left(\partial V \big/ \partial \tau_t^V\right)}{\left(\partial V \big/ \partial \tau_{t+1}^V\right)}$ (89)

Furthermore, let the tax possibility set or the tax structure satisfy the following condition:

$$\overline{R} = R(\tau_t, \tau_{t+1}) \tag{90}$$

Totally differentiate (90) yields:

$$\Delta \overline{R} = \frac{\partial R}{\partial \tau_t^R} d\tau_t^R + \frac{\partial R}{\partial \tau_{t+1}^R} d\tau_{t+1}^R = 0, \tag{91}$$

where:

$\frac{\partial R}{\partial \tau_t^R}$ represents the change in R due to marginal change in the tax rate in period *t*.

$d\tau_t^R$ represents the size of the marginal change in tax in period *t* along the R curve.

$\frac{\partial R}{\partial \tau_t^R} d\tau_t^R$ represents the total change in R due to change in the tax rate in period *t*.

Equation (91) can be re-written as:

$$\nabla R \, d\tau^{R} = 0 \, , \tag{92}$$

where $\nabla R = \left[\dfrac{\partial R}{\partial \tau_t^R}, \dfrac{\partial R}{\partial \tau_{t+1}^R} \right]$ and $d\tau^R = \begin{bmatrix} d\tau_t^R \\ d\tau_{t+1}^R \end{bmatrix}$

$$\text{The slope of the revenue curve} = \frac{d\tau_{t+1}^R}{d\tau_t^R} = -\frac{\left(\partial R / \partial \tau_t^R\right)}{\left(\partial R / \partial \tau_{t+1}^R\right)} \tag{93}$$

By this, our SWF and revenue constraint have been characterized. The following proposition formalizes the notion that the optimal tax system leads to the optimum social welfare. The social optimum is characterized by a tangency condition between the highest level of welfare and the tax possibility set.

Proposition (1): Optimality of Differential Taxation

If $d\tau^V \neq d\tau^R \Big|_{\tau_t = \tau_{t+1}}$, then differential taxation across time is optimal.[64]

Proof of Proposition (1)

Recall that $d\tau^V \Big|_{\tau_t = \tau_{t+1}}$ and $d\tau^R \Big|_{\tau_t = \tau_{t+1}}$ are defined in (89) and (93), respectively.

Let $\tau_t = \tau_{t+1} = \tau$

By equation (88) we know that $\nabla V \, d\tau^V = 0$, which implies that

$d\tau_t^V / d\tau_{t+1}^V = -\dfrac{\left(\partial V / \partial \tau_t^V\right)}{\left(\partial V / \partial \tau_{t+1}^V\right)}$, and by assumption we know that $d\tau^V \neq d\tau^R \Big|_{\tau_t = \tau_{t+1}}$. This indicates that one of the following cases must hold:

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[64] The proposition states that, if at proportional taxation the slopes of the SWF and the R curve are *not equal*, then differential taxation is optimal, as it leads to a tangency point at a higher level of SW. In other words, if the change in taxes that keeps the economy at the same SW level set (slope of SWF) is *not equal* to the change in taxes that keeps the economy at the same revenue set (slope of R), evaluated at proportional taxation, then differential taxation is optimal.

Case (1): $\nabla V\, d\tau^{R}\Big|_{\tau_t=\tau_{t+1}} < 0$

Or

Case (2): $\nabla V\, d\tau^{R}\Big|_{\tau_t=\tau_{t+1}} > 0$

If case (1) is true, it implies that:

$$\frac{\partial V}{\partial \tau_t} d\tau_t^R\Big|_{\tau} + \frac{\partial V}{\partial \tau_{t+1}} d\tau_{t+1}^R\Big|_{\tau} < 0 \Rightarrow \frac{\partial \tau_{t+1}^R}{\partial \tau_t^R}\Big|_{\tau} < -\frac{\left(\partial V/\partial \tau_t\right)}{\left(\partial V/\partial \tau_{t+1}\right)} \Rightarrow \frac{d\tau_{t+1}^R}{d\tau_t^R}\Big|_{\tau} < \frac{d\tau_{t+1}^V}{d\tau_t^V}$$

This implies that the slope of the SWF is larger (steeper) relative to the slope of the revenue curve. Therefore, for each case satisfying this condition there is a set of taxes $(\tau_t' \;\; and \;\; \tau_{t+1}' \in \overline{R})$ such that $(\tau_t' < \tau \;\; and \;\; \tau_{t+1}' > \tau)$ which increases SWF. Therefore, differential taxation is optimal.

Similarly, we can analyze case (2) which implies that:

$$\frac{\partial V}{\partial \tau_t} d\tau_t^R\Big|_{\tau} + \frac{\partial V}{\partial \tau_{t+1}} d\tau_{t+1}^R\Big|_{\tau} > 0 \Rightarrow \frac{\partial \tau_{t+1}^R}{\partial \tau_t^R}\Big|_{\tau} > -\frac{\left(\partial V/\partial \tau_t\right)}{\left(\partial V/\partial \tau_{t+1}\right)} \Rightarrow \frac{d\tau_{t+1}^R}{d\tau_t^R}\Big|_{\tau} > \frac{d\tau_{t+1}^V}{d\tau_t^V}$$

The last expression implies that the slope of the SWF is smaller (flatter) relative to the slope of the revenue curve. Therefore, for each case satisfying this condition there is a set of taxes $(\tau_t' \;\; and \;\; \tau_{t+1}' \in \overline{R})$ such that $(\tau_t' > \tau \;\; and \;\; \tau_{t+1}' < \tau)$ which increases SWF. Therefore, differential taxation is optimal. ■

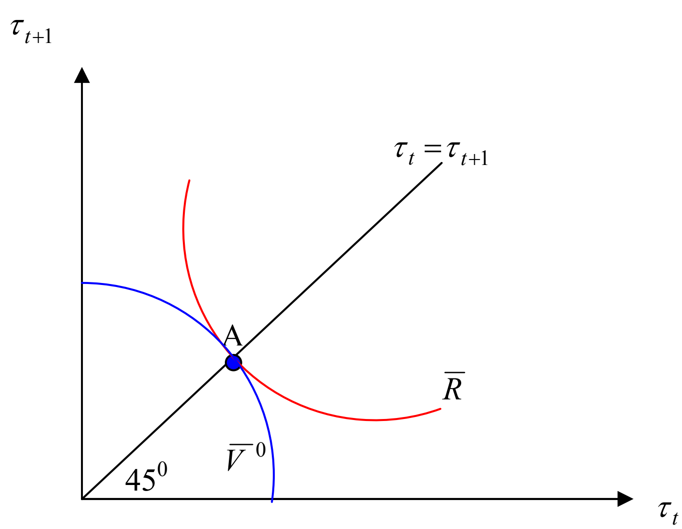
Differential taxation is not the only case in the optimal tax structure; in fact, an interesting case for discussion is the case in which uniform taxation over time is optimal. Formally:

Proposition (2): Optimality of Uniform Taxation

If $d\tau^{V} = d\tau^{R}\Big|_{\tau_t = \tau_{t+1}}$, then uniform taxation across time is optimal.[65]

This condition means that, if the slopes of the SWF and the R curve are *equal* at proportional or uniform taxation, then uniform taxation over time is optimal. Under this condition, the society achieves its optimum welfare level at proportional taxation and any move from that point will lead to a welfare loss. In other words, if the change in taxes that keeps the economy at the same SW level set (slope of SWF) is *equal* to the change in taxes that keeps the economy at the same revenue set (slope of R), evaluated at proportional taxation, then uniform taxation over time is optimal. See Figure C.

Figure C. Uniform Taxation is Optimal



In Figure C, the slopes of the SWF and the revenue curve $(\overline{R})$ are equal along the 45-degree line, which implies that $(\tau_t = \tau_{t+1})$ at point A. If all other feasible tax policies lie on the lower contour set of the SWF, then point A achieves the highest welfare level (given a specific level of government's revenue), and any move from that point will lead

[65] The proof follows easily by following similar steps as shown in proof of proposition (1).

to a lower level of welfare and the society is made worse-off. Under this condition there are no gains from differential taxation and optimality is achieved at proportional taxation.

Interpretation of the results. The above analysis of the tax design problem shows that even in the presence of dynamic inefficiency, there could be overall gains in society's social welfare. By proposing differential taxation over time, the government can shift taxes across time depending on the weights it places on different generations' welfare. If intertemporal equity considerations dominate intertemporal inefficiency concerns, tax shifting allows for welfare gains for the society which can offset, partially or fully, the loss caused by the dynamic inefficiency of the differential tax system. For instance, the government could place a higher weight on the current generation, and in that case it can lower current taxes which lead to an increase in current generation's welfare. At the same time, lower taxes today imply higher ones in the future - in order to maintain the government's intertemporal balanced budget - which lead to a loss in future generation's welfare. However, with the higher weight placed on current generation's welfare, society as a whole benefits from this type of differential taxation. More importantly, this analysis demonstrates that a possible explanation for the existing pattern of changing VAT rates across the EU countries might be explained by this kind of policy in which the government purposely shift taxes across time depending on the weights it places on different generations' welfare. In other words, as the government takes into account *both* equity and efficiency considerations (not only efficiency considerations), a pattern of non-constant tax rates might emerge.

In contrast, if at proportional taxation, the change in taxes that keeps the economy at the same SWF is equal to the change in taxes that maintains the same revenue set, then optimality conditions require uniform taxation over time, as there are no gains from differential taxation. In this case, society is at its socially optimum welfare level, and any move from proportional taxation will result in welfare loss, as shown in Figure C.

Concluding Remarks

In this section we developed a theoretical framework to model the impact of consumption taxes on economic growth and its sources. Our results indicate that savings is the channel through which consumption taxes affect both capital accumulation and productivity growth, and that these effects feed through to overall GDP growth. Indeed, our results show that the impact of consumption taxes on the savings rate, and hence on economic growth and its sources is theoretically ambiguous as it depends on the interaction between the utility parameters, the interest rate and the tax structure.

Furthermore, our analysis provides a rationale for the observed variation in the effective VAT rate over time in our sample. Indeed, we obtained two main results. First, we have shown that under certain conditions differential taxation over time is optimal. The argument simply goes as follows: if the government takes into account both equity and efficiency considerations, then there might be conditions in which it can increase the welfare of the society even in the presence of dynamic inefficiency due to differential taxation over time. This can be done by shifting the tax burden across generations depending on the weights placed by the government on each generation’s welfare. For instance, if the government places a higher weight on the current generation, it will tax current consumption less heavily relative to future consumption. In this case, society as a whole gains by differential taxation as it moves to the socially optimum welfare level, as illustrated in Figure A.[66] Accordingly, the results of our model imply that in the presence of a differential consumption tax system, intertemporal effects are generated; and these effects in turn have influence on savings, and hence on growth and its sources. Second, we have derived conditions under which uniform taxation over time is optimal, and showed that in this case there are no welfare gains from differential taxation, as illustrated in Figure C.

The inconclusive results of our theoretical model motivate further investigation on the empirical front. Moreover, lack of empirical evidence in the existing literature on the relationship between consumption taxes on one hand and growth and its sources on the other, further stresses the need for a comprehensive empirical analysis to study the effects of the VAT on growth and its sources. Therefore, next we move to our empirical analysis.

[66] The opposite case in which the government places a higher weight on future generation is illustrated in Figure B.

Empirical Analysis

Empirical Strategy

Our primary objective here is to extend the literature by providing a comprehensive characterization of the empirical association between the economy's growth rate and its sources on one hand, and the effective VAT rate on the other hand using the best available data. To do this, we extend and complement previous work along three dimensions.

First, our study is considered a first attempt to provide empirical evidence on the relationship between the VAT rate and capital growth, productivity, and economic growth. Second, we adopt a reduced-form approach encompassing a variety of growth determinants identified in the literature, rather than adhering to one particular, narrow, structural model. Third, we employ a variety of estimation methods but focus our attention on estimators that attempt to control for endogeneity, omitted variable bias, simultaneity, and measurement error.

The data. The dataset includes 14 European Union (EU) countries over the period 1960-1995, where available.[67] We use the same dataset used by Beck et al. (2000),[68] and added to that our variable of interest (i.e., effective VAT rate) and two other tax control variables (i.e., consumption tax revenue excluding VAT revenue, and income tax revenue).[69] We followed the typical exercise and generated five-year averages for all the variables for two reasons: (1) to remove the business cycle fluctuation effect, as our

[67] Note that Luxembourg is not included in the sample due to lack of data for the three dependent variables of interest, as well as some independent variables, such as educational attainment.
[68] The dataset is available online at:
http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:20699078~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html
[69] These tax variables are the same ones as those employed in essay one.

concern is to address growth related questions; and (2) because our preferred econometric technique (i.e., the GMM-System estimator, which is discussed in detail in the first essay) is better suited for samples with small number of time observations. As such, we have seven observations per country, where available.[70]

A complete and detailed discussion of the variables' definition and sources is provided in Table A4 of Appendix A, whereas Table A5 provides descriptive statistics of the dataset. The data description shows that the effective VAT rate ranges between zero and 16.30 percent with a sample mean of 4.51 percent.[71] Denmark achieved the highest rate of 16.30 in 1995. Furthermore, the sample mean of our three dependent variables; GDP per capita growth rate, capital per capita growth rate, and productivity per capita growth rate is 0.03, 0.04, and 0.02 percent, respectively.[72]

Our goal is to estimate the impact of the VAT on growth and its sources. Therefore, we are interested in three *dependent* variables; namely economic growth, capital growth, and productivity growth, as follows:

Per capita physical capital growth rate (K-Growth). This is the dependent variable corresponding to the first equation concerned with estimating the rate of capital accumulation measured by the rate of growth of per capita physical capital. Beck et al. (2000) generated this variable by deriving an estimate of the initial level of capital stock for each country in 1950 assuming that the capital-output ratio was in steady-state. In

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[70] Our growth equation includes 96 observations – with two missing observations due to data limitations on the VAT in Germany prior to 1971, whereas capital accumulation and productivity growth equations include 95 observations – with an additional observation lost due to data limitations on these variables in Portugal for the last period (1991-95).

[71] As noted in the first essay, the minimum value is zero because we included observations in years in which the VAT was not yet introduced in some countries. If however, we drop the zeros from the sample, the number of observations drops from 96 to 69 and in that case the minimum effective VAT rate is 0.25 percent in 1970 in Belgium.

[72] For further details on data description, see Table A5 of Appendix A.

later years, capital stock was computed using the aggregate real investment series from the Penn World Tables (5.6) and the perpetual inventory method with an annual depreciation rate of 7 percent.

Per capita productivity growth rate (Prod-Growth). This is the dependent variable corresponding to the second equation concerned with estimating the rate of productivity growth measured by the rate of growth of per capita productivity. We use the same simple measure of productivity as the one used by Beck et al. (2000) and Rioja and Valev (2004). This measure is based on a neoclassical production function of the form:

$$Y_i = A_i K_i^{\alpha} L_i^{1-\alpha} \tag{94}$$

where:

Y is aggregate output

K is physical capital

L is labor

A is the level of total factor productivity

α is capital share in the production, and is assumed to equal 0.3

For simplicity, Beck et al. (2000) assumed that this aggregate production function is the same across countries and over time. The authors computed the per capita productivity growth rate based on the following formula:[73]

Prod-Growth = Growth – (0.3)*(K-Growth)

GDP per capita income growth rate (Growth). This is the relevant dependent variable for the third equation concerned with estimating the "overall" growth rate of the economy measured by the rate of growth of per capita real GDP.

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[73] After dividing by L, taking logs, and rearranging.

Following Beck et al. (2000) and Rioja and Valev (2004), our conditioning information set includes initial income per capita, secondary schooling, government size, openness to trade, and inflation rate. The rationale for including each of these variables is provided below.

Major empirical determinants of economic growth, capital accumulation and productivity growth. Although latest empirical works have shown that growth is associated with a large number of variables, we only include the "key" variables that contribute to economic performance and its sources, which are primarily based on our theoretical foundations.[74] We now proceed into a detailed discussion of the set of independent variables:

Initial real income per capita (Initial Income). This variable is measured by the real GDP per capita (constant 1995 $U.S.). Data are taken for the initial year of the relevant period. Initial income controls for the convergence effect implied in the standard Solow-Swan growth theory. Neoclassical growth theory implies that countries with higher initial per capita GDP have lower growth rates of GDP, capital accumulation, and productivity; therefore, we expect a negative coefficient for this variable in all three equations.

Educational attainment (Schooling). Our measure of educational attainment is given by the average number of years of secondary schooling for population over age 15 years old. This variable controls for the level of human capital in the country. Since this variable has a positve effect on growth, capital accumulation, and productivity, it should

[74] Note that we do not include other variables that have been identified as "important" in explaining growth equations, such as corruption, political instability, law and order, revolutions and coups, assassinations, risk of expropriation, and bureaucratic efficiency. The reason is that our sample includes only developed countries, which allows us to safely assume that those countries have already passed a threshold level for these variables; and hence they are "irrelevant" from that perspective.

appear with a positive coefficient. The intuition is that higher levels of human capital lead to higher levels of efficiency in production and this in turn leads to faster rates of growth in the economy.

Government consumption expenditures (Government size). We use government consumption expenditures as a percent of GDP to control for the size of the government in the economy. Since government consumption expenditures include expenditures that involve distortions of private decisions, these distortions can reflect in slower rates of growth. This is because government operations are carried out inefficiently; for instance, the government's regularity process imposes unnecessary burdens and costs on the economic system, and many of the fiscal and monetary policies, which are primarily conducted by governments, tend to distorts economic incentives and results in poorer efficiency of the system. Therefore, larger government size is expected to affect growth and its sources negatively.

Openness (Openness to Trade). We use the sum of exports and imports as a percent of GDP to measure for the degree of openness in the economy. Theoretically, growth, capital accumulation, and productivity increase with favorable movements in the terms of trade because it improves the allocation of resources by enhancing productivity via encouraging specialization that would be unprofitable in smaller markets. Therefore, the correlation between openness to trade on one hand and economic growth and its sources on the other is positive.

Inflation rate (Inflation). The rate of inflation is considered an indicator of macroeconomic stability. It is computed as the log difference in consumer price index and is included in all three equations to control for the influence of inflation on growth and its sources. Theoretically, inflation affects growth via several channels: first, the uncertainty associated with high and volatile unanticipated inflation leads to lower accumulation rates of capital, and it undermines the efficiency with which productive factors function. In fact, Feldstein (1996b) and Jones and Manuelli (1993) pointed out that this result holds even with fully anticipated inflation given the non-neutralities built into most industrialized countries' tax systems. In addition, it undermines the confidence of domestic and foreign investors about the future path of monetary policy. Second, the accumulation or investment channel operates through the accumulation of human capital and/or investment in R&D. Third, inflation lowers growth through the efficiency channel by reducing total factor productivity, since higher level of inflation leads to higher menu costs (frequent changes in prices which are costly for firms), decreases consumers' optimal level of cash holdings, jeopardizes the efficient allocation of resources because it increases the time allocated and the resources included in gathering price information within this price-instable environment, and finally it produces large forecast errors by altering the information contents of prices. Therefore, inflation affects growth and its sources negatively.

The effective value-added tax rate (VAT Rate$_t$). This is our variable of interest, which is calculated using the formula explained in the first essay.[75] We choose to include the VAT in all three equations in the form of the effective rate, rather than as a revenue measure, for several reasons. First, to achieve consistency and comparability in our results, since it is easier to draw conclusions when we use the same measure to capture the effect of the VAT when we look at growth and its sources as the one used in

[75] Table A4 of Appendix A provides a detailed definition of all the variables employed in the empirical analysis.

addressing consumption behavior. Second, as explained in essay one, using effective VAT rates controls for variations in the VAT statutory rates across EU countries, allowing us to make comparisons more easily. Third, as we are interested in the intertemporal effect generated by the VAT, a measure of *tax rate* is more appropriate in capturing that effect because we can easily comprehend its effect on relative prices. As we explained in essay one, non-constant VAT rates over time generate an intertemporal effect that affects the relative prices between consumption and saving. This effect translates into favorable effect on saving - of course if the tax increases the relative price of current consumption in terms of future consumption (saving) - which plays a key role in capital accumulation and hence on productivity growth as well as economic growth. Therefore, we would expect higher VAT rates to influence growth and its sources positively. However, this is a complicated process in which other forces may reverse our results. For instance, one might argue that VAT is still a form of taxation, and therefore it has a negative effect on growth (consistently with the current theoretical and empirical literature on taxation and growth). Moreover, higher VAT rates may generate a disincentive to work, leading to lower levels of productivity, and hence it might, at least partially, offset its positive effect on productivity. Finally, it is possible also to have a positive effect on capital accumulation, which may not translate into positive effects on growth given the integrated nature of this process and the presence of other off-setting forces, as described above, which may render the VAT to be ineffective in affecting growth. Therefore, there is a wide range of possibilities for the impact of VAT on growth, capital accumulation, and productivity growth.

Consumption tax revenue excluding VAT revenue (TotConsTax_Vat). The share of consumption tax revenue excluding those from the VAT in GDP is included to control for the possible impact of other consumption taxes, apart from the VAT, on growth and its sources. Taxation and growth theories end up in most cases concluding that taxes generate distortions, or deadweight losses to societies.[76] Therefore, their impacts on growth, capital accumulation, and productivity are negative. However, one might argue, like the case with the VAT, that consumption taxes can generate a positive effect on the economy's growth rate and its sources, by altering the relative price of consumption and saving. Therefore, the impact of other consumption taxes on growth and its sources is theoretically ambiguous.

Income tax revenue ($TotincomeTax_t$). We include a measure of income tax revenue as a percent of GDP to control for the potential influence of income taxes in our estimated equations in order to isolate the effect of the VAT on growth and its sources from other taxes. The argument for a potential damaging impact of this tax on growth and its sources follows along the same line as that of the consumption tax control variable. However, it is important to keep in mind that income taxes, unlike consumption taxes, entail two competing effects: the income effect (which tends to increase all periods' savings) and the substitution effect (which tends to lower current period's savings). Therefore, the net effect is uncertain as it depends on which of these two forces dominates. If, for instance, the substitution effect outweighs the income effect, a negative impact on growth and capital accumulation is expected. Nonetheless, if the income effect more than offsets the

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[76] The deadweight loss of taxation is the loss of output which would have not occurred in the absence of the tax. It can be viewed also as the loss of economic welfare above and beyond the tax revenues collected. The economic welfare loss arises from the disincentive effect of taxation on labor supply and saving. See Leach (2003) for more details..

substitution effect, a positive sign is expected. Finally, if the two effects cancel out each others, an insignificant impact is a potential candidate.

Empirical specification. Following the same steps of the first essay, we center our discussion on a "benchmark" set of regressors chosen based on theoretical connection and analytical relevance. We also examine the role of other growth determinants, such as government size, openness to trade, and inflation rate. We follow Beck et al. (2000), and Rioja and Valev (2004) and employ two conditioning sets. First, we use the "simple" conditioning set, which includes initial level of GDP per capita, average years of secondary schooling, our variable of interest (i.e., the effective VAT rate) and the two tax control variables discussed above.[77] Second, we use the "policy" conditioning set, which includes the simple set plus three additional policy variables as discussed earlier (i.e., government size, openness to trade, and inflation rate).

Econometric Issues and Methodology

Following Caselli et al. (1996), Beck et al. (2000), and Rioja and Valev (2004), we are interested in estimating the following general equation with unobserved country-specific and time-specific effects:

$$\ln(y_{i,t}) - \ln(y_{i,t-1}) = \alpha \ln(y_{i,t-1}) + \gamma\, VATRate_{i,t} + \beta' X_{i,t} + \eta_i + \lambda_t + \varepsilon_{i,t} \qquad (95)$$

where:

$\ln(y_{i,t}) - \ln(y_{i,t-1})$: represents the growth rate of real GDP per capita, or physical capital per capita or productivity per capita.

$X_{i,t}$ $K \times 1$ vector of observable independent variables.

β $K \times 1$ vector of parameters.

[77] That is, the "Benchmark" specification employs the "simple" conditioning set discussed in the text.

η_i Unobservable country-specific effect

λ_t Unobservable time-specific effect

$\varepsilon_{i,t}$ Random disturbance term satisfying the following assumptions:

$$E(\varepsilon_{i,t})=0,\ \ E(\varepsilon_{i,t}^2)=\sigma_\varepsilon^2,\ \ and\ \ E(\varepsilon_{i,t}\,\varepsilon_{j,s})=0 \quad if\ i\neq j \quad and/or \quad t\neq s$$

i = 1, ...N, where *N* refers to number of cross-sectional units (countries)

t = 2, ...T Number of time periods (years)

Note that equation (95) can be re-written as:

$$\ln(y_{i,t})=(\alpha+1)\ln(y_{i,t-1})+\gamma\, VATRate_{i,t}+\beta' X_{i,t}+\eta_i+\lambda_t+\varepsilon_{i,t} \qquad |\alpha|<1 \qquad (96)$$

From equation (96), it is clear that (95) is the same as estimating a dynamic equation that includes lagged dependent variable as one of the regressors.

The procedure we adopt here is the same as the one we employed in the first essay. We estimate all three equations using the same four estimators used in the first essay, namely, Pooled OLS (POLS), two-way fixed effect (FE), one step GMM-system, and two-step GMM-system estimators.[78] We do not attempt to re-explain our methodology or our estimators, as they are explained in detail in the first essay; however, we provide reasoning of their appropriateness in the new context of growth and its sources.

Our preferred estimator remains the two-step GMM-system estimator; therefore, we focus our discussion around its suitability when estimating the growth equation. Indeed, there are quite well-known problems when estimating growth equations. Bond et

[78] While we follow Beck et al. (2000), and Rioja and Valev (2004) in using the same econometric methodology (dynamic GMM-system) in estimating all three equations, it is also reasonable to think of all three equations as being dynamic, and that they share similar properties, such as persistence, short time series, endogeneity, measurement error …etc. Therefore, we consider the dynamic GMM-system estimator the appropriate econometric method when estimating growth and its sources.

al. (2001) pointed out that these problems include omitted variable bias, and endogenous and mismeasured explanatory variables. Furthermore, when estimating growth equations, we are usually faced by persistent data (e.g., GDP), as well as short series (e.g., a small number of time observations), as we attempt to average the data every five-year period in order to remove the effect of business cycles. Our preferred GMM-system estimator is capable of obtaining moment conditions that continue to be informative even for persistent data by making use of an assumption about the initial conditions. Furthermore, Bond et al. (2001) argued that simulation results have shown that the required assumptions of the GMM-system estimator on the initial conditions are legitimate and helpful in our empirical application, as they are in line with standard growth frameworks.[79]

Estimation Results

We present the estimation results of each of our equations separately. As explained above, in all three equations we rely on the same set of regressors.[80] Before presenting the results in more detail, we must clarify their interpretation. As discussed in the first essay, our dynamic GMM-system estimator is designed to isolate the effect of the exogenous component of each of the explanatory variables on per capita capital growth, productivity growth, and economic growth. To the extent that our assumptions regarding the instruments utilized in the GMM procedure are correct, we isolate the causal effects of the explanatory variables on growth and its sources. Therefore, when we

[79] For a detailed discussion of the GMM-system, as well as other estimators employed in this analysis, see essay one.

[80] While it is appealing to think that there should be a different set of explanatory variables for each of the estimated equations, we follow the same literature in which all three equations were estimated using the same set of regressors, i.e., Beck et al. (2000), and Rioja and Valev (2004). Furthermore, we identified capital accumulation and productivity growth as the sources of growth, and therefore, it is logical to think of the same set of regrossers that explain growth to explain its sources as well.

point out to the effect of a given variable on capital accumulation, productivity growth, or economic growth, we are referring to the correlation between the exogenous component of that variable and the dependent variable.

We turn now to a discussion of the effect of VAT on capital accumulation, productivity growth, and economic growth.

Value-added tax and capital accumulation. We organize our discussion for the estimation results of the capital accumulation equation around the benchmark empirical specification presented earlier (it is presented in column (4) of Table B15 of Appendix B). We note from the results that the specification tests generally support our dynamic GMM estimates (as shown in columns (3) and (4) of Table B15). The Hansen test of overidentifying restrictions fails to reject the null hypothesis that the instruments are uncorrelated with the error term (*p-value* = 0.30 and 0.54 for the one-step and two-step GMM-System estimators, respectively). Similarly, the tests of serial correlation reject the hypothesis that the error term is second-order serially correlated, providing additional support to the use of appropriate lags of the explanatory variables as instruments for the estimation.

Basic results. Table B15 of Appendix B reports the results of capital accumulation regressions using alternative estimators and utilizing the simple conditioning set. Our preferred estimation method uses the two-step GMM-System estimator. Therefore, we first discuss the results obtained with this estimator (columns (4) of Table B15) and then compare them with those obtained with alternative estimation methods.

The results show a statistically significant relation between the exogenous component of the effective VAT rate and the per capita physical capital accumulation. As expected, the direction of the relation is positive, implying that a one percentage point increase in the VAT rate would lead to a 0.28 percentage point increase in the capital growth rate. The results are statistically significant at the 10 percent level. The economic weight of the results can be shown by a simple example. For instance, the effective VAT rate in Austria increased from the 1985-90 period to the 1991-95 period by about 2.86 percentage point, which represents the average increase in the VAT rate for most countries in our sample. In that case, an exogenous increase in the VAT of the size experienced by Austria would yield higher capital growth of 0.8 percentage points.[81]

Sensitivity analysis. In order to test for the robustness of the basic results and to enlighten their interpretation, we also conduct a sensitivity analysis along two dimensions. First, we utilize alternative econometric techniques. Second, we bring in the importance of other explanatory variables, by using the policy conditioning set discussed earlier.

Alternative estimators. Table B15 of Appendix B presents results obtained with alternative estimation techniques; namely the static OLS estimates using pooled data (POLS) which is shown in column (1), the two-way fixed effect estimator (FE), which appears in the second column, and finally the one-step GMM-System estimator in column (3).[82]

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[81] This result follows from (2.86)*(0.0028) = 0.0080, where 0.0028 is the point estimate of the VAT Rate in column (4) of Table B15 of Appendix B.

[82] The econometric issues associated with each of these estimators, and the properties of their estimates are discussed in detail in the first essay.

In many cases, the results obtained with our preferred two-step GMM-System estimator are qualitatively similar to those obtained with alternative estimators. All estimators yield negative and significant effect (at the 1 percent and 5 percent levels) of the (ln) level of initial income although, the coefficients vary in size. Most interestingly, the VAT Rate appears with a positive and statistically significant coefficient in all estimators, though with varying magnitude and level of significance. All other control variables do not show a clear pattern across alternative estimators with respect to their sign; however, they are all statistically insignificant.

Additional explanatory variables. Tables B16 through B19 of Appendix B present the sensitivity of the basic results to the inclusion of one or more of the policy variables. Generally, the main results do not change much in terms of their sign and magnitude by adding government size, openness to trade, and/or inflation rate. In all cases, the coefficient of the effective VAT rate is positive and significant. However, the policy variables do not show a clear pattern across various estimators with respect to their sign. However, the impact of the policy variables on capital growth is statistically insignificant for all specifications employing the one-step or the two-step GMM-system estimators. This result holds whether the variables are included in the estimation separately or simultaneously. In fact, all policy variables appear with an insignificant coefficient in most cases (when included separately), with the exception of government size (which is significant in the case of the FE estimator at the 10 percent level) and inflation rate (which is significant in the case of POLS estimator at the 10 percent level as well). When included simultaneously, the impact of policy variables on capital growth changes slightly as openness to trade becomes significant at the 1 percent level in the case if POLS, and at the 10 percent level in the case of FE estimator, whereas government size becomes insignificant in the case of FE estimator.

Value-added tax and productivity growth. The benchmark empirical specification of the productivity growth equation is presented in column (4) of Table B20 of Appendix B. As in the case of the capital growth equation, the results show that the specification tests generally support our dynamic GMM estimates (as shown in columns (3) and (4) of Table B20). The Hansen test of overidentifying restrictions fails to reject the null hypothesis that the instruments are uncorrelated with the error term (*p-value* = 0.21 and 0.19 for the one-step and two-step GMM-System estimators, respectively). Similarly, the tests of serial correlation reject the hypothesis that the error term is second-order serially correlated, providing additional support to the use of appropriate lags of the explanatory variables as instruments for the estimation.

Basic results. The estimation results of the productivity growth regressions using the simple conditioning set and various estimators are reported in Table B20 of Appendix B. The results of the two-step GMM-System estimator show a statistically insignificant relation between the exogenous component of the effective VAT rate and productivity growth, while the positive sign is still maintained. While the positive sign is consistent with our expectations that the increase in the VAT rate leads to an increase in capital accumulation and productivity growth through its positive impact on savings, the insignificant effect could be attributed to the fact that VAT (as other forms of consumption taxes) do distort the labor-leisure decision, resulting in a negative impact of the VAT on labor supply, as it would drive down the real wage. In fact, Metcalf (1995) pointed out that other than its negative impact on labor supply, the VAT is a distortionfree tax.[83] Therefore, the positive impact of the VAT on productivity (through the savings channel) is partially canceled out with its negative impact on productivity (through the labor supply channel) leaving a net outcome of positive and insignificant coefficient.

Sensitivity analysis. We conduct a sensitivity analysis to test for the robustness of our results along the same dimensions as we did for the capital accumulation equation, namely, by providing estimation results based on other econometric techniques, and by testing for the relevance of other policy explanatory variables as follows:

Alternative estimators. The estimation results using alternative estimation methods, namely POLS, two-way FE, and one-step GMM-System are shown in Table B20 of Appendix B, columns (1), (2), and (3), respectively.

The results obtained with the two-step GMM-System estimator are qualitatively similar to those obtained with alternative estimators, in this case as well. All estimators yield negative and significant effect (at the 1 percent and 5 percent levels) of the (ln) level of initial income although, the coefficients vary in size. Most interestingly, the VAT Rate appears with a positive but insignificant coefficient in all estimators, though with varying magnitude. All other control variables have an insignificant effect on productivity growth.

Additional explanatory variables. Tables B21 through B24 of Appendix B present the sensitivity of the core results to the inclusion of one or more of the policy variables. Generally, the main results are not sensitive to adding government size, openness to trade, and/or inflation rate. In all cases, the coefficients of the effective VAT rate are positive and insignificant. However, openness to trade and inflation rate do not

[83] Metcalf (1995) argues that the effect of the VAT on labor supply depends on its impact through cross-price elasticities, and treatment of work-related expenses under the VAT.

show a clear pattern with respect to their sign across various estimators, and they do not have a significant effect on the rate of productivity growth, with one exception in the case of POLS in which inflation is significant at the 1 percent level when included simultaneously with other policy variables (column (1) of Table B24). Government size, however, appears constantly with a negative sign and insignificant coefficient (except in the case of FE, the coefficient is significant at the 10 percent level when included separately, and at the 5 percent level when included simultaneously with other variables).

Value-added tax and economic growth. Column (4) of Table B25 of Appendix B presents the basic empirical specification of the growth equation. As in the case of the capital growth equation and the productivity growth equation, the results show that the specification tests generally support our dynamic GMM estimates (as shown in columns (3) and (4) of Table B25). The Hansen test of overidentifying restrictions fails to reject the null hypothesis that the instruments are uncorrelated with the error term (*p-value* = 0.14 and 0.29 for the one-step and two-step GMM-System estimators, respectively). Similarly, the tests of serial correlation reject the hypothesis that the error term is second-order serially correlated, providing additional support to the use of appropriate lags of the explanatory variables as instruments for the estimation.

Basic results. Table B25 of Appendix B reports the estimation results of the growth regressions using the simple conditioning set and various estimators. The results of the two-step GMM-System estimator show a statistically significant relation between the exogenous component of the effective VAT rate and the per capita growth rate. The direction of the relation is positive, implying that a one percentage point increase in the VAT rate would lead to a 0.23 percentage point increase in the growth rate. The results are statistically significant at the 10 percent level. The economic weight of the results can be shown by a simple example. For instance, the effective VAT rate in Austria increased from the 1985-90 period to the 1991-95 period by about 2.86 percentage points, which represents the average increase in the VAT rate for most countries in our sample. Therefore, the effect of such increase on capital growth would be 0.66.[84]

Sensitivity analysis. The sensitivity analysis is conducted along the same dimensions as we did for the capital growth and for the productivity growth equations as follows:

Alternative estimators. The results of the sensitivity analysis using the simple conditioning set and various estimators are reported in Table B25 of Appendix B. In many cases, the results obtained with our preferred two-step GMM-System estimator are qualitatively similar to those obtained with alternative estimators. All estimators yield negative and significant effect of the (ln) level of initial income although, the coefficients vary in size. Most interestingly, the VAT Rate appears with a positive and statistically significant coefficient in all estimators, though with varying magnitude and level of significance. The educational attainment coefficient is unexpectedly negative; however, it is insignificant across various estimators. This could be explained by the fact that almost all countries in our sample are developed; hence an additional year of schooling does not generate a significant effect on the rate of growth. The two tax control variables are consistently insignificant.

Additional explanatory variables. Tables B26 through B29 of Appendix B present the sensitivity of the basic results to the inclusion of one or more of the policy

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[84] This result follows from: (2.86)*(0.0023) = 0.0066, where 0.0023 is the point estimate of the VAT Rate in column (4) of Table B25 of Appendix B.

variables. Generally, the core results do not change by adding government size, openness to trade, and/or inflation rate. In all cases, the coefficient of the effective VAT rate is positive and significant. However, the policy variables do not show a clear pattern across various estimators with respect to their sign, and interestingly, they do not have a significant effect on the rate of growth across different estimators. For instance, government size and openness to trade seem to have insignificant effects on the rate of growth; these results hold whether they are included separately or simultaneously with other policy variables. Inflation rate appears with a significant coefficient only in the case of POLS estimator when included separately.

Concluding Remarks

The purpose of this section is to examine the empirical correlation between the VAT and capital growth, productivity growth, and economic growth. Furthermore, this section evaluates the robustness of the main results across various estimators and specifications. After controlling for the potential biases associated with persistence, simultaneity, endogeneity, measurement error, omitted variables, and unobserved country-specific effects, the results suggest that the effective VAT rate is positively and significantly correlated with growth and capital accumulation. The correlation is found to be robust in the four estimators employed in the analysis. Regarding productivity growth, we find that the VAT has no statistically significant effect on the productivity measure used. The potential negative impact of the VAT on labor supply might explain the insignificant effect of the VAT on productivity. When the positive and significant effect of the VAT on capital accumulation is combined with the absence of an effect on productivity, the net effect does appear to influence the overall impact of the VAT on economic growth.

Conclusions, Policy Implications, and Future Research

In this essay, we developed a theoretical framework and an empirical analysis to study the impact of the VAT, as a form of taxing consumption, on capital accumulation, productivity growth, and overall economic growth. On the theoretical front, we used a two-sector endogenous growth model based on Diamond's (1965) overlapping generation model, and found that the impact of consumption taxes on growth and its sources feeds mainly through the savings rate, nonetheless, these effects are theoretically ambiguous as they depend on the interaction between utility parameters, the interest rate, and the tax structure. Furthermore, we provided a theoretical framework in which equity and efficiency considerations are important factors determining optimal tax structure, and identified conditions under which taxes could be evolving or constant over time.

Empirically, we examined the impact of the VAT on capital accumulation, productivity growth, and economic growth using a panel of 14 EU countries over the period 1961-95. To deal with the typical issues that arise when estimating growth equations, such as persistence and endogeneity, we employed the recently developed dynamic panel GMM-System estimators. We found that the VAT affects the sources of growth differently. In particular, we found that it affects physical capital accumulation significantly, whereas its influence on productivity growth is statistically insignificant. When both effects are combined, the significant effect on capital accumulation seems to dominate the absence of an effect on productivity yielding a positive and significant effect on overall economic growth. More specifically, we found, using the simple conditioning information set, that a one percentage point increase in the VAT rate would lead to a 0.23 percentage point increase in the growth rate, and to a 0.28 percentage point increase in the capital growth rate, *ceteris paribus*. Finally, our main results are robust to changes in model specifications and econometric methodologies.

Several policy implications follow from the main findings of this study. First, if the government is to consider both equity and efficiency when designing its tax policy, then it may conduct a differential tax policy over time, by shifting taxes across generations depending on the weights it places on each generation's welfare. The results of such policy include an improvement in society's welfare, as it moves to a higher social welfare level, and the observed variation in effective VAT rates. Second, since the results show that the VAT, as a form of taxing consumption, boosts capital accumulation, and hence the economy's growth rate, policymakers should take into considerations this result when designing tax reform proposals that aim at increasing saving and investment incentives, and ultimately economic growth. Finally, an important result of this study is that productivity is not the most effective channel to influence economic growth through the VAT, rather it is capital accumulation. This is important for policymakers to keep in mind when designing and/or evaluating the costs and benefits of various tax reform proposals. For instance, policymakers may need to focus on the most effective investment channels through which the VAT can be used to achieve the highest growth rate of capital, and eventually of the economy's income, rather than wasting their resources on channels that mainly affect productivity, as it seems to be less relevant to affect the economy's growth rate via the VAT.

This study could be extended in several directions. For instance, including income taxes in the model might be interesting to examine how the main results may change when we make the model more "realistic." In addition, incorporating administrative and compliance costs may lead to different conclusions that might be of interest theoretically and empirically. Moreover, further examination of the differential impact of the VAT on the composition of investment both theoretically and empirically would provide more clear answers on the most effective investment channels to achieve the highest level of capital accumulation and economic growth via the VAT. Finally, extending the analysis to developing countries is a straight forward exercise that could be done as data becomes available.

Appendix A: Data Appendix

Table A1. *Essay One's Data Sources and Definitions*

Variable	Name	Source	Definition
C_t	Household final consumption expenditure (constant 1995 $U.S.)	World Development Indicators CD-ROM 2004. The World Bank	Household final consumption expenditure (formerly private consumption) is the market value of all goods and services, including durable products (such as cars, washing machines, and home computers), purchased by households. It excludes purchases of dwellings but includes imputed rent for owner-occupied dwellings. It also includes payments and fees to governments to obtain permits and licenses. Here, household consumption expenditure includes the expenditures of nonprofit institutions serving households, even when reported separately by the country. Data are in constant 1995 U.S. dollars. Household final consumption expenditure per capita (private consumption per capita) is calculated using private consumption in constant 1995 prices and World Bank population estimates.
Y_t	Gross Domestic Product (GDP) (constant 1995 $U.S.)	World Development Indicators CD-ROM 2004. The World Bank	GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant 1995 U.S. dollars. Dollar figures for GDP are converted from domestic currencies using 1995 official exchange rates. For a few countries where the official exchange rate does not reflect the rate effectively applied to actual foreign exchange transactions, an alternative conversion factor is used. GDP per capita is gross domestic product (constant 1995 $U.S.) divided by midyear population.

Variable	Name	Source	Definition
W_t	Households' wealth – proxied by financial system deposits (real $U.S.)	Financial Structure and Economic Development Database, the World Bank. Available online at: http://www.worldbank.org/research/projects/finstructure/database.htm	Wealth (financial system deposit) is calculated using the following formula: W_t = {Financial system deposits as a % of GDP*GDP}/100 Financial system deposits as %GDP is defined as demand, time and saving deposits in deposit money banks and other financial institutions as a share of GDP. Calculated using the following deflation method: $\{(0.5)*[F_t/P\_e_t + F_t\text{-}1/P\_e_t\text{-}1]\}/[GDP_t/P\_a_t]$ Where F is demand and time and saving deposits, P_e is end-of period consumer price index (CPI), and P_a is average annual CPI. Wealth per capita is wealth (financial system deposits) divided by population.
Old_t	Old dependency ratio (annual, %)	World Development Indicators CD-ROM 2004. The World Bank	Percentage of the total population that is 65 or older. Population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship - except for refugees not permanently settled in the country of asylum, who are generally considered part of the population of the country of origin.
$TotConsTax\_VAT_t$	Total consumption taxes excluding VAT (constant 1995 $U.S.)	OECD Revenue Statistics CD-ROM 1965-2001 (2002). Also available on line at: http://thesius.sourceoecd.org/vl=2303064/cl=27/nw=1/rpsv/ij/oecdstats/16081099/v55n1/s5/p1	Total consumption taxes excluding VAT is calculated by subtracting VAT revenues ($U.S.) from tax revenues on goods and services ($U.S.). The calculated series is deflated by the CPI. Taxes on goods and services include all taxes and duties levied on the production, extraction, sale, transfer, leasing or delivery, of goods, and the rendering of services, or in respect of the use of goods or permission to use goods or to perform activities are included here. It covers: a. multi-stage cumulative taxes b. general sales taxes – whether levied at manufacture/production, wholesale or retail level. c. value-added taxes. d. excises e. taxes levied on the import and export of goods. f. taxes levied in respect of the use of goods and taxes on permission to use goods, or perform certain activities g. taxes on the extraction, processing or production of minerals and other products. The per capita version of the series is calculated by dividing all consumption taxes excluding VAT by population.

Variable	Name	Source	Definition
TotIncomeTax$_t$	Total income tax revenue (constant 1995 $U.S.)	OECD Revenue Statistics CD-ROM 1965-2001 (2002). Also available on line at: http://thesius.sourceoecd.org/vl=2303064/cl=27/nw=1/rpsv/ij/oecdstats/16081099/v55n1/s5/p1	Total income tax revenue is calculated by the following formula: TotincomeTax$_t$ = Taxes on income, profit and capital gain ($U.S.) + Taxes on payroll and workforce ($U.S.) The calculated series is deflated by the CPI. Taxes on income, profit and capital gain include all taxes levied on the income or profits (i.e. gross income minus allowable tax relieves or tax deductibles) of individuals and enterprises. Also covered are taxes levied on the capital gains of individuals and enterprises, and gains from gambling. Taxes on payroll and workforce include taxes paid by employers, employees or the self-employed either as a proportion of payroll or as a fixed amount per person, and which are not earmarked for social security expenditure. The per capita version of the series is calculated by dividing all income tax revenue by population.
Inflation$_t$	Inflation rate (consumer price, annual %)	World Development Indicators CD-ROM 2004. The World Bank	Inflation rate as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a fixed basket of goods and services that may be fixed or changed at specified intervals, such as yearly. The Laspeyres formula is generally used.
URate$_t$	Unemployment rate (annual %, monthly averages)	OECD Economic Outlook, No. 75. Also available online at: http://ceres.sourceoecd.org/vl=617395/cl=91/nw=1/rpsv/ij/oecdstats/16081153/v115n1/s1/p1	Unemployment rate is defined as the ratio between the number of unemployed and the total labor force. Where: Total labor force or currently active population comprises all persons who fulfill the requirements for inclusion among the employed or the unemployed. The employed include all persons above a specified age who during a specified brief period, either one week or one day, were in the following categories: a. Paid employment: 1. At work: persons who during the reference period performed some work for wage or salary, in cash or in kind; 2. With a job but not at work: persons who, having already worked in their present job, were temporarily not at work during the reference period and have a formal attachment to their job.

Variable	Name	Source	Definition
$URate_t$… Cont'd.	Unemployment rate (annual %, monthly averages)	OECD Economic Outlook, No. 75. Also available online at: http://ceres.sourceoecd.org/vl=617395/cl=91/nw=1/rpsv/ij/oecdstats/16081153/v115n1/s1/p1	This formal job attachment should be determined in the light of national circumstances, according to one or more of the following criteria: (a) if he continued receipt of wage or salary; (b) an assurance of return to work following the end of the contingency, or an agreement as to the date of return; (c) the elapsed duration of absence from the job, which, wherever relevant, may be that duration for which workers can receive compensation benefits without obligations to accept other jobs. b. Self-employment: <u>1. At work:</u> persons who during the reference period performed some work for profit or family gain, in cash or in kind; <u>2. With an enterprise but not at work:</u> persons with an enterprise, which may be a business enterprise, a farm or a service undertaking, who were temporarily not at work during the reference period for any specific reason. <u>The Unemployed:</u> comprise all persons above a specified age, who during the reference period were: a. Without work, i.e. were not in paid employment or self-employment during the reference period. b. Currently available for work, i.e. were available for paid employment or self employment during the reference period. c. Seeking work, i.e. had taken specific steps in a specified recent period to seek paid employment or self-employment. The specific steps may include registration at a public or private employment exchange; application to employers; checking at worksites, farms, factory gates, market or other assembly places; placing or answering newspaper advertisements; seeking assistance of friends or relatives; looking for land, building, machinery or equipment to establish own enterprise; arranging for financial resources; applying for permits and licenses, etc.

Variable	Name	Source	Definition
LTR_t	Long-term interest rate (annual %, average)	OECD Economic Outlook, No. 75. Also available online at: http://ceres.sourceoecd.org/vl=617395/cl=91/nw=1/rpsv/ij/oecdstats/16081153/v115n1/s1/p1	Long-term interest rates are averages of daily figures with the exception of Denmark (end of month rates) and France and Ireland (last Friday of the month). These rates measure the yield on long-term government bond on the secondary market with residual maturity of about 10-years. Definitions of long-term interest rates for individual countries are as follows: Austria: 10-year government bond yield. Source: National Bank of Austria (OeNB). Belgium: Government bond yield (more than 5 years, i.e. yield of government bonds with maturities of 6-years and over). Source: National Bank of Belgium (BNB). Denmark: 10-year central government bond yield. Source: National Bank of Denmark. Finland: 10-year government bond yield (bid rates for issues with maturities of 10 years). As from 1 January 1999, the 10 year yield is based on quotations for a fixed rate bullet serial bond maturing on 25 April 2009. Source: Bank of Finland. France: Public and semi-public sector bond yield. Source: Banque de France. Germany: Federal bond yield (outstanding listed federal securities with residual maturities of over 9 to 10 years). Data refer to unified Germany from July 1990 and western Germany prior to this date. Only bonds deliverable at the DTB (German Financial Futures Exchange) are included. Source: Federal Bank of Germany (Deutsche Bundesbank). Greece: 10-year government bond yield. Source: Bank of Greece. Ireland: 15-year government bond yield. Source: Central Bank of Ireland. Italy: 10-year government bond yield (gross yields of Treasury bonds traded on the Italian Exchange, M.O.T., with a residual maturity of 10 years). Source: Bank of Italy. Luxembourg**:** Long term government bond yield. Source: Central Bank of Luxembourg. Netherlands: 10-year government bond yield. Source: Central Bank of Netherlands (De Nederlandsche Bank). Portugal: 10-year government debt bond yield. Source: Bank of Portugal.

Variable	Name	Source	Definition
LTR_t… Cont'd.	Long-term interest rate (annual %, average)	OECD Economic Outlook, No. 75. Also available online at: http://ceres.sourceoecd.org/vl=617395/cl=91/nw=1/rpsv/ij/oecdstats/16081153/v115n1/s1/p1	Spain: Long-term government bond yield (weighted average yields of bonds with maturities of more than two years, weighting the yield each operation by the negotiated amount). Source: Bank of Spain. Sweden: 10-year government bond yield (with the exception of 1994, for which data refer to 9-year government bonds. Source: Bank of Sweden (Sveriges Riksbank). United Kingdom: 10-year government bond yield. Source: Bank of England. Euro area: Weighted average of 10-year government bond yield in euro area countries.

Table A2. *Essay One's Five-Year Averaged Data Description*

Variable	Obs	Mean	Std. Dev.	Min	Max
Country code	120	8	4.338609	1	15
Years	120	1982.5	11.50447	1965	2000
Index of countries	120	4.5	2.300895	1	8
Household final (private) consumption (constant 1995 $U.S.)	118	10338.24	4145.464	2195.548	23121.63
Ln household final (private) consumption (constant 1995 $U.S.)	118	9.15193	0.450124	7.693553	10.04757
GDP (constant 1995 $U.S.)	118	18542.1	8553.299	3220.51	51290.13
Ln GDP (constant 1995 $U.S.)	118	9.70923	0.512891	8.073872	10.84096
GDP growth (annual, %)	118	2.935521	1.691256	-1.069395	8.543363
Household Wealth (Financial System Deposits) (constant 1995 $U.S.)	118	14511.41	26631.73	706.7617	249273.1
Ln household Wealth (Financial System Deposits) (constant 1995 $U.S.)	118	9.122341	0.825936	6.544927	12.3017
Consumer price index (1995 = 100)	120	53.36258	35.52584	1.966127	118.2865
Inflation rate (consumer prices - annual %)	120	6.398743	4.82418	0.459467	23.26107
Long-term interest rate (annual %, average)	101	9.214368	3.594102	4.662833	25.825
Effective VAT rate (%)	118	5.391109	4.861607	0	17.36483
Unemployment rate (annual, %)	118	5.496008	3.871731	0.029847	15.57171
Population, total	120	2.35E+07	2.46E+07	326200	8.21E+07
Ln population, total	120	16.27745	1.364792	12.69515	18.22303
Old dependency ratio (annual, %)	120	13.17189	9.267651	0.0567365	55.43018
Total tax revenue ($U.S.)	120	4229.17	4201.052	75.5	18052.56
Ln total tax revenue ($U.S.)	120	7.69843	1.288984	4.324132	9.800637
Taxes on goods and services revenue ($U.S.)	120	1261.206	1193.909	33.4	5292.02
Ln taxes on goods and services revenue ($U.S.)	120	6.572065	1.181491	3.508556	8.572324
VAT revenues ($U.S.)	120	687.2042	734.7876	0	3159.98
Ln VAT revenues ($U.S.)	91	6.444808	0.942586	4.378846	8.056883
Total consumption tax revenues excluding VAT ($U.S.)	120	572.3795	485.332	33.4	2536.74
Ln total consumption tax revenues excluding VAT ($U.S.)	120	5.984188	0.891196	3.508556	7.838112
Taxes on income, profit, and capital gain ($U.S.)	120	1547.824	1804.589	14.1	9643.26
Ln taxes on income, profit, and capital gain ($U.S.)	120	6.524775	1.484694	2.646175	9.172083
Payroll tax revenue ($U.S.)	120	51.4105	122.3998	0	709.54
Ln Payroll tax revenue ($U.S.)	73	3.072156	1.956312	-2.30259	6.562047
Total income tax revenue ($U.S.)	120	1599.234	1846.315	15.3	9734.64
Ln total income tax revenue ($U.S.)	120	6.56832	1.4756	2.727853	9.181479

Table A3. *Essay One's Annual Data Description*

Variable	Obs	Mean	Std. Dev.	Min	Max
Country code	600	8	4.324099	1	15
Years	600	1980.5	11.55303	1961	2000
Index of countries	600	4.5	2.2932	1	8
Household final (private) consumption (constant 1995 $U.S.)	590	10338.24	4154.774	2095.76	24508.08
Ln household final (private) consumption (constant 1995 $U.S.)	590	9.15193	0.451205	7.647671	10.10676
GDP (constant 1995 $U.S.)	590	18542.1	8579.418	2867.823	58464.23
Ln GDP (constant 1995 $U.S.)	590	9.70923	0.513626	7.961308	10.97617
GDP growth (annual, %)	589	2.93726	2.653008	-7.913779	11.56584
Household Wealth (Financial System Deposits) (constant 1995 $U.S.)	578	13103.88	23954.95	535.5781	434236.8
Ln household Wealth (Financial System Deposits) (constant 1995 $U.S.)	578	9.087622	0.796726	6.283347	12.98135
Consumer price index (1995 = 100)	600	53.36258	35.65954	1.862684	126.6441
Inflation rate (consumer prices - annual %)	600	6.398743	5.379519	-0.7078	28.78333
Long-term interest rate (annual %, average)	493	9.222836	3.814909	4.179167	29.74167
Effective VAT rate (%)	590	5.391109	4.92727	0	19.24977
Unemployment rate (annual, %)	579	5.584017	3.981099	0.014991	18.43692
Population, total	600	2.35E+07	2.45E+07	319000	8.22E+07
Ln population, total	600	16.27745	1.360256	12.67295	18.22479
Old dependency ratio (annual, %)	600	13.17189	9.307893	0.0566084	56.68504
Total tax revenue ($U.S.)	540	4645.98	4273.548	75.5	18689.2
Ln total tax revenue ($U.S.)	540	7.890855	1.197407	4.324132	9.835701
Taxes on goods and services revenue ($U.S.)	540	1382.357	1212.075	33.4	5659.6
Ln taxes on goods and services revenue ($U.S.)	540	6.748348	1.100159	3.508556	8.641109
VAT revenues ($U.S.)	600	687.2042	742.5798	0	3386.5
Ln VAT revenues ($U.S.)	422	6.567667	0.875858	3.273364	8.127552
Total consumption tax revenues excluding VAT ($U.S.)	540	618.7965	496.2563	33.4	2731.8
Ln total consumption tax revenues excluding VAT ($U.S.)	540	6.104857	0.845762	3.508556	7.912716
Taxes on income, profit, and capital gain ($U.S.)	540	1701.493	1857.252	14.1	10492.8
Ln taxes on income, profit, and capital gain ($U.S.)	540	6.728721	1.390647	2.646175	9.258445
Payroll tax revenue ($U.S.)	540	56.32722	131.9931	0	1074.6
Ln Payroll tax revenue ($U.S.)	296	3.495247	1.732126	-2.30259	6.979704
Total income tax revenue ($U.S.)	540	1757.821	1898.946	15.3	10567.5
Ln total income tax revenue ($U.S.)	540	6.771208	1.381647	2.727853	9.265538

Table A4. *Essay Two's Data Sources and Definitions*

Variable	Name	Source	Definition
growth	GDP per capita growth (annual, %)	Levine-Loayza-Beck Dataset on Finance and the Sources of Growth (2000)	Growth rate of real per capita GDP.
K-Growth	Growth rate of physical capital per capita (annual, %)	Levine-Loayza-Beck Dataset on Finance and the Sources of Growth (2000)	Beck et al. (2000) computed capital growth rate by deriving an estimate of the initial level of capital stock for each country in 1950 assuming that the capital-output ratio was in steady-state. In later years, capital stock was computed using the aggregate real investment series from the Penn World Tables (5.6) and the perpetual inventory method with an annual depreciation rate of 7%.
Prod-Growth	Productivity per capita growth (annual, %)	Levine-Loayza-Beck Dataset on Finance and the Sources of Growth (2000)	Productivity growth rate is defined as the rate of growth of the "residual" (after capital and labor growth rates are accounted for). It is computed using the following formula: Productivity growth rate = Real per capita growth rate – (0.3)*(Capital growth rate)
Initial income	Initial per capita income (constant 1995 $U.S.)	Levine-Loayza-Beck Dataset on Finance and the Sources of Growth (2000)	Data of real per capita GDP are taken for the initial year of the period.
Schooling	Secondary schooling	Levine-Loayza-Beck Dataset on Finance and the Sources of Growth (2000)	Average number of years of secondary schooling in total population over 15 years old.
Government size	Government size (as a share of GDP)	Levine-Loayza-Beck Dataset on Finance and the Sources of Growth (2000)	Real government consumption expenditures as a share of real GDP.
Openness to Trade	Openness to trade (as a share of GDP)	Levine-Loayza-Beck Dataset on Finance and the Sources of Growth (2000)	The sum of real exports and real imports of goods and non-financial services as a share of real GDP.

Variable	Name	Source	Definition
Inflation	Inflation rate (annual, %)	Levine-Loayza-Beck Dataset on Finance and the Sources of Growth (2000)	Inflation rates are calculated by log differencing average annual CPI (consumer price index) data from the International Financial Statistics (IFS), line 64.
VAT Rate	Effective Value-Added Tax rate (annual, %)	OECD Revenue Statistics CD-ROM 1965-2001 (2002) and World Development Indicators CD-ROM 2004. The World Bank	We use the same measure of VAT Rate as the one used in the first essay. More specifically, the following formula is used to compute the effective VAT Rate: VATRate = {VAT Revenue (constant 1995 $U.S.)/Total Household (private) final consumption Expenditures (constant 1995 $U.S.)}*(100) For more details about the definition of VAT revenue, as well as household final consumption expenditures see Table A1.
TotIncome Tax	Total income tax revenue (as a share of GDP)	OECD Revenue Statistics CD-ROM 1965-2001 (2002). Also available on line at: http://thesius.sourceoecd.org/vl=2303064/cl=27/nw=1/rpsv/ij/oecdstats/16081099/v55n1/s5/p1	We use the same measure of total income tax revenue as the one used in the first essay. However, it is included as a % of GDP rather than a per capita measure. More specifically, the following formula is used to compute this tax measure: TotincomeTax = Taxes on income, profit and capital gain ($U.S.) + Taxes on payroll and workforce ($U.S.) The calculated series is deflated by the CPI. For more details about the definition of income, profit and capital gain taxes, as well as payroll taxes, see Table A1.
TotConsTax_VAT	Total consumption tax revenues excluding VAT (as a share of GDP)	OECD Revenue Statistics CD-ROM 1965-2001 (2002). Also available on line at: http://thesius.sourceoecd.org/vl=2303064/cl=27/nw=1/rpsv/ij/oecdstats/16081099/v55n1/s5/p1	We use the same measure of total consumption tax revenue excluding VAT revenue as the one used in the first essay. However, it is included as a % of GDP rather than a per capita measure. More specifically, the following formula is used to compute this tax measure: TotConsTax_VAT= tax revenues on goods and services ($U.S.) - VAT revenues ($U.S.) The calculated series is deflated by the CPI. For more details about the definition of taxes on goods and services, as well as VAT revenues, see Table A1.

Table A5. *Essay Two's Data Description*

Variable	Obs	Mean	Std. Dev.	Min	Max
GDP per capita growth (annual, %)	98	.0272449	.0157808	-.01	.07
Capital per capita growth (annual, %)	97	.0360825	.0217254	-.01	.1
Productivity per capita growth (annual, %)	97	.0171134	.0128257	-.02	.05
Initial per capita income (constant 1995 $U.S.)	98	8973.053	4111.321	1377.04	18981.5
Secondary schooling (average number of years in total population over 15)	98	1.650408	.8827942	.25	3.98
Government size (as a share of GDP)	98	.1782653	.0433643	.08	.28
Openness to trade (as a share of GDP)	98	.5596939	.2725461	.15	1.58
Inflation rate (annual, %)	98	.0683673	.0448984	.01	.21
Effective VAT rate (annual, %)	96	4.513227	4.416283	0	16.29806
Total income tax revenue (as a share of GDP)	98	12.0649	5.970669	2	29.5
Total consumption tax revenues excluding VAT (as a share of GDP)	98	6.989082	2.740393	3.356	14.75

Appendix B: Results Appendix

Table B1. *Private Consumption Function: Alternative Estimators (Core Model), five-year averaged data (1961-2000), (Dependent variable: per capita household final consumption):*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	Ln C_t	Ln C_t	Ln C_t	Ln C_t
VATRate$_t$	-0.0041*	-0.0063***	-0.0097***	-0.0111***
	(0.0021)	(0.0021)	(0.0028)	(0.0027)
Ln C_{t-1}	0.5471***	0.3283***	0.3599**	0.3694*
	(0.0622)	(0.0603)	(0.1268)	(0.1884)
Ln Y_t	0.3172***	0.5639***	0.4211***	0.4464**
	(0.0509)	(0.0748)	(0.1228)	(0.1665)
Growth Y	0.0048	0.0089***	0.0073	0.0082*
	(0.0031)	(0.0030)	(0.0046)	(0.0044)
Ln W_t	0.0129	0.0421**	0.0578	0.0537
	(0.0119)	(0.0187)	(0.0600)	(0.0692)
LTR$_t$	-0.0043**	-0.0044**	-0.0075**	-0.0084**
	(0.0017)	(0.0019)	(0.0030)	(0.0031)
Old$_t$	0.0008	-0.0004	-0.0009	-0.0010
	(0.0007)	(0.0012)	(0.0031)	(0.0056)
Ln TotConsTax_VAT$_t$	0.0070	-0.0200	0.0004	0.0003
	(0.0132)	(0.0199)	(0.0239)	(0.0342)
Ln TotIncomeTax$_t$	0.0087	0.0235	0.0427**	0.0388
	(0.0113)	(0.0182)	(0.0193)	(0.0236)
Constant	0.9605***	0.3490	1.1220*	0.8628
	(0.2286)	(0.5538)	(0.5667)	(0.5855)
Observations	94	94	94	94
Number of countries		15	15	15
Hansen Test (*p-value*)[a]			0.49	0.49
Test for 2nd order serial correlation (*p-value*)[b]			0.69	0.72

Note. Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[b] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B2. *Private Consumption Function: Alternative Estimators (Sensitivity Result), five-year averaged data (1961-2000), (Dependent variable: per capita household final consumption):*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	Ln C_t	Ln C_t	Ln C_t	Ln C_t
$VATRate_t$	-0.0039*	-0.0054**	-0.0099***	-0.0102***
	(0.0021)	(0.0022)	(0.0028)	(0.0024)
Ln C_{t-1}	0.5298***	0.3055***	0.4455***	0.4580***
	(0.0536)	(0.0628)	(0.1059)	(0.1164)
Ln Y_t	0.3128***	0.5619***	0.3340**	0.3070**
	(0.0442)	(0.0787)	(0.1317)	(0.1251)
Growth Y				
Ln W_t	0.0222*	0.0488**	0.0777***	0.0821**
	(0.0118)	(0.0195)	(0.0256)	(0.0280)
LTR_t	-0.0041**	-0.0038*	-0.0073***	-0.0066***
	(0.0017)	(0.0020)	(0.0017)	(0.0018)
Old_t				
Ln $TotConsTax\_VAT_t$	0.0022	-0.0196	-0.0028	0.0048
	(0.0135)	(0.0209)	(0.0259)	(0.0187)
Ln $TotInxomeTax_t$	0.0114	0.0248	0.0363	0.0334
	(0.0105)	(0.0191)	(0.0305)	(0.0261)
Constant	1.1031***	0.5040	1.0681	1.1460
	(0.2430)	(0.5781)	(1.0005)	(0.8591)
Observations	94	94	94	94
Number of countries		15	15	15
Hansen Test (*p*-value)[a]			0.75	0.75
Test for 2nd order serial correlation (*p*-value)[b]			0.90	0.90

Note. Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[b] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B3. *Private Consumption Function: Alternative Estimators (Sensitivity Result), five-year averaged data (1961-2000), (Dependent variable: per capita household final consumption):*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	Ln C_t	Ln C_t	Ln C_t	Ln C_t
$VATRate_t$	-0.0039*	-0.0060***	-0.0095*	-0.0094***
	(0.0021)	(0.0022)	(0.0045)	(0.0013)
Ln C_{t-1}	0.5545***	0.3437***	0.4119**	0.4049**
	(0.0537)	(0.0605)	(0.1600)	(0.1533)
Ln Y_t	0.2919***	0.5760***	0.3391***	0.3245*
	(0.0460)	(0.0792)	(0.1072)	(0.1797)
Growth Y	0.0038	0.0091***	0.0012	0.0021
	(0.0032)	(0.0031)	(0.0045)	(0.0046)
Ln W_t	0.0206*	0.0286	0.1081**	0.0844**
	(0.0117)	(0.0183)	(0.0427)	(0.0315)
LTR_t	-0.0041**	-0.0045**	-0.0063***	-0.0062**
	(0.0018)	(0.0019)	(0.0020)	(0.0023)
Old_t				
Ln $TotConsTax\_VAT_t$	0.0009	-0.0228	-0.0024	0.0004
	(0.0137)	(0.0201)	(0.0315)	(0.0153)
Ln $TotInxomeTax_t$	0.0147	0.0198	0.0306	0.0432**
	(0.0109)	(0.0189)	(0.0401)	(0.0181)
Constant	1.0730***	0.2554	1.0615	1.3848**
	(0.2391)	(0.5839)	(1.0932)	(0.5849)
Observations	94	94	94	94
Number of countries		15	15	15
Hansen Test (*p*-value)[a]			0.55	0.69
Test for 2nd order serial correlation (*p*-value)[b]			0.43	0.81

Note. Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[b] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B4. *Private Consumption Function: Alternative Estimators (Sensitivity Result), five-year averaged data (1961-2000), (Dependent variable: per capita household final consumption):*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	Ln C_t	Ln C_t	Ln C_t	Ln C_t
$VATRate_t$	-0.0040**	-0.0055**	-0.0085*	-0.0068**
	(0.0020)	(0.0022)	(0.0044)	(0.0031)
Ln C_{t-1}	0.5015***	0.3049***	0.3668**	0.3616*
	(0.0651)	(0.0634)	(0.1670)	(0.1710)
Ln Y_t	0.3496***	0.5623***	0.3589***	0.3353**
	(0.0502)	(0.0793)	(0.0994)	(0.1354)
Growth Y				
Ln W_t	0.0206	0.0485**	0.1069**	0.0730
	(0.0126)	(0.0197)	(0.0455)	(0.0559)
LTR_t	-0.0043**	-0.0038*	-0.0056**	-0.0056*
	(0.0017)	(0.0020)	(0.0023)	(0.0027)
Old_t	0.0009	-0.0002	0.0006	-0.0037
	(0.0007)	(0.0013)	(0.0025)	(0.0045)
Ln $TotConsTax\_VAT_t$	0.0076	-0.0196	-0.0052	-0.0193
	(0.0130)	(0.0211)	(0.0380)	(0.0274)
Ln $TotInxomeTax_t$	0.0047	0.0249	0.0339	0.0620*
	(0.0106)	(0.0193)	(0.0458)	(0.0298)
Constant	1.0225***	0.5115	1.2671	1.8028*
	(0.2350)	(0.5840)	(1.1376)	(0.9833)
Observations	94	94	94	94
Number of countries		15	15	15
Hansen Test (*p*-value)[a]			0.69	0.56
Test for 2nd order serial correlation (*p*-value)[b]			0.49	0.14

Note. Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[b] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B5. *Private Consumption Function: Alternative Estimators (Sensitivity Result), five-year averaged data (1961-2000), (Dependent variable: per capita household final consumption):*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	Ln C_t	Ln C_t	Ln C_t	Ln C_t
$VATRate_t$	-0.0041*	-0.0063***	-0.0079*	-0.0069**
	(0.0021)	(0.0022)	(0.0043)	(0.0028)
Ln C_{t-1}	0.5470***	0.3375***	0.3564**	0.3455*
	(0.0625)	(0.0740)	(0.1465)	(0.1930)
Ln Y_t	0.3170***	0.6353***	0.3844**	0.4589**
	(0.0511)	(0.0704)	(0.1603)	(0.1710)
Growth Y	0.0048	0.0097***	0.0104	0.0144**
	(0.0031)	(0.0032)	(0.0082)	(0.0065)
Ln W_t	0.0131	0.0126	0.0556	0.0207
	(0.0114)	(0.0215)	(0.0823)	(0.0663)
LTR_t	-0.0042	-0.0050**	-0.0102***	-0.0121***
	(0.0026)	(0.0024)	(0.0033)	(0.0020)
Old_t	0.0008	-0.0004	-0.0042	-0.0046
	(0.0007)	(0.0013)	(0.0024)	(0.0038)
$Inflation_t$	-0.0001	-0.0001	0.0028	0.0057
	(0.0020)	(0.0022)	(0.0052)	(0.0033)
U $Rate_t$				
Ln $TotConsTax\_VAT_t$	0.0069	-0.0206	-0.0348	-0.0192
	(0.0133)	(0.0211)	(0.0361)	(0.0316)
Ln $TotInxomeTax_t$	0.0085	0.0108	0.0761***	0.0623**
	(0.0121)	(0.0193)	(0.0249)	(0.0223)
Constant	0.9629***	-0.0565	1.5531*	1.2132
	(0.2161)	(0.5668)	(0.7884)	(0.9085)
Observations	94	94	94	94
Number of countries		15	15	15
Hansen Test (*p*-value)[a]			0.66	0.66
Test for 2nd order serial correlation (*p*-value)[b]			0.41	0.28

Note. Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[b] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B6. *Private Consumption Function: Alternative Estimators (Sensitivity Result), five-year averaged data (1961-2000), (Dependent variable: per capita household final consumption):*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	Ln C_t	Ln C_t	Ln C_t	Ln C_t
$VATRate_t$	-0.0050**	-0.0061**	-0.0112**	-0.0114***
	(0.0021)	(0.0023)	(0.0043)	(0.0036)
Ln C_{t-1}	0.5499***	0.3457***	0.4478**	0.4358*
	(0.0636)	(0.0790)	(0.1755)	(0.2415)
Ln Y_t	0.3368***	0.6165***	0.3959***	0.3850*
	(0.0547)	(0.0941)	(0.0895)	(0.1993)
Growth Y	0.0056*	0.0095***	0.0093	0.0080
	(0.0032)	(0.0033)	(0.0082)	(0.0113)
Ln W_t	0.0159	0.0129	0.0683	0.0588
	(0.0123)	(0.0213)	(0.0655)	(0.1171)
LTR_t	-0.0041**	-0.0051**	-0.0082***	-0.0089**
	(0.0017)	(0.0020)	(0.0022)	(0.0037)
Old_t	0.0008	-0.0003	-0.0036	-0.0056
	(0.0006)	(0.0013)	(0.0044)	(0.0081)
$Inflation_t$				
U $Rate_t$	0.0028*	-0.0007	0.0046	0.0028
	(0.0014)	(0.0025)	(0.0071)	(0.0060)
Ln $TotConsTax\_VAT_t$	-0.0009	-0.0200	-0.0506	-0.0349
	(0.0133)	(0.0211)	(0.0561)	(0.0763)
Ln $TotInxomeTax_t$	0.0049	0.0128	0.0548**	0.0603
	(0.0116)	(0.0195)	(0.0220)	(0.0643)
Constant	0.7759***	0.0355	0.7280	0.9374
	(0.2492)	(0.6388)	(0.9669)	(1.4607)
Observations	94	94	94	94
Number of countries		15	15	15
Hansen Test (*p*-value)[a]			0.55	0.55
Test for 2^{nd} order serial correlation (*p*-value)[b]			0.52	0.54

Note. Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[b] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B7. *Private Consumption Function: Alternative Estimators (Sensitivity Result), five-year averaged data (1961-2000), (Dependent variable: per capita household final consumption):*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	Ln C_t	Ln C_t	Ln C_t	Ln C_t
$VATRate_t$	-0.0050**	-0.0061**	-0.0079**	-0.0074***
	(0.0021)	(0.0023)	(0.0033)	(0.0021)
Ln C_{t-1}	0.5506***	0.3463***	0.2785*	0.3012*
	(0.0629)	(0.0799)	(0.1451)	(0.1443)
Ln Y_t	0.3377***	0.6159***	0.4922***	0.4258***
	(0.0558)	(0.0952)	(0.0872)	(0.1365)
Growth Y	0.0056*	0.0095***	0.0070	0.0066
	(0.0032)	(0.0033)	(0.0061)	(0.0044)
Ln W_t	0.0154	0.0133	0.0458	0.0399
	(0.0117)	(0.0218)	(0.0640)	(0.0534)
LTR_t	-0.0045*	-0.0049**	-0.0076***	-0.0081***
	(0.0027)	(0.0024)	(0.0019)	(0.0022)
Old_t	0.0008	-0.0003	0.0001	0.0010
	(0.0006)	(0.0013)	(0.0039)	(0.0010)
$Inflation_t$	0.0004	-0.0002	0.0020	0.0027
	(0.0021)	(0.0023)	(0.0022)	(0.0017)
U $Rate_t$	0.0029*	-0.0008	0.0013	0.0026
	(0.0016)	(0.0025)	(0.0050)	(0.0034)
Ln $TotConsTax\_VAT_t$	-0.0008	-0.0198	-0.0055	-0.0160
	(0.0133)	(0.0214)	(0.0439)	(0.0396)
Ln $TotInxomeTax_t$	0.0053	0.0124	0.0487	0.0640
	(0.0123)	(0.0202)	(0.0289)	(0.0394)
Constant	0.7615***	0.0347	1.2310	1.6640
	(0.2297)	(0.6442)	(0.8495)	(0.9461)
Observations	94	94	94	94
Number of countries		15	15	15
Hansen Test (*p*-value)[a]			0.42	0.37
Test for 2^{nd} order serial correlation (*p*-value)[b]			0.69	0.30

Note. Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[b] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B8. *Private Consumption Function: Alternative Estimators (Core Model), annual data (1961-2000), (Dependent variable: per capita household final consumption):*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	Ln C_t	Ln C_t	Ln C_t	Ln C_t
$VATRate_t$	-0.0007*	-0.0013*	-0.0021**	-0.0015*
	(0.0004)	(0.0008)	(0.0010)	(0.0008)
Ln C_{t-1}	0.8836***	0.7900***	0.5562***	0.4389***
	(0.0178)	(0.0226)	(0.0807)	(0.1268)
Ln Y_t	0.0797***	0.1909***	0.2773***	0.3511***
	(0.0155)	(0.0275)	(0.0580)	(0.1091)
Growth Y	0.0028***	0.0031***	0.0024***	0.0029***
	(0.0005)	(0.0006)	(0.0007)	(0.0009)
Ln W_t	0.0088***	0.0075*	0.0265	0.0183
	(0.0026)	(0.0045)	(0.0182)	(0.0222)
LTR_t	-0.0014***	-0.0018***	-0.0010**	-0.0019**
	(0.0003)	(0.0004)	(0.0004)	(0.0007)
Old_t	0.0003***	-0.0001	0.0008	-0.0009
	(0.0001)	(0.0003)	(0.0005)	(0.0009)
Ln $TotConsTax\_VAT_t$	0.0026	-0.0091*	-0.0118	-0.0384*
	(0.0036)	(0.0051)	(0.0118)	(0.0196)
Ln $TotIncomeTax_t$	0.0005	0.0081*	0.0362***	0.0668***
	(0.0027)	(0.0046)	(0.0119)	(0.0180)
Constant	0.2193***	0.0274	0.9797**	1.3893***
	(0.0451)	(0.1637)	(0.3443)	(0.3541)
Observations	445	445	445	445
Number of countries		15	15	15
Hansen Test (*p*-value)[a]			1.00	1.00
Test for 2nd order serial correlation (*p*-value)[b]			0.29	0.12

Note. Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[b] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B9. *Private Consumption Function: Alternative Estimator (Sensitivity Result), annual data (1961-2000), (Dependent variable: per capita household final consumption):*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	Ln C_t	Ln C_t	Ln C_t	Ln C_t
$VATRate_t$	-0.0009*	-0.0016*	-0.0028*	-0.0057*
	(0.0005)	(0.0008)	(0.0015)	(0.0029)
Ln C_{t-1}	0.8891***	0.7526***	0.4038***	0.5569**
	(0.0142)	(0.0222)	(0.0901)	(0.1932)
Ln Y_t	0.0638***	0.2510***	0.3653***	0.5115**
	(0.0123)	(0.0259)	(0.0648)	(0.2067)
Growth Y				
Ln W_t	0.0073***	0.0077	0.0332	-0.0994
	(0.0023)	(0.0047)	(0.0199)	(0.0916)
LTR_t	-0.0017***	-0.0022***	-0.0016***	-0.0014
	(0.0003)	(0.0004)	(0.0004)	(0.0008)
Old_t				
Ln $TotConsTax\_VAT_t$	0.0003	-0.0126**	-0.0028	0.0277
	(0.0033)	(0.0052)	(0.0173)	(0.0340)
Ln $TotIncomeTax_t$	0.0035	0.0066	0.0427***	0.0248**
	(0.0025)	(0.0048)	(0.0070)	(0.0107)
Constant	0.3488***	-0.1641	1.3931***	-0.2921
	(0.0492)	(0.1651)	(0.3237)	(0.9459)
Observations	445	445	445	445
Number of countries		15	15	15
Hansen Test (*p*-value)[a]			1.00	1.00
Test for 2nd order serial correlation (*p*-value)[b]			0.23	0.27

Note. Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[b] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B10. *Private Consumption Function: Alternative Estimator (Sensitivity Result), annual data (1961-2000), (Dependent variable: per capita household final consumption):*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	Ln C_t	Ln C_t	Ln C_t	Ln C_t
$VATRate_t$	-0.0008*	-0.0014*	-0.0017**	-0.0026***
	(0.0004)	(0.0008)	(0.0006)	(0.0006)
Ln C_{t-1}	0.9192***	0.7821***	0.6599***	0.6425***
	(0.0150)	(0.0229)	(0.0530)	(0.0907)
Ln Y_t	0.0427***	0.1917***	0.1970***	0.2267***
	(0.0132)	(0.0268)	(0.0524)	(0.0660)
Growth Y	0.0024***	0.0030***	0.0042***	0.0041***
	(0.0005)	(0.0006)	(0.0007)	(0.0007)
Ln W_t	0.0048**	0.0119**	0.0247**	0.0109
	(0.0023)	(0.0047)	(0.0084)	(0.0120)
LTR_t	-0.0015***	-0.0018***	-0.0010***	-0.0022***
	(0.0003)	(0.0004)	(0.0003)	(0.0004)
Old_t				
Ln $TotConsTax\_VAT_t$	-0.0000	-0.0083	-0.0211**	-0.0137
	(0.0034)	(0.0051)	(0.0094)	(0.0135)
Ln $TotIncomeTax_t$	0.0041	0.0092**	0.0411***	0.0402**
	(0.0026)	(0.0046)	(0.0084)	(0.0147)
Constant	0.2910***	0.0411	0.8558***	0.8287**
	(0.0476)	(0.1583)	(0.2281)	(0.3257)
Observations	445	445	445	445
Number of countries		15	15	15
Hansen Test (*p*-value)[a]			1.00	1.00
Test for 2nd order serial correlation (*p*-value)[b]			0.31	0.11

Note. Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[b] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B11. *Private Consumption Function: Alternative Estimator (Sensitivity Result), annual data (1961-2000), (Dependent variable: per capita household final consumption):*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	Ln C_t	Ln C_t	Ln C_t	Ln C_t
$VATRate_t$	-0.0008*	-0.0016**	-0.0042***	-0.0030***
	(0.0005)	(0.0008)	(0.0011)	(0.0010)
Ln C_{t-1}	0.8763***	0.7442***	0.4845***	0.5603***
	(0.0167)	(0.0226)	(0.0729)	(0.0941)
Ln Y_t	0.0782***	0.2512***	0.3394***	0.2681***
	(0.0141)	(0.0253)	(0.0405)	(0.0772)
Ln W_t	0.0083***	0.0124**	0.0233	0.0372
	(0.0028)	(0.0049)	(0.0158)	(0.0230)
Growth Y				
LTR_t	-0.0017***	-0.0022***	-0.0018***	-0.0019***
	(0.0003)	(0.0004)	(0.0005)	(0.0006)
Old_t	0.0003**	0.0000	-0.0003	0.0005
	(0.0001)	(0.0003)	(0.0007)	(0.0012)
Ln $TotConsTax\_VAT_t$	0.0014	-0.0118**	0.0283	0.0003
	(0.0033)	(0.0052)	(0.0292)	(0.0137)
Ln $TotIncomeTax_t$	0.0014	0.0079*	0.0144	0.0305**
	(0.0026)	(0.0047)	(0.0257)	(0.0118)
Constant	0.3203***	-0.1436	1.0127**	0.9252**
	(0.0499)	(0.1601)	(0.3549)	(0.3264)
Observations	445	445	445	445
Number of countries		15	15	15
Hansen Test (*p*-value)[a]			1.00	1.00
Test for 2nd order serial correlation (*p*-value)[b]			0.23	0.15

Note. Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[b] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B12. *Private Consumption Function: Alternative Estimator (Sensitivity Result), annual data (1961-2000), (Dependent variable: per capita household final consumption):*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	Ln C_t	Ln C_t	Ln C_t	Ln C_t
$VATRate_t$	-0.0008*	-0.0019**	-0.0021**	-0.0023***
	(0.0004)	(0.0008)	(0.0009)	(0.0006)
Ln C_{t-1}	0.9042***	0.7956***	0.5532***	0.6261***
	(0.0164)	(0.0228)	(0.0740)	(0.0570)
Ln Y_t	0.0534***	0.1874***	0.2810***	0.2541***
	(0.0141)	(0.0264)	(0.0600)	(0.0497)
Growth Y	0.0021***	0.0031***	0.0025***	0.0034***
	(0.0005)	(0.0006)	(0.0006)	(0.0006)
Ln W_t	0.0080***	0.0117**	0.0256	0.0042
	(0.0025)	(0.0047)	(0.0211)	(0.0140)
LTR_t	-0.0004	-0.0008*	-0.0010	-0.0022***
	(0.0003)	(0.0005)	(0.0006)	(0.0006)
Old_t	0.0003***	-0.0002	0.0008	0.0004*
	(0.0001)	(0.0003)	(0.0005)	(0.0002)
$Inflation_t$	-0.0013***	-0.0016***	0.0001	0.0003
	(0.0003)	(0.0004)	(0.0006)	(0.0006)
U $Rate_t$				
Ln $TotConsTax\_VAT_t$	-0.0020	-0.0093*	-0.0117	-0.0062
	(0.0035)	(0.0050)	(0.0120)	(0.0120)
Ln $TotIncomeTax_t$	0.0023	0.0047	0.0366***	0.0329**
	(0.0025)	(0.0046)	(0.0107)	(0.0132)
Constant	0.3135***	-0.0042	0.9763**	0.7677**
	(0.0467)	(0.1563)	(0.3583)	(0.2827)
Observations	445	445	445	445
Number of countries		15	15	15
Hansen Test (*p*-value)[a]			1.00	1.00
Test for 2nd order serial correlation (*p*-value)[b]			0.28	0.10

Note. Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[b] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B13. *Private Consumption Function: Alternative Estimator (Sensitivity Result), annual data (1961-2000), (Dependent variable: per capita household final consumption):*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	Ln C_t	Ln C_t	Ln C_t	Ln C_t
$VATRate_t$	-0.0009*	-0.0013*	-0.0020**	-0.0023***
	(0.0004)	(0.0007)	(0.0009)	(0.0006)
Ln C_{t-1}	0.9092***	0.8305***	0.5763***	0.6422***
	(0.0173)	(0.0221)	(0.0733)	(0.0662)
Ln Y_t	0.0585***	0.1661***	0.2431***	0.2283***
	(0.0150)	(0.0278)	(0.0540)	(0.0554)
Growth Y	0.0024***	0.0027***	0.0026***	0.0035***
	(0.0006)	(0.0006)	(0.0007)	(0.0006)
Ln W_t	0.0057**	0.0051	0.0139	0.0075
	(0.0028)	(0.0040)	(0.0130)	(0.0146)
LTR_t	-0.0015***	-0.0006	-0.0014***	-0.0020***
	(0.0003)	(0.0005)	(0.0004)	(0.0005)
Old_t	0.0002**	-0.0000	0.0006	0.0004
	(0.0001)	(0.0003)	(0.0004)	(0.0002)
$Inflation_t$				
U $Rate_t$	0.0004	-0.0001	-0.0014**	-0.0004
	(0.0003)	(0.0005)	(0.0006)	(0.0005)
Ln $TotConsTax\_VAT_t$	0.0006	-0.0081*	-0.0072	-0.0083
	(0.0036)	(0.0045)	(0.0107)	(0.0110)
Ln $TotIncomeTax_t$	0.0010	0.0042	0.0449***	0.0359***
	(0.0027)	(0.0044)	(0.0122)	(0.0113)
Constant	0.2320***	-0.0693	1.1724***	0.8365***
	(0.0490)	(0.1780)	(0.3600)	(0.2475)
Observations	445	445	445	445
Number of countries		15	15	15
Hansen Test (*p*-value)[a]			1.00	1.00
Test for 2nd order serial correlation (*p*-value)[b]			0.31	0.12

Note. Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[b] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B14. *Private Consumption Function: Alternative Estimator (Sensitivity Result), annual data (1961-2000), (Dependent variable: per capita household final consumption):*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	Ln C_t	Ln C_t	Ln C_t	Ln C_t
VATRate$_t$	-0.0008*	-0.0020**	-0.0017**	-0.0021***
	(0.0004)	(0.0009)	(0.0007)	(0.0007)
Ln C_{t-1}	0.9081***	0.8066***	0.5539***	0.6094***
	(0.0162)	(0.0229)	(0.0719)	(0.0682)
Ln Y_t	0.0452***	0.1811***	0.2605***	0.2590***
	(0.0139)	(0.0302)	(0.0618)	(0.0599)
Growth Y	0.0019***	0.0031***	0.0028***	0.0037***
	(0.0006)	(0.0006)	(0.0007)	(0.0006)
Ln W_t	0.0076***	0.0072	0.0150	0.0051
	(0.0025)	(0.0045)	(0.0129)	(0.0163)
LTR$_t$	-0.0004	-0.0008	-0.0015***	-0.0025***
	(0.0003)	(0.0005)	(0.0004)	(0.0006)
Old$_t$	0.0003**	-0.0002	0.0006	0.0005*
	(0.0001)	(0.0003)	(0.0004)	(0.0002)
Inflation$_t$	-0.0015***	-0.0017***	0.0004	0.0008
	(0.0003)	(0.0004)	(0.0005)	(0.0006)
U Rate$_t$	-0.0007**	-0.0001	-0.0014**	-0.0003
	(0.0003)	(0.0006)	(0.0006)	(0.0005)
Ln TotConsTax_VAT$_t$	-0.0016	-0.0101**	-0.0090	-0.0057
	(0.0034)	(0.0050)	(0.0104)	(0.0114)
Ln TotIncomeTax$_t$	0.0032	0.0036	0.0463***	0.0351**
	(0.0024)	(0.0048)	(0.0123)	(0.0121)
Constant	0.3609***	0.0047	1.1947***	0.8462***
	(0.0511)	(0.1881)	(0.3681)	(0.2632)
Observations	445	445	445	445
Number of countries		15	15	15
Hansen Test (*p*-value)[a]			1.00	1.00
Test for 2nd order serial correlation (*p*-value)[b]			0.32	0.13

Note. Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[b] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B15. *Capital Accumulation Equation (1961-1995): Simple Conditioning Set*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	K-Growth	K-Growth	K-Growth	K-Growth
VAT $Rate_t$	0.0017***	0.0018**	0.0014**	0.0028*
	(0.0006)	(0.0009)	(0.0007)	(0.0016)
Initial Income[a]	-0.0157***	-0.0660***	-0.0671**	-0.0936***
	(0.0055)	(0.0164)	(0.0280)	(0.0157)
Schooling[b]	0.0008	-0.0077	-0.0444	-0.0262
	(0.0045)	(0.0115)	(0.0283)	(0.0202)
$TotIncomeTax_t$[a]	-0.0042	0.0014	0.0401	0.0480
	(0.0044)	(0.0090)	(0.0259)	(0.0297)
$TotConsTax\_VAT_t$[a]	-0.0037	0.0035	-0.0035	0.0033
	(0.0049)	(0.0078)	(0.0103)	(0.0110)
Constant	0.1703***	0.6213***	0.5770***	0.7555***
	(0.0477)	(0.1307)	(0.1835)	(0.1124)
Observations	95	95	95	95
Number of Countries		14	14	14
Hansen Test (*p*-value)[c]			0.30	0.54
Test for 2[nd] order serial correlation (*p*-value)[d]			0.96	0.31

Note. Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] In the regression, this variable is included as ln (variable).

[b] In the regression, this variable is included as ln (1+ variable).

[c] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[d] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B16. *Capital Accumulation Equation (1961-1995): Policy Conditioning Set (1)*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	K-Growth	K-Growth	K-Growth	K-Growth
VAT Rate$_t$	0.0016***	0.0013*	0.0016**	0.0018**
	(0.0005)	(0.0007)	(0.0006)	(0.0007)
Initial Income[a]	-0.0191***	-0.0731***	-0.0424***	-0.0525***
	(0.0065)	(0.0181)	(0.0080)	(0.0189)
Schooling[b]	0.0036	0.0124	-0.0280**	-0.0250
	(0.0039)	(0.0102)	(0.0124)	(0.0222)
Government size[a]	0.0028	-0.0250*	0.0455	-0.0214
	(0.0090)	(0.0149)	(0.0353)	(0.0499)
Openness to Trade[a]				
Inflation[b]				
TotIncomeTax$_t$[a]	-0.0035	0.0116	0.0045	0.0332
	(0.0039)	(0.0080)	(0.0122)	(0.0316)
TotConsTax_VAT$_t$[a]	-0.0059	0.0084	0.0161	0.0220
	(0.0053)	(0.0075)	(0.0115)	(0.0145)
Constant	0.2038***	0.5829***	0.4693***	0.3615***
	(0.0755)	(0.1621)	(0.1295)	(0.1295)
Observations	95	95	95	95
Number of Countries		14	14	14
Hansen Test (*p*-value)[c]			0.42	0.43
Test for 2nd order serial correlation (*p*-value)[d]			0.17	0.44

Note. Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] In the regression, this variable is included as ln (variable).

[b] In the regression, this variable is included as ln (1+ variable).

[c] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[d] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B17. *Capital Accumulation Equation (1961-1995): Policy Conditioning Set (2)*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	K-Growth	K-Growth	K-Growth	K-Growth
VAT $Rate_t$	0.0019***	0.0017**	0.0027**	0.0017*
	(0.0006)	(0.0007)	(0.0011)	(0.0009)
Initial Income[a]	-0.0175***	-0.0651***	-0.0322	-0.0604*
	(0.0058)	(0.0200)	(0.0359)	(0.0319)
Schooling[b]	0.0023	0.0058	-0.0408**	-0.0250
	(0.0046)	(0.0143)	(0.0198)	(0.0224)
Government size[a]				
Openness to Trade[a]	-0.0047	-0.0205	-0.0637	0.0139
	(0.0035)	(0.0194)	(0.0397)	(0.0436)
Inflation[b]				
$TotIncomeTax_t$[a]	-0.0024	0.0113	0.0259	0.0253
	(0.0042)	(0.0085)	(0.0187)	(0.0206)
$TotConsTax\_VAT_t$[a]	-0.0038	-0.0017	-0.0060	0.0213
	(0.0045)	(0.0077)	(0.0167)	(0.0150)
Constant	0.1780***	0.5665***	0.2560	0.4998*
	(0.0473)	(0.1771)	(0.3111)	(0.2999)
Observations	95	95	95	95
Number of Countries		14	14	14
Hansen Test (*p*-value)[c]			0.29	0.50
Test for 2^{nd} order serial correlation (*p*-value)[d]			0.12	0.46

Note. Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] In the regression, this variable is included as ln (variable).

[b] In the regression, this variable is included as ln (1+ variable).

[c] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[d] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B18. *Capital Accumulation Equation (1961-1995): Policy Conditioning Set (3)*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	K-Growth	K-Growth	K-Growth	K-Growth
VAT Rate$_t$	0.0011**	0.0015*	0.0018*	0.0017*
	(0.0005)	(0.0008)	(0.0011)	(0.0010)
Initial Income[a]	-0.0185***	-0.0755***	-0.0258	-0.0474*
	(0.0049)	(0.0212)	(0.0240)	(0.0265)
Schooling[b]	0.0014	0.0058	-0.0737**	-0.0258
	(0.0041)	(0.0106)	(0.0342)	(0.0241)
Government size[a]				
Openness to Trade[a]				
Inflation[b]	-0.1034*	-0.0580	-0.0414	-0.0298
	(0.0594)	(0.0685)	(0.0499)	(0.0727)
TotIncomeTax$_t$[a]	-0.0038	0.0130	0.0182	0.0212
	(0.0037)	(0.0082)	(0.0164)	(0.0205)
TotConsTax_VAT$_t$[a]	-0.0011	0.0047	0.0078	0.0204
	(0.0050)	(0.0069)	(0.0112)	(0.0143)
Constant	0.1970***	0.6597***	0.2701	0.3873**
	(0.0425)	(0.1770)	(0.1857)	(0.1959)
Observations	95	95	95	95
Number of Countries		14	14	14
Hansen Test (*p*-value)[c]			0.63	0.38
Test for 2nd order serial correlation (*p*-value)[d]			0.86	0.35

Note. Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] In the regression, this variable is included as ln (variable).

[b] In the regression, this variable is included as ln (1+ variable).

[c] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[d] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B19. *Capital Accumulation Equation (1961-1995): Policy Conditioning Set (4)*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	K-Growth	K-Growth	K-Growth	K-Growth
VAT Rate$_t$	0.0013**	0.0015*	0.0058*	0.0051*
	(0.0006)	(0.0008)	(0.0027)	(0.0026)
Initial Income[a]	-0.0162**	-0.0561**	-0.0667**	-0.0755***
	(0.0069)	(0.0214)	(0.0267)	(0.0236)
Schooling[b]	0.0049	0.0165	-0.0953	-0.1010
	(0.0044)	(0.0119)	(0.0603)	(0.0652)
Government size[a]	-0.0168	-0.0246	-0.0615	-0.0730
	(0.0104)	(0.0170)	(0.1308)	(0.0496)
Openness to Trade[a]	-0.0117***	-0.0291*	-0.0435	-0.0150
	(0.0042)	(0.0164)	(0.0565)	(0.0419)
Inflation[b]	-0.1410**	-0.0386	0.0543	0.0233
	(0.0656)	(0.0702)	(0.0518)	(0.0573)
TotIncomeTax$_t$[a]	0.0025	0.0154	0.0989	0.1004
	(0.0044)	(0.0093)	(0.0950)	(0.0575)
TotConsTax_VAT$_t$[a]	0.0045	0.0021	0.0228	0.0099
	(0.0053)	(0.0081)	(0.0227)	(0.0196)
Constant	0.1143	0.4131**	0.2665	0.3697
	(0.0789)	(0.1890)	(0.3617)	(0.2633)
Observations	95	95	95	95
Number of Countries		14	14	14
Hansen Test (*p*-value)[c]			0.74	0.58
Test for 2nd order serial correlation (*p*-value)[d]			0.82	0.98

Note. Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] In the regression, this variable is included as ln (variable).

[b] In the regression, this variable is included as ln (1+ variable).

[c] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[d] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B20. *Productivity Growth Equation (1961-1995): Simple Conditioning Set*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	Prod-Growth	Prod-Growth	Prod-Growth	Prod-Growth
VAT $Rate_t$	0.0001	0.0005	0.0006	0.0013
	(0.0006)	(0.0008)	(0.0006)	(0.0010)
Initial Income[a]	-0.0150***	-0.0386***	-0.0273**	-0.0496**
	(0.0043)	(0.0114)	(0.0106)	(0.0214)
Schooling[b]	-0.0059	0.0021	-0.0096	0.0017
	(0.0043)	(0.0093)	(0.0109)	(0.0281)
$TotIncomeTax_t$[a]	0.0045	0.0009	0.0129	0.0215
	(0.0028)	(0.0067)	(0.0111)	(0.0164)
TotConsTax_VAT_t[a]	-0.0028	-0.0064	-0.0006	-0.0007
	(0.0044)	(0.0066)	(0.0075)	(0.0080)
Constant	0.1513***	0.3655***	0.2395***	0.4073***
	(0.0372)	(0.0843)	(0.0753)	(0.1524)
Observations	95	95	95	95
Number of Countries		14	14	14
Hansen Test (*p*-value)[c]			0.42	0.34
Test for 2nd order serial correlation (*p*-value)[d]			0.27	0.30

Note. Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] In the regression, this variable is included as ln (variable).

[b] In the regression, this variable is included as ln (1+ variable).

[c] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[d] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B21. *Productivity Growth Equation (1961-1995): Policy Conditioning Set (1)*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	Prod-Growth	Prod-Growth	Prod-Growth	Prod-Growth
VAT $Rate_t$	0.0001	0.0007	0.0008	0.0010
	(0.0006)	(0.0006)	(0.0007)	(0.0011)
Initial Income[a]	-0.0145**	-0.0369***	-0.0408***	-0.0624**
	(0.0056)	(0.0108)	(0.0135)	(0.0306)
Schooling[b]	-0.0059	0.0038	-0.0019	0.0110
	(0.0043)	(0.0101)	(0.0102)	(0.0308)
Government size[a]	-0.0012	-0.0237*	-0.0004	-0.0266
	(0.0090)	(0.0130)	(0.0457)	(0.0661)
Openness to Trade[a]				
Inflation[b]				
$TotIncomeTax_t^a$	0.0047	0.0079	0.0193	0.0423
	(0.0030)	(0.0075)	(0.0304)	(0.0528)
$TotConsTax\_VAT_t^a$	-0.0025	-0.0031	-0.0006	0.0028
	(0.0052)	(0.0068)	(0.0073)	(0.0096)
Constant	0.1440**	0.2875***	0.3373***	0.4140***
	(0.0662)	(0.0901)	(0.0766)	(0.1458)
Observations	95	95	95	95
Number of Countries		14	14	14
Hansen Test (*p*-value)[c]			0.30	0.30
Test for 2^{nd} order serial correlation (*p*-value)[d]			0.25	0.29

Note. Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] In the regression, this variable is included as ln (variable).

[b] In the regression, this variable is included as ln (1+ variable).

[c] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[d] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B22. *Productivity Growth Equation (1961-1995): Policy Conditioning Set (2)*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	Prod-Growth	Prod-Growth	Prod-Growth	Prod-Growth
VAT Rate$_t$	0.0001	0.0006	0.0013	0.0020
	(0.0006)	(0.0007)	(0.0008)	(0.0017)
Initial Income[a]	-0.0153***	-0.0397***	-0.0541*	-0.0710*
	(0.0046)	(0.0117)	(0.0299)	(0.0385)
Schooling[b]	-0.0057	0.0018	0.0174	0.0109
	(0.0044)	(0.0114)	(0.0140)	(0.0183)
Government size[a]				
Openness to Trade[a]	-0.0006	0.0063	-0.0298	-0.0327
	(0.0036)	(0.0157)	(0.0405)	(0.0655)
Inflation[b]				
TotIncomeTax$_t$[a]	0.0048	0.0028	0.0318	0.0437
	(0.0033)	(0.0076)	(0.0203)	(0.0349)
TotConsTax_VAT$_t$[a]	-0.0028	-0.0069	-0.0069	-0.0074
	(0.0045)	(0.0067)	(0.0129)	(0.0131)
Constant	0.1525***	0.3800***	0.4004	0.5247
	(0.0379)	(0.1000)	(0.2549)	(0.3447)
Observations	95	95	95	95
Number of Countries		14	14	14
Hansen Test (*p*-value)[c]			0.40	0.32
Test for 2nd order serial correlation (*p*-value)[d]			0.54	0.78

Note. Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] In the regression, this variable is included as ln (variable).

[b] In the regression, this variable is included as ln (1+ variable).

[c] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[d] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B23. *Productivity Growth Equation (1961-1995): Policy Conditioning Set (3)*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	Prod-Growth	Prod-Growth	Prod-Growth	Prod-Growth
VAT $Rate_t$	0.0006	0.0012	0.0014	0.0020
	(0.0007)	(0.0009)	(0.0012)	(0.0014)
Initial Income[a]	-0.0131**	-0.0399*	-0.0805***	-0.0895**
	(0.0054)	(0.0210)	(0.0207)	(0.0386)
Schooling[b]	-0.0037	-0.0055	0.0070	0.0120
	(0.0053)	(0.0145)	(0.0157)	(0.0223)
Government size[a]				
Openness to Trade[a]				
Inflation[b]	0.0140	0.0761	0.0354	0.0947
	(0.0471)	(0.0623)	(0.0730)	(0.0762)
$TotIncomeTax_t^a$	0.0035	0.0020	0.0442***	0.0352
	(0.0034)	(0.0097)	(0.0149)	(0.0282)
$TotConsTax\_VAT_t^a$	-0.0034	-0.0040	-0.0031	0.0002
	(0.0047)	(0.0086)	(0.0123)	(0.0129)
Constant	0.1269***	0.3687**	0.6308***	0.7184**
	(0.0458)	(0.1700)	(0.1681)	(0.3147)
Observations	95	95	95	95
Number of Countries		14	14	14
Hansen Test (*p*-value)[c]			0.52	0.48
Test for 2[nd] order serial correlation (*p*-value)[d]			0.62	0.67

Note. Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] In the regression, this variable is included as ln (variable).

[b] In the regression, this variable is included as ln (1+ variable).

[c] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[d] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B24. *Productivity Growth Equation (1961-1995): Policy Conditioning Set (4)*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	Prod-Growth	Prod-Growth	Prod-Growth	Prod-Growth
VAT Rate$_t$	0.0007	0.0005	0.0002	0.0016
	(0.0006)	(0.0009)	(0.0014)	(0.0032)
Initial Income[a]	-0.0195***	-0.0375**	-0.0552**	-0.0743*
	(0.0046)	(0.0142)	(0.0195)	(0.0349)
Schooling[b]	-0.0040	-0.0039	0.0182	0.0375
	(0.0044)	(0.0102)	(0.0286)	(0.0502)
Government size[a]	0.0081	-0.0262**	-0.0148	-0.0705
	(0.0074)	(0.0130)	(0.0466)	(0.0853)
Openness to Trade[a]	0.0016	0.0092	-0.0271	-0.0694
	(0.0032)	(0.0149)	(0.0364)	(0.0857)
Inflation[b]	-0.1443***	-0.0931	-0.1171	-0.0405
	(0.0475)	(0.0587)	(0.1005)	(0.2296)
TotIncomeTax$_t$[a]	-0.0006	0.0060	0.0312	0.0719
	(0.0031)	(0.0072)	(0.0335)	(0.0699)
TotConsTax_VAT$_t$[a]	0.0010	0.0045	-0.0225	-0.0169
	(0.0050)	(0.0079)	(0.0160)	(0.0271)
Constant	0.2043***	0.2920**	0.4324***	0.3479
	(0.0564)	(0.1185)	(0.0937)	(0.2161)
Observations	95	95	95	95
Number of Countries		14	14	14
Hansen Test (*p*-value)[c]			0.33	0.33
Test for 2[nd] order serial correlation (*p*-value)[d]			0.24	0.20

Note. Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] In the regression, this variable is included as ln (variable).

[b] In the regression, this variable is included as ln (1+ variable).

[c] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[d] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B25. *Economic Growth Equation (1961-1995): Simple Conditioning Set*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	Growth	Growth	Growth	Growth
VAT Rate$_t$	0.0010*	0.0020***	0.0023***	0.0023*
	(0.0006)	(0.0006)	(0.0008)	(0.0013)
Initial Income[a]	-0.0151***	-0.0808***	-0.0756***	-0.1045*
	(0.0048)	(0.0185)	(0.0228)	(0.0598)
Schooling[b]	-0.0048	-0.0169	-0.0127	-0.0035
	(0.0054)	(0.0124)	(0.0192)	(0.0435)
TotIncomeTax$_t$[a]	0.0018	0.0125	0.0174	0.0411
	(0.0030)	(0.0078)	(0.0180)	(0.0276)
TotConsTax_VAT$_t$[a]	-0.0002	0.0065	-0.0012	-0.0016
	(0.0045)	(0.0063)	(0.0087)	(0.0093)
Constant	0.1502***	0.7261***	0.6695***	0.8767*
	(0.0391)	(0.1591)	(0.1976)	(0.4525)
Observations	96	96	96	96
Number of Countries		14	14	14
Hansen Test (*p*-value)[c]			0.14	0.29
Test for 2nd order serial correlation (*p*-value)[d]			0.32	0.57

Note. Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] In the regression, this variable is included as ln (variable).

[b] In the regression, this variable is included as ln (1+ variable).

[c] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[d] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B26. *Economic Growth Equation (1961-1995): Policy Conditioning Set (1)*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	Growth	Growth	Growth	Growth
VAT $Rate_t$	0.0011*	0.0013*	0.0018**	0.0022*
	(0.0006)	(0.0008)	(0.0008)	(0.0012)
Initial Income[a]	-0.0205***	-0.0586***	-0.0746***	-0.0776*
	(0.0061)	(0.0152)	(0.0199)	(0.0439)
Schooling[b]	-0.0051	-0.0110	-0.0195	-0.0140
	(0.0052)	(0.0125)	(0.0198)	(0.0368)
Government size[a]	0.0126	0.0066	0.0367	0.0211
	(0.0083)	(0.0151)	(0.0243)	(0.0197)
Openness to Trade[a]				
Inflation[b]				
$TotIncomeTax_t^a$	0.0004	0.0063	0.0221	0.0218
	(0.0030)	(0.0086)	(0.0191)	(0.0314)
$TotConsTax\_VAT_t^a$	-0.0029	-0.0061	-0.0065	-0.0024
	(0.0049)	(0.0069)	(0.0121)	(0.0173)
Constant	0.2298***	0.5686***	0.7351***	0.7218**
	(0.0655)	(0.1267)	(0.1288)	(0.3173)
Observations	96	96	96	96
Number of Countries		14	14	14
Hansen Test (*p*-value)[c]			0.29	0.29
Test for 2^{nd} order serial correlation (*p*-value)[d]			0.31	0.30

Note. Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] In the regression, this variable is included as ln (variable).

[b] In the regression, this variable is included as ln (1+ variable).

[c] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[d] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B27. *Economic Growth Equation (1961-1995): Policy Conditioning Set (2)*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	Growth	Growth	Growth	Growth
VAT $Rate_t$	0.0010*	0.0013**	0.0031*	0.0030**
	(0.0006)	(0.0007)	(0.0019)	(0.0012)
Initial Income[a]	-0.0172***	-0.0496***	-0.0381**	-0.0880*
	(0.0058)	(0.0116)	(0.0154)	(0.0463)
Schooling[b]	-0.0022	-0.0065	0.0008	0.0034
	(0.0051)	(0.0112)	(0.0315)	(0.0353)
Government size[a]				
Openness to Trade[a]	0.0015	0.0033	-0.0735	-0.0445
	(0.0040)	(0.0155)	(0.0650)	(0.0457)
Inflation[b]				
$TotIncomeTax_t$[a]	0.0019	0.0024	0.0336	0.0604
	(0.0044)	(0.0075)	(0.0213)	(0.0385)
$TotConsTax\_VAT_t$[a]	-0.0050	-0.0069	0.0078	-0.0032
	(0.0049)	(0.0066)	(0.0081)	(0.0172)
Constant	0.1761***	0.4796***	0.2122*	0.6365*
	(0.0482)	(0.0983)	(0.1097)	(0.3263)
Observations	96	96	96	96
Number of Countries		14	14	14
Hansen Test (*p*-value)[c]			0.63	0.41
Test for 2nd order serial correlation (*p*-value)[d]			0.15	0.49

Note. Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] In the regression, this variable is included as ln (variable).

[b] In the regression, this variable is included as ln (1+ variable).

[c] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[d] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B28. *Economic Growth Equation (1961-1995): Policy Conditioning Set (3)*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	Growth	Growth	Growth	Growth
VAT $Rate_t$	0.0024***	0.0021***	0.0032**	0.0028*
	(0.0006)	(0.0007)	(0.0016)	(0.0016)
Initial Income[a]	-0.0224***	-0.0714***	-0.1357*	-0.0618*
	(0.0049)	(0.0166)	(0.0786)	(0.0360)
Schooling[b]	-0.0027	-0.0045	0.0045	-0.0398
	(0.0044)	(0.0102)	(0.0505)	(0.0392)
Government size[a]				
Openness to Trade[a]				
Inflation[b]	-0.0861*	0.0162	0.1277	0.1693
	(0.0477)	(0.0445)	(0.1115)	(0.1177)
$TotIncomeTax_t$[a]	0.0008	0.0053	0.0718*	0.0245
	(0.0026)	(0.0083)	(0.0423)	(0.0223)
TotConsTax_VAT_t[a]	-0.0019	-0.0040	0.0108	0.0204
	(0.0041)	(0.0077)	(0.0092)	(0.0181)
Constant	0.2237***	0.6575***	1.0414*	0.5055*
	(0.0434)	(0.1362)	(0.5667)	(0.2880)
Observations	96	96	96	96
Number of Countries		14	14	14
Hansen Test (*p*-value)[c]			0.39	0.60
Test for 2nd order serial correlation (*p*-value)[d]			0.42	0.38

Note. Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] In the regression, this variable is included as ln (variable).

[b] In the regression, this variable is included as ln (1+ variable).

[c] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[d] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Table B29. *Economic Growth Equation (1961-1995): Policy Conditioning Set (4)*

	(1)	(2)	(3)	(4)
	POLS	Two-Way FE	GMM-System One-Step	GMM-System Two-Step
	Growth	Growth	Growth	Growth
VAT $Rate_t$	0.0018***	0.0017*	0.0026***	0.0039**
	(0.0006)	(0.0009)	(0.0009)	(0.0019)
Initial Income[a]	-0.0182***	-0.0770***	-0.0751***	-0.0853**
	(0.0048)	(0.0215)	(0.0213)	(0.0347)
Schooling[b]	-0.0021	-0.0195	-0.0307	-0.0297
	(0.0047)	(0.0151)	(0.0228)	(0.0775)
Government size[a]	-0.0078	0.0007	-0.0060	0.0358
	(0.0109)	(0.0175)	(0.0634)	(0.1149)
Openness to Trade[a]	-0.0011	0.0076	-0.0365	-0.0363
	(0.0039)	(0.0192)	(0.0413)	(0.0680)
Inflation[b]	-0.0803	-0.0047	0.0299	0.0754
	(0.0499)	(0.0653)	(0.0586)	(0.1525)
$TotIncomeTax_t^a$	0.0030	0.0078	0.0594	0.0297
	(0.0046)	(0.0096)	(0.0563)	(0.0710)
$TotConsTax\_VAT_t^a$	-0.0004	-0.0023	-0.0035	-0.0084
	(0.0048)	(0.0088)	(0.0094)	(0.0176)
Constant	0.1474**	0.7272***	0.5582***	0.7886***
	(0.0617)	(0.1919)	(0.1147)	(0.2274)
Observations	96	96	96	96
Number of Countries		14	14	14
Hansen Test (*p*-value)[c]			0.59	0.50
Test for 2nd order serial correlation (*p*-value)[d]			0.37	0.59

Note. Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] In the regression, this variable is included as ln (variable).

[b] In the regression, this variable is included as ln (1+ variable).

[c] The null hypothesis is that the instruments used are uncorrelated with the residuals.

[d] The null hypothesis is that the errors in the first-difference regression exhibit no second-order correlation.

Appendix C: Figures Appendix
Annual Effective VAT Rates in Individual EU Countries (1961-2000)

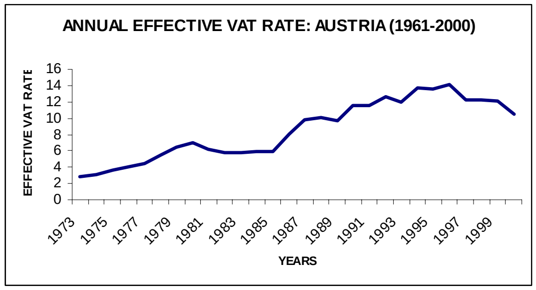

Figure C1. *Annual Effective VAT Rate: Austria (1961-2000)*

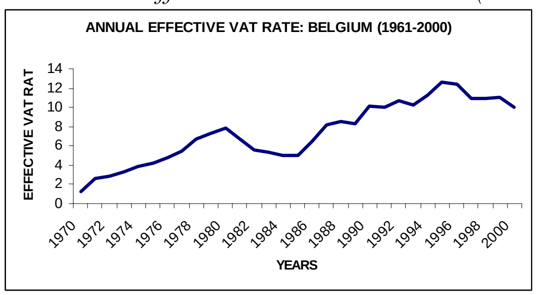

Figure C2. *Annual Effective VAT Rate: Belgium (1961-2000)*

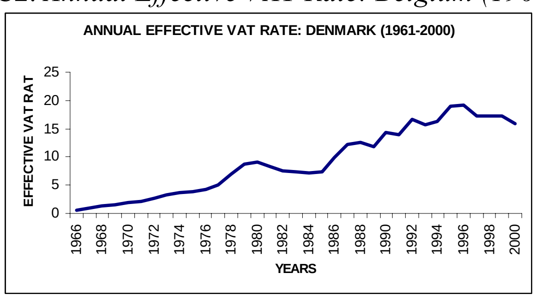

Figure C3. *Annual Effective VAT Rate: Denmark (1961-2000)*

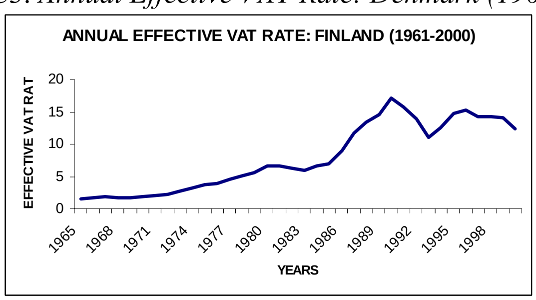

Figure C4. *Annual Effective VAT Rate: Finland (1961-2000)*

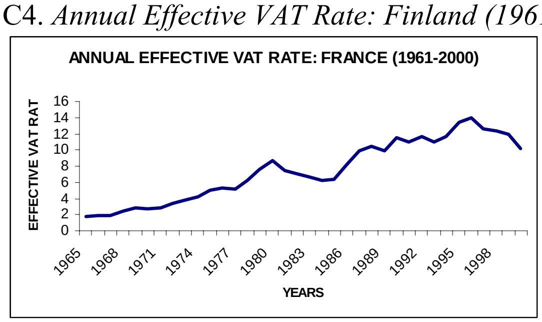

Figure C5. *Annual Effective VAT Rate: France (1961-2000)*

Annual Effective VAT Rates in Individual EU Countries (1961-2000)…Cont'd.

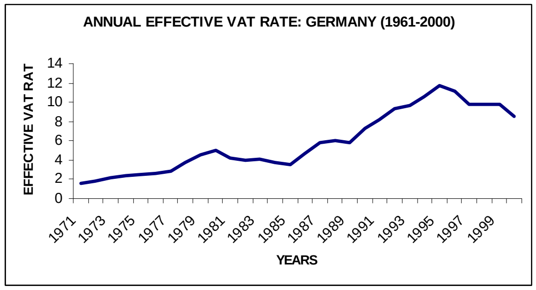

Figure C6. *Annual Effective VAT Rate: Germany (1961-2000)*

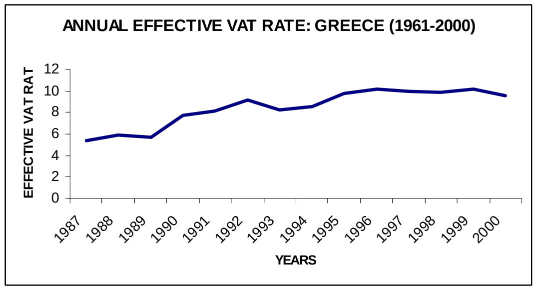

Figure C7. *Annual Effective VAT Rate: Greece (1961-2000)*

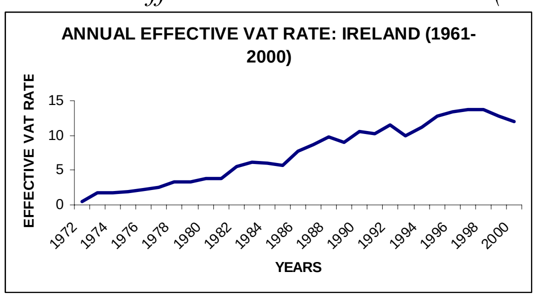

Figure C8. *Annual Effective VAT Rate: Ireland (1961-2000)*

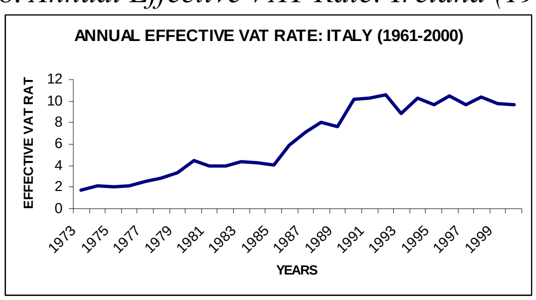

Figure C9. *Annual Effective VAT Rate: Italy (1961-2000)*

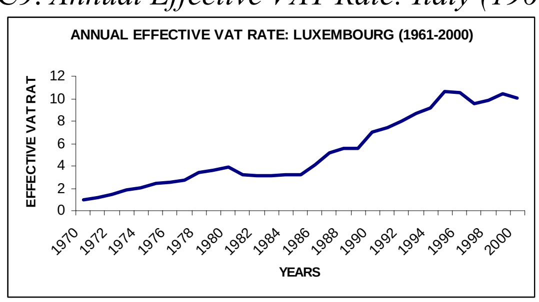

Figure C10. *Annual Effective VAT Rate: Luxembourg (1961-2000)*

Annual Effective VAT Rates in Individual EU Countries (1961-2000)…Cont'd.

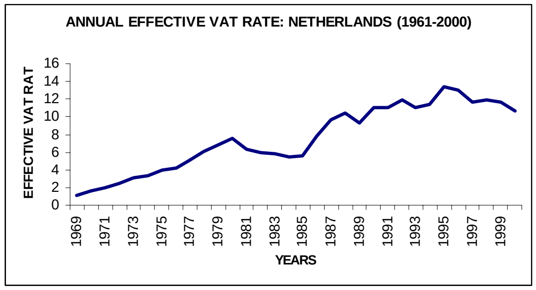

Figure C11. *Annual Effective VAT Rate: Netherlands (1961-2000)*

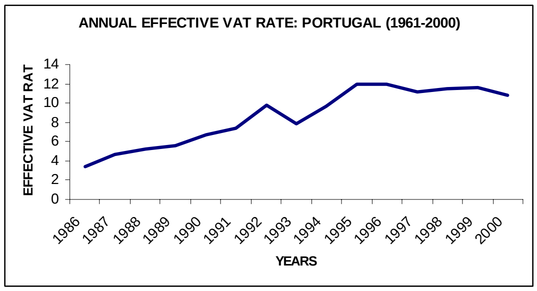

Figure C12. *Annual Effective VAT Rate: Portugal (1961-2000)*

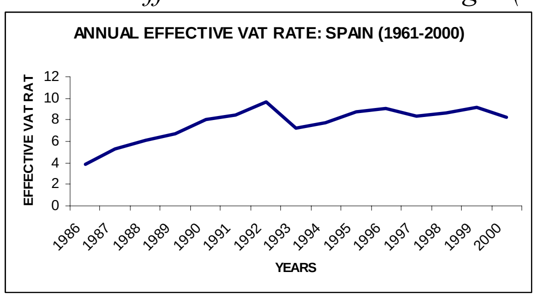

Figure C13. *Annual Effective VAT Rate: Spain (1961-2000)*

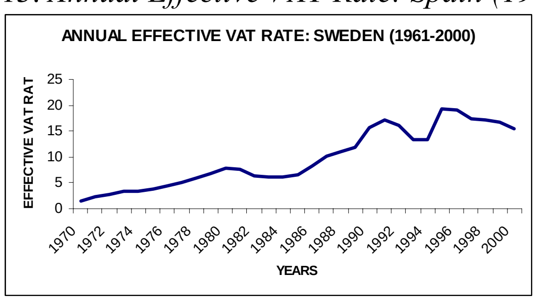

Figure C14. *Annual Effective VAT Rate: Sweden (1961-2000)*

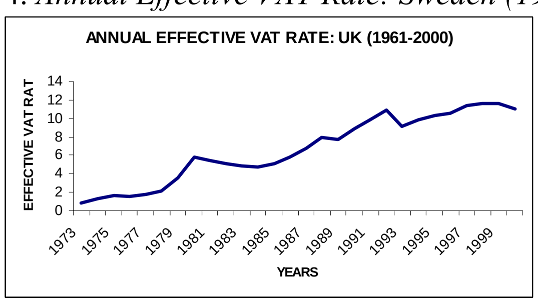

Figure C15. *Annual Effective VAT Rate: UK (1961-2000)*

Five-Year Effective VAT Rates in Individual EU Countries (1961-2000)

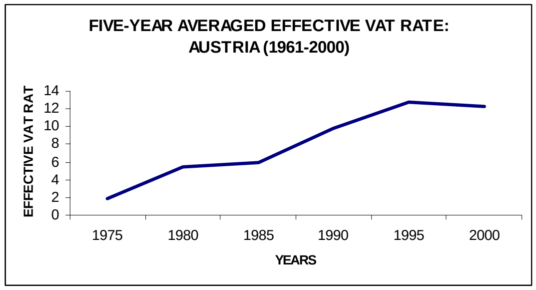

Figure C16. *Five-Year Averaged Effective VAT Rate: Austria (1961-2000)*

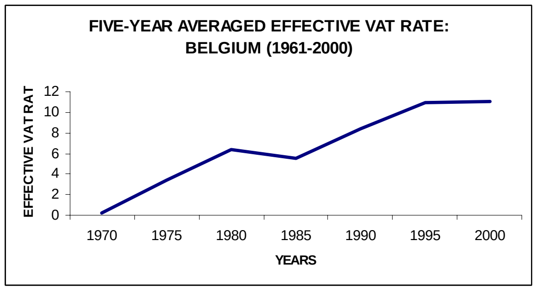

Figure C17. *Five-Year Averaged Effective VAT Rate: Belgium (1961-2000)*

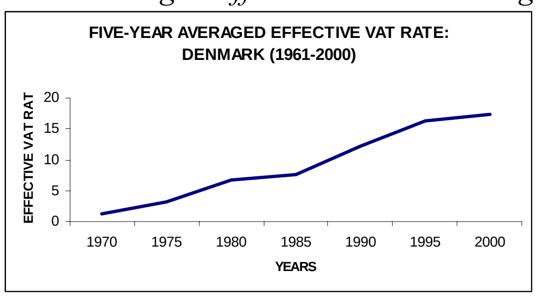

Figure C18. *Five-Year Averaged Effective VAT Rate: Denmark (1961-2000)*

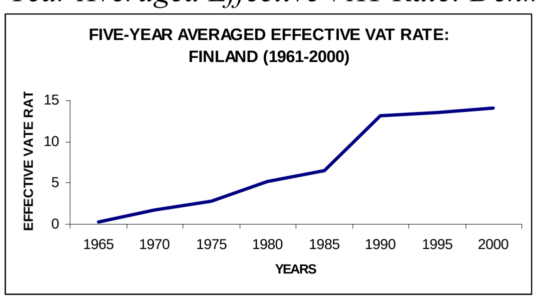

Figure C19. *Five-Year Averaged Effective VAT Rate: Finland (1961-2000)*

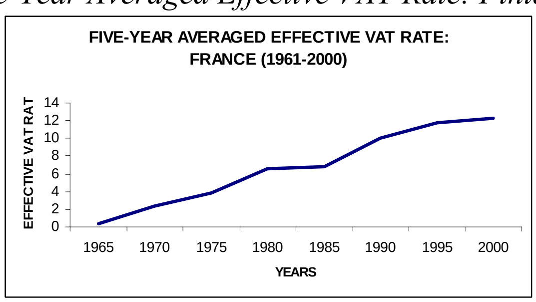

Figure C20. *Five-Year Averaged Effective VAT Rate: France (1961-2000)*

Five-Year Effective VAT Rates in Individual EU Countries (1961-2000)…Cont'd.

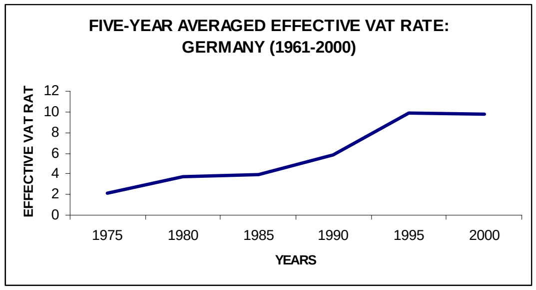

Figure C21. *Five-Year Averaged Effective VAT Rate: Germany (1961-2000)*

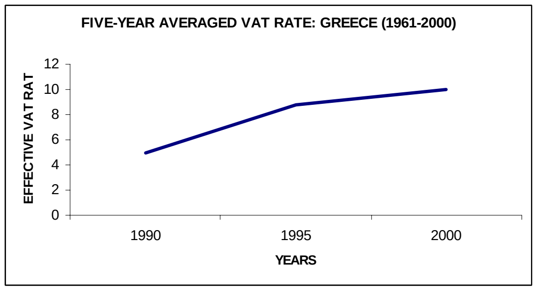

Figure C22. *Five-Year Averaged Effective VAT Rate: Greece (1961-2000)*

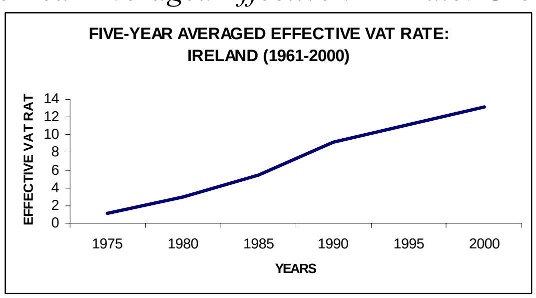

Figure C23. *Five-Year Averaged Effective VAT Rate: Ireland (1961-2000)*

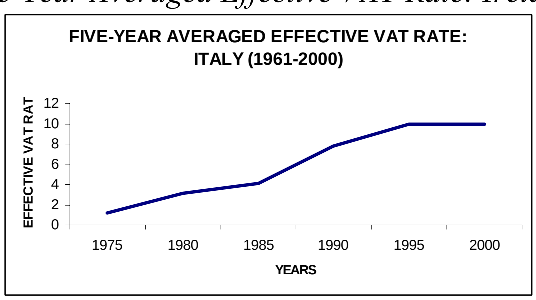

Figure C24. *Five-Year Averaged Effective VAT Rate: Italy (1961-2000)*

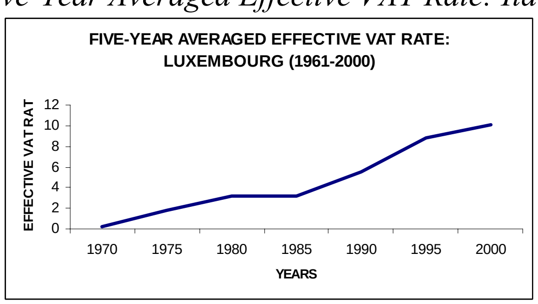

Figure C25. *Five-Year Averaged Effective VAT Rate: Luxembourg (1961-2000)*

Five-Year Effective VAT Rates in Individual EU Countries (1961-2000)…Cont'd.

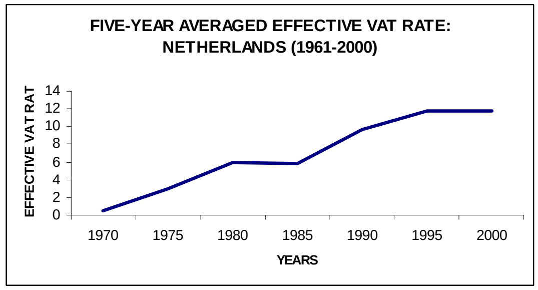

Figure C26. *Five-Year Averaged Effective VAT Rate: Netherlands (1961-2000)*

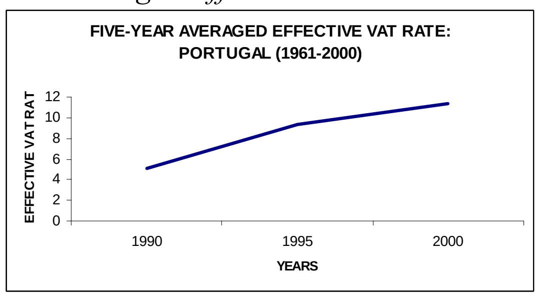

Figure C27. *Five-Year Averaged Effective VAT Rate: Portugal (1961-2000)*

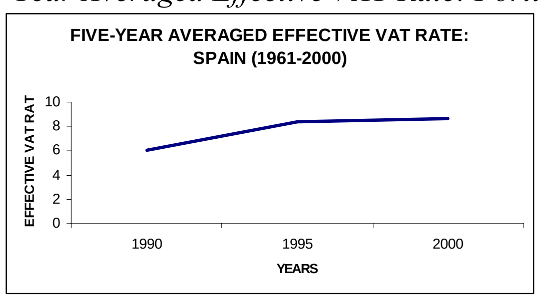

Figure C28. *Five-Year Averaged Effective VAT Rate: Spain (1961-2000)*

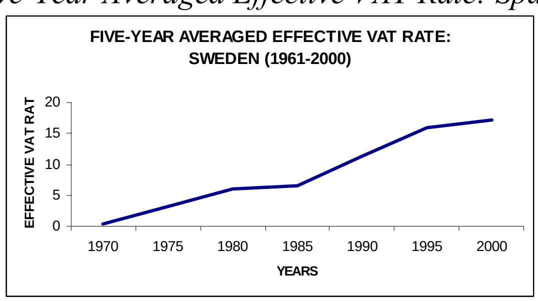

Figure C29. *Five-Year Averaged Effective VAT Rate: Sweden (1961-2000)*

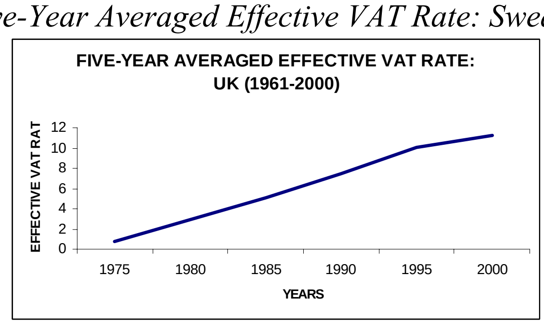

Figure C30. *Five-Year Averaged Effective VAT Rate: UK (1961-2000)*

Annual and Five-Year Effective VAT Rates in Average EU Countries (1961-2000)

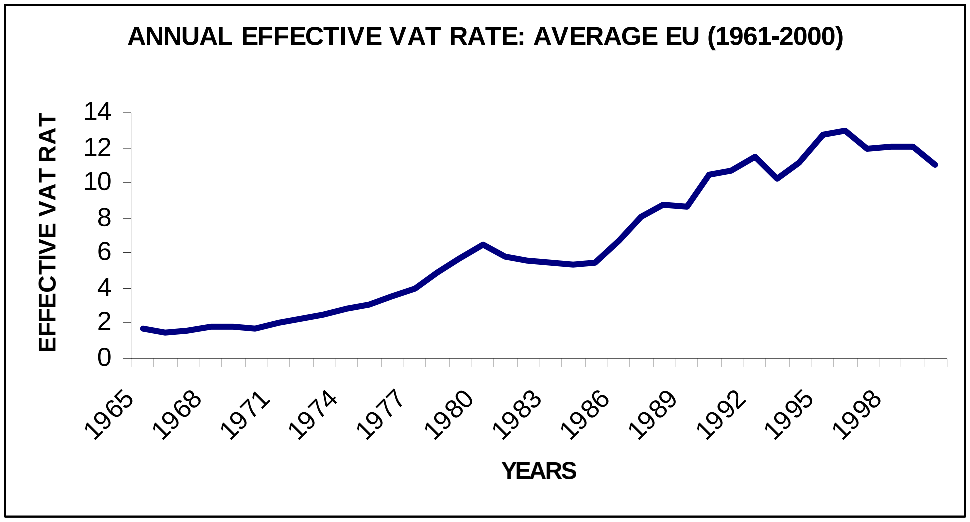

Figure C31. *Annual Effective VAT Rate: Average EU (1961-2000)*

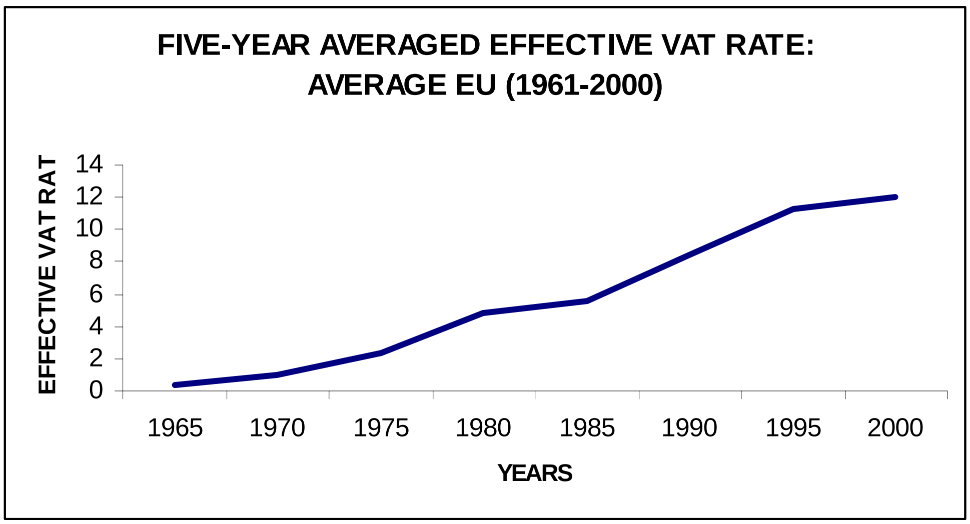

Figure C32. *Five-Year Averaged Effective VAT Rate: Average EU (1961-2000)*

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Asmaa El-Ganainy, from Egypt, completed her Bachelor of Science and Master of Science degrees in Agricultural Economics at Cairo University, Egypt. Before coming to the United States to pursue higher education, she worked as an instructor and then as an assistant lecturer at Cairo University. While working in Cairo University, she had the opportunity to work as a research associate for several international organizations, such as the International Food Policy Research Institute, the World Food Programme of the United Nations, and Abt. Associates (a U.S.-based consulting firm).

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