ENDOGENOUS GROWTH TESTING IN THE EUROPEAN UNION AND DEVELOPING COUNTRIES: TAXATION, PUBLIC EXPENDITURE AND GROWTH

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ABSTRACT

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In endogenous growth models, in contrast to the neoclassical growth models, government expenditure and taxation have an effect on the long run growth rate. In this thesis I examine whether the empirical evidence support the predictions of endogenous growth models or the neoclassical growth models in relation to fiscal policy. For this purpose I use panel data for fifteen European Union (EU) member and thirty-three developing countries between the years 1970 and 1999. I specifically test the following two propositions. The first proposition states that distortionary taxation decreases growth while non-distortionary taxation does not. The second, states that productive government expenditure increases growth while non-productive expenditure does not. The empirical results are quite different between European

Union countries and developing countries. The results do not support endogenous growth especially for developing countries.

Keywords: Endogenous Growth Models, Neoclassical Growth Models, Public Expenditure, Taxation, Panel Data, Fixed Effects

ÖZ

AVRUPA BİRLİĞİ ÜLKELERİNDE VE GELİŞMEKTE OLAN ÜLKELERDE ENDOJEN BÜYÜMENİN

TEST EDİLMESİ: KAMU HARCAMALARI, VERGİLENDİRME VE BÜYÜME

Derin, Pınar

M.S., Ekonomi Bölümü

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Neoklasik büyüme modellerinin tersine endojen büyüme modellerinde hükümet harcamalari ve vergilendirmenin uzun dönem büyüme üzerinde etkisi mevcuttur.

Bu tezde ampirik sonuçların endojen büyüme modellerini mi yoksa neoklasik büyüme modellerini mi desteklediğini araştırdım. Bu sebeple 15 Avrupa Birliği ülkesi ile 33 gelişmekte olan ülke için 1970-1990 yıllarına ait panel veriler kullanılmıştır. Özellikle test ettiğimiz iki söylem şöyledir: Biricisine göre yatırım istekliliğini değiştiren vergilendirme büyümeyi azaltir, yatırım istekliliğini değiştirmeyen vergilendirmenin böyle bir etkisi yoktur. İkinci söylemde, üretken hükümet harcamalari büyümeyi arttırırken üretken olmayan harcamalarin böyle bir etkisi yoktur. Bulunan ampirik sonuçlarda Avrupa birliği ülkeleri ve gelişmekte olan ülkelerde ciddi farklılıklar saptanmıştır ve özellikle gelişmekte olan ülkelerdeki sonuçların endojen büyüme modellerini desteklemediği görülmüştür.

Anahtar Kelimeler: Endojen Büyüme Modelleri, Neoklasik Büyüme Modelleri, Kamu Harcamaları, Vergilendirme, Panel Veriler, Sabit Etkiler Modeli

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Date: Signature:

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CHAPTER 1

INTRODUCTION

In economics, growth has always been one of the most important concepts. Economists have been trying to find out the main determinants of growth for decades. Rather than the short run fluctuations in the GDP rates, the long-run growth performance of countries can sometimes be more important and indicative about the economic conditions in these countries. That is why it becomes crucial to work on long-run growth rates. Endogenous growth theory has in fact many implications. The research and development, the human capital and fiscal policy endogenous growth models are some popular growth models where endogenous factors affect long-run growth. Among these, I decided to work on public policy endogenous growth models because of my special interest on fiscal policy. I decided to find out if the government can influence long-run growth rates. In the neoclassical growth models, growth can be affected only by exogenous variables like labor force growth or technology. In contrast to this view endogenous growth theory postulates that endogenous factors like government expenditures and taxation have significant effects on the long-run income growth rates. The debate between these two important views makes the subject even more interesting to work on. The models and the main differences between the public policy endogenous growth models and the neoclassical growth models are reviewed in Chapter 2.

Therefore I study fiscal policy endogenous growth models in which the composition of taxation and public expenditures is effective on growth. In a world with scarce resources it becomes important to answer the following question: ‘ Is it possible to enhance the growth performance of a country by changing the composition of government expenditures towards productive expenditures and the composition of taxation against income taxes?’

In the estimation process, I specifically test the following two propositions: The first proposition states that distortionary taxation decreases growth while non-distortionary taxation does not. The second one states that productive government expenditure increases growth while non-productive expenditure does not.

The main purpose of this thesis is to check if endogenous growth theory holds empirically, implying that public expenditures and taxation have long-run impacts on the per capita growth rate. In developing countries, the economic concepts and their determinants can sometimes be quite different from developed countries. That is why I will extend Bleaney et al. (2001), who analyze the OECD countries, to two groups of countries: developed (European Union) and developing countries. In the empirical part, I will employ panel data for 33 developing and 15 European Union (EU) countries between 1970-1999 by taking five-year averages. I expect to find different results in the EU and developing countries. The differences in the results might inform us that diverse policy actions are to be taken in order to improve growth in developing countries and developed countries.

Most of the empirical literature employs panel data estimation in growth models. Panel data estimation techniques used in econometrics will be discussed in Chapter 3.

In Chapter 4 a review of existing empirical evidence is given. By using the estimation techniques discussed in Chapter 3, in Chapter 5 the regressions are carried out and empirical results are given. It is important to specify the budget constraint correctly in order to avoid biased results in the estimation of the models. In the literature, the results of public policy endogenous growth model regressions are sometimes biased since they do not specify the budget constraint correctly. Including only government expenditures or taxation might bias the results. The regression analysis in the empirical results part is performed by taking this into account in Section 5.4.2

One of the main problems associated with the estimation of growth models is the endogeneity of the fiscal variables and investment. Introducing relevant and exogenous variables as instrumental variables can solve this problem. The models I estimate in Chapter 5 suffer from the problem of endogeneity. Therefore in Section 5.4.3 I perform instrumental variables estimation to solve this problem. Finally, Chapter 6 presents the conclusions.

CHAPTER 2

GROWTH MODELS

2.1 Introduction

Economists, in some sense have always emphasized that economic growth is important. As a discipline core economic growth theory was born in the late 1960s. After two decades, growth theory became popular again in the mid 1980's by the emphasis on the long-run growth, which is now called endogenous growth theory. It is understood that long-run economic growth is at least as important as short-run fluctuations of growth and in fact it is even more important than that. For instance, it might be important to know why GDP of a country raised three or four percent in the last couple of months. However, it might be even more important to know why African countries have quite low GDP rates than their European counterparts. Or why a country's GDP fell during the last century. The new growth theory or the endogenous growth theory, underlines the importance of the latter questions, related with the long-run growth performances, rather than the former.

Can the government decisions on the share of public expenditure in output or on the composition of expenditures and taxation affect the steady state growth rate? The answer is absolutely 'no' in the case of the neoclassical growth models of Solow (1956), Swan (1956), Cass (1965) and Koopmans (1965). In neoclassical growth models government policy can not have sustained effects on growth rate of per capita income, although government can even influence the population growth which is assumed to affect the growth rate. In these models, if incentives to save or to invest in new capital are affected by fiscal policy, there will be a change in equilibrium capital output ratio and therefore the output path will change, leaving the steady state growth rate unchanged. The long-run growth rate is driven by exogenous factors of population growth and technological progress while public policy can only influence the transition path of the economy towards steady state growth rate. According to the economists supporting 'endogenous growth models' (Barro (1990), King and Rebelo (1990), Lucas (1990), Mendoza et al. (1997), Stokey and Rebelo (1995), Easterly and Rebelo (1993)) the share of public expenditure in output or the composition of expenditures and taxation affect the steady state growth rate. This is in contrast to the neoclassical growth theory where only investment in physical and human capital affects the steady state growth rate. Therefore in the endogenous growth models there is more scope that at least some elements of fiscal variables may influence long-run growth.

Before moving to the empirical analysis it is important to outline the basic public policy endogenous growth model that our empirical analysis rests upon. In this chapter I will outline what endogenous growth theory indicates and what kind of contradictory ideas it involves compared to neoclassical growth models. Brief summaries of the Neoclassical and Endogenous growth models are given in Section 2, to provide the necessary background for the estimation. This chapter depends on Barro and Sala-i-Martin (1995).

2.2 Neoclassical Growth Models (The Solow Model)

While thinking about economic growth, the basic neoclassical model of capital accumulation of Solow (1956), Swan (1964), Cass (1965) and Koopmans (1965) come to our minds. Therefore it might be meaningful to understand the neoclassical, model in order to recognize the emerging ideas that the endogenous growth theory added to the concept of growth. Within this framework I will first set up the neoclassical model of income determination. Then I will present the Solow model and its properties as a special case of that model.

The basic general equilibrium structure, that is common both to the old and the new theories of growth, imply that households own inputs and assets of the economy and choose to consume or save. In addition to this, each household decides on how many children to have, to join to the labor force or not and how much to work or enjoy leisure. There exist firms hiring inputs, like capital and labor, which are used in the production of goods that are sold to other firms and households in the markets. Also in the markets households sell inputs to firms. The relative prices of both inputs and goods are determined by quantities demanded and supplied. For simplification, in the basic models firms and markets are excluded.

The neoclassical model of growth has become the backbone of macroeconomic theory over the last 20 years and more. Thus its main properties are common to most of the models of growth. These properties are that the aggregate output is produced with a neoclassical technology and that markets are competitive and in equilibrium. This is in fact what we call the neoclassical model. The main implication of the neoclassical model is that, at any time output is entirely determined by the supply of productive inputs (labor and capital) and that the aggregate variables over time is determined by households' choices of consumption /saving and work/leisure.

The structure of the economy is assumed to be as follows:

There are only two inputs, physical capital, K, and labor, L to produce goods and services. Thus, given labor supply L; the production function takes the following form:

$$Y = F(K, L) \tag{2.2.1}$$

where Y is the flow of output. The production function is called neoclassical if it satisfies the following three properties. Firstly, for all K>0 and L>0. F (.) display positive and decreasing marginal product in each input,

$$\frac{\partial F}{\partial K} > 0 \qquad \frac{\partial F}{\partial L} > 0 \tag{2.2.2}$$

$$\frac{\partial^2 F}{\partial K^2} < 0 \qquad \frac{\partial^2 F}{\partial L^2} < 0 \tag{2.2.3}$$

Secondly, the production function exhibits constant returns to scale (CRS), so that,

F (λK, λL) = λ.F (K, L) for all λ> 0. (2.2.4)

Lastly, the marginal product of capital (or labor) approaches infinity as capital (or labor) goes to zero and the marginal product of capital (or labor) approaches zero as capital (or labor) goes to infinity:

$$\lim_{K \to 0}(F_k) = \lim_{L \to 0}(F_L) = \infty \tag{2.2.5}$$

$$\lim_{K \to \infty}(F_k) = \lim_{L \to \infty}(F_L) = 0 \tag{2.2.6}$$

The condition of constant returns to scale implies that:

$$Y = F(K, L) = L.F(K/L, 1) = L.f(k) \tag{2.2.7}$$

where $k = K/L$ is the capital labor ratio and $y = Y/L$ is per capita output. By using the above information we can express the production in the intensive form like:

$$y = f(k) \tag{2.2.8}$$

In the production function of constant returns to scale, it can be thought that a representative, single firm can characterize the productive behavior of the economy as a whole.

When we move from the production process to the supply of inputs we see that households in the economy own the inputs. The supply of capital, K (t), changes in time as the result of investment decisions,

$$\dot{K}(t) = I(t) - \delta K(t) = s.F(K,L) - \delta K \qquad (2.2.9)$$

where δ is the rate of depreciation, dot over a variable such as $\dot{K}(t)$ shows the change in time, differentiation with respect to time and $0 \le s \le 1$ defines the saving rate. Notice that we are using continuous-time (the discrete-time version is of $\dot{K}(t)$ is $K_{t+1} - K_t = I_t - \delta K_t$).

The labor force L, changes over time as population, labor force participation and working hours of a typical worker changes. Likewise, growth of population reflects the behavior of migration, mortality and fertility. By assuming that population grows at a constant rate and everybody works at a given intensity, then $\dot{L}/L = n \ge 0$.

If we divide the both sides of equation (2.2.9) by L, then we get:

$$\dot{K}/L = s.f(k) - \delta.k \qquad (2.2.10)$$

The $\dot{K}/L$ can be written as a function of k as

$$\dot{k} \equiv \frac{d(K/L)}{dt} = \dot{K}/L - nk \qquad (2.2.11)$$

If we rearrange the above equations we get

$$\dot{k} = s.f(k) - (n+\delta).k \qquad (2.2.12)$$

The equation (2.2.12) is the fundamental differential equation of the Solow-Swan model where $(n+\delta)$ stands for the effective depreciation rate for capital labor ratio. When saving rate is zero, capital labor ratio declines both due to depreciation of K at a rate of δ and due to growth of L at rate of n.

At the steady state the various quantities grow at a constant rate. In the Solow model the steady state equilibrium corresponds to $\dot{k} = 0$ where the value of k can be denoted by k^*. k^* will algebraically satisfy the condition

$$s.f(k^*) = (n+\delta).k^* \qquad (2.2.13)$$

therefore the per capita quantities k, y and c are not growing at the steady state. The per capita values are constant and they depend on K, Y, and C growing at the same rate as the rate of population growth.

It might be meaningful to mention in this step that changes in the level of saving rate, technology, rate of population growth and depreciation rate do not have an effect on the steady state growth rates of per capita output, capital and consumption, as all are equal to zero at this stage. In order to give explanations on the long-run determinants of economic growth the specification of the above model needs to be changed.

In the Solow-Swan (1956) models the long-run growth rates are determined by exogenous elements. The growth rate of per capita income can be shown as:

$$\gamma_y \equiv \dot{y}/y = f'(k).\dot{k}/f(k) = [k.f'(k)/f(k)]\gamma_k \qquad (2.2.14)$$

where γ_y stands for growth rate of per capita income. γ_k can be shown as:

$$\gamma_k \equiv \dot{k} / k = s.f(k)/k - (n+\delta) \qquad (2.2.15)$$

The expression under the brackets in equation (2.2.14) is usually called capital share, which is rental income on capital in total income. Therefore equation (2.2.14) shows that the relation of γ_y and γ_k depends on the capital share. If we substitute (2.2.15) into (2.2.14) we can get more generally,

$$\gamma_y = s.f'(k) - (n+\delta).cap.share$$

where $cap.share = k.f'(k)/f(k)$

In the model of Solow-Swan (1956) a constant saving rate is assumed where the level of consumption per person is given by $c = (1-s).y$. Therefore $\gamma_c = \gamma_y$ as consumption exhibits the same dynamics as output.

2.3 Endogenous Growth Models

In the middle of 1980's some economists like Romer (1986) became dissatisfied with the neoclassical growth model where the long-run growth is wholly explained by exogenous factors in the economy. As a result of this dissatisfaction new growth models emerged. In these models the key determinants of growth were endogenous factors to the model. The name endogenous growth models is given to these theories since according to these theories determination of long-run growth rates are explained within the model, rather than by some exogenous variables. The Solow-Swan (1956) model, just like the Ramsey (1928) model, finds out that steady-state per capita growth rate depends on the rate of technological progress. In these models technological progress is taken to be exogenous hence these models are not helpful for understanding the determinants of long-term growth rates.

2.3.1 One Sector Models of Endogenous Growth

The basic property of endogenous growth models is that there are no diminishing returns to capital. Although the absence of diminishing returns to capital is unrealistic, if we assume capital in a broader sense that also includes human capital then it seems much more meaningful.

A simple type of production function without diminishing returns to scale can be written as follows:

$$Y = AK \quad ,$$

A is a positive constant reflecting the level of technology. Output per capita is:

$$y = Ak$$

In this equation marginal and average products are equal to a constant A, where A>0. In this model, anything that results in a change in A also affects the long-term per capita growth rate. Various activities of government can be seen as having impacts on the coefficient A and therefore on the long-term growth rate using fiscal policy endogenous growth models. Changes in government activities will result in the shift of the production function affecting both the steady state growth rates and transition to steady state growth rates.

2.3.1.1 Behavior of Households

The important feature of public-policy endogenous growth models of Barro (1990) is that by the fiscal policy both the level of output path and steady state growth rate of per capita income are affected. Barro and Sala-i Martin (1992) has shown this. This model can help us answer why some countries have different growth rates over long periods of time. In the model, government's choices of tax rates and expenditure levels influence the long-term growth rates. In addition to this, a closed economy and a common household's choice on consumption and saving are assumed in the model. The representative infinite lived household aims to maximize the overall utility:

$$U = \int_0^\infty U(c) e^{-(\rho - n)t} dt \qquad (2.3.1)$$

where ρ denotes the time preference and c denotes consumption per person respectively and U(c) is defined as follows:

$$U(c) = \frac{c^{1-\theta} - 1}{1-\theta} \quad \text{where } \theta > 0 \qquad (2.3.2)$$

From equation (2.3.2) it can be seen that marginal utility has constant elasticity, which is equal to –θ.

The representative infinite lived household maximizes the overall utility given by equation (2.3.3) subject to the budget constraint of the household:

$$\dot{a} = (r - n).a + w - c \qquad (2.3.3)$$

where a denotes the quantity of real assets per person, r is the interest rate that denotes real rate of return which can be calculated by a ratio of future consumables to current consumables, w is the wage rate, n is the population growth and $\dot{a}$ represents the change in real assets as given by equation (2.3.3).

If we maximize the utility function (2.3.1) subject to the budget constraint of the household shown by equation (2.3.3) we will get the growth rate of consumption per person which is:

$$\gamma_c = \frac{\dot{c}}{c} = (1/\theta)(r - \rho) \qquad (2.3.4)$$

where

$$r = \rho + \theta\gamma_c \tag{2.3.5}$$

and the transversality condition:

$$\lim_{t\to\infty}\{a(t).\exp[-\int_0^t (r(v) - n)dv]\} = 0 \tag{2.3.6}$$

Therefore when the growth rate of consumption per person is positive, r showing the premium should be larger than the time preference from equation (2.3.5)

2.3.1.2 Behavior of the Firms

Assume that there are n producers and they are producing output y in accordance with the linear production function given by,

$$y = f(k) = Ak \tag{2.3.7}$$

where A>0. The production function is different from the neoclassical production function as there is no diminishing marginal product of capital, as $f''(k) = 0$. Equations (2.2.5) and (2.2.6) are to be violated as $f'(k) = A$ when k goes to zero or infinity.

In order to maximize the profit of the firms, marginal product should be equal to the rental price where the rental price is:

$$R = r + \delta \tag{2.3.8}$$

If we assume marginal product of capital is constant at A, then

$$r = A - \delta \tag{2.3.9}$$

Therefore the real rate of return on capital should be equal to marginal product of capital minus the depreciation rate, when firms are maximizing their profits.

As marginal product of labor is zero, the wage rate, w, will also be zero.

2.3.1.3 Equilibrium Condition

Assume a closed economy so that $a = k$ holds, hence assets per person is equal to capital per person. When $a = k$, $r = A - \delta$, and wage rate being zero are substituted to the above equations (equations (2.3.3), (2.3.4), (2.3.6)) the equations below can be derived.

$$\dot{k} = (A - \delta - n).k - c, \qquad (2.3.10)$$

$$\gamma_c = (1/\theta).(A - \delta - \rho) \qquad (2.3.11)$$

$$\lim_{t \to \infty} \{k(t).e^{-(A-\delta-n).t}\} = 0 \qquad (2.3.12)$$

From equation (2.3.11) it can easily be seen that the growth rate of consumption does not depend on k, stock of capital per person. Alternatively, if at time 0 consumption per capita is c (0) and at time t it is c (t), c (t) will be given by:

$$c(t) = c(0).e^{(1/\theta).(A-\delta-\rho).t} \qquad (2.3.13)$$

Under the assumption that the production function is productive enough for a growth in c but not so productive to avoid unbounded utility:

$$[(1-\theta)/\theta].(A - \delta - \rho) + n + \delta < \rho + \delta < A \qquad (2.3.14)$$

where $\rho + \delta < A$ implying that γ_c is positive and the first part of the equation (2.3.14) implies that the utility is to be bounded and therefore the transversality condition holds.

2.3.1.4 Transitional Dynamics

The model in fact has no transitional dynamics. This means that growth rates γ_k and γ_y are constant and they are equal to the growth rate of consumption, γ_c represented in equation (2.3.11).

When c (t) in equation (2.3.13) is substituted into the consumption growth equation in (2.3.11). We obtain the following:

$$\dot{k} = (A - \delta - n).k - c(0).e^{(1/\theta).(A-\delta-\rho).t} \qquad (2.3.15)$$

where $\dot{k}$ denotes the first difference of k.

From equation (2.3.15) the general solution of k can be derived as follows:

$$k(t) = (constant).e^{(A-\delta-n).t} + [c(0)/\lambda].e^{(1/\theta).(A-\delta-\rho).t} \qquad (2.3.16)$$

where $\lambda = (A-\delta).(\theta-1)/\theta + \rho/\theta - n$. From the condition (2.3.14), λ is positive.

When equation (2.3.16) showing *k(t)* is substituted into the transversality condition denoted by equation (2.3.12), the equation below can be derived.

$$\lim_{t\to\infty}\{constant + [c(0)/\lambda].e^{-\lambda t}\} = 0$$

As long as λ is positive, the transversality condition implies that the constant should be zero. By using equation (2.3.13) and (2.3.15) one can find that:

$$c(t) = \lambda.k(t) \qquad (2.3.17)$$

$$\gamma_k = \gamma_c = (1/\theta).(A - \delta - \rho) \qquad (2.3.18)$$

As $y = Ak$, it implies that $\gamma_k = \gamma_c = \gamma_y = \gamma$ and there is no transitional dynamics that capital, consumption and income all grow at a constant rate γ, which is equal to $(1/\theta).(A - \delta - \rho)$.

2.3.1.5 Determinants of Growth Rate

The major difference between the endogenous growth model and the Solow (1956) growth model is related to the determination of long-run growth rate as it has been mentioned before. In the endogenous growth model where $y = Ak$, the long-run growth rate, just like the short-run growth rate, depends on the parameters affecting willingness to save and productivity of capital as can be seen in equation (2.3.18). Low values of ρ (time preference) and high values of -θ (elasticity of marginal utility) imply higher per capita growth rates and higher saving rates.

Changes in *A*, showing improvement in technology for example, raises the long-run growth rate and changes the saving rate by affecting the average and marginal products of capital. It is also obvious that changes in the government policies resulting in a shift of *A*, have an impact on long-run growth rates.

2.3.1.6 Public Policy Endogenous Growth Models

As already mentioned in the one sector model of endogenous growth, the level of technology, A, affects the long-run per capita growth. Various activities of the government can be seen as a determinant of *A*, like taxation or government expenditures of some economic activity.

There are assumptions at this stage. Firstly, government buys some private sector goods and services and uses these in order to provide free public services to private producers. Secondly, the government's production function does not differ from the production function of each firm.

G represents the total purchases of government. We assume that *G* is non-rival and non-excludable therefore usage of public goods by one person does not decrease the usage of it by others. In fact this assumption is not so valid as there is a limited amount of non-rival and non-excludable public goods in reality.

As was assumed by Barro (1990) the production function will be assumed to have a Cobb-Douglas form:

$$Y_i = AL_i^{1-\alpha}.K_i^{\alpha}.G^{1-\alpha} \qquad (2.3.19)$$

where $0 < \alpha < 1$.

In equation (2.3.19), there are constant returns to scale in terms of private inputs like, *K* and *L*. Under the assumption that labor force, *L*, is constant; if *G* is given fixed, there are diminishing returns to aggregate capital, *K*. However, if *G* increases with *K*, rather than diminishing returns there will be constant returns to scale as *L* is fixed. Therefore just like the model where $Y = F(K) = AK$ the economy is able to grow endogenously.

If the exponent of government purchases is smaller than $1-\alpha$, there will be diminishing returns to scale and because of the diminishing returns, the endogenous growth modeling does not work in the sense that change in *G* cannot affect the income level. Just the reverse of the previous case, if the exponent is larger than $1-\alpha$, the growth rates will increase over time. Hence, we should focus on the special case where exponent of *G* is equal $1-\alpha$. As there is constant returns to scale in *G* and K_i the economy is able to grow endogenously.

Assume that there is a balanced budget so that the government purchases is equal to the tax revenues collected by a proportional tax rate of τ on aggregate gross output:

$$G = \tau.Y \qquad (2.3.20)$$

Under the assumption that τ therefore the G/Y ratios are constant over time, then the firm's after tax profit is:

$$L_i.\left[(1-\tau).A.k_i^{\alpha}.G^{1-\alpha} - w - (r+\delta).k\right] \qquad (2.3.21)$$

where w denotes the wage rate $k_i = K_i / L_i$, (capital-labor ratio) and $r+\delta$ is the rental rate. From the profit maximization and zero-profit condition we know that the wage rate will be equal to the marginal product of labor after tax and the rental rate will be equal to the marginal product of capital after tax. When we assume k_i is held constant at k then the rental price will be:

$$r+\delta = (1-\tau).(\partial Y_i / \partial K_i) = (1-\tau).\alpha.A.k^{-(1-\alpha)}.G^{1-\alpha} \qquad (2.3.22)$$

By using the Cobb-Douglas production function and the balanced budget condition we can denote *G* as:

$$G = (\tau AL)^{1/\alpha}.k \qquad (2.3.23)$$

where *L* denotes lump-sum (non-distortionary) taxation.

If we substitute equation (2.3.23) into equation (2.3.22) we find:

$$r+\delta = (1-\tau).(\partial Y_i / \partial K_i) = (1-\tau).\alpha.A.^{1/\alpha}(L\tau)^{(1-\alpha)/\alpha} \qquad (2.3.24)$$

Marginal product of capital after tax is shown in the right hand side of equation (2.3.24), having the same effects as *A* in the *AK* model where $Y = F(K) = AK$.

When there is no transitional dynamics, then the growth rates of *c*, *k* and *y* are equal to a constant γ:

$$\gamma = (1/\theta).\left[\alpha A^{1/\alpha}.(L\tau)^{(1-\alpha)/\alpha}.(1-\tau) - \delta - \rho\right] \qquad (2.3.25)$$

From the above equation the effects of government to growth rates take two different forms: One is from the tax side that $(1-\tau)$ shows the negative impact of distortionary taxation as τ shows the proportional tax on income which is accepted as distortionary tax. The second is from the term $\tau^{(1-\alpha)/\alpha}$, when we look at the equation (2.3.25) shows the positive impact of *G* on marginal product of capital and on growth. From equation (2.3.25) we can also see that the relation between the per capita growth rate and the government's spending share (shown by G/Y) is U shaped. Therefore at low rates of proportional tax since the positive effect of government share on marginal product of capital is larger per capita growth rises with the tax rate. On the contrary, at higher levels of tax rate, the adverse effect of distortionary taxation becomes more crucial and growth comes to a peak. As the tax rates goes on increasing, the taxation effect dominates and per capita growth rate goes down with τ.

$\gamma_{\max}$ can be obtained by taking the derivative of equation (2.3.25) with respect to τ. The result of the derivative shows that:

$$\tau = G/Y = 1-\alpha \qquad (2.3.26)$$

From the Cobb Douglas production function shown by equation (2.3.19), the marginal product of public services is shown by $\partial Y_i / \partial G = (1-\alpha)Y_i / G$.

As the social marginal product of *G* is calculated by the sum of all firms then,

$$\partial Y / \partial G = (1-\alpha)(Y / G) = (1-\alpha)/\tau \qquad (2.3.27)$$

Therefore equation (2.3.26) above gives us the natural efficiency condition for the size of the government. As $\tau = 1-\alpha$ in the natural efficiency condition. $\partial Y / \partial G = 1$, where $\partial Y / \partial G$ represents the benefit and 1 represents the unit cost of G.

In the model of Barro (1990), the benevolent government is aiming to maximize the utility obtained by a representative household. Even in the natural efficiency condition of the size of the government, the utility maximizing condition might not hold in the case of distortionary taxation. The maximization of utility and maximization of growth rate, γ; in a Cobb-Douglas production function coincide as it has been proved above.

The utility function of the representative household was shown in equation (2.3.1). If we let the consumption function be:

$$c(t) = c(0).e^{\gamma .t} \tag{2.3.28}$$

If we do the integration we can find out that:

$$U = \frac{1}{(1-\theta)} * \left\{ \frac{[c(0)]^{1-\theta}}{\rho - \gamma.(1-\theta)} - (1/\rho) \right\} \tag{2.3.29}$$

The transversality condition implies that $\rho - \gamma.(1-\theta) > 0$. Equation (2.3.29) shows that utility increases by c (0) and γ. Taking the utility level constant the government might not be willing to increase γ because it will lead to a fall in the initial consumption level per person. The initial level of consumption is:

$$C(0) = Y(0) - I(0) - G(0) \tag{2.3.30}$$

where initial level of investment is

$$I(0) = \dot{K} + \delta.K \tag{2.3.31}$$

and

$$I(0) = (\gamma + \delta).K(0) \tag{2.3.32}$$

The initial level of government expenditures is equal to the initial level of government revenues shown by:

$$G(0) = \tau.Y(0) \tag{2.3.33}$$

The Cobb-Douglas production function implies that

$$Y(0) = AL.[k(0)]^{\alpha}.[G(0)]^{1-\alpha} = A^{1-\alpha}.(L\tau)^{(1-\alpha)/\alpha}.K(0) \qquad (2.3.34)$$

If we use equation (2.3.23) where $G = (\tau AL)^{1/\alpha}.k$ for the initial level of G, we can derive the initial level of consumption per person, which is:

$$c(0) = \left[A^{1/\alpha}.(L\tau)^{(1-\alpha)/\alpha}.(1-\tau) - \gamma - \delta\right]k(0) \qquad (2.3.35)$$

When we substitute the initial level of consumption per person into the utility function in equation (2.3.29) then we will have:

$$U = \frac{1}{(1-\theta)} * \left\{ \frac{\{\left[A^{1/\alpha}.(L\tau)^{(1-\alpha)/\alpha}.(1-\tau) - \gamma - \delta\right]k(0)\}^{1-\theta}}{\rho - \gamma.(1-\theta)} - (1/\rho) \right\} \qquad (2.3.36)$$

By using equation (2.3.25), $(\tau)^{(1-\alpha)/\alpha}.(1-\tau)$ in equation (2.3.36) can be written as a function of γ. If we substitute this into equation (2.3.36) we can derive an equation depending on γ but not on τ. Then it will be quite obvious that utility is monotonically increasing with γ. As a conclusion maximizing utility of household corresponds to maximizing the per capita growth rate of income, γ.

Using a less complicated model of Barro and Sala-i Martin (1992) where the alternative production function (of equation (2.3.19)) can be written as:

$$y = Ak^{1-\alpha}g^{\alpha} \qquad (2.3.37)$$

where *g* denotes the publicly provided input and *k* represents private capital. Again it is assumed that the government runs a balanced budget. Therefore the budget constraint is:

$$ng + C = L + \tau ny \qquad (2.3.38)$$

where government balances the productive and nonproductive government expenditures, *g* and *C* (government provided consumption) respectively, by increasing taxes (both non-distortionary lump-sum (L) and distortionary proportional taxes (τ)). When the budget of the government is balanced, equation (2.3.38) holds. In reality, however governments usually experience budget deficits or surpluses. Therefore the real government budget constraint becomes:

$$ng + C + bs = L + \tau ny \qquad (2.3.39)$$

where bs showing the budget surplus. By using an isoelastic utility function long-run growth rate is shown as:

$$\gamma = \psi(1-\tau)(1-\alpha)A^{1/(1-\alpha)}(g/y)^{\alpha/(1-\alpha)} - \lambda \qquad (2.3.40)$$

where ψ and λ denote the parameters in the utility function.

It can be seen that this is a growth function similar to the one in equation (2.3.25) Equation (2.3.40) shows that growth rate is falling by the increase in distortionary taxes (τ) but rising by the increase in productive expenditure *(g).* In addition we can see that non-productive expenditure *(C)* and non-distortionary lump sum taxes *(L)* have no effect on growth.

The public policy endogenous growth models of Barro (1990) predict that shifting of expenditures from productive to non-productive is growth retarding but shifting of taxes from distortionary to non-distortionary is growth enhancing. Although the individual effects of different categories of taxes and expenditures are unambiguous in some occasions the joint effects on per capita income can be ambiguous like increases in productive expenditures that are financed by a distortionary tax. In contrast to this, when increases in the productive expenditures are financed by non-distortionary taxes the effect on growth is unambiguously positive. Likewise, when increases in non-productive expenditures are financed by distortionary taxes, these have unambiguously negative growth effects. Non-productive expenditures financed by non-distortionary taxes have unambiguously zero growth effect.

Therefore model (2.3.40) is the model that I will test by using the data. From the theoretical models distortionary taxation is predicted to have negative coefficients when regressed on the per capita GDP growth. On the contrary, productive expenditure is predicted to have positive coefficients. Non-productive expenditures, non-distortionary taxation and budget surplus (assuming Ricardian equivalence holds and compositions of taxes and expenditure stay the same) will have zero effect on growth.

The above is what the theory says. It will be quite interesting to find out if theory holds or for which group of countries does it hold. Therefore I will test the model by running alternative panel data estimation techniques of long-run growth by using some fiscal and non-fiscal variables as independent variables.

CHAPTER 3

METHODOLOGY

3.1 Introduction

A panel data set consists of a time series of cross sections, with data on some countries, individuals or firms for each time period. In this thesis the endogenous public policy growth model, described in Chapter 2, that is estimated, by using panel data on a group of countries over a period of time.

Panel data (i.e., cross sectional time series data with $i = 1,......., N$ countries in each time period and with $t = 1,......., T$ observations per individual over time) is increasingly being used in both macroeconomic and more traditional microeconomic level studies of economic problems. Most of my basic empirical reference articles on public policy growth models are handled by using panel data (Barro (1991), Deverajan et al. (1996), Grier and Tullock (1989), Easterly and Rebelo (1993), Kormendi and Meguire (1985), Mendoza et al. (1997), Bleaney et al. (2001, 1999)). Consequently, it is important to outline panel data estimation techniques before moving to the empirical analysis.

Table 3.1, which is adapted from Johnston (1984), shows some panel data models that have different assumptions. The subscript i denotes the N cross-sectional units and the subscript t denotes the T time periods.

There are three competing formulations according to Table 3.1. The first is to ignore the panel nature of the data and treat the disturbance term as identically and independently distributed. The disturbance is uncorrelated with the explanatory variables. In this case data can be pooled and ordinary least squares (OLS) can be

Table 3.1 Panel Data Models

MODEL $y_{it} = \alpha_{it} + X'_{it}\beta + u_{it}$	INTERCEPT TERM	DISTURBANCE TERM
Pooled Model	$\alpha_{it} = \alpha$	u_{it}
One-Way Fixed Effects	$\alpha_{it} = \alpha + \mu_i$	u_{it}
Two-Way Fixed Effects	$\alpha_{it} = \alpha + \mu_i + \lambda_t$	u_{it}
One-Way Random Effects	randomly changing over i	$u_{it} = \mu_i + v_{it}$
Two-Way Random Effects	randomly changing over i	$u_{it} = \mu_i + \lambda_t + v_{it}$

used to estimate the model. We call this the pooled model. The pooled model essentially postulates that both the intercept and the slope coefficients are the same across individual units and time.

The second and third formulations refer to error component regression models. There are two main versions of these models: the fixed effects model and random effects model. As shown in Table 3.1, the difference between these two models lies in the assumptions that each makes about the individual and time specific error components, μ_i and λ_t. Also both the fixed effects and the random effects models are categorized as one-way and two-way. In the one-way error component models each cross section unit (i.e. countries) has its own intercept. This is sometimes called individual-specific heterogeneity. In the two-way error component models in addition to the individual-specific heterogeneity, there is time-specific heterogeneity.

This chapter presents the main panel data estimation techniques and the tests that provide us with a choice between alternative panel data estimations.

In addition to this, the instrumental variables estimation (two stage least squares) is explained.

This chapter depends on Baltagi (2001), Wooldridge (2002), Greene (1997) and Johnston et al. (1997) and the notation usually refers to Baltagi (2001).

3.2 Panel Data Error Component Regression Models

Panel data regressions are different from regular cross-section and time series regressions in that they have double subscripts on their variables.

$$y_{it} = \alpha + X'_{it}\beta + u_{it} \quad i = 1,........,N \quad t = 1,.........,T \qquad (3.1)$$

where the subscript t denoting time, i denoting individuals, countries, firms and α denoting a scalar. β I s the slope coefficient of dimension $Kx1$ and X_{it} is the it th observation from K explanatory variables.

One-way error component model for disturbances,

$$u_{it} = \mu_i + v_{it} \qquad (3.2)$$

Most of the panel data applications and software programs usually perform a one-way error component model but since the two-way regressions are also performed, they will both be explained.

Likewise *two-way error component model* for disturbances,

$$u_{it} = \mu_i + \lambda_t + v_{it} \qquad (3.3)$$

The first term of the decomposition, μ_i ,is called the individual effect, λ_t is called the time effect and v_{it} shows the stochastic disturbance term.

At this stage we assume v_{it} is uncorrelated with X_{it}. Equation (3.2) has two parts. The first part, denoted by μ_i, varies across individuals or the cross sectional unit but is constant across time; this part may or may not be correlated with the explanatory variables. The second part, denoted by v_{it}, varies unsystematically across both times and individuals.

In fact, this formulation involves the notion that two observations from two different cross sectional units are less likely to be similar than two observations from the same cross sectional unit. Most of the empirical applications are has one of the assumptions about the individual effect, μ_i. In the 'Random Effects Model' μ_i is assumed to be uncorrelated with X_{it}. In the 'Fixed Effects Model' μ_i is assumed to be correlated with X_{it}.

The main difference between one-way and two-way error component models can be seen in equations (3.2) and (3.3) that there is additional inclusion of individual invariant, time specific effect, λ_t, in the two-way error correction modeling. In the empirical analysis of this thesis, μ_i will represent the differences in implementation of public policy across countries for the whole time span affecting the long-run growth rate. Alternatively there might be significant differences from one year to another year in every country in public policy determinants.

In the vector form the model can be written as:

$$y = \alpha \ L_{NT} + X\beta + u = Z\delta + u \qquad (3.4)$$

where y is of dimension $(Tx1)$, X is $(NTxK)$, $Z = [I, X], L_{NT}$ is a vector of ones of dimension NT and $\delta' = (\alpha', \beta')$

Disturbance terms shown in equations (3.2) and (3.3) can be written in the matrix form as:

$$u = Z_{\mu}\mu + v \qquad (3.5)$$

for one-way error component regression model and

$$u = Z_\mu \mu + Z_\lambda \lambda + v \qquad (3.6)$$

for two-way error component regression model, where

$u' = (u_{11},.....,u_{1T},........,u_{N1}........,u_{N1})$

$Z_\mu = I_N \otimes L_T$, is the matrix of country specific dummies where I_N denotes the identity matrix of dimension N and L_T vector of ones having dimension T. $Z_\lambda = L_N \otimes I_T$, is the matrix of time specific dummies where I_T denotes the identity matrix of dimension T and L_N vector of ones having dimension N.

As it has already been mentioned, the main distinction between two special models of panel data, fixed and random effects, is whether the individual effect, is correlated with the explanatory variables or not.

3.2.1 Estimation Of Random Effects Models

It will be appropriate to use random effects when we select *N* cross section units randomly from a large population. Usually this is the situation in household panel studies. In random effects the design of the panel will be in such a way that it will be representative of the population that we try to make conclusions about. In the cases where the random effects model is relevant, *N* is very large. Hence focusing on a specific set of panels out of *N*, like the fixed effects model, leads to loss of degrees of freedom. This loss can only be avoided by using random effects that is assuming μ_i being random and uncorrelated with X_{it}. It is important to know that, this orthogonality condition along with v_{it} being uncorrelated with X_{it} is sufficient for OLS to be asymptotically unbiased. The main question asked in here is why don't we simply run OLS than?

When the true model is the random effects model, firstly, although OLS estimates of β will be consistent, the standard errors will be understated. Secondly, feasible generalized least-squares (GLS) procedure is more efficient compared to OLS.

The random effects model is one way to deal with the problem that T observations on N cross section units are not the same as observations on NT different cross section units. To solve this problem first we derive the estimator of covariance matrix for the error term, than we use this covariance structure in the estimation procedure of β.

We assume that,

$E[v]=0$

$E[\mu_i \mu_j]=0, \quad \text{for } i \neq j$

$E[\mu_i v_j]=0$

$E[vv']=\sigma_v^2 I_{NT}$

$E[\mu_i \mu_i]=\sigma_\mu^2$

$E[\mu_i]=0$

given these we can compute the variance-covariance matrix as:

$$\Omega = E[uu'] = Z_\mu E(\mu\mu')Z'_\mu + E(vv') \qquad (3.7)$$

$$= \sigma_\mu^2 (I_N \otimes M_T) + \sigma_v^2 (I_N \otimes I_T)$$

where $\text{var}(u_{it}) = \sigma_\mu^2 + \sigma_v^2$ which is homoscedastic for all *i* and *t*.

Then, for this 'error components' model

$E[u_{it}u_{is}] = \sigma_\mu^2 + \sigma_v^2 \qquad \text{for} \quad t = s$

$E[u_{it}u_{is}] = \sigma_\mu^2 \qquad \text{for} \quad t \neq s$

and zero otherwise.

$\Omega = E[uu']$ can be denoted as

$$\Omega = \begin{pmatrix} \sigma_\mu^2 + \sigma_v^2 & \sigma_\mu^2 & \cdots\cdots\cdots & \sigma_\mu^2 \\ \sigma_\mu^2 & \sigma_\mu^2 + \sigma_v^2 & \cdots\cdots\cdots & \sigma_\mu^2 \\ & & \sigma_\mu^2 + \sigma_v^2 & \\ \sigma_\mu^2 & \sigma_\mu^2 & & \sigma_\mu^2 + \sigma_v^2 \end{pmatrix} \tag{3.8}$$

the disturbance covariance matrix for full NT observations is

$$V = \begin{pmatrix} \Omega & 0 & \cdots & 0 \\ 0 & \Omega & & 0 \\ & & \Omega & \\ 0 & 0 & \cdots\cdots & \Omega \end{pmatrix} = \Omega \otimes I_N \tag{3.9}$$

The block diagonality of Ω makes it easier to find an inverse.

‘Generalized Least Squares’ requires $V^{-1/2} = I \otimes \Omega^{-1/2}$. We start with finding $\Omega^{-1/2}$, that is

$$\Omega^{-1/2} = \frac{1}{\sigma_v}\left[I_T - \frac{\theta}{T} ii' \right] \tag{3.10}$$

where $\theta = 1 - \sqrt{\dfrac{\sigma_v^2}{T\sigma_\mu^2 + \sigma_v^2}}$ (3.11)

is an unknown quantity that is to be estimated. The transformation of y_i and X_i is therefore

$$\Omega_i^{-1/2} y_i = \frac{1}{\sigma_v}\begin{bmatrix} y_{i1} - \theta\bar{y}_{i.} \\ y_{i2} - \theta\bar{y}_{i.} \\ . \\ . \\ . \\ . \\ . \\ y_{iT} - \theta\bar{y}_{i.} \end{bmatrix} \tag{3.12}$$

where $\overline{y_{i.}} = \overline{X_{i.}}\beta + error$ (3.13)

and the i th term of $\overline{y_{i.}}$ is

$$\overline{y_{i.}} = \frac{1}{T}\sum_{t=1}^{T} y_{it} \quad (3.14)$$

and $\overline{X_{i.}}$ is defined in a similar way.

By using the data set as a whole the GLS estimator of β, is computed with these partial deviations, shown in (3.12) on the same transformations of x_{it}. It should also be noted that in the Least Squares Dummy Variables (LSDV) model, $\theta = 1$ (when it is equal to 1, fixed and random effects will be indistinguishable as we can interpret θ as the remaining effect when σ_v is equal to 0)

The GLS estimator can be represented as a weighted average of within and between estimators, just like the OLS estimator. Assume Z_μ is a matrix of dimension $NTxN$, which is N dummy variables, each corresponding to a cross section unit (as it has been mentioned before). We define $M_D = Z_\mu (Z_\mu{}' Z_\mu)^{-1} Z_\mu$, as an idemponent, symmetric matrix.

Just like in Equation (3.13), when we premultiply any matrix by M_D, data is transformed into means. Between estimator of β is estimated in this way and its formulation is:

$$\hat{\beta}_B = (X' M_D X)^{-1} X' M_D y \quad (3.15)$$

It should be noted that some information is left out by the between estimator.

We can define a new symmetric idempotent matrix, $N_D = I_{NT} - Z_\mu (Z_\mu{}' Z_\mu)^{-1} Z_\mu$.

$$N_D = \begin{bmatrix} N^0 & 0 & \cdots & 0 \\ 0 & N^0 & \cdots & 0 \\ & & & \\ 0 & 0 & \cdots & N^0 \end{bmatrix} \tag{3.16}$$

Note that multiplying any $Tx1$ vector, call w_i, by N^0 makes

$$N^0 w_i = w_i - \overline{w_i} \tag{3.17}$$

Premultiplying by this matrix transforms the data and than compute OLS. We end up with the following within estimator:

$$\hat{\beta}_W = [(N_D X)'(N_D X)]^{-1}(N_D X)'(N_D y) \tag{3.18}$$

$$= (X'N_D X)^{-1} X'N_D y$$

$\hat{\beta}_W$ derived in equation (3.18) is equivalent to running OLS in the following equation:

$$y_{it} - \overline{y_{i.}} = (X_{it} - \overline{X_{i.}})\beta + error \tag{3.19}$$

When the assumptions of random effects model are correct then although the within estimator is also consistent it is not efficient. The estimator uses only the variation within each cross-section unit therefore it is called the within estimator.

$$\hat{\sigma}_v^2 = \frac{1}{NT - NK - N}\hat{u}_w'\hat{u}_w \tag{3.20}$$

$$\hat{\sigma}_\mu^2 = \hat{\sigma}_B^2 - \frac{\hat{\sigma}_v^2}{T}$$

$$\hat{\sigma}_B^2 = \frac{\hat{u}_B'\hat{u}_B}{N - K}$$

where $\hat{u}_w$ and $\hat{u}_B$ are the residuals from within and between estimation respectively.

By using the above information $\hat{\theta}$ can be computed. After finding $\hat{\theta}$, we can run OLS , in order to find the GLS estimators, on the transformed variables $\tilde{y}$ and $\tilde{X}$ where

$$\tilde{y}_{it} = y_{it} - \overline{y_{i.}} + \hat{\theta}\overline{y_{i.}} \text{ and } \tilde{X}_{it} = X_{it} - \overline{X_{i.}} + \hat{\theta}\overline{X_{i.}} \tag{3.21}$$

3.2.2 Testing for Random Effects

In order to test for random effects model Breush and Pagan (1980) performed a Lagrange Multiplier (LM) test. This LM test is easy to implement, as it only requires the OLS residuals $\hat{u}_{it}$. For the hypothesis:

$H_o : \sigma_\mu^2 = 0$ (or alternatively $corr[u_{it}, u_{is}] = 0$)

$H_1 : \sigma_\mu^2 \neq 0$

Hence, the null hypothesis implies that the variance of the individual specific term, μ , is zero. Therefore the null hypothesis supports the pooled model. On the other hand the alternative hypothesis implies that the variance of the individual specific term is not equal to zero, therefore the random effects model holds.

The test statistics can be computed as follows:

$$LM = \frac{NT}{2(T-1)}\left[\frac{\sum_{i=1}^{n}\left[\sum_{t=1}^{T} v_{it}\right]^2}{\sum_{i=1}^{n}\sum_{t=1}^{T} v_{it}^2} - 1\right]^2 \tag{3.22}$$

$$= \frac{NT}{2(T-1)} \left[\frac{\sum_{i=1}^{n} (T\overline{v_{i.}})^2}{\sum_{i=1}^{n}\sum_{t=1}^{T} v_{it}{}^2} - 1 \right]^2$$

LM is distributed as chi-squared with one degree of freedom under the null hypothesis. If the calculated value exceeds the tabulated chi-squared value, we reject the null hypothesis. Consequently, we can conclude that the random effect model is more appropriate than OLS (pooled model), implying that there are country-specific effects in the data.

3.2.3 Estimation of Fixed Effects Model

The fixed effects model is an appropriate specification if we are focusing on a specific set of cross section units and we are confident that the differences between cross section units can be viewed as parametric shifts, differences in the constant terms, in the regression function. There might be N countries that are selected from the set of countries because of their special properties but not randomly. Note that this holds for our data set consisting of 15 EU countries and 33 developing countries.

3.2.3.1 One-Way Fixed Effects Models

As it has been mentioned before in the one-way fixed effects the least squares dummy variable approach include only individual specific effect, but not a time specific intercept.

Considering the one-way error component regression models if we substitute (3.5) to (3.4) we get

$$y = \alpha \ L_{NT} + X\beta + Z_{\mu}\mu + v = Z\delta + Z_{\mu}\mu + v \qquad (3.23)$$

then get OLS estimates of α, β and μ. In the fixed effects model, the individual specific effects are assumed to be individual specific intercepts to be estimated, or more crucially $\mathrm{cov}(\mu_i, X_{it}) \neq 0$

The parameters that we are interested in are α and β. We can obtain LSDV (Least squares dummy variables) estimator by premultiplying model (3.23) by $N_D = I_{NT} - Z_\mu (Z_\mu' Z_\mu)^{-1} Z_\mu$. The transformed model turns out to be:

$$N_D y = N_D X\beta + N_D v \tag{3.24}$$

It should be noted that N_D idempotent matrix destroys all the individual effects as $M_D Z_\mu = Z_\mu$ and therefore $N_D Z_\mu = N_D L_{NT} = 0$. It is also important to underline that (3.21) shows the generalized least squares (GLS)

If we rename the transformed models variables as $\tilde{y} = N_D y$, $\tilde{X} = N_D X$ and perform OLS on the transformed model:

$\tilde{\beta}_W = (X' N_D X)^{-1} X' N_D y$, which is the within estimator in (3.18). The within estimator is the only possible fixed effects estimator. Data of fixed effects remove means of these variables across cross section units.

Remember that the simple regression is:

$$y_{it} = \alpha + \beta X_{it} + \mu_i + v_{it} \tag{3.25}$$

and the average of the regression over time is:

$$\bar{y}_{i.} = \alpha + \beta \bar{X}_{i.} + \mu_i + \bar{v}_{i.} \tag{3.26}$$

We can difference equations (3.25) and (3.26) to yield

$$y_{it} - \bar{y}_{i.} = \beta(X_i - \bar{X}_{i.}) + v_i - \bar{v}_{i.} \tag{3.27}$$

$\tilde{\beta}_w$ can be obtained from this equation

The average of the regression across all the observations in the simple regression is:

$$\overline{\overline{y}} = \alpha + \beta \overline{\overline{x}} + \overline{\overline{v}} \tag{3.28}$$

The restriction $\sum_{i=1}^{N} \mu_i = 0$ is imposed in order to avoid the dummy variable trap. $\widetilde{\beta}_w$ derived from equation (3.27) can be substituted into equation (3.28) and we can obtain $\widetilde{\alpha}$ where $\widetilde{\alpha} = \overline{\overline{y}} - \widetilde{\beta}_w \overline{\overline{x}}$. Afterwards we can find by using equation (3.26) that $\widetilde{\mu}_i = \overline{y}_{i.} - \widetilde{\alpha} - \widetilde{\beta}_w \overline{x}_{i.}$

In many software packages to implement the fixed effects estimator, the easiest way is to include (N-1) dummy variables, with N cross section units. That is why the procedure is called 'Least Squares Dummy Variable (LSDV)'. The reason behind taking N-1 dummies is to avoid multicollinearity among regressors.

However if N is very large it becomes cumbersome to include N-1 dummies in the regression and the LSDV suffers from loss of degrees of freedom. In that case the fixed effects estimators can be found alternatively by transforming all variables and subtracting the means as in equation (3.23) and afterwards running OLS on the transformed variables. At this stage we should take care that the standard errors are to be corrected as $\text{var}(\beta_W) = \sigma_v^2 (X' N_D X)^{-1}$.

The fixed effect estimator is called the within estimator as it is a simple OLS of means difference variables that is, it uses the variation within an individual's set of observations.

Another drawback of fixed effects model, rather than the loss of degrees of freedom in large N panels, can be seen that the effects of time invariant variables, schooling, sex, race etc, can not be seen in fixed effects model as they are wiped out in the transformation procedure.

When the covariance between the individual specific effect and any regressor is not zero that is the fixed effects model is correct, neither OLS nor GLS provide consistent estimators on the contrary LSDV is the best, linear unbiased estimator.

Finally the fixed effects model uses the within variation in the data only but is the most flexible error component model that it allows for the endogeneity of the regressors.

3.2.3.2 Two-Way Fixed Effects Models

If some omitted variables are constant over time but vary across cross sectional units, on the other hand if some are constant across cross sections but vary over time, then it might be better to include both individual and time specific effects in the model. This can be achieved by including both N-1 individual and T-1 time dummy variables. We again face with the problem of loss of degrees of freedom. If both N and T are large there will be enormous number of dummy variables in the regression (N-1+T-1) resulting in a fall of degrees of freedom even more compared to the case of one-way fixed effects.

This time we will substitute (3.6) into the (3.4) and we get:

$$y = \alpha \ L_{NT} + X\beta + Z_{\mu}\mu + Z_{\lambda}\lambda + v = Z\delta + Z_{\mu}\mu + Z_{\lambda}\lambda + v \qquad (3.29)$$

Recall that Z_{μ} and Z_{λ} are matrices of individual and time dummies respectively. Z_{λ} is of dimension $NTxT$.

Just like the one-way fixed effects model, we will again transform the model by using N_D. Now N_D depends on the time specific dummies as well. In two-way fixed effects the transformation will wipe out both time and individual effects therefore within estimator in two-way fixed effects model cannot estimate time-invariant variables as well as individual-invariant variables.

$$\tilde{u} = N_D u \text{ where } \tilde{u}_{it} = u_{it} - \bar{u}_{i.} - \bar{u}_{.t} + \bar{\bar{u}} \tag{3.30}$$

In addition to equation (3.23) averaging over individuals gives:

$$\bar{y}_{.t} = \alpha + \beta \bar{X}_{.t} + \lambda_t + \bar{v}_{.t} \tag{3.31}$$

In order to avoid dummy variable trap or perfect multicollinearity, the restrictions that $\sum_{n=1}^{N} \mu_i = \sum_{t=1}^{T} \lambda_t = 0$ are imposed.

The transformed equation turns out to be:

$$y_{it} - \bar{y}_{i.} - \bar{y}_{.t} + \bar{\bar{y}} = (x_{it} - \bar{x}_{i.} - \bar{x}_{.t} + \bar{\bar{x}}) + (v_{it} - \bar{v}_{i.} - \bar{v}_{.t} + \bar{\bar{v}}) \tag{3.32}$$

where $\bar{y}_{.t} = \frac{1}{N}\sum_{i=1}^{N} y_{it}$ and $\bar{\bar{y}} = \frac{1}{NT}\sum_{i=1}^{N}\sum_{t=1}^{T} y_{it}$.

When we run OLS on this transformed model we can get $\tilde{\beta}_w$. By using $\tilde{\beta}_w$ we get:

$$\tilde{\alpha} = \bar{\bar{y}} - \tilde{\beta}_w \bar{\bar{x}} \tag{3.33}$$

$$\tilde{\mu}_i = (\bar{y}_{i.} - \bar{\bar{y}}) - \tilde{\beta}_w (\bar{x}_{i.} - \bar{\bar{x}}) \tag{3.34}$$

$$\lambda_t = (\bar{y}_{.t} - \bar{\bar{y}}) - \tilde{\beta}_w (\bar{x}_{.t} - \bar{\bar{x}}) \tag{3.35}$$

3.2.3.3 Testing for Fixed Effects

The joint significance of dummies is to be tested by using an F-test. In one-way error component model null hypothesis is:

$H_{01} : \mu_1 = \mu_2 = ... = \mu_{N-1} = 0$

Alternatively in two-way fixed effects null hypothesis turns out to be:

$H_{02} : \mu_1 = \mu_2 = ... = \mu_{N-1} = 0$ and $\lambda_1 = ... = \lambda_{T-1} = 0$

In both cases the restricted sum of squared residuals (SSR_R) is taken from the OLS on the pooled model and unrestricted sum of squared residuals (SSR_U) is taken from within regression.

For one-way fixed effects:

$$F_{01} = \frac{SSR_R - SSR_U}{SSR_U} . \frac{NT - N - K}{N - 1} \approx F_{N-1, N(T-1)-K} \qquad (3.36)$$

Alternatively for two-way fixed effects:

$$F_{02} = \frac{SSR_R - SSR_U}{SSR_U} . \frac{(N-1)(T-1) - K}{N + T - 1} \approx F_{N+T-1, (N-1)(T-1)-K} \qquad (3.37)$$

As one can recognize, these are simple Chow tests.

3.2.3.4 Unbalanced Panels and Fixed Effects

It is very common in panel data sets to have missing values due to randomly missing observations. I will not consider unbalanced random effects because in the public policy endogenous growth models the countries are not chosen randomly and intuitively the regression will fit into fixed effects model. Therefore if we have missing data, it might be meaningful to work out unbalanced fixed effects models in details.

The modification to allow for unequal sample sizes is very simple. (In fact the software packages fully automate the computation.) The first modification is the change of sample size from NT to $\sum_{i=1}^{N} T_i$; this will result in changes in sum of squared residuals, variances and F statistic. Second modification rests upon the group means, which must be based on $\sum_{i=1}^{N} T_i$.

The overall means for the explanatory variable becomes:

$$\bar{\bar{x}} = \frac{\sum_{i=1}^{N}\sum_{t=1}^{T_i} x_{it}}{\sum_{i=1}^{N} T_i} = \frac{\sum_{i=1}^{N} T_i \bar{x}_{i.}}{\sum_{i=1}^{N} T_i} \tag{3.38}$$

When matrices of sum of squares are summed across groups

$$\sum_{i=1}^{N} X_i' N_i^{0} X_i = \sum_{i=1}^{N}\left(\sum_{t=1}^{T} (x_{it} - \bar{x}_{i.})(x_{it} - \bar{x}_{i.})' \right) \tag{3.39}$$

Sum of squared matrices for y and cross products are calculated in a similar way. For the one-way fixed effects no other changes are necessary but for two-way fixed effects the procedure is much more complicated. Although algebra is quite cumbersome in fact application is much more simpler. The easiest way to handle is to add T dummy variables where T is the dates mentioned in full data set. Then when we drop one dummy to avoid collinearity and run LSDV all of the problems are solved automatically.

3.2.4 Hausman’s Test for Fixed or Random Effects

Up to now, we have made the distinction between fixed and random effects at a variety of points and the assumptions underlying them. An unavoidable question is: ‘Which one should be used?’ There has been a debate on the selection of fixed effects model vs. random effects model. Proponents of random effects argue that, fixed effects models are costly since there are degrees of freedom lost and in large data sets random effects have some intuition. On the other hand the major advantage of fixed effects models is that there is no assumption that time invariant effect have to be uncorrelated with other regressors as in random effects case. Therefore in general fixed effects models are preferable unless we can measure all individual effects to be correlated with other regressors.

If the individual effects are uncorrelated with the explanatory variables fixed effects estimator is consistent but inefficient. On the other hand, random effects estimator is both consistent and efficient. Alternatively, if individual effects are correlated with explanatory variables random effects turns out to be inconsistent but fixed effects estimator is both consistent and efficient. Hausman (1978)'s specification test based on these differences between fixed and random effects estimators. The null hypothesis to be tested is, two estimates should not differ systematically and test depends on this difference.

$$H = (\hat{\beta}_{GLS} - \hat{\beta}_W)'(\Sigma_W - \Sigma_{GLS})^{-1}(\hat{\beta}_{GLS} - \hat{\beta}_W) \qquad (3.40)$$

where Σ_W and Σ_{GLS} are variance covariance matrices of within and between estimators respectively.

Hausman test statistic is asymptotically distributed as chi-square (χ^2) with k (number of explanatory variables) degrees of freedom under the null hypothesis that random effects model is correct. Therefore rejection of null hypothesis in Hausman specification test, with high values for H, will result in acceptance of fixed effects model.

3.2.5 Instrumental Variables and Two-Stage Least Squares

OLS estimators are best linear unbiased as long as the classical assumptions hold. If the assumption of independence of the regressors from the error term, which is one of the major assumptions, does not hold OLS estimators turns out to be biased and inconsistent. Instrumental variables regression is a general way to obtain consistent estimator even when the regressor is correlated with the error term, u.

If we think of the variation of X having two parts: one that is correlated with the error term and the second part that is uncorrelated with the error term and if we could isolate the second part from the first, then we can focus on the variations of X uncorrelated with u and disregard the second part. In fact this is what instrumental variable procedure does. We use some additional variables, instrumental variables, to have information about the variations of the explanatory variable that is uncorrelated with the disturbance term and therefore we can still estimate consistent estimators.

In order to find out the motivation behind the need of instrumental variables, we can consider our basic model in equation (3.1), that is:

$y_{it} = \alpha + X'_{it}\beta + u_{it} \qquad i = 1,.........., N$ and $t = 1,.........., T$

where Y is an $NTx1$ vector, X is an $NTxK$ and α is an $Nx1$ vector of individual effects. Unlike the simple error correction models, by assumption some columns of X are correlated with u_{it} therefore OLS estimator turns out to be inconsistent. The instrumental variable estimation uses additional set of instruments W, which is a NxL matrix and $L \geq K$.

A valid instrument variable must possess two vital properties. These are instrument relevance and instrument exogeneity. If an instrument is relevant then the variation in the instrument is related to the variation in the explanatory variable. Therefore the variables in W are correlated with the variables in X and in the limit $p\lim(W'X / N) \neq 0$. If in addition the instrument is exogenous then the variables in W are in the limit uncorrelated with the disturbance term u, that is,

$p\lim(W'u/N)=0$.

If the instrument W, satisfies the conditions of instrument relevance and exogeneity then the coefficient estimated using IV estimation is called two stage least squares (2SLS). As its name suggests, 2SLS estimator is derived in two stages. At the first stage we decompose the endogenous explanatory variable into two: component that is correlated with the error term and that is uncorrelated with the error term. At the second stage the problem free component is regressed on the dependent variable using OLS. By using this procedure we derive 2SLS estimators or by another name instrumental variable estimators denoted by $\hat{\beta}^{IV}$.

As it has been mentioned before, the distinction between random and fixed effects model is whether the individual effect is correlated with X_{it}. If the individual effect is uncorrelated with the explanatory variables and the explanatory variables are correlated with the error term, GLS-IV estimation can be used.

Letting equation (5.2), $u_{it}=\mu_i+v_{it}$, holds, then as we have found out from equation (5.7) to (5.12):

$$E(uu')=\Omega=T\sigma_\mu^2 M_D+\sigma_v^2 I_{NT}$$

or alternatively,

$$E(uu')=(T\sigma_\mu^2+\sigma_v^2)M_D+\sigma_v^2 N_D$$

where M_D is the projection matrix on the matrix of individual dummies in one-way error component regression and $N_D=I_{NT}-M_D$. M_D and N_D depends on both matrix of individual dummies and time dummies in the two- way error component regression.

π is defined as the projection operator that: $A^{\pi} = A(A'A)^{-1} A'$. As we have mentioned W is a set of variables uncorrelated with u. There are different possible instrumental variables set but here I will use, the instrument set of the form $\widetilde{W} = [N_D Z, M_D B]$ where B is the matrix of potential instruments. The GLS-IV estimator is given by

$$\hat{\beta}_{GLS}^{IV} = (X'\Omega^{-1/2'} \widetilde{W}^{\pi} \Omega^{-1/2} X)^{-1} X'\Omega^{-1/2'} \widetilde{W}^{\pi} \Omega^{-1/2} Y \qquad (3.41)$$

The GLS-IV estimator is a matrix that is the weighted average of within IV and between IV estimators. That is,

$$\hat{\beta}_{GLS}^{IV} = \Gamma \hat{\beta}_{W}^{IV} + (1-\Gamma)\hat{\beta}_{B}^{IV} \qquad (3.42)$$

where $\Gamma = [\sigma_v^{-2} X'(N_D W)^{\pi} X + T\sigma_*^{-2} \overline{X}' \overline{B}^{\pi} \overline{X}]^{-1} \sigma_v^{-2} X'(N_D W)^{\pi} X \qquad (3.43)$

$$\sigma_*^2 = T\sigma_\mu^2 + \sigma_v^2 \qquad (3.44)$$

$$\hat{\beta}_{W}^{IV} = [X'(N_D W)^{\pi} X]^{-1} [X'(N_D W)^{\pi}] \qquad (3.45)$$

$$\hat{\beta}_{B}^{IV} = [\overline{X}' \overline{B}^{\pi} \overline{X}]^{-1} [\overline{X}' \overline{B}^{\pi} \overline{Y}] \qquad (3.46)$$

In equations (3.43) and (3.46), $\overline{X} = [\overline{X}'_1, \overline{X}'_2 .... \overline{X}'_N]'$ where $\overline{X}_i$ is the mean of the T observation on X (it is similar for B, Y and W).

To sum up, in the empirical estimation of public policy endogenous growth models, in Chapter 5, the panel data estimation techniques summarized in this chapter will be used.

First of all the Hausman test will be performed in order to choose the random effects model or the fixed effects model for both one-way and two-way error component regressions. Afterwards Breush-Pagan test and F-tests will be carried out and the model (fixed or random effects model) chosen by using these tests will be estimated. Finally as our public policy endogenous growth model suffers from the problem of endogeneity, the instrumental variables, Two Stage Least Squares, estimation will be handled.

CHAPTER 4

REVIEW OF EXISTING EMPIRICAL EVIDENCE

It is important to outline major empirical studies about public policy endogenous growth models in order to shape the empirical specification[1]. In addition to this, I compare my empirical results with the previous studies summarized in this chapter and comment on my findings accordingly in Chapter 5.

In this section all of the studies except Kocherlakota and Yi (1997) that I consider uses panel data. The studies can be grouped into three according to their country groups. Firstly, some studies like Bleaney et al. (2001), Kneller et al. (1998), Kocherlakota and Yi (1997), Mendoza et al. (1997) include only developed countries. Secondly, some of the studies like Barro (1991), Easterly and Rebelo (1993), Kormendi and Meguire (1985) and Grier and Tullock (1989)[2] include both developed and developing countries. Finally few public policy endogenous growth studies include developing countries as a different group, like Deverajan et al. (1996).

In the previous empirical studies there is lack of results in developing countries. Most of the empirical studies use the data of only developed countries or both developed and developing countries without a separate classification for developing countries. Therefore, instead of considering only developed countries in my thesis, I decided to include both developed and developing countries in separate groups.

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[1] Main theoretical studies are summarized in chapter 2. Therefore I will only consider previous empirical studies.

The majority of the related papers takes either five-year averages or includes lagged dependent variable in the regression to find out the long-run effects on growth. Kocherlakota &Yi (1997) use annual data but include lagged dependent variables in the model. In contrast to this main articles referred to, take five-year averages to avoid cyclical fluctuations [Grier&Tullock(1989), Deverajan et al.(1996), Mendoza et al.(1997), Kneller et al. (1999),Bleaney et al.(2001)]. Just like these main articles I will take five-year averages in this thesis, leaving the lagged model for a future study.

In the empirical specification part I have extended Bleaney et al. (2001). This is the paper that my thesis generally rests upon. The paper tests whether the prediction of endogenous growth models i.e. that government expenditure and taxation both have permanent and temporary effects on growth, hold or not. In order to test this prediction, panels of annual and period averaged data for the OECD countries during 1970-1995 are used. Unlike this thesis, the paper does not test the predictions of endogenous growth theory using developing and developed countries comparably but only using OECD countries. The results of the paper strongly support endogenous growth theories that productive expenditures have positive and distortionary taxation have negative and significant effects on long-run per capita growth rates.

Another important paper indicating the link between the composition of public expenditure and economic growth is Deverajan et al. (1996). The paper concludes that the effect of public expenditures on long-run growth does not only depend on the productivity and components of public expenditures but on the initial shares. The

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[2] Grier and Tullock (1989) include countries in two groups: OECD countries and rest of the world (ROW)

most interesting part of this paper is that, they utilize a panel of developing countries in contrast to many studies in the literature of public policy endogenous growth using only developed countries in the data set (as it was mentioned above). In this paper they use data from 43 developing countries over 20 years and find out that an increase in current expenditure has significantly positive growth effects in contrast to the negative effects of capital expenditures, which are usually assumed to be productive. They argue what makes particular component of government expenditure productive. They show that the answer does not depend on the sign of the component in the production function; rather, it is a relationship between the coefficient and the actual share in the budget, which determines whether a component is productive, or not. Therefore although capital expenditures are usually considered productive when they are used in excess they become unproductive and turn out to have negative growth effects. This result is in fact in contrast to Bleaney et al. (2001) where productive expenditures have positive significant effects on growth using a group that mostly involves developed countries (OECD). Hence the effect of productive expenditures on growth is not the same for developing and developed countries.

Easterly and Rebelo (1993) is another fairly article that relates the fiscal variables, level of development and rate of growth. This paper's cross section data of 100 countries set comprises the period 1970-1980 and combines information from five sources: Summers and Heston (1991), Barro and Wolf (1989), Government Financial Statistics (GFS), International Financial Statistics (IFS) and Easterly, Rodriguez and Schmidt-Hebbel (1993). The main findings are: Firstly, there is a strong relation between fiscal structure and development level. Income taxes are important in developed countries while poor countries rely mostly on international trade taxes. Secondly, fiscal policy is influenced by population, which shows the scale of the economy. Finally investment in transport and communication consistently affect growth rate and the effects of taxation are difficult to isolate empirically. Their most important result is that the link between most fiscal variables and growth is found out to be statistically fragile. The statistical significance of the fiscal variables heavily depends on what other control variables are included in the regression. They argue that this fragility is partly a result of multicollinearity. Fiscal variables are highly correlated with the level of income and highly correlated among each other. For instance countries having higher tax revenues also have higher spending.

Although in many studies only developed countries or both developed and developing countries without separate classification is used, in Grier and Tullock (1989), the results are investigated in two separate groups. The paper examines the empirical regularities in economic growth by using pooled cross section / time series data on 113 countries. They use six five-year average observations for 24 OECD countries and for 89 other countries grouped as rest of the world (ROW). Percentage change in real GDP is considered as the dependent variable. Initial real GDP, population growth, the share of government consumption of GDP, inflation and standard deviation of inflation are used as independent variables in the regression. The final results are compared for two country groups, OECD and the ROW.

They find out that in the OECD countries, initial per capita income has a negative and significant coefficient, confirming the hypothesis of convergence. Alternatively, in the ROW, the coefficient turns out to be positive and significant, showing that richer countries grow faster. Population growth is positive and significant for both subsamples. In the OECD countries average inflation does not influence growth but in ROW it has a negative and significant effect on growth. Government growth has negative and significant effect on growth for both groups. They find out that coefficient values in the regressions vary widely across the identifiable group of countries. Therefore this paper shows that it is important to work on different country groups before coming to a conclusion. It is obvious that in developed and developing countries the results are not the same.

In Kocherlakota and Yi (1997), the authors try to develop and implement an empirical framework to test endogenous growth. Even though the literature on testing endogenous growth rests upon panel data, this paper considers time series data in two developed countries, United States and United Kingdom for 100 years (1891-1991) and 160 years (1831-1991) respectively. The annual rate of real per capita GDP growth is used as the dependent variable. The independent variables are different for the United States and the United Kingdom. For the United States two measures of tax rates are used in the regression: marginal tax rates and federal receipts as shares of GDP and two measures of public capital, non-military equipment capital and nonmilitary structural capital, are used. For the United Kingdom the standard rate of income tax is used as a tax measure. As a public capital measure ratio of nominal gross public income to nominal GDP and ratio of real public fixed capital to real GDP are used.

The main finding in Kocherlakota and Yi (1997) is that when both the spending variable and the tax variable are included in the growth regression, results supporting endogenous growth theories are obtained. In addition to this they argue that failing to include both tax variables and public capital variables biases the result in favor of neoclassical growth models. Therefore in this thesis, the inclusion of both tax variables and public expenditure variables help us to avoid biased results. But it should be noted that the results the authors obtained in this paper is found by using only time series data for two developed countries, United States and United Kingdom. Therefore contradictory results might have been found by using a developing country group.

Mendoza et al. (1997) is one of the key papers used as a guide through my thesis. This paper provides evidence in support of Harberger's (1964) claim. Harberger (1964) conjectured that although the theory predicts that the tax rate is an important determinant of long-run growth and the investment rate, in practice changes in tax policy is ineffective to influence the growth rate. The empirical results in this paper support the superneutrality conjecture. The analysis is held by a cross-section time series panel for 18 OECD countries based 5-year averages using tax rates, initial income levels, enrollment in secondary education, government_purchases and terms of trade as explanatory variables and per capita GDP growth as the dependent variable. In line with Harberger (1964), panel regressions show that the effect of changes in tax structure on private investment is economically and statistically significant but these effects cannot produce noticeable growth effects. In Mendoza et al. (1997) it is also noted that inclusion of investment ratio as an explanatory variable in the regression addresses the endogeneity problem, as orthogonality condition between errors and explanatory variables are likely to be violated. They argue that it is difficult to define good instruments for instrumental variable (IV) estimation and the lag values are used as instruments in their regression for comparisons with the previous studies.

On the grounds of these findings in the previous studies, I will now move to the estimation of the model.

CHAPTER 5

ESTIMATION AND EMPIRICAL RESULTS

5.1 Introduction

In this chapter, the estimation results of the error component regression models that are described in the methodology section are derived and compared for European Union countries and developing countries. In section 5.2 model specification of the regression model is performed. By using the theoretical results, decisions on the dependent and explanatory variables to test the public policy endogenous growth models is given in this section. In section 5.3 the data used are described in detail and the descriptive analysis of data for EU and developing countries are made. In order to find out if diverse fiscal policy actions are to be taken to enhance growth in developing and developed countries these two different country groups are chosen. European Union countries denote the developed countries and 33 countries shown in Appendix A denote the developing countries. In section 5.4 the empirical results are given. In the section 5.4.1, error component regression results for one-way and two-way fixed effects models are summarized and Hausman's test results are shown. In the 5.4.2, I will analyze the biases that might occur as a result of misspecification in the budget constraint. In the section 5.4.3 attempts to solve the problem of endogeneity that is really common in our type of regressions by using Instrumental Variables estimation.

5.2 Model Specification

To test if fiscal variables play a role in the growth process, it is important to test the prediction of the models with respect to government expenditure and taxation together. This is missing in the most of the studies in the literature, as it has been discussed in the review of existing empirical evidence. In these studies usually the effect of taxation is missing, but it is just seen as an implicit financing method of government expenditure that leads to systematic biases (i.e. Deverajan et al. (1996)). In this thesis I will test if the results of recent public policy endogenous growth models like Barro (1990) and Mendoza (1997) hold by paying attention to avoiding the systematic errors associated with the mis-specification of budget constraint of the government.

Therefore the model that I will estimate will be as follows:

The growth rate is presented by g_{it} where i denote the country and t denotes time. g_{it} is function of non-fiscal variables (conditioning), NF_{it}, and a vector of fiscal variables F_{jt}.

$$g_{it} = \beta_0 + \sum_{i=1}^{m} \beta_i NF_{it} + \sum_{j=1}^{k} \eta_j F_{jt} + u_{it} \qquad (5.1)$$

when we assume that all the elements (deficit and surplus) of fiscal variables are included under F_{jt}:

$$\sum_{j=1}^{k} F_{jt} = 0 \qquad (5.2)$$

In order to avoid perfect collinearity of fiscal variables one element of the fiscal variables should be omitted from the equation. This is assumed to be the compensating element within the budget constraint. The equation becomes:

$$g_{it} = \beta_0 + \sum_{i=1}^{m} \beta_i NF_{it} + \sum_{j=1}^{k-1} \eta_j F_{jt} + \eta_k F_{kt} + u_{it} \qquad (5.3)$$

when F_{kt} is the omitted variable to avoid multicollinearity. This compensating element is usually selected from the fiscal variables set that is assumed to have zero effect on growth. In this thesis F_{kt} is the non-distortionary taxation, non-productive expenditures or both of them.

Therefore the equation to be estimated becomes:

$$g_{it} = \beta_0 + \sum_{i=1}^{m} \beta_i NF_{it} + \sum_{j=1}^{k-1} (\eta_j - \eta_k) F_{jt} + u_{it} \qquad (5.4)$$

From the above equation it can, be seen that the coefficient of F_{jt} is $(\eta_j - \eta_k)$ instead of η_j. Therefore the proper interpretation of a fiscal variable coefficient is the effect of a unit change in the variable offset by a unit change in the omitted fiscal variable, which in fact denotes the implicit financing element. When we transform the variables by omitting a fiscal variable as in our case, testing might include the equality of η_j to η . When the hypothesis of equality cannot be rejected then more exact parameter estimates can be obtained by omitting the both categories, both non-distortionary taxation and non-productive expenditures in our case. To sum up, it will be appropriate to test the specification of the government budget constraint from the most complete specification to least complete specification.

As the basic contradiction between endogenous and neoclassical public policy models comes from the difference in long-run effects, I will check if fiscal variables having an impact on long-run per capita growth rate. Therefore the important question is that how can long run information be obtained from annual data. As it has been in the previous chapter, one standard method in the literature is taking five- year averages in order to avoid cyclical fluctuations. An alternative method, is using as many lags as possible to get the long-run effects can estimate of the model with the annual data. For simplicity I will only take the five-year averages in this thesis. The use of the lags in order to get the long-run effects is left for future study.

5.3 Data: Definitions and Sources

In order to test for the public policy endogenous growth models following Barro (1990), I have to test if some components of government expenditures and taxation have significant long-run effects on per capita growth rate. In testing if public policy endogenous models hold, I use panel data instead of time series or cross sectional data. There are a number of benefits and limitations associated with using panel data generally. The benefits of using panel data are explained in Baltagi (2001) by using Hsiao (1985,1986), Klevmarken (1989) and Solon (1989) as reference. Firstly, panel data suggest that countries, and years (in our case) are heterogeneous. As cross sectional and time series estimations do not control for this heterogeneity they result in biased estimates. To sum up, panel data is able to control for the country and time invariant variables but a time series or a cross section data alone cannot.

Secondly panel data is more informative, having more variability, more degrees of freedom, more efficiency and less collinearity among the variables. In our case I will use 11 variables, by using only one country for the time period or countries in one-year leads to very low degrees of freedom and multicollinearity among the variables will be serious. In addition by using the additional informative data I will have more reliable estimates of the variables. Finally, panel data can relate country experiences at one point of time to other experiences in another point of time.

In addition to the benefits there are some limitations associated with panel data. The most important is the data problem that I suffered through my data collection process. In some countries no data was available for specified years (i.e.1982 data for Turkey), also in some categories of public expenditure and taxation (i.e. social security contributions and taxes on payroll and manpower in Turkey) no data was available. Missing data are not included. In the estimation process five-year averages are taken therefore the missing data problem is somehow solved. When five-year averages are taken, if for some years data is missing the average is taken for the remaining years.

Although there is data problem in panel estimation, most of the empirical studies related to endogenous growth testing used panel data as mentioned in Chapter 4. Hence I decided to use five-year averages of the annual data between 1970 and 1999 in 15 EU and 33 developing countries. As suggested in the study by Grier and Tullock (1989), it will use two groups of countries: EU members representing developed countries and 33 countries representing the developing countries. It is known that in developing countries and developed countries the fiscal policy actions and their results on the economy can sometimes be different. Therefore it is important to test fiscal policy endogenous growth models in two separate country classifications. The lists of countries are shown in the Table A1 and A2 in the appendix.

The five-year average of the annual data between 1970-1999 is used but as data is not available for all these periods in all the countries, unbalanced panel (panel where some data is missing) is used. Although it could be better to use the most recent data, years 2000 and 2001 are not included in the estimation, because for most of the countries they are missing.

Note that the fiscal variables can be classified into four main categories: distortionary taxation, non-distortionary taxation, productive expenditures and non-productive expenditures. The other fiscal variables used are government budget surplus, other revenues and other expenditures. The 'other revenues' and 'other expenditures' are the revenues and expenditures whose classifications are ambiguous.

In Table 5.1 thirteen variables, one of which (per capita growth rate of real GDP) is the dependent variable, that are used in the regressions are given. Table 5.1 shows how using Government Finance Statistics (GFS) of IMF and World Development Indicators (WDI) of World Bank's data classifications, we derived these variables. For some variables (i.e. productive expenditures and distortionary taxation) the data source classification part includes more than one classification. In that case it means data source classifications are aggregated in order to find the variable. For instance in order to find the value of variable 'productive expenditures' I have aggregated 'general public services expenditure', 'defense expenditure', 'educational expenditure', 'health expenditure', 'housing expenditure' and 'transport and communication expenditure'.

Table 5.1 Variables aggregation by using data source classifications

Variables	**Data Source Classifications**
Growth	GDP per capita growth (annual %)**
Initial GDP	GDP in 1970 US$
Investment	Gross Fixed Capital Formation (%of GDP)**
Labor Force Growth	Labor Force growth (annual %)**
Budget Surplus	Overall budget balance, including grants (% of GDP)**
Net Lending	Lending minus repayments*
Productive expenditures	General public services expenditure* Defense expenditure* Educational expenditure* Health expenditure* Housing expenditure* Transport and communication expenditure*
Non-productive expenditure	Social security and welfare expenditure* Expenditure on recreation* Expenditure on economic services*
Other expenditures	Other expenditures*
Distortionary taxation	Taxation on income and profit* Social security contributions* Taxation on payroll and manpower*
Non-distortionary taxation	Taxation on domestic goods and services*
Other revenues	Taxation on international trade* Non-tax revenues* Other tax revenues*
School Enrollment rate	School enrollment, secondary (% net)*

*From Government Finance Statistics of IMF, **From World Bank World Development Indicators

On the classification of taxes as distortionary and non-distortionary and government expenditure as productive and non-productive, there is an ongoing debate. Although, the major taxes used all over the world are somehow distortionary, the relevant distortion in the classification is the distortion in the incentive to invest (in physical and/or human capital). By following Barro (1990), income and property taxes are assumed to be 'distortionary'. The expenditure based 'consumption' taxes (taxation on domestic goods and services in the GFS classification) are assumed to be 'non-distortionary' as they do not reduce returns to investment although they may affect labor/leisure choice[3]. This thesis, in the allocation of government expenditures as productive and non-productive, follows Barro and Sala-i Martin (1995) and Deverajan et al. (1996). The expenditures with a substantial (physical or human) capital component are considered as 'productive'. The major 'non-productive' expenditure is the social security expenditures. In Barro (1990) it is predicted that social security expenditures have zero effect on growth as these enter the utility function but not the production function.

In conclusion, my data set covers 15 developed European Union countries and 33 developing countries. (Two groups are taken separately in order to show whether the test results are contradictory in these two groups of countries).

Fiscal variables are obtained from IMF's Government Financial Statistics (GFS) and remaining data (GDP per capita growth, labor force growth, secondary school

[3] In some other studies (like Mendoza et al., 1997) consumption taxes are assumed to be distortionary as they influence labor-leisure decisions thereby affecting the decision to invest.

enrollment rate data) is obtained from the World Bank's WDI 2002 CD-ROM's as mentioned in Table 5.1.

5.3.1 Hypothesis and Variables

This section of the thesis, informing the previous results found where applicable, outlines the hypotheses applied in the regressions. In this section Grier and Tullock (1989) is used.

(1) Initial Conditions: There is a mainly held idea that countries, which are behind in technology will grow faster relative to more developed countries. Therefore countries having lower initial income levels (real GDP per capita in 1970 in our case) will grow faster and countries having higher initial income levels will grow relatively slower. Therefore developing countries and developed countries converge to each other. Here convergence suggests that higher initial income means lower future growth compared to other countries, due to diminished returns to further investment in any given technology. This statement simply summarizes the 'convergence' phenomenon.

In many empirical studies initial GDP is included in the regressions. The literature show that convergence usually holds in developed country groups or when we consider both developing and developed countries, but does not hold in developing countries when considered separately. The results of some studies that include initial GDP in the growth regressions are shown in Table 5.2. By using Table 5.2, one can easily see that the empirical papers including the initial growth as an explanatory variable for GDP growth mostly consider developed countries (OECD) or both developed and developed countries without separate classification. The results are the same in these studies. It is found that the convergence hypothesis is strongly

Table 5.2 Initial GDP in the Growth Literature

Paper	*Initial GDP variable*	*Country Group*	*Results*
Barro (1991)	Real per capita (p.c.) GDP (1960)	98 countries	Growth rate negatively related to initial income
Grier et al. (1989)	Initial p.c. real GDP	OECD countries +89 countries	Significant convergence effect in OECD countries Insignificant and positive relation between initial GDP and growth rate in rest of the world
Levine et al.(1992)	Real GDP 1960	119 countries all over the world	Qualified support for the convergence hypothesis Robust and negative correlation Over1960-89 but not hold over 1974-89
Easterly et al. (1993)	Log of real GDP p.c. 1960	100 countries all over the world	Negative significant relation between initial GDP and GDP growth
Kneller et al.(1999)	Initial p.c. GDP (thousands of 1970 US $)	22 OECD countries	Robust significant results supporting convergence
Mendoza et al. (1997)	GDP in 1965	G7 countries+11OECD	Robust significant results supporting convergence
Mankiw et al.(1992)	Log of income p.c. 1960	98 Non oil producer countries 75 Intermediate countries 22 OECD countries	Coefficient of initial income slightly positive non oil producers but zero for intermediate sample. No tendency for poor countries to grow faster than rich countries. Significant tendency towards convergence in OECD sample
Kormendi et al. (1985)	GDP p.c. income US$ 1975	Cross section of 47 countries	Significant convergence
Fischer (1993)	Initial real GDP in 1960	101 countries	Robust and significant convergence effect

supported by the data. In contrast to these findings in a few papers (like Grier et al. (1989)), where developed and developing countries are considered as different groups, it is found that poor countries do not have a tendency to converge to rich countries. In this thesis considering two groups of countries I expect to find out different results in terms of convergence. I expect to find negative coefficients of initial GDP in EU countries and positive coefficients of initial GDP in developing countries from the results of the previous empirical studies.

(2) The Labor Force Growth Rate

In section 2.2 it is mentioned that steady state growth rate should equal the growth rate of labor force plus growth rate of exogenous technological change.

As it has been noted in Kormendi et al. (1985), according to neoclassical growth theory the labor force has a one-to-one effect on income growth rate in the steady state. However, in transition to steady state the effect might be less than one-to-one if capital accumulation or labor force growth does not change as much as population growth. In the literature when labor force growth data is not available population growth is used as an explanatory variable.

In the Table 5.3 the usage of labor force growth variable in general GDP growth regressions is summarized. It can be seen that labor force growth and population growth rate are used interchangeably. The effect of labor force growth is usually found out to be insignificant.

In my regression I do not expect the labor force to have a significant effect on growth as it has been found out in many empirical studies. The variability of labor force growth is much more higher than the variability in the GDP per capita

Table 5.3 Labor Force Growth in the Growth Literature

Paper	*Variable*	*Country Group*	*Results*
Grier et al. (1989)	Population Growth	22 OECD countries +89 countries	Positive and significant effect in OECD countries Positive but sometimes insignificant results in sub-sections of rest of the world group
Levine et al. (1992)	Population Growth	119 countries all over the world	Insignificant effects that is not robust. Positive and negative coefficients depending on other explanatory variables
Kneller et al. (1999)	Labor Force Growth	22 OECD countries	Insignificant negative effects of labor force growth on GDP p.c. growth
Bleaney et al. (2001)	Labor Force Growth	22 OECD countries	Insignificant negative and positive effects of labor force growth on GDP p.c. growth
Kormendi et al.(1985)	Population Growth	Cross section of 47 countries	Significantly positive effect of population growth growth on GDP p.c. growth
Fischer (1993)	Population Growth	101 countries	Insignificant negative effects of labor force growth on GDP p.c. growth

growth rate. Therefore the relation between labor force growth and per capita growth rate found to be insignificant in many studies.

5.3.2 Descriptive Analysis of Data

Table 5.4 indicates some descriptive statistics for the data set of 15 European Union countries and 33 developing countries. The set of variables included in the regressions are named as conditioning variables. The conditioning variables are chosen based on the other empirical studies and economic theory. In Levine et al. (1992) it is mentioned that 'When the dependent variable is the average annual growth rate of GDP per capita, the I-variables (conditioning variables) consist of investment share of GDP, the initial level of real GDP per capita, the initial secondary-school enrollment rate and average annual rate of population growth'. Therefore in this thesis conditioning variables contains the investment ratio, labor force growth rate and initial GDP by using Barro-type regressions and secondary school-enrollment rate (human capital measures). Human capital plays a special role in a number of models of endogenous growth theory. In Romer (1990) human capital is a key input to the research sector, which creates the new products, or ideas that underlie technological improvement. Hence, countries with greater initial stocks of human capital practice a more rapid rate of introduction of new goods and thereby likely to grow faster. Nelson and Phelps (1966) suggested, a large stock of human capital makes it easier for a country to absorb the new products or ideas that have been discovered elsewhere. Thus, a follower country with more human capital is likely to grow faster because it catches up more quickly to the technological leader.

It can be seen from Table 5.4 that European Union countries grew at 2.4% on the average with investment ratios of 22.3% and labor force growth around 0.9%. On

Table 5.4 Descriptive Statistics for EU and developing countries

Variable	Country group	Observations	Mean	St.Deviation	Minimum (Country)	Maximum (Country)
GDP p.c. growth (%)	European Union	90	2.447193	1.658019	-1.844044(Finland)	8.231742(Ireland)
	Developing	196	1.745159	2.841093	-7.1434(Nicaragua)	8.3928(Brazil)
Initial GDP	European Union	90	30.45903	26.14785	1.050316(Greece)	91.13224(Germany)
	Developing	196	23.2731	27.0125	.001(Bolivia)	90.4788(Zambia)
Investment	European Union	90	22.37615	3.08842	15.84541(Sweden)	29.87251(Portugal)
	Developing	186	20.48307	5.644167	8.8431(Zambia)	40.1382(Thailand)
Labor force growth (%)	European Union	90	.8736366	.5653086	-.0135202(Ireland)	3.845654(Portugal)
	Developing	198	2.724246	.6628304	1.2077(Thailand)	4.268(Mexico)
Budget surplus	European Union	89	-3.96091	3.895967	-13.02823(Greece)	4.695937(Luxembourg)
	Developing	165	-4.145267	4.201872	-20.56637(Togo)	3.78922(Panama)
Net lending	European Union	87	3.92054	8.151137	-1.298579(UK)	33.07392(Netherlands)
	Developing	160	1.297255	2.003898	-1.3418(Panama)	11.3435(Togo)
Distortionary taxation	European Union	90	10.42842	4.283278	4.031775(Spain)	17.76838(Luxembourg)
	Developing	173	6.219116	3.196476	1.2901(Guatemala)	16.4941(Syria)
Non-distortionary taxation	European Union	90	10.02112	2.768087	3.155174(Spain)	16.48368(Denmark)
	Developing	172	5.746917	2.761791	1.5671(Colombia)	16.8651(Syria)
Other revenues	European Union	90	3.587794	1.552866	.892953(Belgium)	7.920609(Ireland)
	Developing	174	7.199709	4.340397	1.1272(Burkina Faso)	27.3696(Syria)
Productive expenditure	European Union	78	14.39951	4.079259	5.186571(Spain)	22.91607(Netherlands)
	Developing	167	12.99986	5.336078	3.4975(Kenya)	30.2627(Syria)
Non-productive expenditure	European Union	78	18.78685	5.237968	6.678867(Greece)	30.42588(Belgium)
	Developing	167	7.410821	3.920453	1.4042(Cameroon)	23.7696(Syria)
Other expenditures	European Union	76	5.56153	3.690186	.5622163(Finland)	16.03261(Italy)
	Developing	166	4.103979	3.566502	.1992(El Salvador)	18.8006(Egypt)

the contrary developing countries experience lower average per capita GDP growth rates (1.74%), investment ratio (20.4%) but higher labor force growth rates (2.72%) than European Union countries. Among the fiscal variables the mean of distortionary taxation and non-distortionary taxation seem to be similar in both country groups. But when we compare EU countries and developing countries it can be seen that developing countries have very low tax revenues compared to EU countries. The gap between the fiscal policy variables in developing and EU countries are lower in productive expenditures and other expenditures. In terms of budget surpluses both country groups experience budget deficits on average. As expected the budget deficits are slightly higher in developing country group.

When the standard deviation of variables is compared, developing countries have higher standard deviations in many of the variables. European Union member countries denote a more homogenous group compared to the developing countries. European Union countries share many properties: like the location, same economic policies and usually similar economic conditions. Therefore it is in fact not surprising that standard deviation of variables are smaller in European union countries compared to the developing counterparts.

5.4 Empirical Results

The empirical results section will include the main contributions of the thesis. Firstly, I run the error component regression models and choose the appropriate econometric model. In the second part, I will investigate whether misspecification in the budget constraint bias the estimation results. Lastly, I will solve the serious endogeneity problem that is common in the growth models by using instrumental variables estimation.

5.4.1 Error Component Regression Results

The empirical results of four forms of panel data estimator for each regression are considered in this section. These are one-way (with only country dummies) fixed effects, one-way random effects, two-way (with both country and time dummies) fixed effects and two-way random effects.

First of all to test whether GLS or simple OLS is appropriate for the model Breush-Pagan Lagrange Multiplier test for random effects is held. In all of the regressions the calculated value exceeded the tabulated Chi-square value leading us to conclude that the random effect model is more appropriate than OLS (pooled model). In other words there are country-specific effects in the data. The results of the Breush-Pagan tests are given in Table 5.5.

Table 5.5 Breush Pagan and Hausman Test Results

Omitted Fiscal Variables	Non-Distortionary Taxation		Non-Productive Expenditures		Non-Dist. Taxation and Non-Prod. Expend.	
Country group	Developing	EU	Developing	EU	Developing	EU
Breush-Pagan	Chi2 (1)=5.83	Chi2 (1)=13.92	Chi2 (1)=14.56	Chi2 (1)=15.48	Chi2 (1)=22.02	Chi2 (1)=21.69
Hausman Statistics	Chi2 (11)=38.49	Chi2 (11)=20.46	Chi2 (11)=55,35	Chi2 (10)=35.69	Chi2 (11)=20.48	Chi2 (10)=19.66

The next question is how to treat the country-specific effects. If the country-specific effects are uncorrelated with the regressors, the random effect estimator will be the consistent and efficient estimator. Otherwise it will be inconsistent and biased.

In contrast to this, the fixed effects model will be unbiased in both cases, although it will be inefficient, as the fixed effect estimator uses the within variation, if the country specific effect is uncorrelated with the regressors.

The second test that is commonly used in panel data, aims to determine whether fixed effects or random effects estimator is more appropriate. I have performed the Hausman specification test, which is explained in section 3.2.4. The Hausman statistics are also shown in Table 5.5. The null hypothesis of the Hausman test suggests that random effect is appropriate. Note that a large value of Hausman statistic is evidence against null hypothesis, indicating that fixed effect estimator should be used. As can be seen in Table 5.5, Hausman statistics have large values resulting in rejection of null hypothesis. We choose fixed effect models for each regression. In fact this also makes economic sense. When we interpret the country-specific effects as reflecting technological and resource endowments, climate, institutions and so on that differ across countries, it can be argued that these are likely to be correlated with the fiscal variables in the country.

Therefore, only one-way and two-way fixed effect estimation results are given. Table 5.6 shows the one-way fixed effects results of the regressions in developing countries avoid multicollinearity in fiscal variables, fiscal variables assumed to have zero effects on growth are canceled. Hence, in the first column non-productive expenditures and in the last column both non-distortionary taxation and non-productive expenditures are omitted.

As many studies in the growth literature I have found negative significant coefficients for initial GDP indicating that convergence hypotheses hold for

Table 5.6 One-way Fixed Effects Estimation Results for Developing and EU Countries

Dependent variable: GDP per capita growth (Five- year averages) (The values in parenthesis are t-ratios)						
Omitted Fiscal Variable(s)	Non-Distortionary Taxation		Non-Productive Expenditures		Non-Dist. Taxation and Non-Prod. Expend.	
Country group	Developing	EU	Developing	EU	Developing	EU
Initial GDP	.0052274 (0.41)	-.0204404 (-1.62)	.0094914 (0.73)	-.028102 (-1.90)	.0084711 (0.67)	-.014516 (-1.47)
Investment	.2990004 (5.16)	.1322258 (0.71)	.2947588 (4.95)	.0753888 (0.45)	.2809382 (4.89)	.0955483 (0.55)
Labor force growth	-.3982425 (-0.73)	-.4007123 (-0.49)	-.3104183 (-0.57)	-.1361146 (-0.17)	-.2706114 (-0.50)	-.4596559 (-0.57)
Budget surplus	-.0692544 (-0.68)	.6020587 (3.89)	-.0007097 (-0.01)	.6625756 (4.42)	-.0003811 (-0.00)	.5194926 (4.81)
Net lendings	-.3345173 (-1.26)	.0779499 (0.25)	-.3260637 (-1.18)	.065183 (0.22)	-.3126987 (-1.17)	.100735 (0.34)
Distortionary taxation	-.0487335 (-0.29)	-.4026557 (-2.42)	-.1313992 (-0.80)	-.3759367 (-2.71)	-.1192546 (-0.73)	-.371534 (-2.61)
Non-distortionary taxation	-	-	.0730778 (0.39)	.4371795 (1.52)	-	-
Other revenues	.4250308 (2.63)	-.3194861 (-0.64)	.3608115 (2.21)	-.1141203 (-0.26)	.3497188 (2.22)	-.2087985 (-0.46)
Productive expend.	-.1764741 (-1.95)	.4203877 (1.07)	-.1925656 (-2.03)	.2874508 (0.80)	-.1821962 (-2.00)	.3452078 (0.94)
Non-productive expend.	-.2796305 (-1.84)	.1382097 (0.59)	-		-	
Other expenditures	-.1193624 (-0.98)	.2453858 (1.15)	-.0572515 (-0.47)	.1189049 (0.72)	-.0434073 (-0.38)	.1699564 (1.01)
Sec. Sch. enroll. Rate	-.0666263 (-2.29)	.0677706 (0.90)	-.0569272 (-1.97)	.0735043 (1.03)	-.053019 (-1.87)	.0712709 (0.97)
Adjusted R^2	0.4684	0.5331	0.4583	0.5741	0.4601	0.5476

European Union countries. In contrast to European Union countries there is no significant support towards convergence for developing countries. Therefore there is no special tendency for poor countries to grow faster than their richer counterparts.

The other conditioning variables are investment ratio, labor force growth and secondary school enrollment rate. By using Table 5.6, investment ratio has significantly positive impact on per capita growth rates in developing countries, positive but insignificant effects on European Union countries. Therefore in developing countries a policy increasing the investment will be more effective in increasing the growth rates compared to EU countries. This might be a result of the fact that initial investments are higher in European Union countries therefore the new investments through years might be not much effective on growth as its marginal contribution on growth falls.

The labor force growth does not have significant effects on growth in both developing and EU countries as it was expected. Although it is not significant in all regressions, it is not omitted because it is assumed to be one of the main determinants of growth in many studies. As it has already been mentioned the variability in the labor force growth is higher compared to the GDP per capita growth rates therefore there seems to be no significant relation between these two variables.

As a measure of human capital secondary school enrollment rate is used. It has a positive but statistically insignificant effect on growth in EU countries on the contrary for developing countries the effect is significant but negative, which is not expected. In fact the results about secondary school enrollment rate is quite interesting. In the literature, improvement in the human capital usually results in improvement in per capita income. Kneller et al. (1999), which runs a similar regression, find negative and statistically insignificant coefficients for secondary school enrollment rate.

The reason for finding a negative significant impact might be that school enrollment rate is not the appropriate as an indicator of human capital. Alternatively, the economy might not be available to translate the increase in human capital to the growth dynamics in the developing countries.

Net lending variable in the regression is statistically insignificant for both developing and EU countries.

The effects budget deficits are complex. In the overlapping generations models government deficits tend to reduce the savings rate and the rate of growth.[4] In the infinite horizon models the effects of deficits depend on the variables that have to be adjusted in the future to compensate for the deficits. If a higher deficit today will later be compensated by higher income taxes the rate of growth will decline. Budget surplus has positively significant impact on growth in EU countries (just like Kneller et al. 1999 when OECD countries are considered). Therefore findings of the overlapping generations models and the infinite horizon models hold. Unlike EU countries, the developing countries do not represent a significant impact of budget surplus on the growth rate.

Our main concern in these regressions is the effects of distortionary taxation and productive expenditure on growth. Growth models, both neoclassical and endogenous, feature simple channels that link certain taxes to the rate of growth. Increases in income taxes, distortionary taxes, lower the net rate of return to private investment making investment activities less attractive and lowering the rate of growth. Theory holds in EU countries as distortionary taxation significantly reduces

[4] Alogoskoufis and Ploeg (1991)

growth. In the developing countries the effect is negative but statistically insignificant. The reason behind this might be that the link between investment and taxation might not be as powerful as developed countries. One of the most surprising results in the regression is the coefficient of productive expenditure. Productive expenditures have significantly negative impact on growth in developing countries. This result strongly supports Deverajan et al. (1996). In this paper it is mentioned that ' The relationship between capital component of public expenditure on per capita growth is negative. Thus seemingly productive expenditures when used in excess could become unproductive. These results imply that developing country governments have been misallocating public expenditures in favor of capital expenditures'. The result therefore seems meaningful. The developing country governments usually rely on capital expenditures, which are considered to be productive. In order for a productive expenditure to increase the growth rate, the initial level of expenditures should be low. In the developing country case the misallocation of expenditures in advance for excessive productive expenditure makes it become unproductive. Another explanation of the negative effect of productive expenditures on growth in developing countries might be that it takes longer time for productive expenditures to be effective on the growth rate. In developing countries expenditures are high but their effects on growth are limited. Unlike the developing countries the coefficient of productive expenditures turns out to be positive but insignificant in EU countries.

When we compare the adjusted R-squares in the one-way fixed effects regressions it can be observed that adjusted R-square is higher in EU countries (around 0.55) than in developing countries (0.45). The regressions where both non-distortionary taxation and non-productive expenditures are omitted also have slightly higher

Table 5.7 Two-way Fixed Effects Estimation Results for Developing and EU Countries

Dependent variable: GDP per capita growth (Five- year averages) (The values in parenthesis are t-ratios)						
Omitted Fiscal Variable(s)	Non-Distortionary Taxation		Non-Productive Expenditures		Non-Dist. Taxation and Non-Prod. Expend.	
Country group	Developing	EU	Developing	EU	Developing	EU
Initial GDP	-.0286484 (-0.64)	-.0529475 (-1.67)	-.0386467 (-0.86)	-.0627435 (-1.77)	-.0309907 (-0.70)	-.0485659 (-1.68)
Investment	.3042064 (4.93)	.001044 (0.01)	.309624 (4.88)	.003804 (0.05)	.2908875 (4.77)	-.0061015 (-0.03)
Labor force growth	-.3204535 (-0.56)	.0187168 (0.02)	-.2213507 (-0.39)	.0207124 (0.02)	-.1943427 (-0.34)	.0273015 (0.03)
Budget surplus	-.1091364 (-1.03)	.5456378 (1.74)	-.056208 (-0.56)	.532536 (1.93)	-.0585534 (-0.58)	.5194887 (2.81)
Net lendings	-.3016124 (-1.08)	.1066797 (0.27)	-.2541994 (-0.89)	.1016375 (0.35)	-.2698256 (-0.96)	.1009447 (0.27)
Distortionary taxation	-.043783 (-0.24)	-.6185026 (-1.25)	-.1192551 (-0.67)	-.5818502 (-1.75)	-.1014853 (-0.58)	-.5795167 (-1.83)
Non-distortionary taxation	-	-	.1622614 (0.85)	.0329696 (0.11)	-	-
Other revenues	.3997744 (2.39)	-.3978909 (-0.63)	.3759373 (2.27)	-.373780 (-0.65)	.3471126 (2.14)	-.3664891 (-0.69)
Productive expend.	-.1904248 (-2.06)	.5851121 (1.37)	-.2157714 (-2.24)	.575689 (1.47)	-.1948584 (-2.11)	.5668532 (1.50)
Non-productive expend.	-.2139899 (-1.37)	.0329696 (0.11)	-	-	-	-
Other expenditures	-.1423588 (-1.12)	.14263 (0.50)	-.1206226 (-0.94)	.1226113 (0.60)	-.0875565 (-0.72)	.1193751 (0.67)
Sec. Sch. enroll. Rate	-.0738346 (-2.09)	-.0141541 (-0.16)	-.0692764 (-1.97)	-.0141236 (-0.15)	-.0643573 (-1.85)	-.0137307 (-0.16)
Adjusted R^2	0.4683	0.5531	0.4751	0.5821	0.4636	0.5619

adjusted R-squares compared to the cases where only non-productive and non-distortionary taxation are omitted.

When two-way fixed effects (Table 5.7) are compared with one-way fixed effects (Table 5.6) by including time dummies to the model with intercept dummies we see that the adjusted R-square improves very slightly. The variables to do not change signs and significant estimators still seem significant. As in the regressions country and time specific dummies are jointly significant and all of the variables included are jointly significant in all regressions, it might be better to inform also the two-way fixed effects models in this thesis. In Table 5.7 initial GDP is again significant and negative in European Union countries but insignificant in developing countries. Investment ratio is again significantly positive for EU countries and insignificant in developing countries. Labor force growth is again statistically insignificant in both groups. Budget surplus is significant only in EU countries. Distortionary taxation is significant again only in EU and when the omitted variable is non-productive expenditures or both non-distortionary taxation and non-productive expenditures. Just like the one-way fixed effects estimation results productive expenditure is significant only in developed countries with a negative coefficient. In the EU countries the coefficient is positive but still insignificant but *p* values increase. The secondary school enrollment rate is still negatively significant in developing countries.

Therefore the empirical results do not change much between one-way and two way fixed effects. As it has been mentioned in Chapter 3, the main difference between one-way and two-way fixed effects model is that time dummies are included in two-way fixed effects model. The time dummies are jointly significant therefore two-way fixed effects results are also stated.

5.4.2 Misspecification in the Budget Constraint

It is argued that to specify the government budget correctly is important for the exact interpretation of the fiscal variables. In the growth literature, some studies include only expenditures and some studies include only revenues and find results accordingly. In this section I will try to answer the question: "How serious are the errors from omitting some fiscal variables that should be included in the budget constraint?" In order to show this I will use Tables 5.8 to 5.13. Table 5.8 shows that misspecification of the budget constraints leads to some biases in the coefficients.

There are biases in some variables that the coefficients change sign and some statistically insignificant variables become significant and some insignificant variables become significant. The biases associated to the parameters are important. In order to see the biases in the first column of the table all three tax revenues and in the second column all three expenditures are omitted. I performed the regressions similarly by using two-way fixed effects. Initial GDP does not support the convergence hypothesis any more for both country groups. Investment ratio still has a robust positive impact on growth for developing countries. Although the coefficients fall slightly, there is no major change in the investment ratio compared to Table 5.8. This is logical that in the sensitivity tests of Levine and Renelt (1992), investment turns out to be the major robust estimator of growth. When we look at the coefficient of the productive expenditures the bias is more obvious as the coefficient falls sharply especially for the EU countries. Therefore exclusion of taxation biases the effect of productive expenditure on growth.

Table 5.8 Misspecification in the budget constraint I/ One-Way Fixed Effects

Dependent variable: GDP per capita growth (Five- year averages)

Omitted Fiscal Variable(s)	All Revenues		All Expenditures	
Country group	Developing	EU	Developing	EU
Initial GDP	.0068585 (0.56)	-.0027655 (-0.08)	.0087792 (0.66)	.0169859 (0.61)
Investment	.2870917 (5.08)	.0246328 (0.12)	.270077 (4.55)	.138712 (0.93)
Labor force growth	-.455551 (-0.87)	-.2727363 (-0.30)	-.4428562 (-0.80)	-.3291372 (-0.43)
Budget surplus	-.0888073 (-0.95)	.4432865 (2.78)	.1005898 (1.21)	.591751 (4.92)
Net lendings	-.33417 (-1.50)	.0674105 (0.20)	-.2174524 (-0.79)	.172599 (0.67)
Distortionary taxation	-	-	-.271073 (-1.78)	-.2646628 (-2.67)
Non-distortionary taxation	-	-	-.0211293 (-0.12)	.2218072 (1.63)
Other revenues	-	-	.2822359 (1.75)	-.1503819 (-0.34)
Productive expend.	-.1878447 (-2.29)	-.1149006 (-0.32)	-	-
Non-productive expend.	-.2731692 (-1.91)	-.1984223 (-0.95)	-	-
Other expenditures	-.1642441 (-1.57)	.0537592 (0.25)	-	-
Sec. Sch. enroll. Rate	-.057727 (-2.07)	.0308505 (0.38)	-.058347 (-1.99)	.0602319 (0.87)
Adjusted R^2	0.4720	0.4252	0.4402	0.5813

Note that the values in parenthesis are t-ratios

Alternatively Table 5.9 shows the result when we run two-way fixed effects estimations. Omitting some fiscal variables or including only the specified fiscal variables changes the coefficient's sign, its magnitude and their significance. It is obvious that when we omit taxation from the equation productive expenditure show negative growth effects not only in developing countries but also in EU countries. Just like in Table 5.8 initial GDP does not support for convergence as the coefficients turn out to be insignificant (although for both country groups it becomes negative). Budget surplus is no more significant in EU countries. In contrast to this *p* values for budget surplus in developing countries increase. There is only a slight change in the productive expenditure's coefficient. On the other hand, the coefficient is underestimated and turns out to negative effects on growth in EU countries too. Note that the coefficient of productive expenditure has positive coefficients in Table 5.7 for EU countries. Similarly when expenditures are omitted from the regression the negative effect of distortionary taxation decrease since taxes partially finance productive expenditures in EU countries. Omitting all expenditures expected to overstate the distortionary taxation coefficient in this group that the coefficient of distortionary taxation increases when we omit government expenditures from the model. On the contrary in the developed countries as the tax revenues are not usually used to finance growth-enhancing expenditures, the negative effect of distortionary taxation on growth deepens. The coefficient becomes significant for both one-way and two way fixed effects in the developing countries. But the coefficient becomes in significant in two-way fixed effects shown in Table 5.9.

Table 5.9 Misspecification in the budget constraint I / Two-Way Fixed Effects

Dependent variable: GDP per capita growth (Five- year averages)

Omitted Fiscal Variable(s)	All Revenues		All Expenditures	
Country group	Developing	EU	Developing	EU
Initial GDP	-.020563 (-0.50)	-.0002386 (-0.00)	-.0343312 (-0.75)	-.0244703 (-0.22)
Investment	.2891419 (4.85)	-.0809307 (-0.41)	.283786 (4.45)	.1127537 (0.66)
Labor force growth	-.3590222 (-0.66)	.3617384 (0.36)	-.3517118 (-0.61)	-.1980735 (-0.19)
Budget surplus	-.1278236 (-1.32)	.2241005 (1.23)	.0603748 (0.69)	.448594 (2.42)
Net lendings	-.2932661 (-1.27)	-.0247607 (-0.06)	-.1218875 (-0.43)	.2108225 (0.55)
Distortionary taxation	-	-	-.28048 (-1.70)	-.244404 (-1.41)
Non-distortionary taxation	-	-	.0423866 (0.23)	.1594679 (0.72)
Other revenues	-	-	.2973511 (1.79)	-.2638992 (-0.44)
Productive expend.	-.1971338 (-2.35)	-.2979268 (-0.81)	-	-
Non-productive expend.	-.2042534 (-1.38)	-.2611649 (-1.24)	-	-
Other expenditures	-.1892796 (-1.77)	-.0833379 (-0.37)	-	-
Sec. Sch. enroll. Rate	-.0679452 (-1.96)	-.0343156 (-0.40)	-.0766284 (-2.14)	-.0045859 (-0.05)
Adjusted R^2	0.4701	0.5165	0.4410	0.5158

Note that the values in parenthesis are t-ratios

Table 5.10 shows the estimation results of the one-way fixed effects regression where the only included fiscal variable in the regression is the distortionary taxation in the first column and productive expenditure in the second column (rather than net lendings and budget surplus). It obvious that the bias in the model increases. The model even becomes jointly insignificant in EU countries where distortionary taxation has positive and insignificant effect on growth. On the contrary distortionary taxation have negative significant effect on growth for developing countries. Remember that in the Table 5.6 the effect of distortionary taxation was insignificant in developing countries. When we include only the productive expenditures the results again diverge from the results in the Table 5.6. Initial GDP turns out to have positive insignificant coefficients this time. Investment still has positive and significant effect on growth in developing countries and the significance increases in the case of EU countries. In table 5.10 it is shown that both developing and EU countries experience negative and significant productive expenditures coefficients. Also labor force growth has significant effects on growth in EU countries.

Alternatively we consider two-way fixed effects by including only distortionary taxation first and afterwards considering only productive expenditures, just like Table 5.10. The results again support that there are biases associated with the misspecification of budget constraint. First let us consider the case where we include only distortionary taxation. When we compare Table 5.11 with Table 5.7, we see that initial GDP has negative and significant effects on growth in Table 5.7 and has positive and but insignificant effects. The labor force growth is not significant in both tables for both developing countries and EU countries. In Table

5.11 the signs of the coefficients are reversed. The coefficient is positive for developing countries and negative for EU countries in Table 5.11.

In the second column of Table 5.11 only productive expenditure is included in the regression. For developing countries the productive expenditure still has a negative significant effect on growth when it is compared to Table 5.7. The coefficient fall from 0.56 to 0.07 but it should be noted that it is insignificant.

In order to see the effects of the misspecification of the budget constraint, I have performed some other regressions. These are included in Appendix B. Table B1 and Table B2 show the regression results when we only include distortionary taxation and non-distortionary taxation in the first columns and productive and non-productive expenditure in the second columns. Both of these tables support that we derive biased results when we exclude some necessary elements of the budget constraint.

Therefore by the help of Tables 5.8-5.11 we see that it is important to specify the budget constraint correctly. All of the variables included in the budget constraint should be included in the regressions in order to avoid biased results.

5.4.3 Problem of Endogeneity and Instrumental Variable Estimation

In the simple estimation procedure, the right hand side variables are assumed to be uncorrelated with the error term, or in another words exogenously determined. In my regressions, there is in fact collinearity between certain elements of fiscal policy and the error term. In the fixed effects estimation results correlation between the independent variables and the error term is changing between 0.63 and 0.88[5].

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[5] Note that the correlation results are given in fixed effects estimations using Stata (corr (u_i, Xb))

Table 5.10 Misspecification in the budget constraint II / One-Way Fixed Effects

Dependent variable: GDP per capita growth (Five- year averages)

Included Fiscal Variable(s)	Distortionary Taxation		Productive Expenditure	
Country group	Developing	EU	Developing	EU
Initial GDP	.0163949 (1.49)	.0247898 (1.31)	.009802 (0.89)	.0229939 (0.89)
Investment	.2229679 (4.52)	.0390045 (0.27)	.2537381 (4.98)	.2746318 (1.36)
Labor force growth	.4738496 (1.00)	-.3914706 (-0.79)	.2074326 (0.43)	-1.059952 (-1.72)
Budget surplus	-	-	-	-
Net lendings	-	-	-	-
Distortionary taxation	-.1944419 (-1.69)	.1817185 (0.81)	-	-
Non-distortionary taxation	-	-	-	-
Other revenues	-	-	-	-
Productive expend.	-	-	-.215662 (-3.30)	-.4129792 (-1.67)
Non-productive expend.	-	-	-	-
Other expenditures	-	-	-	-
Sec. Sch. enroll. Rate	-.0128695 (-0.51)	-.0134764 (-0.33)	-.0362743 (-1.42)	.0480709 0.83
Adjusted R^2	0.3806	0.0361	0.4111	0.1013

Note that the values in the parenthesis are t-ratios

Table 5.11 Misspecification in the budget constraint II / Two-Way Fixed Effects

Dependent variable: GDP per capita growth (Five- year averages)

Included Fiscal Variable(s)	Distortionary Taxation		Productive Expenditure	
Country group	Developing	EU	Developing	EU
Initial GDP	-.0059485 (-0.17)	.0640766 (0.79)	-.0442397 (-1.19)	.0721449 (0.78)
Investment	.2285458 (4.56)	.1772615 (1.32)	.2619993 (5.02)	.1505606 (0.80)
Labor force growth	.5628372 (1.21)	-.0657289 (-0.15)	.2023647 (0.42)	-.0460652 (-0.08)
Budget surplus	-	-	-	-
Net lendings	-	-	-	-
Distortionary taxation	-.1468922 (-1.30)	.0147051 (0.08)	-	-
Non-distortionary taxation	-	-	-	-
Other revenues	-	-	-	-
Productive expend.	-	-	-.162531 (-2.43)	.0773851 (0.28)
Non-productive expend.	-	-	-	-
Other expenditures	-	-	-	-
Sec. Sch. enroll. Rate	-.0554748 (-1.66)	-.0269161 -0.73	-.0562489 (-1.70)	.0085964 (0.17)
Adjusted R^2	0.4214	0.3138	0.4426	0.3849

Note that the values in parenthesis are t-ratios

Therefore there is for sure collinearity between the independent fiscal variables and the error term.

In order to solve the problem of endogeneity, instrumental variables estimation techniques are used. On the other hand, there is a major problem about the selection of the instruments. The most commonly used technique is to use the first lags. Likewise in order to run 2SLS I have used lagged values of all fiscal variables as instruments. Therefore the first lags of the fiscal variables and investment included in Table 5.6 are used as the instruments of themselves.

When the fixed effects regression results in Table 5.6 and 5.7 and the fixed effects Instrumental Variables estimation results in Table 5.12 and 5.13 are compared, we can see that the fiscal effects explained earlier are not biased by endogeneity but mostly holds for the Instrumental Variables estimation also. The interpretation of key fiscal variables does not change much.

When we compare Table 5.12 with Table 5.6, in both tables initial GDP has a significant negative effect on growth in EU countries and positive but insignificant effect on growth in developing countries. The main difference in the coefficient of initial GDP is that the coefficient increases in the instrumental variables case.

In both of the table’s investment ratio have positive and significant growth effects in EU countries. In the instrumental variables case investment becomes significant in a regression of developing countries. Labor force growth is statistically insignificant and budget surplus is significant in EU countries in both tables. Net lendings turns out to have negative significant effects on growth in developing countries when IV estimation is used.

Table 5.12 One-way Fixed Effects Estimation Results for Developing and EU Countries by Instrumental Variables

Dependent variable: GDP per capita growth (Five- year averages)
(The values in parenthesis are t-ratios)

Omitted Fiscal Variable(s)	Non-Distortionary Taxation		Non-Productive Expenditures		Non-Dist. Taxation and Non-Prod. Expend.	
Country group	Developing	EU	Developing	EU	Developing	EU
Initial GDP	.0176972 (1.14)	-.0061637 (-1.71)	.0206577 (1.22)	-.0380482 (-1.70)	.0169053 (1.05)	-.0082516 (1.17)
Investment	.2810131 (4.49)	.0604499 (1.18)	.2847926 (4.15)	.0115419 (1.04)	.2623906 (4.07)	.0316712 (1.71)
Labor force growth	-.426224 (-0.68)	-.1878436 (-0.18)	-.5623443 (-0.92)	-.0805341 (-0.08)	-.4740154 (-0.78)	-.2458739 (-0.24)
Budget surplus	-.0961462 (-0.89)	.6063826 (1.94)	-.0140701 (-0.14)	.7009563 (3.23)	-.0052501 (-0.05)	.7225279 (3.29)
Net lendings	-.6441997 (-2.47)	.2652363 (0.58)	-.6364405 (-2.28)	.1838175 (0.43)	-.654973 (-2.37)	.2014191 (0.47)
Distortionary taxation	-.1325658 (0.77)	-.4566735 (-1.97)	-.0251399 (-0.15)	-.5638612 (-2.66)	-.0102147 (-0.06)	-.5733196 (-2.65)
Non-distortionary taxation	-	-	.1603107 (0.81)	.4601261 (1.21)	-	-
Other revenues	.4961979 (2.91)	-.5520915 (-0.74)	.4113175 (2.32)	-.3858406 (-0.53)	.3802448 (2.24)	-.5597897 (-0.77)
Productive expend.	-.2597876 (-2.69)	.2938644 (0.39)	-.2713222 (-2.65)	.3095347 (0.44)	-.2478399 (-2.48)	.3747973 (0.53)
Non-productive expend	-.2057065 (-2.53)	-.108698 (-0.53)	-	-	-	-
Other expenditures	-.2590531 (-2.15)	.1829862 (0.68)	-.1891894 (-1.46)	.1396532 (0.58)	-.1525991 (-1.30)	.2556466 (1.14)
Sec. Sch. enroll. Rate	-.0670799 (-2.14)	.0264066 (0.23)	-.0649 (-2.06)	.0789716 (0.70)	-.0579826 (-1.87)	.0406998 (0.37)
R^2(within)	0.4163	0.6713	0.3721	0.6963	0.3566	0.6646

Table 5.13 Two-way Fixed Effects Estimation Results for Developing and EU Countries by Instrumental Variables

Dependent variable: GDP per capita growth (Five- year averages)
(The values in parenthesis are t-ratios)

Omitted Fiscal Variable(s)	Non-Distortionary Taxation		Non-Productive Expenditures		Non-Dist. Taxation and Non-Prod. Expend.	
Country group	Developing	EU	Developing	EU	Developing	EU
Initial GDP	.0503878 (1.02)	-.0477949 (-1.84)	.0122796 (0.24)	-.1112608 (-1.97)	.0220715 (0.43)	-.0879995 (-1.74)
Investment	.3110315 (4.63)	.7696428 (2.08)	.2948918 (3.96)	.1830769 (1.85)	.2718406 (3.91)	.1880894 (1.60)
Labor force growth	-.8678195 (-1.27)	1.516862 (1.14)	-.7320768 (-1.10)	.4497349 (0.28)	-.6617613 (-1.00)	.5184266 (0.35)
Budget surplus	-.1170906 (-1.04)	.2721379 (1.65)	-.0265465 (-0.24)	.5266457 (1.98)	-.028316 (-0.26)	.5461016 (2.24)
Net lendings	-.8956663 (-2.98)	.1953021 (0.34)	-.6916671 (-2.21)	.2070065 (0.28)	-.7020477 (-2.28)	.1726601 (0.25)
Distortionary taxation	-.0605452 (-0.11)	-.241255 (-1.26)	-.0104474 (-0.05)	-.4025635 (-1.62)	-.0378272 (-0.20)	-.4174377 (-1.74)
Non-distortionary taxation	-	-	.2362391 (1.12)	-.1549599 (-0.26)	-	-
Other revenues	.4599493 (2.62)	-.3529196 (-0.41)	.390653 (2.12)	-.7264094 (-0.65)	.3427379 (1.93)	-.6267807 (-0.62)
Productive expend.	-.2963061 (2.95)	.5727154 (0.78)	-.2900451 (-2.70)	.8140925 (0.90)	-.2608744 (-2.49)	.8002133 (0.93)
Non-productive expend	-.1068846 (2.85)	-.106809 (-2.25)	-	-	-	-
Other expenditures	-.2562951 (2.04)	-.3936144 (-1.11)	-.2017355 (-1.46)	.2394077 (0.74)	-.1507187 (-1.19)	.2027202 (0.73)
Sec. Sch. enroll. Rate	-.0504276 (1.34)	-.1204126 (-1.15)	-.056934 (-1.45)	-.0620006 (-0.43)	-.0546186 (-1.40)	-.0415726 (-0.36)
R^2(within)	0.4552	0.8576	0.3970	0.7791	0.3791	0.7774

The effect of productive expenditure on growth is significantly negative for developing countries and insignificant but positive for EU countries. When we compare Table 5.6 to 5.12 the difference seems to be in the magnitude of the coefficient when we compare productive expenditures. The coefficients in the IV regression are higher. Secondary school enrollment rate has still negative and significant coefficients in developing countries.

Note that the results do not change much when two-way fixed effects model in instrumental variable estimation is used.

To sum up the instrumental variable estimation did not change our empirical results.

5.4.4. Major Empirical Findings

The major empirical findings in this thesis using both fixed effects model and instrumental variable estimation are as follows:

(1) There is a support for the convergence hypothesis in EU countries that poorer EU countries have a tendency to converge to richer EU countries. Therefore poorer EU countries grow faster than their richer counterparts and there is a negative and significant relationship between initial levels of GDP and the growth rate in EU countries. In fact this sounds reasonable as EU countries employ the same type of economic policies. These policies might help poorer EU countries (like Portugal) to grow faster than its richer counterparts (like United Kingdom). On the other hand, supporting the results of some papers. The convergence hypothesis does not hold in developing countries. In the regression analysis, the coefficient of initial GDP turns out to be positive but statistically insignificant.

(2) In the instrumental variables regressions investment has a positively significant impact on growth in both EU and developing countries. But it should be

noted that the impact is quite higher in developing countries compared to EU countries. Therefore increasing investment in developing countries might have larger positive effects on growth than the EU countries.

(3) Labor force growth does not have significant effect on growth in every regression and for both country groups.

(4) Distortionary taxation has negative effect on growth but it is only significant for EU countries. Therefore changes in the income taxes might not be an appropriate policy for developing countries but it is effective for EU countries.

(5) The most interesting results in this thesis are found to be related to the productive expenditures. Productive expenditures only have significant effects only in on developing countries and it is negative in contrast to the theory. A similar result was found by Deverajan et al. (1999) concluding that productive expenditures are excess in developing countries that productive expenditures turns out to be unproductive. In EU countries productive expenditures have positive but insignificant effects on growth.

(6) Non-productive expenditures and non-distortionary taxation have coefficients close to zero for both countries but not equal to zero as theory suggests.

(7) When we compare the two country groups, although we cannot say that one group absolutely supports endogenous growth theory, we can conclude that the model has a better fit for European Union countries. In fact we cannot reject that fiscal policy has an impact on the per capita growth rates. In the developing countries public expenditures seem to be a more effective fiscal policy tool for changing the growth rates whereas in EU countries taxation seems to be a more effective fiscal policy tool.

(8) In the regressions two-way fixed effects models suggest a slight improvement in the estimation process. As both time dummies and country dummies are jointly significant. It can be that the model can be estimated by including time specific effects as well as the country specific ones.

CHAPTER 6

CONCLUSIONS

In this thesis, the impact of fiscal policy variables on long-run per capita GDP growth was examined for 15 European Union and 33 developing countries by, using annual data from 1970 to 1999, taking 5-year averages in order to avoid short-term fluctuations. By using panel data estimation techniques I performed several regressions by including only the intercept dummies (one-way) and by including both the intercept and the time dummies (two-way).

This thesis aims to contribute to the literature in two-ways: Firstly, we know that endogenous growth theory predicts that long run per capita growth depends on both the level of taxation and expenditure. Therefore it is important to use the correct specification of the budget constraint. Failures to take account the government budget constraint (using only expenditures or tax revenues) results in a biased regression, as it has been proved by the empirical results that we found, which has been ignored in most of the previous research. Secondly, in order to solve the problem of the endogeneity of fiscal variables I have introduced instrumental variables estimation we have seen that the basic results of the estimation did not change.

In the light of this information the main findings of this thesis by both avoiding misspecification in budget constraint and controlling for the endogeneity problem are as follows: There is a support for convergence hypothesis in EU countries. Hence, poorer EU countries grow faster than their richer counterparts. In contrast to EU countries, the convergence hypothesis does not hold in developing countries.

In the instrumental variables regressions investment has a positively significant impact on growth in both EU and developing countries. Distortionary taxation has negative effect on growth but it is only significant for EU countries. Therefore changes in the distortionary taxes might not be an effective policy for developing countries. The most surprising result in this thesis is that productive expenditures only have significant effects on developing countries and the effect is negative in contrast to the theory supporting Deverajan et al. (1999) concluding that productive expenditures are excess in developing countries that productive expenditures turns out to be unproductive.

As a conclusion although it is difficult to conclude that endogenous growth models hold, with the empirical results found in Chapter 5, it is quite obvious that data the supports endogenous growth models more for developed country group, the EU countries. On the other hand for developing countries it will not be correct to say that government is ineffective in altering the growth rate. Public expenditures have statistically significant impacts on the growth rate but in contrast to the theory the impact is found to be negative. In the developing countries public expenditures might be a more effective fiscal policy tool to enhance long run growth rates whereas in EU countries taxation might be a more effective policy tool.

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APPENDICIES

APPENDIX A

Table A1 Developing Countries

Developing Countries	*Data Available*	*WDI Classification*
Argentina	1970-1999	Upper Middle Income
Bolivia	1975-1999	Lower Middle Income
Brazil	1980-1999	Upper Middle Income
Burkina Faso	1970-1995	Low Income
Cameroon	1975-1999	Low Income
Chile	1970-1999	Upper Middle Income
Colombia	1970-1999	Lower Middle Income
Costa Rica	1970-1999	Upper Middle Income
Egypt, Arab Rep.	1975-1999	Lower Middle Income
El Salvador	1970-1999	Lower Middle Income
Ethiopia	1975-1999	Low Income
Guatemala	1970-1995	Lower Middle Income
India	1970-1999	Low Income
Indonesia	1970-1999	Low Income
Kenya	1970-1999	Low Income
Korea, Rep.	1970-1999	Upper Middle Income
Malawi	1975-1990	Low Income
Malaysia	1970-1999	Upper Middle Income
Mali	1975-1990	Low Income
Mauritius	1975-1999	Upper Middle Income
Mexico	1970-1997	Upper Middle Income
Morocco	1970-1995	Lower Middle Income
Nicaragua	1970-1994	Low Income
Panama	1970-1999	Upper Middle Income
Philippines	1970-1999	Lower Middle Income
Senegal	1975-1985	Low Income
Sri Lanka	1970-1995	Lower Middle Income
Syrian Arab Republic	1970-1995	Lower Middle Income
Thailand	1970-1999	Lower Middle Income
Togo	1980-1990	Low Income
Turkey	1970-1999	Upper Middle Income
Zambia	1970-1999	Low Income
Zimbabwe	1975-1999	Low Income

Table A2 European Union Countries		
European Union Countries	*Data Available*	*WDI Classification*
Austria	1970-1995	High Income
Belgium	1970-1990	High Income
Denmark	1970-1999	High Income
Finland	1970-1999	High Income
France	1975-1995	High Income
Germany	1975-1999	High Income
Greece	1970-1985	High Income
Ireland	1980-1998	High Income
Italy	1975-1990	High Income
Luxembourg	1970-1995	High Income
Netherlands	1975-1999	High Income
Portugal	1970-1990	High Income
Spain	1970-1998	High Income
Sweden	1970-1999	High Income
United Kingdom	1970-1999	High Income

APPENDIX B

Table B.1 Misspecification in the budget constraint III / One-Way Fixed Effects

Dependent variable: GDP per capita growth (Five- year averages)

Included Fiscal Variable(s)	Distortionary and Non-distortionary taxation		Productive and Non-productive expenditures	
Country group	Developing	EU	Developing	EU
Initial GDP	.0106444 (0.93)	.0258563 (1.33)	.0068618 (0.61)	.0090811 (0.34)
Investment	.2384343 (4.62)	.0378408 (0.26)	.2744115 (5.20)	.1699007 (0.81)
Labor force growth	.3532014 (0.73)	-.3742027 (-0.74)	.0801787 (0.16)	-.9692293 (-1.60)
Budget surplus	-	-	-	-
Net lendings	-	-	-	-
Distortionary taxation	-.1817622 (-1.43)	.1496547 (0.61)	-	-
Non-distortionary taxation	-.1167825 (-0.88)	.0979492 (0.35)	-	-
Other revenues	-	-	-	-
Productive expend.	-	-	-.1786928 (-2.56)	-.1178076 (-0.38)
Non-productive expend.	-	-	-.1884073 (-1.47)	-.2601886 (-1.49)
Other expenditures	-	-	-	-
Sec. Sch. enroll. Rate	-.0204061 (-0.77)	-.0183362 (-0.42)	-.0523933 (-1.88)	.0222538 (0.38)
Adjusted R^2	0.3939	0.0155	0.4132	0.1351
Number of obs.	162	62	158	51

Note that the values in the parenthesis are t-ratios

Table B.2 Misspecification in the budget constraint III / Two-Way Fixed Effects

Dependent variable: GDP per capita growth (Five- year averages)

Included Fiscal Variable(s)	Distortionary and Non-distortionary taxation		Productive and Non-productive expenditures	
Country group	Developing	EU	Developing	EU
Initial GDP	-.0353657 (-0.92)	.0567931 (0.68)	-.0474011 (-1.25)	.0648384 (0.73)
Investment	.2559414 (4.88)	.1800659 (1.32)	.2719721 (5.00)	.0592591 (0.32)
Labor force growth	.4026601 (0.86)	-.0812706 (-0.19)	.1331892 (0.27)	.0300268 (0.06)
Budget surplus	-	-	-	-
Net lendings	-	-	-	-
Distortionary taxation	-.1541697 (-1.23)	.0441981 (-0.39)	-	-
Non-distortionary taxation	-.1003081 (-0.75)	-.0991833 (0.21)	-	-
Other revenues	-	-	-	-
Productive expend.	-	-	-.1494486 (-2.14)	.3522482 (1.16)
Non-productive expend.	-	-	-.0864464 (-0.66)	-.2644953 (-1.84)
Other expenditures	-	-	-	-
Sec. Sch. enroll. Rate	-.0619711 (-1.86)	-.0228205 (-0.59)	-.0621919 (-1.82)	-.0182272 (-0.36)
Adjusted R^2	0.4438	0.2977	0.4367	0.4364
Number of obs.	162	62	158	51

Note that the values in the parenthesis are t-ratios