TAX STRUCTURE AND ECONOMIC GROWTH: AN OECD ANALYSIS

by

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ABSTRACT

LUKE ALLEN RAYNOR. Tax structure and economic growth: an OECD analysis.
(Under the direction of DR. SOREN BO NIELSEN)

The purpose of this thesis is to provide an analytical analysis on how different tax structures of OECD countries affect their rates of economic growth from the period 1980-2004. This thesis attempts to gather results so that governments may better structure their tax system in order to promote more pro-growth friendly structures of taxation. The measures of taxation that I will be testing are three of the most prominent methods of taxation in most OECD countries; the Value-Added Tax, the Labor Income Tax, and the Corporate Income Tax. This is a very popular topic in today's media, especially in Europe where there has been a fallout from the recent financial crisis which is leading to measures of austerity throughout the region. Even in the U.S. there has been much debate on how to move forward from the financial crisis in order to generate more economic growth, and fiscal policy has been at the forefront of some of these debates. There has been recent evidence of governments lowering or raising taxes in order to try and promote economic growth, such as Sweden reducing their corporate tax rate to 22% from 25%. In order to provide a thorough discussion and analysis of tax structure and economic growth I will review and report findings in previous literature, present different econometric methods that can be deployed in analyzing these relationships and also discuss the results that are obtained from my findings.

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CHAPTER 1: INTRODUCTION

"Once one starts to think about these things, it's hard to think about anything else."[1] This quote comes from Robert E. Lucas Jr. in his paper titled *On the Mechanics of Economic Development.* Lucas was talking about ways in which India could get their economy to grow as fast as Egypt's or Indonesia's. Economic growth has been one of the main focuses of macroeconomic research in the last generation. The reason for this is because it affects a country's future standard of living. If a country has a high rate of economic growth, their citizens will enjoy higher rates of income and standards of living in the future. For example, if a country has a per-capita GDP, or standard of living, of $40,000 now and it grows at a 3.0% rate for the next 20 years, they will then have a future per-capita GDP of $76,020. If that same country were to grow at a 2.0% rate instead, they would then have a $59,438 per-capita GDP 20 years later. That is a difference of about $16,582 in what seems like a small change of just one percentage point of the economic growth rate. One can now see what Lucas was referring to in his paper *On the Mechanics of Economic Development.*

[1] Lucas Jr., Robert E. "On the Mechanics of Economic Development." Journal of Monetary Economics 223-42. Print

One of the most important responsibilities of any government is to manage fiscal policies. A country's government must decide who to tax and how much to tax them in order to raise revenues for government services provided to the public. They must also decide what to spend the tax revenues on, whether it is defense, public infrastructure, or redistribution programs. Spending decisions by the government may affect the livelihood and incomes of millions of state employees and also those that rely on income redistribution programs like unemployment compensation, nutrition programs and state run health care. The provisions of roads, ports and other government facilities through public spending can also indirectly influence the productivity of a nation because the private sector may be able to use these added investments to generate an increase in efficiency or productivity for themselves. For example, the design of a new highway system or high speed rail system could allow businesses to transport goods more efficiently and faster which could lead to greater productivity levels for the nation itself.

Through revenue and spending programs administered governments, it seems obvious that fiscal policy structures might have some effect on the growth rate of the economy. Theory predicts that higher taxes can give people less incentive to work, invest and save, by lowering the after tax returns on labor and capital which puts downward pressure on the economy and potentially lowering the economic growth rate. Taxes may also cause resources and capital to be allocated less efficiency across different sectors of the economy, thus causing distortions. On the other hand, taxes may increase economic growth rates by progressing investment in public infrastructure, or by providing public goods that can limit market externalities and also accommodate public needs, such as healthcare. If the tax revenues are spent on necessary government infrastructure then the

productivity gains may offset the losses. The research done in this paper tries to test the theory that different tax structures have an effect on a country's economic growth rate, and also to bring some insight into which taxes are more efficient in promoting economic growth.

This paper wishes to use an endogenous growth model to predict changes in a country's rate of growth due to a change in fiscal policy structure. According to the Solow Model, growth depends solely on the accumulation of capital and labor. However, empirically, this model only accounts for a very small portion of the variance explained in the rate of growth. Recent research has shown that there are some variables that are left out that can have some positive spillovers such as education, investment, and research and development spending. More recent research has also focused on how the tax structure has affected the rate of growth. This paper wishes to find the effect that a change in a country's fiscal policy has on its economic growth rate. For example, if a certain country lowers its corporate tax rate from 35% to 25% what effect will this have on their long-run rate of growth? Not only will I be studying statutory top marginal income tax rates, I will also test whether or not effective marginal income tax rates on labor and capital can influence the rate of economic growth. Statutory and effective tax rates are not always the same at the corporate level, or the personal income level and therefore can possibly produce different results. Asea, Mendoza, and Milesi-Ferretti (1997) created their own formulas for calculating backward looking effective average tax rates, but I will instead use forward looking effective marginal tax rates. There are differences between forward looking and backward looking marginal effective tax rates. Backward looking marginal effective tax rates are calculated based on real data such as

the Asea et al.1997 paper. Forward looking marginal effective tax rates are based on stipulations in the tax code such as the interest expense deduction and uses theoretical formulas to perform the calculations. I hope the research that I perform will provide new insight to statutory and effective tax rates and how they can hinder or promote economic growth.

CHAPTER 2: PROBLEM STATEMENT

In order to better understand how a country's fiscal structure affects its economic growth rate a broader theoretical understanding of economic growth is needed. This thesis seeks to answer the following research question:

What affects do different tax structures have on economic growth?

The following questions will also try to be answered in this thesis:

- Which taxes have the greatest effect on the economic growth rate?
- What shifts in tax structure can be made to promote more economic growth?
- What differences to effective tax rates have on economic growth than statutory tax rates

2.1. Structure of the Paper

For the remainder of the thesis I will begin by describing what economic growth is and how it is usually calculated. This will be followed by an extensive literature review on previous studies dealing with the theory of economic growth from some of its earliest origins and also the literature dealing with the effects of taxation on economic growth. I will then give a brief description of the specific taxes that I am using in this analysis and also the empirical method that I will employ to test my hypothesis. The empirical analysis will take up a large portion of this thesis because I intend to employ many different methods for testing my hypothesis and also use various statistical techniques to verify these methods. Finally, after the results have been gathered I will write the

conclusion to the thesis and also provide some policy recommendations based on the results if the results provided show any significance.

CHAPTER 3: DEFINING ECONOMIC GROWTH

Economic growth can be defined as the increase in the size of an economy between two time periods. When referring to economic growth I am mainly concerned with a country's gross domestic product (GDP). GDP is defined as the final value of all finished goods and services produced between a countries borders during a specific time period. It is calculated as the sum of private consumption, government expenditures, private capital investment and net exports at market prices in an open economy. The equation for GDP is shown below.

$$Y = C+I+G+NX$$

Where Y= total output, C equals private consumption, I equals the sum of all spending on capital, G equals the sum of government spending and NX is equal to total net exports, which can be negative. Economic growth is the basis of future standards of living and prosperity among different nations. As stated earlier, small differences in growth rates can lead to a substantial difference in future levels of per capita GDP, or standards of living. I will be using these terms interchangeably because GDP per capita is the common measure to compare standards of living across countries. To help us see why the study of economic growth is important I refer to U.S. GDP from 1970-2004 graphed in figure 1.

As you can see from the graph there is an upward trend in U.S. GDP from 1970 to 2004. The same holds true for other OECD countries. Economists are very interested in

what causes this upward trend of growth and what policies can be implemented in order to maintain this upward trend in GDP. To see how economic growth rates are calculated please see the appendix for calculating growth rates.

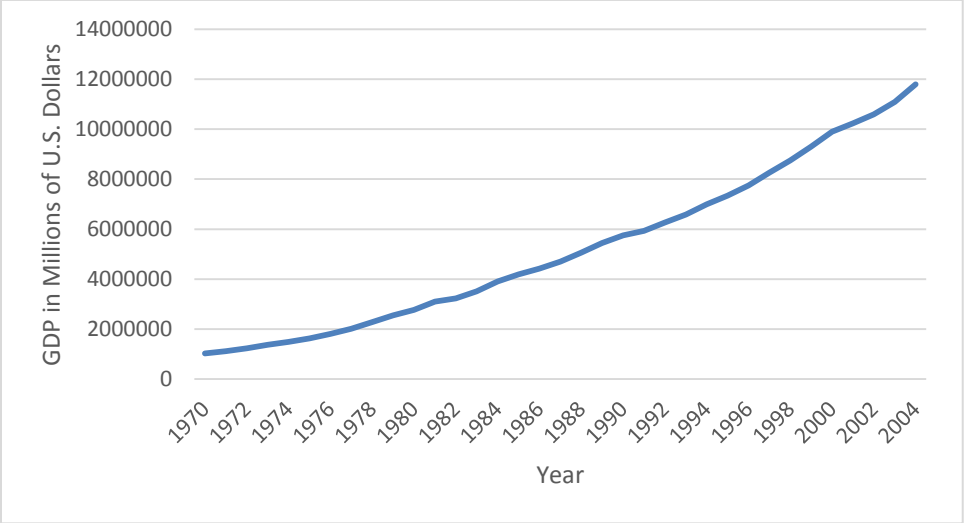

Figure 1: U.S. GDP 1970-2004

CHAPTER 4: ECONOMIC GROWTH THEORY

To start with the foundations of economic growth theory I will begin by reviewing Robert Solow's research in his 1956 paper titled "A Contribution to the Theory of Economic Growth". His work laid the foundation for what is known today as exogenous growth theory. The Solow Model, or sometimes referred to as the neoclassical model of economic growth, is one of the first and most widely used macroeconomic models used to predict economic growth. According to this model, output is assumed to be a function of labor and capital accumulation while the labor force growth rate and the savings rate are either determined outside of the model, or exogenous. Solow starts with a Cobb-Douglas production function in a closed economy

$$Y = AK^{\alpha}L^{1-\alpha}$$

Where Y is output, or simply GDP, K is capital, L is labor and A represents the current state of technological progress. Since we are mainly concerned with output per worker rather than total output, it is common to write the above equation in per worker terms by diving through the above equation by L. This then gives us:

$$y = Ak^{\alpha}$$

Where *k* denotes the amount of capital per worker. Capital is constantly being created through investment and constantly destroyed through depreciation in the Solow model. It is assumed in this model that there is a constant exogenous savings rate so that a set

proportion of output is invested to contribute to capital accumulation (McCracken 2006). This gives us

$$I = sY$$

$$\Delta K = I - \delta K = sY - sK$$

Where *I* is investment, *s* is the exogenous savings rate and δ the depreciation rate of capital. We then find an expression for the change in capital per worker.

$$\Delta k = \Delta\left(\frac{K}{L}\right) = \frac{\mathrm{L\Delta K - K\Delta L}}{L^2} = \frac{\Delta K}{L} - \frac{K}{L}\left(\frac{\Delta L}{L}\right)$$

$$= \frac{sY - \delta K}{L} - \frac{K}{L}\hat{L}$$

Then, divide through by k to obtain the growth rate of capital per worker.

$$\dot{k} = \frac{\Delta k}{k} = \frac{\Delta k}{K/L} = s \cdot \frac{A}{k^{1-\alpha}} - \delta - n$$

Where *n* is the population growth rate. The above equation can also be written as

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

These calculations come from McCraken (2006). One of the main implications of the Solow Model is that very little can affect the long run, steady state of growth of output. Changes in levels of K or L, or changes in the exogenous savings rate, s, can only have short run growth effects or on levels of output.

The Solow Model was not very good at accounting for a large part of either the long-run growth rate of output or cross-country income differences due to the fact that if capital's share in total output is modest then capital accumulation can't account for a large part for cross country income differences and long run growth rates. New growth theory began to develop in the 1980's with research by Paul Romer and Robert E. Lucas

(1988), among others. This newer theory is known as new growth theory or endogenous growth theory. Endogenous growth theory emphasizes that economic growth is an endogenous outcome of an economic system, not the result of forces that impinge from outside (Romer, 1994). Endogenous growth theory differs from neoclassical growth theory because it does not explain growth in income per capita by exogenous technological change. Endogenous growth models try to model the growth of *A*, or endogenous technological change, by introducing a research and development (R&D) sector which produces new technologies in the economy, or by introducing human capital such as Lucas did (1988). Endogenous growth models assume a largely conventional production function in which labor, capital, and technology are combined to produce improvements in technology in a deterministic way (Romer, 2006).

Romer (1986) designed a model that included knowledge as an input in production that had increasing marginal productivity. This model is a competitive equilibrium model that includes endogenous technological change as an endogenous variable in the model. According to Romer, per capita output can grow increasingly over time, which differs from the decreasing returns to scale of per capita output in the Solow model. Exogenous technological change is ruled out in Romer's model and long-run growth is mostly directed by the accumulation of knowledge by economic agents. Knowledge is assumed to be the product of a research technology that exhibits diminishing returns to scale (Romer, 1986). Knowledge created by one firm will have a positive spillover effect by increasing the production possibilities of other firms because it is not easy to keep knowledge fully secret and protected. Externalities, increasing

returns in output growth and decreasing returns in the production of new knowledge are what differs from the previous work done by Solow.

Lucas (1988) considered an alternative to the standard exogenous technological change that was shown in the Solow Model. He added human capital to the model as an endogenous source of economic growth. Lucas theorized that skill level was a good proxy for human capital and that this could be attained by education or learning-by-doing. According to Lucas, human capital would have a positive effect on economic growth and would better help show the differences in cross country levels of income through time. Lucas stated that human capital would have a spillover effect on future generations and on the formation of new goods from old goods. Adding human capital to the standard neoclassical model formed an endogenous growth model that helped explain exogenous technological through education attainment and learning by doing. I will be using tertiary education in my model as my measure for human capital.

Nonneman and Vanhoudt (1996) wanted to add to previous research done by Mankiw, Romer and Weil (1992) in which they added human capital to the Solow Model. Nonneman and Vanhoudt also added endogenous technological know-how to the augmented Solow Model to better help explain cross country variations in GDP per capita. There were now three types of capital included in this growth model. Physical capital was considered to be the ratio of accumulated domestic investment to GDP, human capital was the percentage of the working age population that was enrolled in secondary education and technological know-how was the ratio of domestic R&D spending to GDP. They used a standard Cobb-Douglas production function to determine output, thus

$$Y = F(H^{\alpha_H} K^{\alpha_K} T^{\alpha_T})$$

Where Y is output, H is human capital, K is physical capital, and T is technological know-how. The α's represent the respective factor shares in total income. Nonneman and Vanhoudt relaxed the assumption that countries were close to their steady state, as in Solow (1956). When relaxing this assumption they found that their model accounted for nearly 80 percent of the cross country variation in GDP per capita. Both physical capital and technological know-how were shown to be significant and human capital was now shown to be insignificant in this model.

4.1.Taxation and Economic Growth Theory

According to Myles (2007), taxation enters the endogenous growth model because different taxes or public policy instruments can have an effect on some of the variables that are important to economic growth such as the rate of investment and the level of educational attainment. For example, if the growth rate of output is

$$g_Y = f\big(a_1(t_1), a_2(t_2)\big)$$

Where a_1 and a_2 are two activities such as R&D or education and t_1 and t_2 are two taxes such as the corporate income tax or the personal income tax. The effect of the tax will then be

$$\frac{dg_Y}{dt_i} = \frac{\partial g_Y}{\partial a_i}\frac{da_i}{dt_i} \ (Myles\ 2007)$$

As you can see the tax can have an effect on both the action and the growth rate. The effect can be large on the rate of growth or the action such as educational attainment or R&D expenditures. Not every country has the same structure so there may be difference in the way one country responds to a tax policy from another.

Taxes influence an individual's decision to work, invest, save and spend. A government's tax structure is composed of many different taxes that include value-added taxes, income taxes, corporate taxes, property tax, excise taxes, tariffs and many more. Governments wish to maximize their tax revenue for public goods and services but they also would like to design a tax structure that does not overly distort the decisions that an individual makes in order to promote economic growth. The corporate income, personal income, and value added tax seem to be the three largest revenue generating forms of taxation. The personal income tax does not include other taxes on labor such as payroll taxes and social security contribution provided by the employer and employee. These added contributions also generate a substantial amount of revenue for OECD countries. As of 2008, the average OECD country was generating over 50% of their tax revenue from these taxes alone. (Figure 2). Of course the degrees to which these taxes are levied differ across OECD countries and these differences could be tied to economic growth and performance. The way in which these different taxes are designed and implemented is a very important regarding economic growth. I will focus on these three major forms of taxation in order to see how they affect output per capita and also how to design or shift a tax structure in order to minimize the negative effect that they may have on output growth.

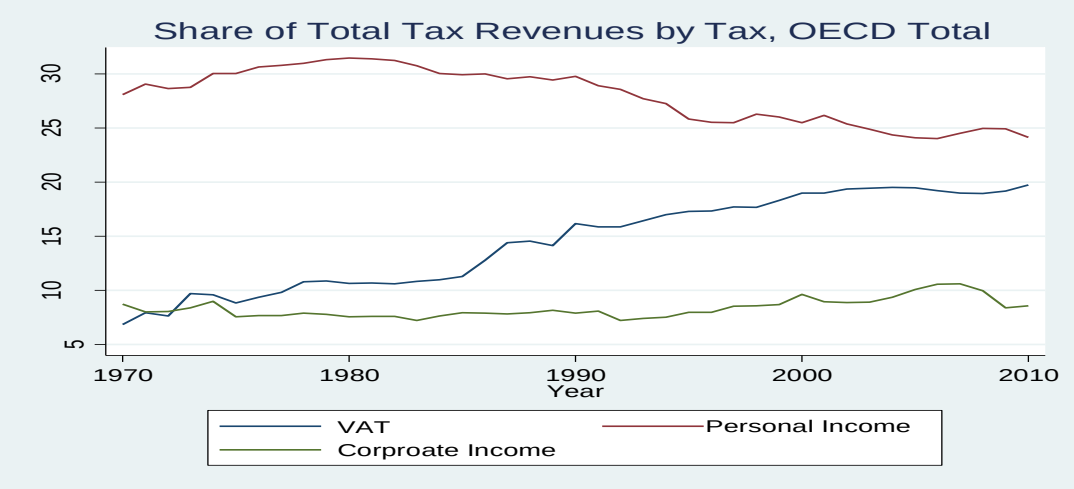

Figure 2: Share of Total Tax Revenues by Tax, OECD sub sample.

CHAPTER 5: COMPONENTS OF THE TAX STRUCTURE

The corporate income tax is a tax imposed on the income, or the equity capital of legal corporate entities within a country. A firm or corporation's investment decisions are influenced by the expected return that they will receive on these investments. The after tax return on an investment or project depends directly on the amount of corporate taxation. A higher rate of corporate taxation will lower the amount of investment by firms because it will reduce the after tax return on these investments. The corporate tax rate enters the growth model because we are interested in seeing how taxation affects investment behavior and the corporate tax rate is the best available proxy for this. As seen in Hall and Jorgensen (1967) tax policy can have a substantial effect on the behavior of investment. Hall and Jorgensen found that the investment tax credit of 1962 had very dramatic effects on investment, which lead to an investment boom. The tax credit led to a large increase in capital investment on machines and equipment. This relates to the corporate tax rate because people will be more likely to invest in corporations if the after tax return on an investment is higher and firms will also likely invest in more capital due to having less of their earnings taken away. Gordon and Lee (2005) estimate that the corporate tax rate has the largest negative effect on output per capita growth. The OECD also concluded in their 2009 report "Economic Policy Reforms: Going for Growth" that the corporate tax rate has a negative effect on output growth. The corporate tax rate also shows a clear negative downward trend since the 1980's (See Figure 3).

This clear downward trend indicates that reducing the rate of corporate taxation might have some sort of positive effect on economies in the OECD countries, or at least governments may believe this. Looking at figure 3 it seems that there may be some positive economic repercussions from reducing the corporate tax rates since this downward trend has continued since 1980. This consistent drop in the corporate tax rate may help us better understand how reducing it can influence economic growth rates

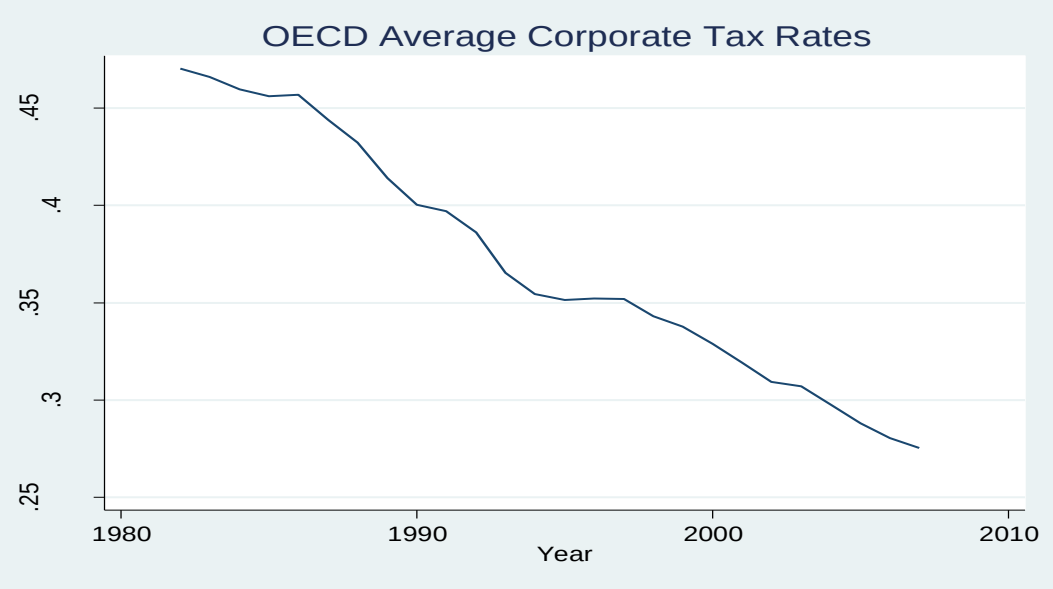

Figure 3: OECD Average Corporate Tax Rate, 1982-2007

However, statutory corporate tax rates do not give us all of the information available about the effective tax burden on corporate income. There are many deductions that corporations can use to reduce the effective tax rate that they pay. For example, in the United States, corporations may deduct the depreciation of the capital stock and immediate write-offs of research and development expenditures, among others. The deductions of depreciation and research and development expenditures are the more

important deductions because they may influence firms to undertake more capital investment or spend more on research and development, both which can have a substantial impact on the rate of economic growth. This can considerably lower the rate of taxation that an individual corporation may pay. For this reason I would also like to analyze the effective tax rates that corporations pay on their income after analyzing the effect that statutory tax rates have on the rate of growth of the economy. The consequences of the corporate tax are one of the most debated subjects in public finance because there are many economists that believe corporations should not be taxed at all[2]. Goolsbee (2004) found that the taxing of corporate capital would lead to a movement of capital from the corporate sector to the non-corporate sector. The non-corporate sector is not exempt from taxes, but has to pay the personal income tax instead of the corporate income tax. Goolsbee (2004) noted that taxing corporations does lead to less economic activity being undertaken by corporations. This study also noted that U.S. states with relatively high corporate income taxes would lead to the number of firms doing business as corporations lower relative to states with lower corporate income taxes. This same theory may hold true for individual countries and therefore lead to lower rates of economic growth for countries with higher taxation.

The corporate income tax may also affect behavior that firms undertake on day to day business decisions. The tax on corporations may affect physical investment, and also firms financing decisions. As shown earlier, physical capital investment is one of the main components for neo-classical growth theory. If the rate of corporate taxation can

[2] businessweek.com/articles/2012-02-26/should-we-abolish-the-corporate-income-tax

impact physical capital investment that firms undertake then it should certainly influence the rate of economic growth in an economy.

5.1 Labor Income Tax

Most individuals in a society perform work or labor to generate income in order to live and earn economic income. In order for governments to tax income there must be a definition of income in order to levy these taxes. The Haig-Simons (H-S) definition of income is: money value of the net increase in an individual's power to consume during a period[3]. Therefore this equals the amount actually consumed during the period plus net additions to wealth (Gayer and Rosen, 2008). The items that are to be included in the H-S criteria for income include: wages and salaries, profits, royalties, rents, dividends, among others.

In this paper, personal income taxes will be referring to taxes levied on labor income. Personal income taxes are taxes on money that people earn through working. At the personal level there are also taxes on interest, dividends, and capital gains in addition to the personal income tax levied on wages, but I will only be concerned with the tax rate on labor income. I will only be concerned with the tax rate on labor income because the labor income tax is one of the three main tax components that I wish to test for and I am excluding the tax rates on dividends and capital gains from the analysis to solely focus on an individual's decision to provide labor. Most governments receive a majority of their tax revenue from income taxation (Figure 2). The personal income tax is being included in this growth model because taxes on labor can have adverse effects on an individual's decision to find work and also to perform an extra hour of work (see figure 5). The

[3] This is named after Robert M. Haig and Henry C. Simons who were economists in the first half of the 20th century.

personal income tax may also have an adverse effect on an individual's decision to invest in education which will be elaborated on more later. According to economic theory, a person will have less incentive to work if they will receive less money for performing that work. Many countries enforce what is known as a progressive tax system. In a progressive tax system workers that earn more money pay a higher average tax rate. For example, the current marginal tax rates for a single worker in the U.S. range from 10 percent to 39.6 percent depending on how much income you earn[4]. These different rates of taxation from 10 percent to 39.6 percent are called marginal tax rates. In a progressive tax system higher earners have a higher marginal rate of taxation. While testing the effect that the personal income tax rate has on economic growth, I will specifically want to test how marginal tax rates influence economic growth rates. It can be seen from figure 4 that there has been a sharp decline in the average highest marginal tax rate in OECD countries from 1980-2000. This tells us that governments have also lowered the labor income tax rates during the period that I will be analyzing. Since there has been a constant downward trend in the highest labor income tax rate among OECD countries, this could lead us to some significant information on whether governments are making the right choice by lowering these tax rates in regards to economic growth. Also, since the average marginal tax rate on labor income is being reduced during this period it may give us some good insight on how labor income taxes directly affect the rate of economic growth. A higher marginal income tax rate will discourage a worker from working one extra hour or possibly discourage them from seeking more education since the after tax return on working an extra hour or receiving more education will be lowered. This could have a

[4] forbes.com/sites/moneybuilder/2013/01/05/updated-2013-federal-income-tax-brackets-and-marginal-rates/

direct affect on the economic growth rate because education is a major contributor to economic growth as seen in Nonneman and Vanhoudt (1996). According to the OECD, progressivity differs significantly across countries. Since there are many differences in the progressivity of the tax system we should be able to see to what degree it affects output per capita on average.

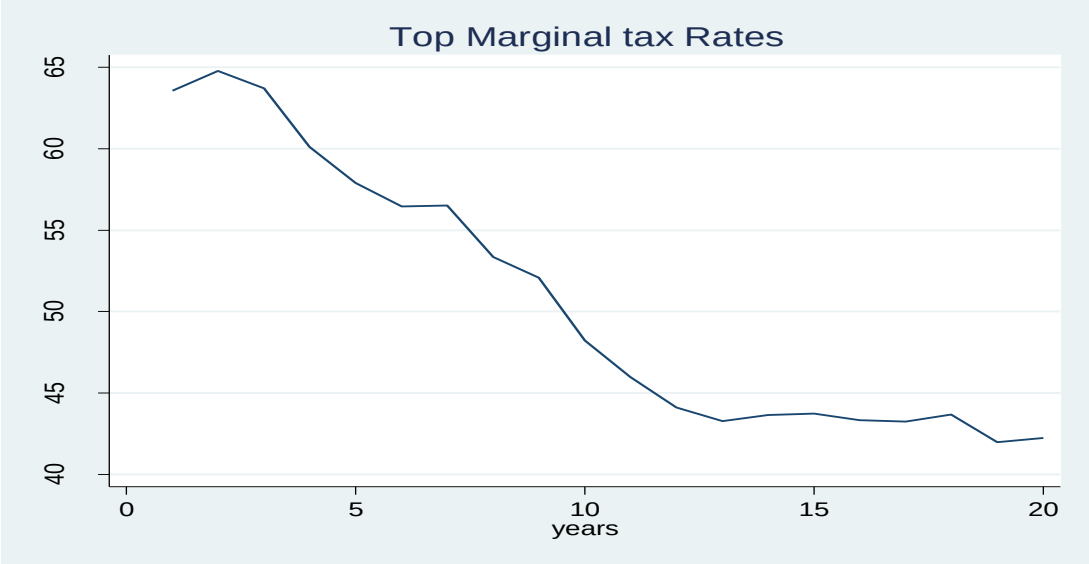

Figure 4: Average OECD top marginal personal income tax Rate

There have been policies in the past regarding personal income taxation and economic growth as well that have been implemented to help spur the rate of economic growth. The United States implemented the Economic Growth and Tax Relief Reconciliation Act (EGTRRA) of 2001, also known as the "Bush Tax Cuts", which reduced income tax rates among other things to possibly help the U.S. economy grow at a faster pace to get out of a recent recession. Public policy mechanisms like the EGTRRA can give us some insight to what happens to the economic growth rate when countries

increase or decrease their marginal income tax rates and also show the importance for the research in my thesis since these measures have been tried in the past.

Top marginal tax rates on wages have varied greatly throughout the time period that I am analyzing for my thesis (see the summary statistics in table 2). For example, in the United States in the 1980's the top statutory marginal income tax rate was reduced from 70 percent to 28 percent and then it was increased again in the 1990's from 28 percent to 39.5 percent. This tells us that politicians could believe that statutory marginal income tax rates have some influence on economic activity and also may give us some insight into how it influences the rate of economic growth. There is a large debate not only on how income tax rates affect rates of economic growth, but also how they can affect behavior. Personal taxation may have a substantial effect on labor supply and also savings decisions that individuals and households make. As stated earlier, labor supply and saving are two very important components of economic growth theory as shown by Solow (1956). There has been previous work studying the elasticity of labor supply with respect to the after-tax wage. If there is more elasticity in labor supply, then an increase in the tax rate can reduce the amount of labor supplied, or hours worked. In figure 5, it can be seen that a tax rate, t, on earnings reduces the opportunity cost of leisure and shifts the individual's budget constraint downwards. As you can see the tax rate has changed the individual's work and leisure decision and has also lowered their income. This behavior effect on labor supply could possibly have a substantial effect on the economic growth rate.

Taxes on labor income may also have an effect on an individual's saving and investment decisions. If an individual's tax rate is increased for example, then they may

have to reduce current savings rates to be able to continue current levels of consumption for economic needs and wants. The same can hold true for a decrease in the marginal income tax rate. Savings are a major driver of economic growth and therefore this effect from higher marginal tax rates may show up in my analysis.

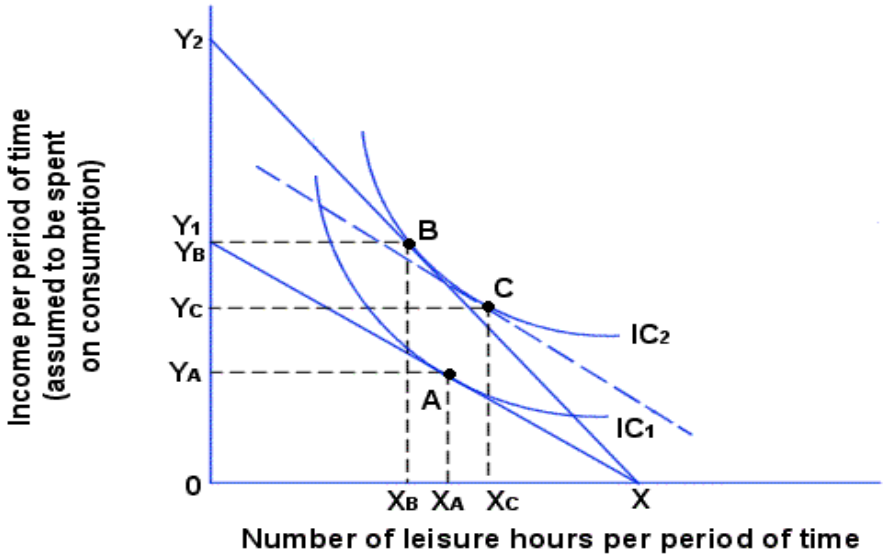

Figure 5: Proportional income tax decreasing ours of labor supplied
Source:econbrowser.com/archives/2010/11/assessing_fanta.html

There are also studies on how different taxes effect the amount of educational attainment in an economy. Alstadsæter (2005) researched how different taxes had an effect on education in Norway. The results that she came up with were very ambiguous because different taxes had different effects on educational attainment in Norway. Some taxes are shown to encourage educational attainment while other taxes were shown to discourage educational attainment. Some of these results can be seen in table 1.

Table 1: Results of different effects of multiple taxes

	Effect on Education
Proportional Wage Tax	0
Proportional Capital Income Tax	+
Proportional Income Tax	+
Proportional Wage Tax and direct costs of education	-
propotional wage tax and non-pecuniary returns to education	+
proportional wage tax and non-pecuniary costs of education	-
proportional wage tax when labor supply is endogenous	-
Progressive wage tax	-

As you can see the taxes that I am including in my model include the income tax, and also the progressive wage tax since I will be using the top marginal tax on labor income in my analysis. The results are mixed for these different taxes and it seems based on this analysis that we can't conclude how human capital accumulation will be directly affected by taxes. Controlling for higher education attainment should help us see directly how taxes influence the rate of economic growth though.

5.2 Value-Added Tax

A value-added tax is a form of a consumption tax, which is essentially a tax on the spending of goods and services. For a buyer, a value-added tax is just a tax on the purchase of a good or service. From the perspective of a seller or producer of a good it is a tax on the value that they added to the product. A value added tax differs from a general sales tax because it is collected more than once. The value-added tax is collected by the government at all stages of production and when the sale of the item occurs. All OECD countries excluding the U.S. have a value added tax and raise a substantial amount of their total revenue by levying this tax. In theory, a higher value-added tax rate will depress consumption because the amount of goods and services that can be purchased with a certain income will become less but this may encourage saving, which was shown

to be one of the drivers of economic growth according to Solow (1956). Consumption taxes are thought to have smaller adverse effects on growth than many other types of taxes because the same tax rate is applied to current and future income (OECD Going for Growth). The value added tax component is also said to have less variability in generating revenue and tends to be more stable than both taxes on income and capital (Holcombe and Sobel, 1997). This is an important part of this analysis because I would like to know what changes in the tax structure can be made in order to promote more economic growth. If the value added tax tends to be less cyclical and less harmful to output growth then it is possible that a shift towards more revenue coming from a value-added tax can be advantageous. From figure 2 it can be seen that there has been a large increase in the share of total tax revenue received from the Value-Added Tax. There has been a sharp incline in the simple average of the value-added tax rate for OECD member countries since the 1980's as well (See Figure 6). This comes in opposition to the steep decline in the rates of corporate taxation for OECD member countries. This could show us that governments have figured out that value-added taxes are more pro-growth than corporate taxes and the constant increases in the average value added tax rate may give us some insight into how it has affected the rate of economic growth for OECD member countries since the 1980's. The rise of the value added tax started in the 1960's and the 1970's in Western Europe and Latin America (James, 2011). The growth that can be seen in Figure 6 can be partly attributed to the fact that the European Economic Community (EEC) required member states to implement a value added tax. Currently, the United States is the only OECD member country that does not have a value-added tax, and many of the countries included in this study are former EEC countries and current European

Union members as well. Another contributor to as why the average VAT has increased so much in OECD countries over the sample period is because the VAT replaced most turnover taxes that were in place before the VAT's were created and thus increased as the turnover taxes were phased out (James, 2011).

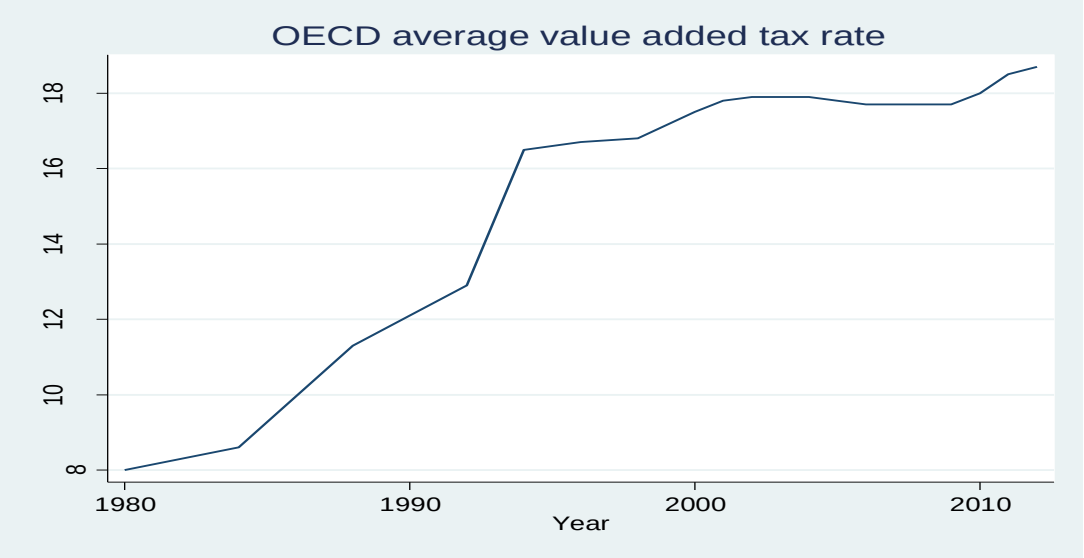

Figure 6: Average VAT rate in OECD countries, 1980-2012

CHAPTER 6: PREVIOUS STUDIES ON ECONOMIC GROWTH

There is an extensive amount of literature available on the ways that government spending affects economic growth rates and also how the structure of taxation distorts the efficiency of the private sector, but there is only a limited amount of research done on how the tax structure of a government affects the economic growth rate.

One of the earliest studies on how taxation affected economic growth was done by Marsden (1983). Marsden paired ten countries together, each with approximate per capita income levels, but different ratios of total tax revenues, or average tax rates. Marsden found for the 1970's that each of the low tax countries had higher growth rates when compared to the higher tax countries. It is stated by Koester and Kormendi (1989) that the countries he chose were ad hoc and a better approach should be used.

Koester and Kormendi (1989) used data from 63 countries to examine the impact of average and marginal tax rates on the level and growth of economic activity. They wanted to test the "supply-side" hypothesis that higher tax rates inhibit economic activity and growth. Koester and Kormendi used the total tax revenue divided by gross domestic product as the average tax rate variable and the marginal tax rates were obtained for each country from the time series regression of tax revenues on GDP. The slope coefficient obtained from that regression constituted the measure of marginal tax rates. They first found that there was a significant negative impact on the economic growth rate of both average tax rates and marginal tax rates. When controlling for initial per-capita income

such as Baumol (1986), capital accumulation and labor force growth in the standard neo-classical framework, the negative effect that the marginal and average tax rates had on the economic growth rate went away. Since there was no affect on the on the economic growth rate Koester and Kormendi decided to test the effect that marginal and average tax rates would have on the level of economic activity. They found a strong simple correlation between income per capita and average tax rates, which is known as Peltzman-Rabushka endogeneity. To account for this endogeneity bias they decided to test the effects of changes in the marginal tax rates while holding constant the average tax rates. By controlling for average tax rates they uncovered a significantly negative effect of progressivity on income per capita. Koester and Kormendi concluded that reducing the marginal income tax rate by ten percentage points could lead to a 15.2 percent increase in GDP in least developed countries (LDC's) and a 7.4% increase in GDP in non LCD's which would coincide more with my OECD sub-sample. They concluded that holding average tax rates constant, reducing marginal tax rates are associated with an upward shift in the growth path of the economy. This analysis is important for my research because I will be testing marginal income tax rates as well and this could give us some more insight into how the progressivity of the tax structure affects economic growth.

According to Engen and Skinner (1992) one view of government fiscal policy was that it stifles economic growth through distortionary effects of taxation and another view was that government plays a central role in economic growth by providing public goods and services. Since neo-classical growth theory did not allow for fiscal policy to affect the growth rate of the economy and rather only the level of output of the economy, Engen and Skinner relaxed the assumption that countries were on a steady state growth path and

allowed them to be in a transition path towards the steady state. They focused on how government fiscal policies affected the allocative efficiency of capital accumulation and labor supply, thus allowing fiscal policy to affect the growth rate and the level of economic output. Using data from 107 countries Engen and Skinner developed a model that integrated the effect of government spending, and the distortionary effects of taxation, in a model of output growth. They came to the conclusion that a balanced budget increase in government spending and taxation of 10 percentage points was predicted to decrease long-term growth rates by 1.4 percentage points. Long-term growth rates were considered greater than 15 years in their paper. Their research also found that taxes on labor income were likely to have quite different effects on output growth other than corporate, interest and trade taxesThis paper was mainly motivated by the previous work done by Gordon and Lee (2005) in their paper titled *"Tax Structure and Economic Growth"*. In their paper they wanted to explore how tax policies affect a country's growth rate using cross country data from 1970 to 1997. Gordon and Lee believed that tax policy could affect the rate of growth of GDP. The main objective of their paper was to test how components of the tax structure affected things like entrepreneurial activity, research and development, and work among others, and how this would then spillover to the growth rate of per capita GDP. In their study they noted that there were endogenous factors that could cause incidental or reverse causality. They noted that during periods of high growth there would generally be a greater demand for new infrastructure and public spending, therefore tax increases would be necessary in order to finance the increase in demand from these programs. They used the weighted average of personal and corporate income taxes in other countries, weighting by the inverse of the distance between the two

countries in order to solve this problem. This method could possibly work because there was a very high correlation between the tax rates in nearby countries. The main objective of their paper was to set up an endogenous growth model that was specified like

$$GR = \beta_0 + \beta_1\tau + \beta_2 t + \beta_3 S + \beta X + e$$

Where GR is the annual growth rate of GDP per capita, τ is the top statutory corporate tax rate in the 1980's, t is a representation of the personal income tax rate, S is the consumption tax rate, X is a control vector including the log of GDP per capita in 1970, government expenditures over GDP in 1970, the primary school enrollment rate in 1970, trade openness, the average tariff rate, and an index for government corruption, the average rate of inflation, and the annual rate of population growth (Gordon and Lee 2005). Their estimating equation is based on influential previous work done in endogenous growth literature. For the representation of the personal income tax variable they experimented with including the ratio of the average tax rate by the top marginal tax rate. This would provide more information on the progressivity of the personal income tax if taxes were enforced. There could be some problem with the enforcement of taxes in lesser developed countries. The main representation that they used for the personal income tax was the top statutory marginal tax rate on wage income. They thought that this would best represent the effects that a higher rate has on entrepreneurial activity and economic growth. Gordon and Lee performed two different methods while trying to analyze the effects that the tax structure had on economic growth rates. The first method that they used was a cross-sectional growth regression with and without instrumental variables. They ran a mix of regressions that included continental dummy variables and a dummy for OECD countries. Their results were consistent with many other previous

studies on growth literature in that they found that countries with lower levels of initial per capita GDP grew faster, education had a significant and positive effect on growth, an increase in the rate of population growth would lead to a decrease in GDP per capita growth, higher inflation rates lowered economic growth rates and countries that had more open trade saw higher rates of economic growth. The coefficient on the corporate tax rate is shown to be negative and significant in all of the cross-sectional growth regressions that they perform. When adding the top personal tax rate, the average tax rate, government expenditure-to-GDP ratio, average tariff rates, and commodity tax rates the corporate tax rate remains negative and significant. None of the coefficients on any of the other tax variables showed any significance in the cross-section growth regressions. When using an instrumental variable of the weighted average of the corporate tax rate weighted by the reciprocal of distance between the two countries they find that the coefficient of the estimate of the corporate tax rate becomes about 60% greater. They state that this could be due to rapid economic growth driving up the demand for needed infrastructure and investments. The next method that Gordon and Lee used was a panel data method. They used data in three five year periods and one 3 year period. They then regressed the annualized growth rate of GDP per capita on the corporate tax rate in the initial year of each observation, and other control variables. The estimated coefficient on the statutory corporate tax rate remained negative and significant at the ten percent level. Personal tax rates remained insignificant in the panel data regressions. According to Gordon and Lee a low corporate tax rate can generate both a higher rate of capital investment and more learning through entrepreneurial activity. They then looked for how the corporate tax rate affected personal tax payments by regressing personal tax payments

on the corporate tax rates controlling for GDP per capita and country dummies. Their estimates showed that the corporate tax rate is associated with an increase in personal income tax revenue, which leads to people reporting more wage and salary income and therefore not engaging in as much entrepreneurial activity when the corporate tax rates are higher. They conclude that the corporate tax rate is significantly negatively associated with GDP per capita growth. Their suggestion is to lower the corporate tax rates to help increase per capita GDP growth.

CHAPTER 7: EMPIRICAL STRATEGY

For this thesis I would like to test how different tax structures or more specifically, rates of taxation, affect the rate of economic growth for OECD member countries. The taxes that I will test for include the labor income, corporate income, and the value added tax rate. I chose these specific rates of taxation because they compose of a very large set of overall tax revenues for most OECD countries (See Figure 2). As of 2010, these three taxes account for over 50% of all tax revenue received by OECD countries. What distinguishes my thesis from past empirical work on economic growth and taxation is focusing on tax rates, rather than shares of tax revenue received by governments. Gordon and Lee (2005) and Easterly and Rebelo (1993) were among the few that tested how tax rates affected economic growth. Property taxes have also been used in recent literature by Arnold (2008) and Xing (2011) to help see how shifts in tax structures could be done to promote more economic growth. Property taxes are also a very large component of tax revenue for most OECD countries but finding consistent rates of taxation was difficult, therefore I have left them out of the analysis for this thesis. Levine and Renelt (1992) said that "there does not exist a consensus theoretical framework to guide work on growth". Therefore there are many different approaches that may be taken to estimate economic growth rates. The empirical aim for this paper will be to set up a regression equation as such.

$$Y=\beta 1Ct+\beta 2PT+\beta 3VT+\beta 4X+e$$

Where *Y* is GDP growth per capita from 1980-2004, *Ct* is the top corporate tax rate, *Pt* is the labor income tax rate, *Vt* is the value-added tax rate, *X* is a control vector including some of the most commonly used variables in economic growth literature and *e* is the estimated residuals from the regression results.

I will be using panel data methods for the empirical analysis. Panel data is also known as a cross-sectional time series regression. There are multiple observations being studied at different points in time. This is preferred to cross sectional data because a cross sectional study can only account for multiple observations over a single snapshot in time. Panel data is also preferred to standard time series analysis because multiple observations can be used over multiple time periods instead of just one observation. Panel data methods have also been used extensively in recent literature on taxation and economic growth[5]. From a statistical point of view, panel methods increase the sample size which should improve the efficiency of parameter estimates. For example, in Gordon and Lee (2005) they tested two models; a cross-sectional regression model and also a panel regression model. Their cross-sectional regression model only had 70 observations while the panel model had has many as 270 observations.

The panel data method that I will be using will be similar to the panel regressions used in Gordon and Lee's 2005 paper "Tax Structure and Economic Growth". I will be using data collected from 1980-2004 in OECD member countries. I chose to stop at the year 2004 in order to get the most efficient data set and therefore exclude data from the recent financial crisis that started as early as 2006[6]. Instead of using every year available in the data set I will split the data into five five-year panels. Therefore, the growth rates

[5] For more information see Gordon and Lee (2005) and Arnold (2008)
[6] federalreserveeducation.org/about-the-fed/history/2006andbeyond.cfm

will be measured as the growth rate of GDP per capita in each five year panel. The reason for doing this is to help account for the business cycle effect that occurs in macroeconomic data. This method should minimize the cyclical effects that occur during these time periods. There is no scientific method that I chose for selecting the five year periods in my panel regressions. The reason that I chose five year periods is because it has also been done by Gordon and Lee (2005), Xing (2011) and Asea, Mendoza and Milesi-Ferretti (1997). Also, by using averages across five year periods we can see how changes of tax structures over periods of time affect the long run growth rate of GDP. Most changes in the tax structure do not occur on a year to year basis because they have to be voted on and passed by the countries government. I believe that this will be a more efficient method than using yearly data.

In the Solow Model growth simply depends on the accumulation of capital and labor. I will be using an endogenous growth framework to determine the effects that taxation have on the rate of economic growth and the more recent endogenous growth literature has shown that there are other variables that can influence the rate of growth. I will introduce what Solow (1956) introduced in his basic framework an include some form of physical capital to be included in my model. The variable that I have chosen to compensate for physical capital accumulation is gross-fixed investment as a percentage of GDP. This has been commonly used in more recent growth literature[7]. The control vector, X, will also include the logarithm of initial GDP per capita in 1980, a measure for school enrollment rates, and population growth rates.

[7] Xing (2011) and Arnold (2008) recently used gross fixed investment as a percentage of GDP as their proxy for physical capital.

The variables used in the estimating equation come from previous studies in economic growth literature. Mankiw, Romer, and Weil (1992) developed one of the most instrumental papers in growth literature and in their paper they regressed growth rates of GDP on initial GDP per capita and education enrollment rates. They found that both of these variables being included in the analysis were highly influential in determining cross country differences in rates of economic growth. The rate of population growth is also being used for the accumulation of labor, as done in the earliest work done by Solow (1956).

I will also be controlling for the amount of government revenue as a percentage of GDP that governments raise in order to pay for the necessary public goods and services that they provide. This has been done in the most recent work on tax structures in models of economic growth[8]. Government need to raise money to pay for defense, social welfare programs, and public infrastructure such as highways and bridges. Controlling for government revenue will also allow me to test how shifts in the tax structure can be made in order to promote the most pro-growth friendly tax structure. For example, if we control for government revenue then we can test how the growth rate of GDP per capita can be affected by making shifts in the tax structure from one tax to the next if one or more of the taxes is deemed less harmful for growth than the other taxes

There are many ways to account for taxation in models of economic growth and also many different methods have been used for analysis. Gordon and Lee (2005) used the top corporate tax rates in the 1980's to account for corporate taxes, the top marginal tax rates on wage income for their labor income tax measure, and commodity tax rates in

[8] Arnold (2008) and Gordon and Lee (2005) both controlled foe the amount of government revenue to GDP.

1999 to serve for their consumption tax rate. The commodity tax rates were taken from a data set provided by Price Waterhouse Coopers and Earnest and Young, and they were given as statutory commodity tax rates in a given country. My first method will be to test how statutory tax rates affect the rate of economic growth in the period 1980-2004. The statutory tax rates on labor, capital, and consumption include the top marginal tax rate on labor income, the top statutory corporate tax rate, and also the statutory value added tax rate, which is the most general form of a consumption tax that countries administer. The first method in analyzing on how different tax structures affect the rate of economic growth will test how these top statutory taxes affect the rate of economic growth. The statutory corporate tax rates are also known as the top marginal tax rate on corporate income.

There have not been many studies using the general top statutory tax rates in economic growth analysis so I will also try another measure of the tax structure to see if there is an effect on growth as well. The next empirical strategy that I will employ will be to include effective marginal tax rates (EMTR's) on corporation and also effective rates of taxation on labor income. The reason that I have also chosen to do this is because corporations rarely pay the actual statutory top corporate tax rate. The EMTR's may also be a better measure of the perceived tax burden on investment since most companies will pay a tax rate that is closer to the EMTR rather than the statutory tax rate. Figure 7 shows both the EMTR's and average top statutory top tax rates on corporate income in OECD member countries from 1982-2007. I believe that this could have a substantial effect on the ways that corporations and individuals evaluate their after-tax return on their investments and therefore may influence the amount of investment and business activity

that occurs in any given economy. If firms know that they will most likely pay a lower tax rate on their income than the rate that is imposed on them by the government then they should be more likely to engage in productive economic activities, which can have a substantial effect on the rate of economic growth. The reason for there being a somewhat large difference in EMTR's that firm's pay and the actual statutory top tax rate is because there is a wide number of deductions and loopholes in many country's tax systems that allow for them to write-off certain taxes[9].

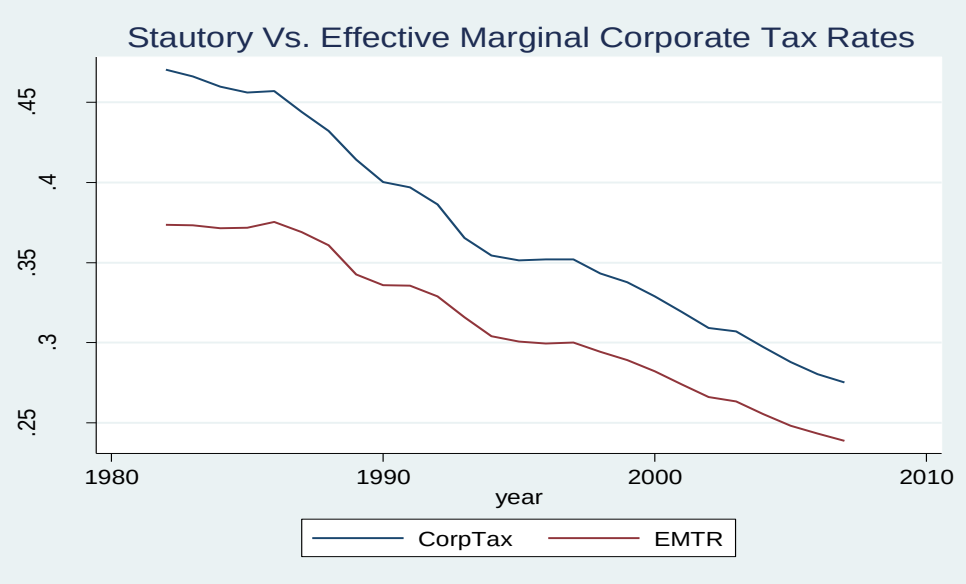

Figure 7: Average statutory vs. average effective corporate tax rates

The calculation for the effective tax rate comes from Devereux, Griffith, and Klemm (2002) and follows.

"Consider a simple one period investment, in which a firm increases its capital stock for one period only. It does so by increasing its investment by 1 at the beginning of the period, and reducing it by 1-δ at the end of the period, where δ represents economic depreciation. The higher capital stock generates a return at the end of the period of ρ+δ, where ρ is the financial return. The discount rate is r. Ignore inflation.

[9] reclaimdemocracy.org/real_tax_rates_plummet/

One unit of capital generates a tax allowance with a net present value (NPV) of A. So introducing tax reduces the cost of the asset to 1-A, while the saving from the subsequent reduction in investment becomes (1- δ)(1-A). The total return ρ+δ is taxed at the rate τ. The NPV of the investment with the tax then becomes

$$R = \frac{(\rho + \delta)(1 - \tau) - (r + \delta)(1 - A)}{1 + r}$$

The cost of capital is the value of ρ, denoted $\tilde{\rho}$, for which the investment is marginal, i.e. R=0. The effective marginal tax rate (EMTR) is $(\tilde{\rho} - r)/ \tilde{\rho}$." (Devereux, Griffith, and Klemm, 2002).

I have decided to directly quote the way in which the EMTR on corporations is calculated because it is a somewhat complicated calculation and it is also been used in other research papers dealing with EMTR on corporations such as Loretz (2008).

There is not much literature available on how effective rates of corporate taxation influence economic growth so I hope that the results I gather from this analysis will bring some insight into the topic and therefore be useful for governments to know so they can better structure their tax code.

The next step in the second part of the analysis will be to calculate effective marginal tax rates on labor income and add this to regression model along with the effective taxes on corporate income. There are many different ways to calculate effective marginal labor taxes[10]. I have chosen a method similar to that of the OECD in their "Taxing Wages 2011" publication, which is also known as the tax wedge. I have chosen this method because the marginal personal income tax rate is not the only tax that goes into an individual's decision to work or an employer's decision to hire a worker. Most OECD countries also impose a tax on employee's contribution and an employer's contribution to social security. The OECD calculation for the tax wedge also includes an employer contribution to social security rate of taxation but I have decided to leave this

[10] See Mendoza , at al (1997) for ways to calculate effective average tax rates on labor

out of the equation because workers do not directly bear this tax and this would also make my tax wedge over 100% for some of the sample countries which is not feasible since individuals do not pay to work in most cases. I would like to be consistent at the central government level and therefore just add the employee contribution and sub-central rate of taxation to the highest marginal tax rate on wage income and see if this has any effect on the rate of economic growth for OECD member countries. I believe that this should give us some more useful insight into the analysis because some countries, such as Australia, did not have an employee contribution to social security during the time period I have analyzed and this makes their effective marginal tax rate the same as their statutory top tax rate on labor income. The effective marginal tax rate on wage income will therefore be calculated as

$$\begin{aligned} \boldsymbol{EMTR = Top\ Marginal\ \ Federal\ Tax\ Rate} \\ \boldsymbol{+ Employee\ Social\ Security\ Contribution\ Rate} \\ \boldsymbol{+ Sub\ Central\ Government\ Tax\ Rate} \end{aligned}$$

I have decided to only include the effective tax rate on labor and capital in the further analysis and to exclude the effective tax rates on consumption. This was decided upon because I have not found a good measure to use for effective tax rates for a value-added tax and the research on this topic is very limited. In Mendoza, Razin, and Tesar (1995) they calculate a measure for an effective tax rate on consumption using OECD data. This is one of the only measures for an effective tax rate on consumption that I have found when performing my analysis. I do not find this measure very useful to refer to for my thesis though. The measure that Mendoza et al. (1995) uses tax revenues received from excise taxes and also revenues received from general taxes on goods and services,

not VAT's. Since I am studying value-added tax rates I would find this measure to not be very useful for the analysis. The VAT also seems to be one of the more difficult taxes to avoid and more efficient taxes when it comes to tax collection as explained by Mello (2008). Based on the results of the Mello (2008) paper it seems that the VAT is highly efficient and even when the VAT is raised there does not seem to be much of a loss in revenues received from these tax rates. Also, the data for testing consumption taxes in more recent studies such as Xing (2011) and Arnold (2008) to not include value added tax rates but rather taxes on consumption in general. Although I have decided to leave effective value-added tax rates out of the analysis, I believe that more research should be done on this subject to help with the study of effective tax rates for the VAT.

CHAPTER 8: DATA

The data for this project was collected from different sources to get the most updated and optimum data sets in order to provide the best results in the statistical analysis. Data for GDP per capita came from the OECD statistics database and is calculated in constant 2005 U.S. dollars dating back to 1980. This data was then used to calculate the growth rate of GDP per capita used in the statistical analysis. Tertiary education is used as the variable for educational attainment, or human capital, in this analysis. Data for tertiary education comes from the World Bank's World Development Index (WDI). Tertiary education is defined as the total enrollment in tertiary education expressed as a percentage of the total population of the five year age group following one from secondary school leaving. Tertiary education is used because I believe that the amount enrolled in higher education should be a better contributor to economic growth than the percentage of the population enrolled in general education, especially for OECD countries since they tend to include more advanced economies. Population growth rates are defined as the annual rate of population growth for the OECD member countries and were also gathered from the OECD in their labor force statistics database. Gross fixed capital formation as a percentage of GDP is used for physical capital accumulation in this analysis. This data was gathered from the OECD statistical database and others such as Xing (2011) and Arnold (2008) have used this variable in their analysis on economic

growth and taxation. The logarithm of initial GDP per capita was used as a convergence variable in the analysis and was taken at each initial period in the five year panels. Government revenue as a percentage of GDP was used as a control variable in order to see how different taxes had an effect on the rate of economic for the countries in the analysis. Government revenue as a percentage of GDP is also used to help see how a shift from one tax to another tax will influence the rate of growth and therefore help us see which taxes are more pro-growth friendly. The data for the tax variables comes from both the World Tax Database (WTB) and also the OECD tax database. The World Tax database was formally run by the Office of Tax Policy Research at the University of Michigan, but this is no longer the case. The top statutory corporate tax rate is assigned for the corporate tax variable in the analysis on statutory tax rates. The top marginal tax rate on wage income is also taken from the OECD and is calculated as the top statutory marginal tax rate at the central government level. VAT tax rates were taken from the OECD revenue statistics and were given as the central government value-added tax rate for the time period.

CHAPTER 9: EMPIRICAL RESULTS

As stated earlier, the first method that I have chosen to test is whether or not statutory top rates of taxation on corporate income, labor income, and consumption have any effect on the rate of GDP per capita growth. I will do this by regressing GDP growth per capita on initial GDP per capita, population growth rates, physical capita, human capital and then adding the selected tax variables to the estimating equation.

Table 2 shows summary statistics for the regression analyses that I will be performing. It can be seen that not every variable has the same amount of observations, but running unbalanced panel regressions is not uncommon and was even done in previous research such as Gordon and Lee (2005).

Table 2: Summary statistics for regression analysis

Summary Statistics for Regression Analysis

Variables	OBS	Mean	S.D.	Min	Max
GDP Per Capita Growth	149	0.017952	0.015461	-0.0191504	0.076229
Logarithm of Initial GDP Per Capita	149	9.917628	0.445383	8.48695	11.01852
Top Statutory Corporate Tax Rate	146	36.26027	8.973451	9.8	56
Tertiary Education Enrollment Rate	151	35.18127	18.06143	1.44892	90.30488
Population Growth Rates	167	0.68352	0.791305	-1.379877	6.031158
Top Stautotry Income Tax Rate	141	48.84291	14.71297	11.5	85
Gross Fixed Capital Formation (%GDP)	149	22.44899	3.989896	14.8	36
Value-Added Tax Rate	170	13.0644	8.839971	0	25
Effective Labor Tax Rate	170	45.63153	29.75714	0	93.75
Effective Corporate Tax Rate	151	7.50896	13.27231	0	45.066
Government Revenue (%GDP)	112	35.3716	8.148521	15.5626	50.4788

I will begin by performing a regression analysis with the control vector of variables that I have chosen and without the selected tax rates to test and see if I have a good model to perform the analysis with. If the variables that I have chosen do not have the expected signs or are insignificant, then these variables will not be ideal for usage totest if the statutory tax rates have any effect on the rate of economic growth. I expect to get a negative coefficient on the logarithm of initial GDP per capita as did Mankiw, Romer, and Weil (1992). The reason for the expectation of a negative sign on initial GDP per capita is because of the convergence hypothesis, which states that poorer countries should grow faster than rich countries. Maniw, Romer and Weil (1992) tested for this convergence hypothesis and they found that the coefficient on initial GDP in OECD countries was negative and highly significant. Convergence occurs because countries may be outside of their steady state long run growth path and the countries that are farther away from their steady state growth path will tend to grow faster than those that are closer or that are already on the steady state growth path. The rate of population growth should also yield a negative coefficient because GDP per capita is also known as

$$\frac{Y}{N}$$

Where Y is GDP and N is the population rate. If N is growing at a faster rate than Y then that will bring down the rate of GDP growth per capita because the denominator will be growing at a faster rate than the numerator, or a high rate of change in *N* may reflect changes in the demographic composition where *N* could also be decreasing. Tertiary education enrollment rates should produce a positive coefficient because education has

shown to be very important in economic growth models[11]. By examining table 2 one can also see that the standard deviation is relatively high for the percentage of the population enrolled in tertiary education. Since most of the OECD member countries are more advanced I would hypothesize that this would have a substantial effect on growth rates of GDP per capita. Physical capital accumulation should also bring about a positive coefficient because Solow (1956) showed that physical capital accumulation is one of the main components of economic growth. As stated earlier I will be using panel data from 1980-2004 and the data will be split into five, five-year period panels.

I intend to run the initial regression analysis testing the statutory top tax rates on labor, consumption and corporate income will be performed as follows

$$\begin{aligned} \boldsymbol{GDP\ Per\ Capita\ Growth} &= \boldsymbol{a} + \boldsymbol{\beta_1 Initial\ GDP\ per\ Capita} + \boldsymbol{\beta_2 Physical\ Capital} \\ &+ \boldsymbol{\beta_3 Human\ Capital} + \boldsymbol{\beta_4 Population\ Growth} \\ &+ \boldsymbol{\beta_5 Corporate\ Tax\ Rate} + \boldsymbol{\beta_6 Labor\ Income\ Tax\ Rate} \\ &+ \boldsymbol{\beta_7 ValueAdded\ Tax\ Rate} + \boldsymbol{e} \end{aligned}$$

Where $\boldsymbol{a}$ constant term and $\boldsymbol{e}$ is the error term in the regression. I first performed regression analysis without the selected tax variables and results are shown in table 3.

Column 1 reports a standard pooled regression of GDP growth per capita on the growth variables that I have chosen. All of the results are consistent with previous work done on economic growth and my hypothesis except for physical capital accumulation, which is the amount of gross fixed capital formation as a percentage of GDP for the countries in this data set.

[11] Barro (1991) and Mankiw, Romer, Weil (1992) both showed this in their analysis.

Column 2 reports another pooled OLS regression with robust standard errors. I ran the second regression with robust standard errors in order to combat possible heteroskedasticity in the error terms. The results in column 2 are very similar to those results reported in column one, with only the standard errors being reduced slightly. Physical capital is still shown to be negative and significant which contradicts economic theory and previous work[12].

Table 3: Growth regressions without tax variables

Dependent Variable: GDP growth per capita	1	2	3	4
Initial GDP per capita	-0.0170414**	-.016715288**	-.0194702**	-.0284256**
	[.000]	[.000]	[.000]	[0.002]
Human Capital	0.0001927**	.0000641**	.0001826**	0.0002341*
	[.013]	[.000]	[0.027]	[0.085]
Physical Capital	-0.0003531	-0.0001633	-.0004528**	-0.00203075**
	[.243]	[0.52]	[.001]	[0.00]
Population Growth	-0.0058525**	-.0072992**	-0.006293**	-0.0015927
	[.005]	[.000]	[.007]	[0.669]
Observations	138	138	138	138
P-values in brackets				
Constant Not Reported				
*Significant at 10% level				
** Significant at 5% level				
Five Year Panels: 1980-1984, 1985-1989,1990-1994,1995-1999,2000-2004				

Column 3 reports a panel regression with random effects. Running a random effects panel regression model is useful because it is assumed that the variation across countries is random and not correlated with the independent variables in the model. There are differences across countries that cannot be accounted for and may have some influence on the dependent variable. We can't conclude that all countries in the OECD

[12] Arnold (2008) and Xing (2011) both found significant positive correlations with gross fixed capital formation in their studies on OECD countries. They used the same measure as myself which is gross fixed capital formation as a percentage of GDP

sub sample are the same because there are differences in natural resources, culture, climate, etc. Some of these differences can have a significant effect on the growth rate of GDP per capita. For example, Norway has an influx of oil and therefore this may contribute to them having a higher GDP per capita than some countries. The coefficients in the random effects model are all statistically significant at the five percent level. The coefficients on human capital, initial GDP per capita, and population growth rates are all consistent with my earlier predications but physical capital is still shown to be negative, but this time it is significant. The coefficients in a random effects regression represent the average effect that the independent variables have on the dependent variable when the independent variables change across time and between countries.

The final model that is reported in column number 4 is a panel regression with fixed effects. Fixed effects panel regressions allow us to see how the dependent variable is affected by changes in the independent variables over time. Fixed effect regressions are the most natural measures used when it is assumed that something within the individual countries may bias the outcome variables. Fixed effects regressions remove time-invariant time characteristics from the independent variables and therefore allow us to assess their net effects. A fixed effects regression is essentially a paneled regression with dummy variables exhibited for each entity, which in this case would be each country that we have chosen.

All of the variables in the four regressions performed are consistent with my hypothesis and also with previous literature except for physical capital accumulation. Physical capital accumulation is one of the main components of economic growth according to Solow and therefore there should be a reason for the coefficient on the

variable being consistently negative and insignificant. If you take a look at the summary statistics in table 2 you can see that there is not a large amount of variation for gross fixed capital formation. Using variables with a low amount of variation in regression analysis will not render us conclusive results and therefore coefficients may not be giving us very much useful information. Figure 8 shows a time series graph of the average of OECD countries gross fixed capital formation as a percentage of GDP. The data is from 1980-2008 and as you can see form examining the graph the amount of gross-fixed capital formation seems to vary between 21 and 23 and a half percent. This is not a very considerable amount of variation and therefore may not be important for the rest of my analysis. However, we are interested in net physical capital accumulation per inhabitant rather than gross fixed capital formation as a percentage of GDP, but it is very difficult to estimate the net physical capital stock due to trying to estimate the depreciation rate of capital. There are different methods to estimating the depreciation rate but this is not an exact science and it is also not essential to my analysis regarding the effects that tax rates have on rates of economic growth. I have decided to leave physical capital accumulation out of the further regressions for these reasons.

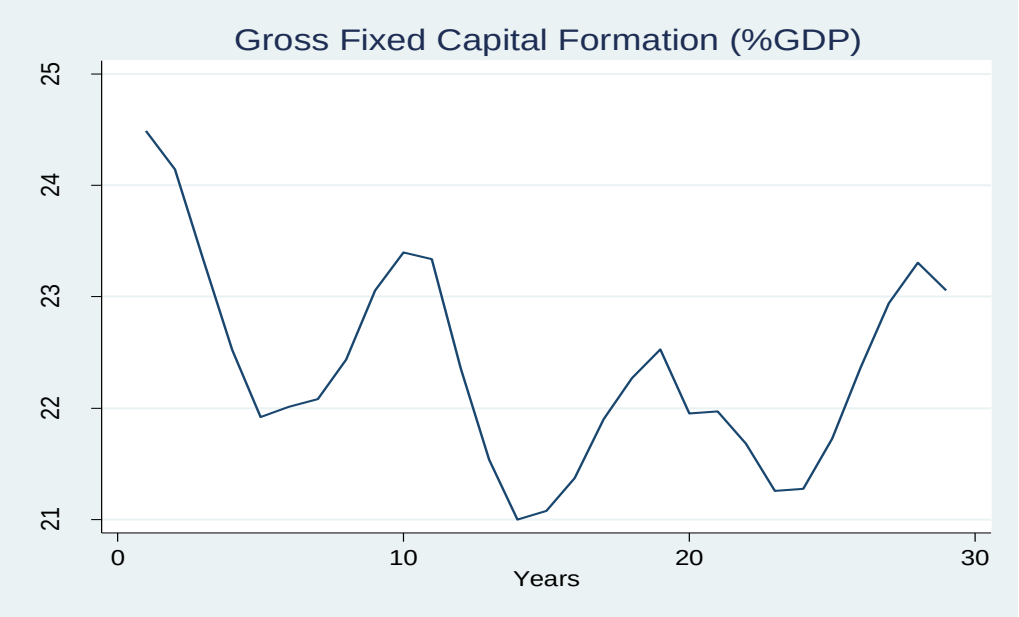

Figure 8: Average gross fixed capital formation as a percentage of GDP, OECD sample

When deciding which model is best to use for the remainder of the analysis, more statistical testing will have to be performed. I chose to run fixed effects regressions andrandom effects regressions because they are the two most commonly used panel regressions. Fixed effect regressions were also used by Gordon and Lee (2005) in their analysis. To decide between using a fixed effects model and a random effects model a Hausman Test will have to be performed between the two regression models. The null hypothesis of the Hausman test is that the preferred model is random effects versus the alternative which is a fixed effects model. The Hausman test tests whether the unique errors of the regression are correlated with any of the regressors and the null hypothesis is that they are not. I performed the Hausman test after performing both the fixed and random effects regressions under the null hypothesis that the random effects model is the one that should be used. I received a probability greater than the chi-squared value of

0.0704 and therefore failed to reject the null hypothesis for the Hausman test which means that the random effects model is preferred to the fixed effects model.

The next step will be to test the pooled regression model in column 1 and the random effects model against each other to see which model is appropriate for further usage. To test which of these models is better I will have to perform the Breusch and Pagan Lagrangian multiplier test for random effects. The null hypothesis in this case is that the pooled OLS regression is preferred to the random effects regression. I performed the test and received a probability greater than chibar-squared value of 0.0078 which means that I have rejected the null hypothesis that the pooled regression model is preferred to the random effects regression. For the remainder of the analysis I will use the random-effects model to test how the taxes affect the rate of economic growth.

After testing the validity of my preliminary model I will now move on to testing how the tax rates effect GDP growth rates for OECD countries. As stated previously, I will be using a random effects panel regression for the remainder of the models because the statistical testing showed that this was the appropriate measure to use over the pooled regressions and fixed-effect regressions. First, I will be including the top marginal statutory tax rates on labor income, corporate income, and the value-added tax rate in the analysis. I will be controlling for government revenue as a percentage of GDP to see how potential shifts in the tax structure may have an effect on the growth rate. For example, if one tax is to have a positive coefficient and the other tax variable has a negative coefficient then we can say that a shift from the tax with a negative coefficient to the one with a positive coefficient will be better for economic growth while maintaining the same amount of revenue for public expenditures. The regression output is reported below.

Table 4: Regression results with statutory tax variables included

Dependent Variable: GDP Growth Per Capita	1	2	3
Initial GDP Per Capita	-0.0109468**	-0.010622**	-0.0096357**
	[0.012]	[0.122]	[0.042]
Human Capital	0.000179**	0.0001966	0.0001687**
	[0.038]	[0.122]	[0.043]
Population Growth	-0.005568**	-0.0055981**	-0.0056635**
	[0.035]	[0.035]	[0.032]
Government Revenue/GDP	-0.0001419	-0.000129	-0.0002335
	[0.443]	[0.490]	[0.348]
Statutory Corporate Tax Rate	0.0000668		
	[0.673]		
Statutory Labor Income Tax Rate		-0.000816	
		[0.593]	
VAT			0.0001114
			[0.572]
Observations	107	106	107
P-Values In Brackets			
Constant Not Reported			
*Significant at 10% Level			
**Significant at 5% level			
Five Year panels: 1980-1984,1985-1989,1990-1994,1995-1999,2000-2004			

Column 1 reports the random effects regression including government revenue as a percentage of GDP as a control variable and also the top statutory marginal tax rate on corporate income. Initial GDP per capita, tertiary education attainment and population growth rates are all showing up significant and are also showing their expected signs. The control variable, government revenue as a percentage of GDP has a negative coefficient but is rendered insignificant in this analysis. The sign on the coefficient is consistent with previous work done by Arnold (2008) and also Xing (2011). It could be said that this control variable has a negative coefficient because public spending could possibly be crowding out private spending or private investment. However, this subject would be a whole different study in itself and cannot be concluded from these regression results.

There can also not be much information taken away from this coefficient because it is not significant in these results. There should also not be any premature policy implications resulting from the government revenue as a percentage of GDP variable because we are not certain as to what the governments are using these revenues for. Some of the spending could be productive government spending while some of it could be unproductive government spending. The variable still has to be included in the analysis as a control variable when trying to analyze different shifts in the tax structure. Column 1 also reports a positive coefficient on the statutory top marginal tax rate on labor income, but it is also not significant. Information cannot be taken away from the statutory labor income tax rate because it is not considered significant. Coefficients on variables can sometimes be insignificant because of multicollinearity. Multicollinearity occurs when two or more of the predictor variables are correlated with each other. If there is a problem with multicollinearity then this will cause the standard errors on the predictor variables to become biased upwards and therefore be inflated. I have decided to perform a test to see if there is possible multicolinearity within the variables by calculating the correlations between all of the variables. The correlation matrix is shown below.

Table 5: Correlation matrix of tax variables

	GDP growth	Initial GDP	Corporate Tax	Human Cap	Populatio	Government Rev	Personal Tax	VAT
GDP growth	1							
Initial GDP	-0.2439	1						
Corporate Tax	0.0048	-0.021	1					
Human Capital	-0.0048	0.5401	-0.2706	1				
Population Growth	-0.1692	0.0621	-0.0865	0.2079	1			
Government Rev	-0.0958	0.4507	0.0579	0.1548	-0.4266	1		
Personal Tax	-0.0702	-0.181	0.4569	-0.4716	-0.1183	0.045	1	
VAT	0.052	-0.0325	-0.1889	-0.0647	-0.3284	0.6194	-0.1499	1

It can be seen from the table above that there are no very high correlations between predictor variables. The highest correlation is between the VAT and the control variable, government revenue as a percentage of GDP at about 62%. This correlation of 62% should not cause a multicollinearity issue since we would typically look at correlations approaching 90% or higher. An alternative method for testing for multicollinearity is to look at the variance inflation factors (VIF). The VIF is calculated as such.

$$VIF_j = \frac{1}{1 - R_j^2}$$

Where R_j^2 is the R-squared of regressing variable j against all other variables. A rule of thumb is to look at VIF's greater than 10. I have performed the VIF procedure in my data analysis software and the results are reported below.

Table 6: VIF for predictor variables

Variable	VIF
Government Revenue	3.62
VAT	2.57
Initial GDP	2.22
Human Capital	1.93
Personal Tax	1.7
Population growth	1.41
Corporate Tax	1.37

The variance inflation factors indicate that there should not be a problem with multicollinearity in the regression analysis.

Column 2 reports the results of the regression when adding the top statutory labor income tax rate to the analysis. The coefficient on the variable for the labor income tax rate is negative but the standard errors indicate that the variable is not significant. One could expect the coefficient on the variable for the top statutory labor income tax to be negative because higher marginal taxes on labor income can possibly discourage people from obtaining education since the after tax return of performing a higher skilled job will become lower. However, we cannot make any conclusions about the coefficient on the variable for the labor income tax rate because it is not significant. The coefficient on the government revenue as a percentage of GDP, or the overall tax burden has remained negative and insignificant. There is one less observation in column 2 due to the fact that there was a calculation missing for one of the labor income tax rates, and it was excluded from the regression.

Column 3 from table 4 reports the results when adding the value added tax rate to the analysis. The coefficients on human capital, initial GDP, and population growth remain significant while also keeping their expected signs. The coefficient on the VAT is

positive but it is not significant along with the other tax variables that were included in the analysis. The coefficient on the VAT tells us that a 1 percentage point increase in the value added tax rate can lead to a 0.011% increase in the growth rate of GDP per capita in a given five year period. This should not be concluded though because the coefficient on the VAT variable is not significant in the analysis.

By analyzing columns one through four in table 4 we cannot gather conclusive information on how statutory tax rates affect the rate of growth of GDP per capita for OECD countries. I will further the analysis by including effective tax rates on labor income and capital income to the basic regression model that I have built for this thesis. Table 7 below shows the results of adding the given effective tax rates on labor and capital to the analysis.

Column 1 reports regression results after adding the effective corporate tax rates to the analysis. The signs and the coefficients on initial GDP per capita, human capital, and population growth remain the same and are significant at the ten percent and five percent levels, respectively. The coefficient for the overall tax burden, or government revenue as a percentage of GDP still remains negative and insignificant. When adding the effective corporate tax rate we can see that the coefficient is negative and also significant at the 10% level.

Table 7: Regression results with effective tax rates on labor and capital

Dependent Variable: GDP Growth Per Capita	1	2	3
Initial GDP Per Capita	-.0082616*	-0.0097406**	-0.0090709*
	[0.063]	[0.032]	[0.070]
Human Capital	0.0001303*	0.0001488*	0.0001281
	[0.098]	[0.063]	[0.109]
Population Growth	-0.006304**	-0.0063241**	-0.0064799**
	[0.016]	[0.026]	[0.020]
Government Revenue/GDP	-0.0001527	-0.0001724	-0.0001611
	[.401]	[0.365]	[0.393]
Effective Corporate Tax Rates	-0.0220663*		-0.0214474*
	[0.052]		[0.075]
Effective Labor Tax Rates		-0.0043987	-0.0011592
		[0.473]	[0.855]
Observations	107	107	107
P-Values In Brackets			
Constant Not Reported			
*Significant at 10% Level			
**Significant at 5% level			
Five Year panels: 1980-1984,1985-1989,1990-1994,1995-1999,2000-2004			

The coefficient on the effective corporate tax rate implies that a decrease in the effective corporate tax rate by one percentage point will decrease the growth rate of GDP per capita during a five year period by 0.022%. This result is not surprising because Gordon and Lee (2005), Arnold (2008), and Xing (2011) also got results showing that corporate tax rates have a significant negative effect on GDP per capita. This result is important because now we can say with some confidence that higher taxes on capital may influence the growth rate of the economy and also should be considered for possible restructuring. The effective corporate tax rate may be influencing the growth rate because firms and corporations may be able to forecast their expected effective corporate tax rate and this may influence them from doing business or generating economic activities in a certain country. The reason that effective tax rates may be showing significance while the

statutory tax rates are not showing significance could be because the effective tax rates are usually lower and differ substantially from each other from country to country as seen from figure 7. It seems that if a country would like to increase its rate of economic growth of GDP per capita by using fiscal policy then finding a way to reduce the effective marginal corporate tax rate would be a good way to do this. A government could possibly do this by lowering the corporate tax rate or increasing the deductions and credits that they allow for the corporate tax rates.

Column 2 reports regression results after adding effective tax rates on labor income to the equation. The sign of the coefficients all remain consistent with initial GDP per capita, population growth rates and human capital reinforcing that the model is valid. The coefficient for government revenue as a percentage of GDP is still negative and has remained insignificant. The coefficient on the variable for the effective marginal labor tax rate is negative which implies that an increase in the effective tax rate on labor income by one percentage point can lead to a decrease in the growth rate of GDP per capita by 0.0439%. However, we can't conclude this with certainty since the coefficient on the effective tax rate on labor income is not significant. It seems based on column 2 that effective taxes on labor income do not influence the growth rate of GDP per capita for the OECD sub-sample that I have chosen.

Column 3 reports the regression results after adding both the effective tax rates on labor income and the effective tax rates on corporations. The results in column 3 remain consistent with the results in column 1 and 2 except that the coefficient on human capital has become insignificant. The coefficients on initial GDP per capita, and population growth rates do remain significant and keep their expected signs. Adding the two

effective tax rate variables could possibly be making the coefficient on human capital become insignificant. The coefficient on government revenue as a percentage of GDP has remained negative and is also still insignificant. The effective tax rate that corporations pay is still significant and negative and the marginal impact still remains the same but only slightly lower. The effective marginal tax rate on labor income still remains negative and insignificant, however this time the standard error has been driven up quite a bit. This could be due to the fact that the effective marginal tax rate on corporate income has taken away some of the effects that the effective labor income tax rates have on the growth rate of GDP per capita or due to multicollinearity. To test for multicollinearity I performed a simple correlation between the respective effective tax rates on labor income and corporations. The correlation is 36.18% and therefore multicollinearity should not be a problem in the regression analysis for column 3. What remains interesting is that the coefficient on the corporate tax rate is both negative and has remained significant. We can now say with more confidence that effective marginal tax rates on corporate income influenced the growth rate of GDP per capita for the OECD sample that I have chosen from 1980-2004 and that reducing the effective corporate tax rate by one percentage point can lead to an increase in the growth rate of GDP per capita by up to 0.02% for any given five year period. One of the goals of this research paper was to test how effective corporate tax rates on labor and capital differed in influencing the rate of economic growth from statutory tax rates on labor and capital. As we can see from the regressions that have been performed most of the tax variables that I have included in my analysis have not been shown to be significant except for the effective corporate tax rate that corporations pay. The coefficient on the effective corporate tax rate has been shown to be

negative and significant in both of the regressions where it was included. After analyzing these regressions I believe that we can conclude that effective tax rates that corporations pay are harmful for economic growth and we can say this with 90% confidence after analyzing the results.

CHAPTER 10: CONCLUSION AND REMARKS

The main research question for this thesis was how do different tax structures affect the rate of economic growth for a sample of OECD member countries. These different tax structures included the labor income tax rate, the capital income tax rate which is best accounted for by the corporate income tax rate and also the value added tax. I decided upon choosing OECD countries because most of the countries that are in the OECD are considered advanced or industrialized nations and much of the work done on economic growth includes many countries, not just the OECD sub sample. My analysis includes all 34 OECD countries that are currently members. I also wanted to test which of the taxes would be the most harmful, or helpful, for economic growth and how a possible shift in the tax structure holding revenue constant would influence the growth rate of GDP per capita. Finally, I wanted to see how effective tax rates on labor on capital differed from statutory tax rates on labor and capital.

I first began the analysis by detailing exactly what economic growth is and how it plays a vital role in public policy along with being one of the most researched topics in macroeconomics. I then reviewed previous literature on the subject of macroeconomic growth and also earlier studies showing the effects that taxation has on economic growth. After reviewing the various studies I decided upon the model that I would be using to test these various hypothesis which included initial GDP per capita, population growth rates, and human capital accumulation.

Using data from all 34 OECD countries I first tested how statutory taxes on labor, capital, and consumption affected the growth rate of GDP for the sub sample of data. The initial results were inconclusive and none of the aforementioned tax rates were shown to show any significance at all. I performed simple testing for multicollinearity because the predictor variables could have been highly correlated with each other. The multicollinearity tests showed us that there was not an issue with this in my analysis.

Next, I moved forward with the analysis to test how effective corporate tax rates differ from statutory tax rates in impacting the growth rate of GDP per capita. The methods for calculating the effective tax rates on labor and capital were given and then put forward in the regression analysis. The effect tax rates on capital showed us that they are negatively correlated with GDP growth rates and significant in all regressions performed. This result is consistent with Gordon and Lee (2005) and Arnold (2008) where they also showed that taxes on capital were harmful for economic growth. The effective tax rates on labor that were calculated similar to that as the OECD tax wedge was shown to have a negative coefficient but it was not significant as noted by the p-values. I also tested how the given effective tax rates impacted GDP per capita growth when put in the regression analysis together. The results when performing the regression analysis with both the effective tax rate on labor and the effective tax rate on capital to not differ much from when performing the regression with the effective tax rate variables separately. The effective tax rate that corporation pay, or effective tax rate on capital is still shown to have a negative coefficient and be statistically significant while the effective tax rate on labor income remains negative and insignificant.

Based upon the results that I have received in my analysis, it is hard to determine a way in which governments can shift their tax base from implementing one tax towards another. I had hoped to be able to see how economic growth rates would be affected if a country decided to shift the tax base from form of taxation to another form of taxation but that has proven to be difficult since only the effective tax rate on capital has shown to be significant in my analysis. When looking at the results of this paper, I would suggest that governments look at ways to reduce the effective tax rates that corporations pay whether it be by reducing the statutory tax such as Sweden has done[13], or by creating more ways that corporations can reduce their effective marginal tax rate, such as tax deductions.

To conclude, it seems that statutory tax rates on labor, capital, and consumption did not have a statistically significant effect on the growth rate of GDP for OECD member countries form 1980-2004. This could be due in large part to many of the OECD countries being advanced industrialized economies and therefore finding more efficient ways in which they can use the revenues generated from these given taxes. Example of efficient ways that these governments can use these tax revenues could include healthcare spending, education spending and spending on infrastructure and development. Further, effective tax rates on capital seem to have a substantial negative effect on the rate of economic growth and therefore public policy makers should look for ways in which they can reduce effective tax rates on corporate income in an ever increasing global economy. Finally, most of the tax variables that I included in my analysis showed no significance and therefore I am unable to conclude a way in which governments can maintain the

[13] loc.gov/lawweb/servlet/lloc_news?disp3_l205403335_text

same amount of government revenue while promoting more pro-growth friendly tax structures besides reducing the tax burden on corporate income.

Although I did not get the results that I had hoped with the research and data analysis for this thesis, I learned invaluable lessons regarding economic growth, public finance and many econometric methods. There were many roadblocks along the way concerning data and also different methods on calculating some of the variables used in the analysis as well. The research on the literature review and background information helped me learn a great deal about tax policy and also economic growth theory, which made performing the research much more enjoyable. The most important thing that I believe I got out of performing this thesis was the knowledge gained on data methods and econometrics. I gained a great deal of experience working with panel data and also different approaches to regression analysis using panel data methods, which is essential for performing research on macroeconomic and financial data in todays' world. I feel that I have come out of this thesis with a greater amount of knowledge on economic growth, and econometric methods which will help me greatly throughout the rest of my career and education.

REFERENCES

Arnold, J. (2008), “Do Tax Structures Affect Aggregate Economic Growth?: Empirical Evidence from a Panel of OECD Countries”, OECD Economics Department Working Papers, No. 643, OECD Publishing. dx.doi.org/10.1787/236001777843

Asea, Patrick, Enrique G. Mendoza, and Gian M. Milesi-Ferretti. "On the Ineffectiveness of Tax Policy in Altering Long-run Growth: Harberger's Superneutrality Conjecture." Journal of Public Economics 66 66(1997): 99-126. Web. 12 Dec. 2012.

Barro, Robert, and Xavier Salai-Martin. Economic Growth. Cambridge, MA: The MIT Press, 2004. Web. 12 Jan. 2013

Baumol, William J. "Productivity Growth, Convergence, and Welfare: What the Long-Run Data Show." The American Economic Review 76.5 (1986): 1072-1085. Web. 25 Jan. 2013. jstor.org/stable/1816469

Devereux, Michael P., Rachel Griffith, and Alexander Klemm. "Corporate Income Tax Reforms and International Tax Competition." Economic Policy (2002): 450-495. Web.

Engen, Eric M; Skinner, Jonathan, 1992. “Fiscal Policy and Economic Growth”, NBER Working Paper, No. 4223

Gayer, Ted, and Harvey S. Rosen. Public Finance. NY, NY: McGraw-Hill/Irwin, 2008.

Goolsbee, Austan. "The Impact of the Corporate Income Tax: Evidence from State Organizational Form Data." Journal of Public Economics 88(2004): 2283-2299.

Gordon, Roger H., and Young Lee. "Tax Structure and Economic Growth." Journal of Public Economcis 89(2005): 1027-1043.

Hall, Robert E., and Dale W. Jorgensen. "Tax Policy and Investment Behavior." The American Economic Review 57.3 (1967): 391-414. Web. 25 Jan. 2013. <jstor.org/stable/1812110>.
Sobel, R.S. & Holcombe, R.G., 1992. "Cyclical Variability in State Government Revenues," Working Papers 1992_06_7, Department of Economics, Florida State University.

James, Kathryn. "Exploring the Origins and Global Rise of VAT." Tax Analysts (2011): 15-22. Web. 3 Feb. 2013

Levine, Ross, and David Renelt. "A Sensitivity Analysis of Cross-Country Growth Regressions." The American Economic Review 82.4 (1992): 942-963. Web. 15 Jan. 2013

Loretz, Simon. "Corporate Taxation in the OECD in a Wider Context." Oxford Review of Economic Policy 24(2008): 639-660. Web. 4 Apr. 2013.

Lucas Jr, Robert E. "On the Mechanics of Economic Development." Journal of Monetary Economics 22(1988): 3-42. Web. 12 Dec. 2012

N. Gregory Mankiw & David Romer & David N. Weil, 1992. "A Contribution to the Empirics of Economic Growth," NBER Working Papers3541, National Bureau of Economic Research, Inc.

Marsden, K 1983, 'Links between taxes and economic growth: some empirical evidence ', World Bank Staff Working Papers no. 605

McCraken, Casey. "Whether State Fiscal Policy Affects Economic Growth." Diss. Stanford University, 2006. Print.

Mendoza, Enrique, Razin Asaf, & Tesar, Linda, 1995. "Effective Tax Rates In Macroeconomics: Cross-Country Estimates of Tax Rates on Factor Incomes and Consumption," NBER Working Papers 4864, National Bureau of Economic Research, Inc.

Myles, Gareth. "Economic Growth and the Role of Taxation." OECD (2007): N. pag. Web. 1 Mar. 2013.

OECD. Economic Policy Reforms: Going for Growth. France: OECD Publishing, 2009. Web. 15 May 2013. <oecd.org/eco/growth/economicpolicyreformsgoingforgrowth2009.htm>.
OECD. Taxing Wages. France: OECD Publishing, 2011. Web. 15 May 2013. <oecd-ilibrary.org/taxation/taxing-wages-2011_tax_wages-2011-en>.

Romer, Paul. "The Origins of Endogenous Growth." The Journal of Economic Perspectives 8.1 (1994): 3-22. Web. 7 Feb. 2013.

Romer, David. Advanced Macroeconomics. NY, New New York: McGraw Hill, 2006.

Solow, Robert M. "A Contribution to the Theory of Economic Growth." The Quarterly Journal of Economics 70.1 (1956): 65-94.

Xing, Jing. "Does Tax Structure Affect Economic Growth? Empirical Evidence from OECD Countries." Oxford Center for Business Taxation Ox1.1HP (2011)

APPENDIX A: CALCULATING GROWTH RATES

GDP growth rates can be measured in both discrete time and in continuous time. GDP growth is traditionally measured from period to period such as quarter to quarter, or year to year. The level of output at time *t* is denoted Y_t in discrete time.

The rate of growth of output between times *t* and *t+1* is defined as:

$$g_Y = \frac{Y_{t+1} - Y}{Y_t} = \frac{\Delta Y}{Y_t}$$

The rate of change in continuous time is then

$$\dot{Y} = \frac{dY}{dt}$$

Dividing by *Y* gives the proportional growth rate

$$g_Y = \frac{dY/dt}{Y} = \frac{\dot{Y}}{Y}$$

Using the chain rule for taking derivatives

$$g_{Y/L} = \frac{d\ln(\frac{Y}{L})}{dt}$$

This result allows for expressions of per capita GDP growth rates.

$$= \frac{d(\ln(Y) - \ln(L))}{dt}$$

$$= \frac{1}{Y}\frac{dY}{dt} - \frac{1}{L}\frac{dL}{dt}$$

$$= g_Y - g_L$$

The material in this appendix for calculating growth rates comes from Barro and Salai-Martin (2004).