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The Evolution of Growth Models and their Suitability for Development Planning in Modern Economies: The Example of Greece and its Growth Determinants

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Abstract

This thesis reviews the evolution of the economic growth theory beginning with the classical economists of 18th century and ending with the endogenous growth models that incorporated endogenously the term of productivity in the production function. It discusses in detail the effects of several macroeconomic variables in growth process and presents empirical evidence on the importance of technology and productivity in sustainable, long-term economic growth.

This thesis, based on the principals of endogenous growth theory, attempts to explain the economic growth complications met in developed, mainly tertiary economies the last two decades by using the example of Greek economy for the period 1995 – 2016. It studies the behaviour of tertiary labour productivity and analyzes its relationship with its core determinants as having been identified by theory and their contribution to sustainable growth. It argues for the reliability of labour productivity ratio as an index of competiveness between economies whose most of their GDP is generated by the services sector. At the end, it concludes if future labour productivity growth rates can be forecasted through an autoregressive model with one and two lags.

This thesis found that for Greek economy during the examined period, the main source of its GDP was the tertiary sector while total productivity was strongly affected by tertiary productivity. Both GDP and productivity growth have been deeply affected by the external debt crisis. As a ratio, tertiary labour productivity is determined only by the tertiary GDP, not by the total working hours in this sector. The adapted version of the second Kaldor's law in services is verified therefore. The business tertiary sector is found to be labour – intensive but its productivity was not affected by variables which are indicators of technical progress such as investment in technical infrastructure and adequately educated workforce. Instead of that, profit and minimum wage remain the sole determinants of productivity of Greek business tertiary sector.

Keywords: Labour productivity, tertiary sector, Greece, growth, growth theory

List of Abbreviations

ACF	Autocorrelation Function
ADF	Augmented Dickey Fuller Test
CO	Cochrane Orcutt Method
DW	Durbin Watson Criterion
EMU	Economic Monetary Union
EU	European Union
GDP	Gross Domestic Product
GFCF	Gross Fixed Capital Formation
ICT	Information and Communications Technology
LC	Labour Compensation
LP	Labour Productivity
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Square Method
PACF	Partial Autocorrelation Function
R&D	Research and Development
TFP	Total Factor Productivity
UK	United Kingdom
US	United States
VIF	Variance - Inflation Factor Criterion

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1. Introduction

1.1. Definition

Since the beginning of economic science, the subject of economic growth has attracted the academic interest more than any other topic. For the first economic philosophers such as Smith, Ricardo, Malthus and Marx, economic growth was an issue of vital importance for the sustainability and continuity of the first industrialized economies after the boom of the "industrial revolution" during 18th and 19th centuries. The term "economic growth" refers to the annual rate of growth of the national Gross Domestic Product (GDP). Therefore, the economists who have dealt with this subject, tried to detect all those factors which affect economic growth and contribute to higher living standards at a constant population growth (Sharipov, p. 759, 2015). However, although the theoretical background of economic growth has concluded to a wide range of discrete factors which promote growth, the reality remains dramatically different. There are still countries that suffer from poverty and lack of resources with extremely low growth potentials. Beyond that point, even the more developed economies have faced deep financial crises and have been condemned to low GDP growth rates for extensive periods. Moreover, economies which achieved admirable growth rates, they could not sustain them. What is more, countries that were pioneers in economic growth with prolonged, high growth rates, did not achieve to combine them with a fair income distribution and waive the social inequality. All these facts indicate that even the latest growth theories are unable in practice to constitute a reliable guideline for high and sustainable GDP growth rates (Kim & Heshmati, p. 3-4, 2014).

The economic growth theory is divided into three broad sections: the classical, the Keynesian and Post-Keynesian and the neoclassical. All of them, through different approaches, reach a common conclusion: the continuous addition of new inputs in capital and labour cannot generate higher output infinitely due to their diminishing returns. This phenomenon can be waived only by the presence of

technical progress which leads to higher productivity (Barro & Sala i Martin, p. 16-19, 2004). Before the models of Lucas (1988) and Romer (1986) who were the first ones who studied technical progress endogenously, all the previous models treated this variable as exogenous. Therefore, before the development of the endogenous growth models as the newest addition in neoclassical growth theory, all the previous models had a major drawback: they could analyze economic growth only in the short run. However, even from the era of Adam Smith, the concept of productivity growth has been outlined by all major economists as the only variable which can maintain growth and keep an economy away from recession. Thus, the last two decades, there has been a vast academic literature which studied productivity and the major factors behind it (Dutt, p.1241, 2017).

Although economic growth remains an ultimate target for policy makers and the growth rate of GDP a key measure of performance of an economy, it cannot be absolutely reliable for the prosperity of a nation. Consequently, the economic growth theory focuses only on the factors which contribute to the GDP growth of an economy for a given period. In contrary, **economic development** refers not only to the GDP growth but to the improvement of several other indexes which are indicative of the prosperity of a nation. Such indexes are:

- The quality of the health system
- The admission percentage in education system
- The job satisfaction, the working conditions and the rights of the labour force
- The per capita allocation of GDP (Gini index)
- The corruption, the social and political instability, the uncertainty from unemployment and the social justice
- The consumer confidence index (CCI) about the current and future economic conditions
- The purchasing power parity (PPP)
- The life expectancy at birth ratio and the adult life expectancy
- The quality of the technical infrastructure such as transportation, telecommunications and information technology

For this reason, although the terms **"economic growth"** and **"economic development"** are usually confused and used to describe only the GDP growth, they are absolutely discrete (Katseli & Magoula, p. 349 – 350, 2003). Usually, economic growth precedes of the economic development. However, the presence of economic growth does not imply necessarily the boost of the main indexes of economic development.

Through the evolution of the economic growth theory, two fundamental concepts have arisen: the **diminishing marginal productivity of capital** (physical and human) and the **conditional convergence** of national GDP per capita around the world. The second is a theoretical effect of the first. The diminishing marginal productivity of capital means that the continuous investment in capital in an economy cannot contribute to the total output growth indefinitely. Thus, in the long-run, economic growth freezes and the economy shrinks into recession. The diminishing returns of capital were already known from the classical period when Adam Smith outlined the need for labour transfer from agricultural sector to the industrial. According to Smith, the land quantity for cultivation is limited so the addition of new capital and labour cannot produce more output (Kim & Heshmati, p. 7 & 264, 2014). However, the diminishing returns of capital are present in every production sector, even in industry.

The axiom of diminishing returns led Solow (1956) and Swan (1956) to conclude that in the long run the GDP growth rate of an economy will revert to the rate of its technological progress. In simple terms, this means that the long-term growth of an economy is defined only by its technological growth. As the use of technology can be applied more in the industrial sector than in the agricultural, this constitutes a reason that explains the rapid and enhanced growth of industrialized economies than the agricultural ones (Aghion & Howitt, p. 21, 2009). Triggered by the assumption of the declining marginal productivity of the capital, Solow and Swan predicted that in the long run there will be conditional convergence between the GDP per capita of the economies globally assuming that they have equal rates in savings and growth of population. Contemporary studies added in these two variables more constants such as human capital, government policies, geographical criteria etc. (Barro & Sala i Martin, p. 17, 2004).

Contrary to the theoretical predictions and guidelines for long run growth and convergence, it is admitted that the growth process is often indissolubly correlated with **business cycles** and finally, with **crises** which cannot be forecasted by any growth model and there are not any restorative forces to prevent them. Business cycles are the cyclical fluctuations in actual output around its trend level as defined by a given level of capital, labour, and technology. When actual output is above the trend, it means that the economy grows faster than expected and expands while when actual output is below its trend it means that the growth rate decelerates and the economy moves into recession (Miles & Scott, p. 346 – 347, 2005). Recession implies that the GDP growth rate remains positive but lower than its normal trend. If the declining GDP growth rates fall to negative, are long-lasting and the total output of the economy declines substantially then the economy passes into a phase of depression and can be characterized as economic crisis (Miles & Scott, p. 350, 2005). There are several, historical examples of crises around the world mainly in developing economies which pursued high, short-term growth rates instead of solid, sustainable growth rates and finally suffered from heavy and prolonged periods of economic crisis due to imprudent fiscal and monetary policies. All these cases indicate that the sustainable GDP growth is a process that requires stability in several, other macroeconomic variables which are not taken into account by the major growth models. Such variables are inflation, the external debt, the balance of payments, the foreign direct investment, the efficiency of financial institutions and the tax policies (Stiglitz et al, p. 28 - 30, 2006).

Closing this section, it must be clarified that the growth process is more than complicated in order to be described adequately by any growth model. What is more, every growth theory or model is based on several assumptions that empirically are not treated as realistic. Due to its profound role in the normal continuity of the capitalist markets, having learnt by the failures of the past, most of the developed economies tend to show a conservative behaviour today. They have confronted with low, positive growth rates, having incorporated the variable of GDP growth in their general stability policy along with the rest macroeconomic variables that were mentioned in the previous paragraph. In the next chapters, all

the above fundamental aspects of economic growth will be analyzed theoretically and empirically through a chronological review of the major growth models.

1.2. Scope

This thesis initially starts with the review of the main economic growth theories and models and their evolution through time beginning from the period of the classical growth theory and closing with the endogenous growth models. It highlights their major concepts, points and conclusions, it gathers and discusses the major academic work around them and challenges their empirical validity in modern economies. The empirical part, based on the Kaldorian framework and using Greek economy as test case, tests its validity in de-industrialized economies which turned into tertiary ones and decides if it can be adapted and enhanced in tertiary business sector by investigating the variable of labour productivity.

The chapters 2, 3 and 4 are devoted to the review of the major theories of economic growth. Chapter 2 deals with the work of Adam Smith, David Ricardo and Karl Marx. Chapter 3 reviews the theory of John Maynard Keynes and the work of the most important Post-Keynesian academics such as Nicholas Kaldor (Kaldor's Growth Laws), Roy Harrod and Evsey Domar (Harrod – Domar model). Chapter 4 signals the beginning of the neoclassical growth theory by dividing it to exogenous and endogenous. It discusses analytically all the aspects of the exogenous Solow – Swan model which is the foundation of neoclassical growth theory and closes with the models of Lucas and Romer who first incorporated endogenously technology in the AK model. It also presents the ambiguous evidence of financial liberalization and openness through the McKinnon – Shaw argument.

Chapter 5 is the empirical part of this thesis. It starts with the provision of key statistics, domestic and global, on the topics of growth and productivity. It proceeds to the empirical review of a paper by Drakopoulos and Theodossiou (1991) who checked the validity of the Kaldorian Laws in Greek economy during the period 1967 – 1988. Following the same approach but using data from the

period 1995 – 2016, it concludes if their findings are in line with the sample of this thesis. The main difference between the two samples is the industrialization trend of the Greek economy. At the end, based on the 2nd and 3rd Kaldorian Laws regarding sectoral productivity, this thesis tries to explain the growth and productivity trends of Greek business tertiary sector for the period 1995 – 2016.

The incentive for research of this thesis is triggered by the global phenomenon of the constantly low GDP growth rates of the most developed economies and their intensively and unpredictably volatile productivity rates. Although growth and productivity remain a major target of the government policies and academic research has added a lot of empirical evidence in the factors which promote growth, all the mainly tertiary developed economies seem to have been condemned to low GDP growth rates even in periods out of recession. Another reason for research is the lack of empirical evidence on the productivity forces of the tertiary sector and especially this of business services which contributes more than any other in the GDP of these economies. The ultimate purpose of this thesis is to decompose the set of variables which define the labour productivity of business tertiary sector and conclude if labour productivity can constitute an accurate measure of competitiveness and performance for a specific production sector and for the whole economy. Although this thesis is adapted on Greek economy for the period 1995 – 2016, its approach and its conclusions can be used as a basis for further research in the future.

2. The Classical Growth Theory

2.1. Introduction

The Classical Growth Theory is the beginning of the major theories of economic growth. There have been several philosophers whose the work is part of the Classical Growth Theory however the main findings belong to Adam Smith, David Ricardo and Karl Marx. Although it is absolutely normal to be regarded as outdated for the planning of economic growth policies by governments, none can deny that it was the foundation for the neo-Keynesian and neoclassical economists of the 20th century to formulate their own theories of growth.

The classical theory has its beginning since the second half of 18th century. It starts with Adam Smith and comes to an end with Karl Marx during the second half of 19th century. After the Marxist approach, the interest for economic growth theory froze and it took more than fifty years to become again a field for research by Keynes. The classical theory treats growth as the result of capital accumulation. The force that activates this mechanism is the profit which is accumulated and reinvested through a cyclical process (Thirlwall, p. 130, 2006). Behind this force there are some influential factors hidden. The first is the allocation of available funds into productive investment. This means that the expenditure of the capitalists for land rent is always an obstacle to growth because it is unproductive. And when there is no availability of capital for reinvestment then the economy enters a stationary state. The second factor behind the profit increase is the production efficiency or otherwise the division of labour according to Smith. With the Marxist approach in the topic of growth, new variables were added into the profit mechanism. These variables were the technical progress and the competition (O' Hara, p. 243, 1999).

The basic assumptions that apply to the Classical Growth Theory are:

1. All capital is active and is used in the production process. This includes and the profit when is reinvested and is added to the existing capital

2. The labouring population's work and consumption behaviour depends on the wage rate
3. The wage rate is determined by the Law of Supply and Demand in short-term basis. However, there is always a lowest point in wages that Smith and Ricardo call it the "subsistence wage" and reflects the minimum wage required by the working class to survive. Although the wage rate is very sensitive to population changes, in the long run it always returns to its subsistence level and for this reason is treated as a constant variable. For Marx that lowest point is determined by the size of the "reserve army of labour" (Tsoulfidis, p. 3, 2011)
4. The level of saving and investment is determined by the rate of profit
5. All savings are invested (Johansen, p. 219, 1987)

2.2. The Theory of Adam Smith

2.2.1. The Growth Equation and its Determinants

One broad contribution of Adam Smith's work was the introduction of the term of "growth" into economics. In his major work, "An Inquiry into the Nature and Causes of the Wealth of Nations", Smith signals the beginning of the Classical Growth Theory (Black, p. 59, 2002).

According to Smith, the total output of an economy is equal to the total value of the products generated within a specific period under conditions of full employment of the productive resources. He excludes services from the total output because he divides labour into productive and non-productive: the first refers to the production of material goods and the second to the production of services. Consequently, Smith's basic growth equation concludes that the production is a function of three factors: land, labour and capital (Drakopoulos & Karagiannis, p. 84, 2003). For the Scottish philosopher, the forces which maintain active the growth process are: a) the division of labour and b) the increasing returns. It must be mentioned however that the increasing returns practically

result from labour specialization (division of labour). Therefore, the division of labour is hidden behind every crucial factor that affects the rate of change of the total output. Finally, Smith outlines something that today is trivial to every well-known growth theory: the growth of the output depends directly on: a) investment and capital accumulation and b) labour productivity (Thirlwall, p. 123, 2006).

Investment and capital accumulation are the result of the process of saving and (re-)investing the profit generated by industry and agriculture. Labour productivity is the generated output per used labour unit. To what extent and for how long they will affect the growth of the total output is defined by the intensity of the division of labour in the production. It is obvious therefore why Smith regards the division of labour as the boosting force behind every factor that affects the growth of the output. However, the division of labour is limited and determined by the size of the market.

By proceeding now to the mathematic format of the Smithian growth model, as it has been mentioned above, Smith separates the labour into productive and non-productive. The productive labour includes the manufacturing and agricultural sectors mainly while the non-productive labour includes the sector of services. The productive labour offers revenues to the capitalist equal with the rent plus the profit. On the other side, the non-productive labour survives with the revenues originated by the productive sector. So, for Smith there are N workers in the productive sector who generate revenues (Smith, p. 393-394, 2010). It is also known that capital is the sum of fixed capital plus variable capital. The variable capital consists of:

1. Wages, W = w*N. This is the product of the wage rate, w with the total number of productive workers, N
2. Cost of use of the raw materials, m*N with m being the raw material consumption per worker (Smith, p. 80, 2010)

On the other hand, the fixed capital is symbolized as k*N where k reflects the fixed capital investment per productive worker. Machinery, technology and equipment plus human capital and money constitute the fixed capital according to Adam Smith. After these clarifications, the total capital can be expressed as:

$$K = (m + w + k) * N$$

2-1

The gross income (or gross product) is:

$$QG = Q + Int$$

2-2

Where Q is the national product and Int is the intermediate product. By subtracting the wage costs of the productive workers w*N, the intermediate products Int and part of the fixed capital dK = dkN which gradually expends during the production process (d is the depreciation rate of the capital) (Chang, p. 6-7, 2010), the net income (or net product) transforms into:

$$QN = QG - (w + m + dk)\, N = QG - cN$$

2-3

In the equation above, the variable cN symbolizes the value of the goods consumed per worker in the various production stages. Thus, the net product is:

$$QN = P + R$$

2-4

In equation 2-4, P is the profit and R is the rent. The net income is the sum of profits and rents (Chang, p. 7, 2010). This net income can be used in three main ways: a) in the capital accumulation process, b) for financing the social, political and cultural life and c) for the consumption of goods that do not satisfy basic needs and are indicative of a higher social status and a luxurious life (Smith, p. 425-426, 2010). The growth model can be derived from the basic equation:

$$QG = A\,(k)\,N$$

2-5

Here, A is the labour productivity depending on the capital endowment per worker, k. The total income is a dependent variable of the labour productivity and the amount of labour. By combining 2-3 and 2-5, the equation of net output is transformed into:

$$QN = QG - c\,N = [A\,(k) - c]\,N$$

2-6

One basic principle of the Smithian growth model states that only a percentage of this net output is saved and invested again:

$$I = \Delta K = s\,[A\,(k) - c]\,N$$

2-7

In equation 2-7, s is the rate of saving (Chang, p. 7, 2010). The rest of the net product (1-s) [A(k) - c] is spent to the consumption of luxurious goods and other needs. By dividing the parts of equation 2-7 with the total capital K = (m + w + k), two rates are derived: a) the growth rate of the capital stock and b) the growth rate of the total output. In mathematic terms:

$$\frac{I}{K} = \frac{\Delta K}{K} = g_k = \frac{s[A(k) - c]N}{(k + w + m)N} = \frac{s[A(k) - c]}{(k + w + m)}$$

2-8

The main conclusions from the last equation are:

1. As the wage rate (w) gets lower the higher is the net product per worker. So when [A(k) – c] rises, the labour cost becomes cheaper and as a result there is an increase in g_K (growth rate of the capital stock)

2. A higher g_K triggers more investment so the capital investment per worker (k) increases. The direct effect of this is a higher labour productivity. But a higher labour productivity pushes g_K upwards again. Thus, the result is a continuous, cyclical process of growth
3. A higher rate of growth always leads to a higher propensity for saving (Matthews & Ortmann, p. 6-12, 2000)

2.2.2. Capital Accumulation and Labour Productivity

In the context of the analysis of the factors that sustain the growth of the output, three facts are treated as axiomatic regarding the investment and capital accumulation:

1. All savings are invested and depend proportionally on the total income
2. Cumulative investment is fundamental in growth and prerequisite for the market widening, for promoting labour specialization and for pushing up the wages in order to satisfy the labouring needs of the expanding market
3. As capital accumulation process goes on, the profit rate will start declining because of: a) the increasing competition between the industrial producers and b) the rising wages. As far as investment, it will cease to exist at the moment that the return on investment will be lower than the minimum rate that motivates individuals to save. When profit falls to zero, the economy falls in a stationary state (Sardadvar, p. 9, 2011). Even in the case when the rate of profit starts falling, there will be always new, arising investment opportunities to push it again upward (Rostow, p. 139, 1990)

Regarding the third fact, it is clear that for Adam Smith, the rate of profit will have a declining behaviour. This happens because due to competition, the capitalists aim to more intensive division of labour in order to achieve better labour productivity. This requires lower labour unit costs and cheaper selling price of the product. As this process is repeated again and again, the capitalists are always obliged to invest to new fixed capital with improved mechanization thus the capital – output ratio increases. At the end, the capitalists are driven to over-accumulation of supplies while the rising capital-output ratio causes a downward

trend in the rate of profit. This situation is terminated when the rate of profit gets null and the economy falls in a stationary state. At that point, any current investment cannot be profitable and the growth of economy has frozen. What is more, the wages stuck in the bottom as no demand for labour exists due to the absence of new investment activities (Tsoulfidis & Paitaridis, p. 307-309, 2012).

Moving now to labour productivity, it is affected by the division of labour via three ways:

1. Improvement of the workforce's specialization
2. Time saving in production as the workers focus on a single task
3. Invention of new technology that enhances the production per capita (Rostow, p. 35, 1990)

Regarding the process of growth, Smith was confident enough to believe that it can be a self-generated process although today, this has been proved rather false. The main reason behind that perception was an "invisible hand" that coordinated the economic decisions and activities of the individuals who acted for their personal benefit. The gist of this "invisible hand" was that, all these individuals who were chasing their personal benefit, they intensified competition (Bowles & Edwards, p. 57, 2001). In Smith's process, the first of the two critical factors of growth, the continuous capital investment, expands the market. This has as a result the return of new profit which is reinvested through a cyclical process. However, this cannot be done indefinitely because of the phenomenon of diminishing returns. So, it is very profound to become clear the existence of increasing and diminishing returns in the growth process. More specifically, it is necessary to be clarified that the diminishing returns arise by productive resources as well as the increasing returns do. For Smith, the diminishing returns are directly linked to land-based activities such as agriculture and mining because land is a fixed factor of production (Thirlwall, p. 124, 2006). Surely, this does not underestimate the contribution of agriculture to the growth process. Rather the contrary, the agricultural production provides the necessary goods for the survival of the urban population. Moreover, the surplus of the agricultural sector can be easily exchanged with industrial products and this increases their demand. Therefore, equilibrium in the expansion of the industrial and agricultural sectors

is necessary in the growth process in order to mitigate the negative effects of the diminishing returns. The following diagram presents every phase of the cyclical, self-generating growth process in Smith's model:

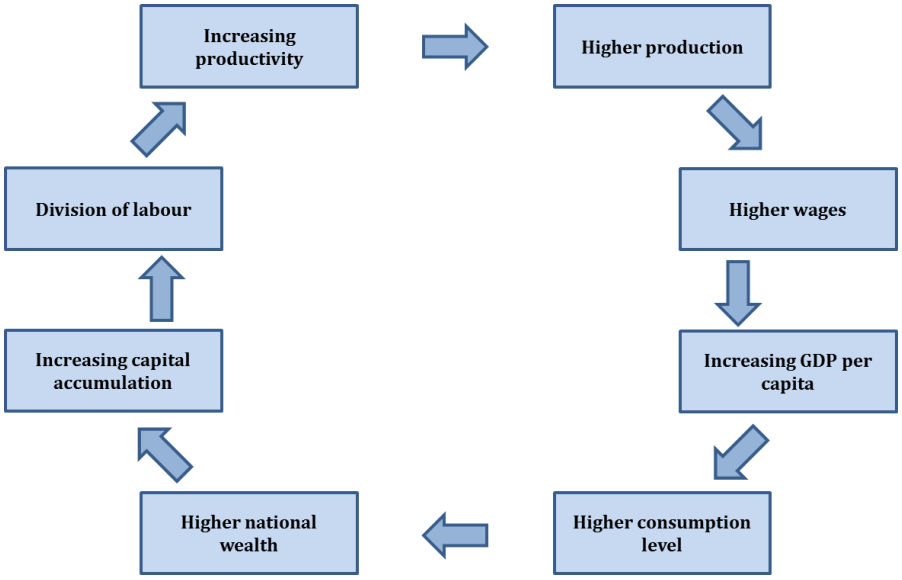

Figure 1: 2.2.2 Smith's model cyclical, self-generating process

Source: Drakopoulos & Karagiannis (2003)

2.2.3. International Trade and Technological Progress

Two other variables that comprised core subjects of study for the economists of the next generations and can be met in the work of Adam Smith were international trade and technological progress. For Smith, contrary to capital accumulation and labour productivity, international trade and technological progress do not constitute direct determinants of economic growth. However, both of them seem to have an invisible, beneficial role in his model.

Although the International Trade Theory starts officially with David Ricardo, Smith speaks about international trade adopting the dominant philosophy of that period. The main concept was that economies can beneficiate from international trade if and only if they import goods that cannot be found in the local market or they are cheaper than the domestic ones. The key point for Adam Smith is that local and international markets are the same thing. Thus, indirectly, international

trade can have positive effects to growth as it expands the size of the market and the national production surplus can be channeled outside the boarders of the country. As it was mentioned before, the pioneering force of economic growth according to Smith, the division of labour is determined by the size of the market. Rationally, the market expansion through international trade creates the capacity for more division of labour and opportunities for growth (Kibritcioglu, p. 4-5, 2002). From this point of view, it is clear that a rich economy which produces plethora of industrial products and exports them is always on an advantageous position in comparison to a poor economy that lacks capital and knowledge and remains stuck on the agricultural sector (Afonso, p. 4, 2001).

The latter led the Scottish philosopher to write down some thoughts about rich and poor countries. Firstly, rich countries are always leaders in the growth process as they have more experience and poor countries must follow. Secondly, although the wages are higher in rich economies, the labour unit cost is lower than this of poor economies. This can be justified by two factors: high division of labour and contemporary transportation system which both, make capital cheaper and the prices of the commodities lower. Thus, it is undoubted that a rich economy can benefit from free trade and massive production more than a poor one does (Rostow, p. 45, 1990). The possibility of convergence between rich and poor economies is left open by Smith. The only thing that has been mentioned on this topic is that every economy has its own ceiling in growth. And it is possibly unavoidable this ceiling to be touched one day.

Going now to the topic of technology, Adam Smith recognizes the importance of innovation and new technological inventions and accepts that new technology can promote higher labour productivity and division of labour and vice versa. However, because technology was just in its very beginning during the years of Adam Smith, he could not incorporate the variable of technology in the growth process under a concrete role. As it was written before, new technology is one of the channels through which division of labour affects labour productivity (2.2.2). Smith pays high attention to the technological inventions developed by specialized workers. He indicates technological progress as one of the major benefits of the division of labour. It can be achieved through three ways:

a) When the workers get specialized in the production of technological equipment (machines)
b) When the workers focus on the development of new knowledge
c) When the workers are engaged to a specific phase of the production process (Lavezzi, p. 4, 2001)

So, the majority of economists today supports that in Smith's work, the key factors in the growth process are capital accumulation and labour productivity with technological progress to spring mainly as a positive result of economic growth (Brewer, p. 5-7, 1991, Ahmad, p. 447-450, 1996). On the other hand, it is a bilateral process as technological progress affects positively labour productivity. It is obvious therefore that in Smith's theory, even in an indirect way, technology plays an important role irrespective of the fact that is not translated into a direct determinant of growth. The graph below can show clearly how Smith perceived technological progress in the growth process:

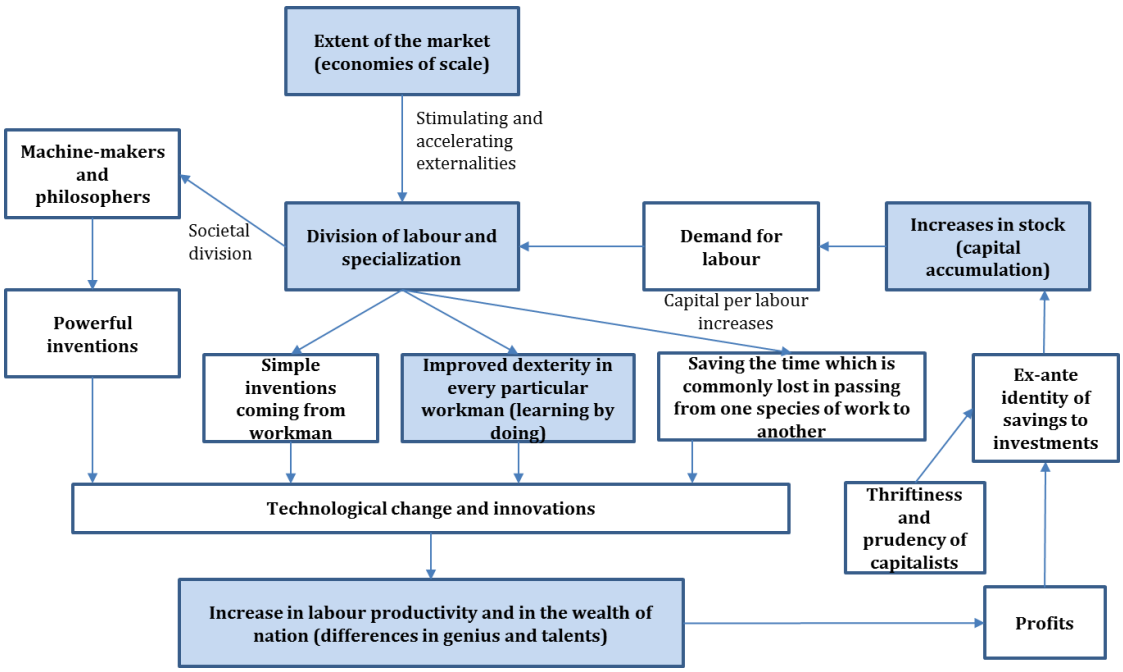

Figure 2: 2.2.3 Technological progress in growth process in Smith's model

Source: Kibritcioglu (2002)

2.2.4. Public Sector and the Government's Role

Last very crucial point in Smith's work is the role of the government. For Smith, the government intervention should be limited to the minimum degree because it distorts the competition in the market. The truth is that this opinion was quite revolutionary for that era. Until Smith's theory, the majority of the philosophers tended to believe that the government control over the markets was necessary for social normality instead of chaos. On the other hand, Smith stated that a market under conditions of perfect competition with absolute absence of monopolies could lead to a state of perfect equilibrium (Bowles & Edwards, p. 59, 2001). For this reason, he has been known as one of the most passionate supporters of the free market with the theory of Laissez-faire (Reinert, p. 271, 1997). Thus, he argues that the role of the government should include only three responsibilities: a) public defense and security, b) justice and c) construction of public works. The construction of public works must be responsibility of the government because can rarely attract the interest of individuals. This is due to the fact that the expenses are usually much higher than the anticipated profit. However, public works are highly important because they offer social benefits with the improvement of the living standards and the fabric of the society and promote various corporate benefits such as the facilitation of the trade through the development of the transportation system (Rostow, p. 48-49, 1990).

2.2.5. Main conclusions

By ending now with Adam Smith's theory, it was shown that in his model economic growth is determined by two key factors: a) capital accumulation (investment) and b) labour productivity. Apart from these, there are also some other variables that according to him affected indirectly the total output growth. These variables are international trade, technological progress and the absolutely discrete role of government, focusing only on the construction of public works such as the transportation system. Today, these variables are treated as core axes

in economic growth policies. The graph below presents how these variables contribute to the growth process in Smith's theory.

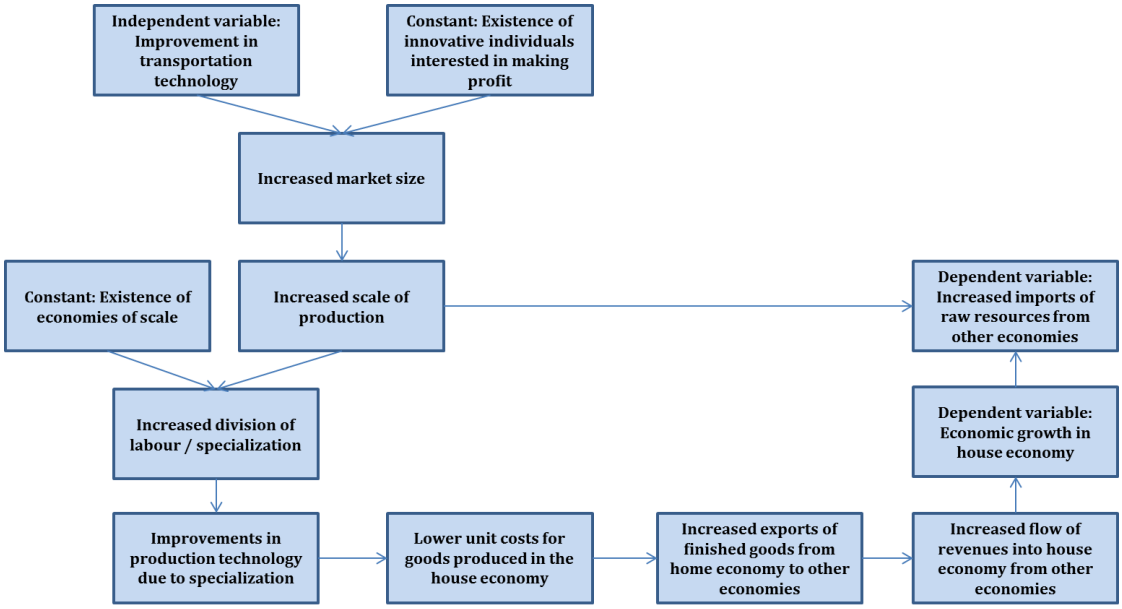

Figure 3: 2.2.5 Growth process in Smith's theory

2.3. The Theory of David Ricardo

2.3.1. The Growth Equation and its Determinants

David Ricardo was the next classical economist who throws light on the topic of economic growth. Having studied Smith's work and adopted his basic principles such as the classical equation of economic growth where the total output is a function of land, capital and labour, Ricardo's approach focuses more on the distribution of the total income of the economy and not on its determinants as his predecessor did (Rostow, p. 77, 1990).

In opposite to Adam Smith, Ricardo predicts that a stationary state in the economy cannot be avoided when the rate of growth is null. This means that capital accumulation and profit reinvestment which are major determinants of growth for Ricardo as for Smith too, freeze. The responsible factor for this

situation is something that was already known before: the diminishing returns in agriculture. This can be explained by the figure below:

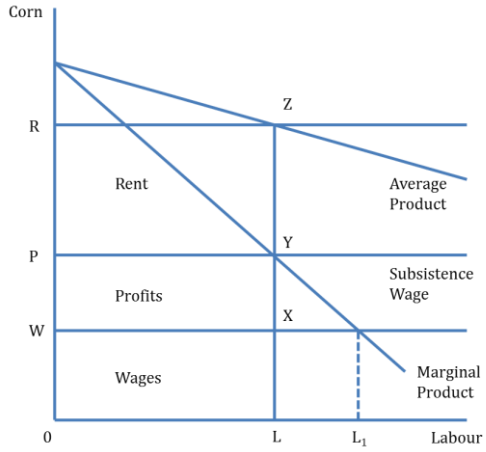

Figure 4: 2.3.1 David Ricardo's corn model for diminishing returns

Source: Thirlwall (2006)

This figure represents the well-known corn model of David Ricardo. In this model the profits are pushed from up and down between the subsistence wage and the rent that is paid to landlords. The rent price relates positively to the price of food because it constitutes the wage of landlord. So, as the food price increases, the landlord demands a higher rent in order to fulfill the living needs. From the moment that there is an increase in the price of food because of the diminishing returns of agriculture on the one hand and the population growth on the other, the same happens with the rent. Ricardo's basic assumption in this model is that the economy is regarded as "one big farm" where corn (food) and manufactured goods are consumed in fixed proportions so corn can be treated as the accounting unit. In the level of employment L, the total output is 0RZL. Rent is PRZY and is defined by the difference of the average and the marginal product of the labour force in land. Both average and marginal products are decreasing since land is limited: when labour-cum-capital increases, even the least fertile parts of land must be cultivated or the same quantity of land must be cultivated more intensively. The second requires less land per unit of product, therefore it makes the investment more expensive in terms of labour-cum-capital (Kurz & Salvadori, p. 103, 2003). Wages are 0WXL thus the profit is WPYX. When output increases the marginal

product of labour meets the subsistence wage at L_1 and the profit falls to zero. Thus from the moment that the profit rate in agriculture falls to zero, the industrial sector starts attracting all the investment funds. As a consequence, the profit rate starts declining again in industrial sector this time. When the profit rate is eliminated, capital accumulation stops and the economy moves to a stationary state. Wages, similarly to rents, also depend positively on the food prices. It is obvious why in Ricardo's model the increase of food price constitutes a serious cause of the decline of profit. But for Ricardo, the total demand for goods and the competition between capitalists do not have negative effects in profit. He believes that all capital can be invested without limitations from the moment that supply generates its own demand. Thus, the conclusion is that the negative factors for the inevitable decline of profit are the food prices and the rate of wage (Thirlwall, p. 127-128, 2006).

In practice, the situation as described above shows that economic growth is highly dependent on capital accumulation or in other words on the reinvestment of profits. This explains why Ricardo passionately supported the abolition of every kind of taxation, levies and tariffs on imported goods. He believed that the competition by cheaper, imported goods could be the only way for wages and rent prices to be kept in low levels and so the stationary state to delay at some point. This concept led Ricardo to some other very important findings in his theory on growth. Firstly, the reality of diminishing returns can be faced only in terms of either continuous technological progress in agriculture or import of cheaper agricultural products than the domestic ones. Secondly, if there are no opportunities for technological progress or import of cheaper goods in agriculture, the only way for the real wages to remain stable is the ratio of capital to population to remain constant and the two variables to grow proportionally. If there is a rise in population and wages, it will push upward the real costs in agriculture. Thus, every new unit of output will require more labour and capital than before. Thirdly, as a consequence of the previous two, the rents will increase, profits in agriculture will fall and the same will happen to the rest sectors of the economy. To make it simpler, profits could possibly grow only if the real wages decreased. At the end, Ricardo concludes that the long-term rate of profit is

determined by the level of profit in the agricultural sector (Rostow, p. 79, 1990). The figure below shows how the Ricardian theory of growth identifies the growth process:

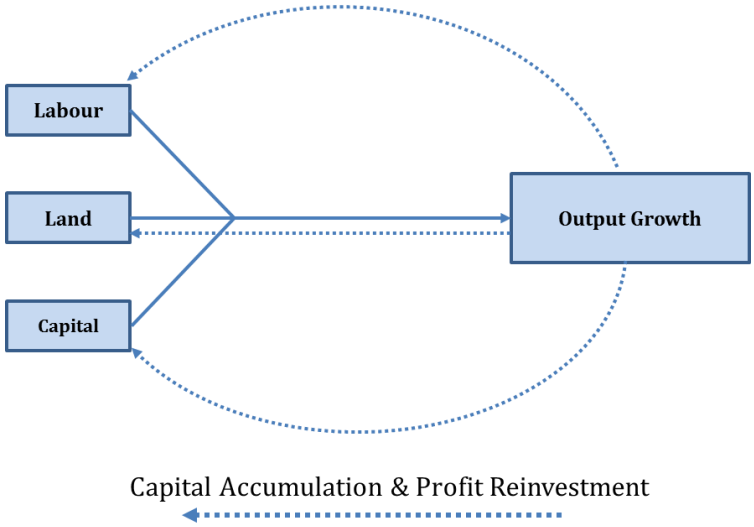

Figure 5: 2.3.1 Growth process in Ricardian Theory

Therefore, it is apparent that capital accumulation is the key in the whole process.

2.3.2. Capital Accumulation and its Variables

Ricardo mentions a number of factors which affect the process of capital accumulation and he attempts to analyze them further. He treats the population growth as a major cause of the capital accumulation disruption. For the majority of classical economists the variable that determines the rate of growth of population is the wage rate. When the market wage rate moves higher than the natural wage rate (equilibrium wage rate) the result will be a population increase. In other words, the growth of population relates positively to the wage rate (D'Agata & Freni, p. 30, 2003). For this reason, Ricardo tended to believe that a declining rate of increase in population combined with continuous advancements in technology plus the import of cheaper food were the only ways in order the economy to stay away from a stationary state (Rostow, p. 80, 1990). However, the simultaneous increase of wage rate and population can be destructive not only for

the capital accumulation process but for the population as well. This happens because initially, the higher wage rate pushes the population size upwards. Then, the higher wage rate makes the labour cost more expensive and therefore the profit declines and the capital accumulation stops. This fact puts in danger the survival of the population and the results cannot be prosperous for the working class which inevitably will shrink (Rostow, p. 80, 1990). This topic attracted the interest of many modern economists as far as the consequences of population growth are concerned. For example, Lucas (1988) supports that labour can be more important than capital in the growth process and rejected Ricardo by expressing the view that population increase and its higher density can result in better division of labour. So, a higher human capital per person can improve the productivity of the total human capital. On this path, Blanchard and Fisher (1989) use the example of China's rate of growth and population increase, both positive, proving that both can have the same direction. Finally, it was Romer's approach (1986, 1990) that incorporated the knowledge spillovers within the growth process and his main findings support the investment in human capital. This makes human capital to exhibit increasing returns thus future investments in human capital can be even more productive (Holcombe, p. 47-51, 1998). There is also a paradox that is mentioned in "The Worldly Philosophers" of Heilbroner. The author outlines that in the modern world although there is still some coexistence between growth and wage increase, the population in the most corners of the planet tends to stabilize for a wide range of other reasons. Thus, the wage rate increase does not seem to affect the global fertility rates today as it is supported in Ricardo's model (Heilbroner, p. 128, 2000). The conclusion of Ricardian theory that historically has been proved true and has been applied widely by developed economies is that the import of cheaper goods tends to apply downward pressure to the wages and to the prices of the domestic goods.

Proceeding now to wages, it was mentioned that in the Ricardo's corn model, they constitute one of the two key determinants of capital accumulation (the other is the rent price of land). However, as it has been empirically proved there are numerous cases where a market wage rate higher than the subsistence wage rate did not lead necessarily to population increase as Ricardo believed. This happens

when the workers obtain a better wage and they start consuming goods that do not belong to the subsistence class. In other words, they start enjoying goods that are not high in the hierarchy of their living needs. Instead of that, these goods make their lives more comfortable and prestigious. Thus, a better quality of life is considered more important than the prospect of a big family (Heilbroner, p. 128, 2000). Consequently, in long run, the natural wage rate tends to remain higher without having negative effects in profit. What is more, in a paper of Fiaschi and Signorino (2004) where the authors work on the Ricardian model by treating the natural wage endogenously, they found that globally, there is equilibrium at the normal level between wage rates and profit with capital and labour force constant over time. However, the long-term equilibrium always depends on the initial condition: an economy with a higher initial natural wage sustains a higher equilibrium market wage and a smaller labour force than a poor country. This means that both nominal and real natural wages in rich and developed economies will be higher than those in the poor ones (Fiaschi & Signorino, p. 47, 2004). This point of view indicates that although a market wage rate equal to the natural wage rate is necessary for the continuous capital accumulation, it does not mean that economies with low natural wage rates offer necessarily more opportunities for capital accumulation. Thus, Ricardo's views seem to be partially true. Indeed, equilibrium between natural and market wage rate is mandatory for the continuity of capital accumulation. But in case that the market wage rate moves and remains in long-term basis in a higher level than the equilibrium, it will not be the primary cause of a possible pause in capital accumulation process.

2.3.3. International Trade and Technological Progress

Proceeding beyond the area of wages, Ricardo dedicated one large part of his work to the sector of international trade. International trade had a so profound place in his theory that led him to write a whole chapter about this topic in the "Principles of Political Economy and Taxation" known as "*comparative advantage*". Therefore in this case, the emergence of the contribution of international trade in the growth process was not the only notable achievement

of Ricardo. The most significant thing was the consolidation of international trade theory as a concrete entity in economics with its own rules and principles. As Smith did before, Ricardo absolutely encourages free trade adopting all the benefits described in Smithian theory such as the betterment of division of labour and productivity achieved by the enhancement of the market. Thus after the "Laissez faire, laissez passer" of Adam Smith, now it is the turn of Ricardo to support passionately the abolition of the Corn Laws that had been implemented by the British Parliament for the benefit of land owners but with negative effects for the producers and the growth process in general. Ricardo believes that the countries that participate in the process of international trade, they enjoy some very important benefits such as:

a) Rise in the volume and the variety of the goods that can be found within an economy
b) Cheaper imported goods promote saving because there is more profit and consequently, there is more available capital in the economy
c) Wage rates will fall due to the competition from the import of cheaper, basic for the living needs, goods (Drakopoulos & Karagiannis, p. 118-119, 2003)

In long-term basis, the benefit from open, international trade is that the economy will remain away from the stationary state by keeping positive the rate of profit for the investors (Afonso, p. 4, 2001).

For Ricardo there are two prerequisites for two countries to get involved in an international trade relationship. These two prerequisites are:

a) When two countries have different "absolute advantages" in terms of cost in the production of different goods
b) When two countries have different "comparative advantages" in terms of cost in the production of different goods

The first prerequisite refers to the benefit that a country will lack when it produces a good with lower cost and does not participate in international trade. The second refers to the benefits that a country can have from international trade given the conditions below:

a) Every country possesses different quality of productive resources

b) The transfer of productive resources from country to country presents a range of obstacles that makes it almost impossible

The conditions above have as a result every country to produce different goods in different cost (Drakopoulos & Karagiannis, p. 119, 2003). The notions of "absolute" and "comparative" advantages are analyzed by Ricardo with a simple numerical example in six paragraphs in his work. Thus Ricardo outlines:

> "If Portugal had no commercial connection with other countries, instead of employing a great part of its capital and industry in the production of wines, with which it purchases for its own use the cloth and hardware of other countries, it would be obliged to devote a part of that capital to the manufacture of those commodities, which it would thus obtain probably inferior in quality as well as quantity.
>
> The quantity of wine which it shall give in exchange for the cloth of England, is not determined by the respective quantities of labour devoted to the production of each, as it would be, if both commodities were manufactured in England, or both in Portugal.
>
> England may be so circumstanced, that to produce the cloth may require the labour of 100 men for one year; and if it attempted to make the wine, it might require the labour of 120 men for the same time. England would therefore find it its interest to import wine, and to purchase it by the exportation of cloth.
>
> To produce the wine in Portugal, might require only the labour of 80 men for one year, and to produce the cloth in the same country, might require the labour of 90 men for the same time. It would therefore be advantageous for it to export wine in exchange for cloth. This exchange might even take place, notwithstanding that the commodity imported by Portugal could be produced there with less labour than in England. Though it could make the cloth with the labour of 90 men, it would import it from a country where it required the labour of 100 men to produce it, because it would be advantageous to it rather to employ its capital in the production of wine, for which it would obtain more cloth from England, than it could produce by diverting a portion of its capital from the cultivation of vines to the manufacture of cloth.
>
> Thus England would give the produce of the labour of 100 men, for the produce of the labour of 80. Such an exchange could not take place between the individuals of the same country. The labour of 100 Englishmen cannot be given for that of 80

> Englishmen, but the produce of the labour of 100 Englishmen may be given for the produce of the labour of 80 Portuguese, 60 Russians, or 120 East Indians. The difference in this respect, between a single country and many, is easily accounted for, by considering the difficulty with which capital moves from one country to another, to seek a more profitable employment, and the activity with which it invariably passes from one province to another in the same country.
>
> It would undoubtedly be advantageous to the capitalists of England, and to the consumers in both countries, that under such circumstances, the wine and the cloth should both be made in Portugal, and therefore that the capital and labour of England employed in making cloth, should be removed to Portugal for that purpose. In that case, the relative value of these commodities would be regulated by the same principle, as if one were the produce of Yorkshire, and the other of London: and in every other case, if capital freely flowed towards those countries where it could be most profitably employed, there could be no difference in the rate of profit, and no other difference in the real or labour price of commodities, than the additional quantity of labour required to convey them to the various markets where they were to be sold" (Ricardo, p. 134-136, 1821).

The tables and the figures below describe analytically the numerical example of Ricardo starting with the case of the "absolute advantage":

	Number of men working for a year required to produce a given quantity of cloth and wine traded	
	Cloth	Wine
England	45	50
Portugal	50	45

Table 1: 2.3.3 Ricardo's absolute advantage – Initial phase

Table 1 shows that England and Portugal produce cloth and wine in the given prices. In the these prices, England gains specialization in cloth because it can sell it with 5 units profit in Portugal while Portugal gains specialization in wine because it can sell it with 5 units profit in England. Both countries beneficiate from international trade and this is presented by Figure 6 where the curves of the two countries are crossed:

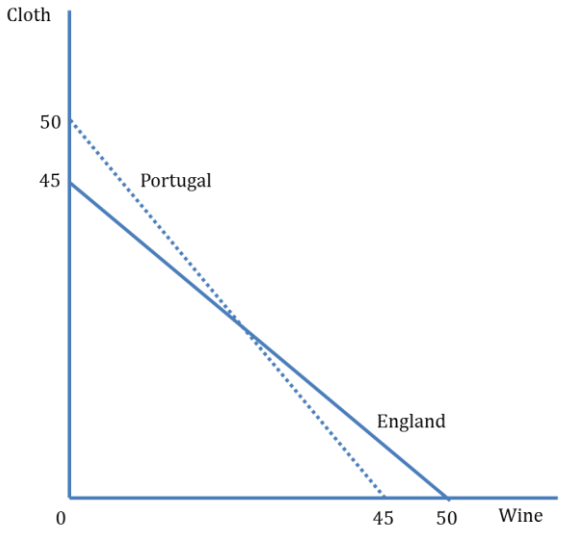

Figure 6: 2.3.3 Ricardo's absolute advantage – Initial phase

However, if England applies new technology in agriculture and drops the cost of wine production, it will be able to produce wine in the same price with Portugal. This is shown in Table 2:

	Number of men working for a year required to produce a given quantity of cloth and wine traded	
	Cloth	Wine
England	45	45
Portugal	50	45

Table 2: 2.3.3 Ricardo's absolute advantage – England invests in technology

In this case England can export cloth in Portugal but Portugal does not have any advantage to export wine in England. So Portugal lacks its absolute advantage in international trade. The case is presented by the figure below.

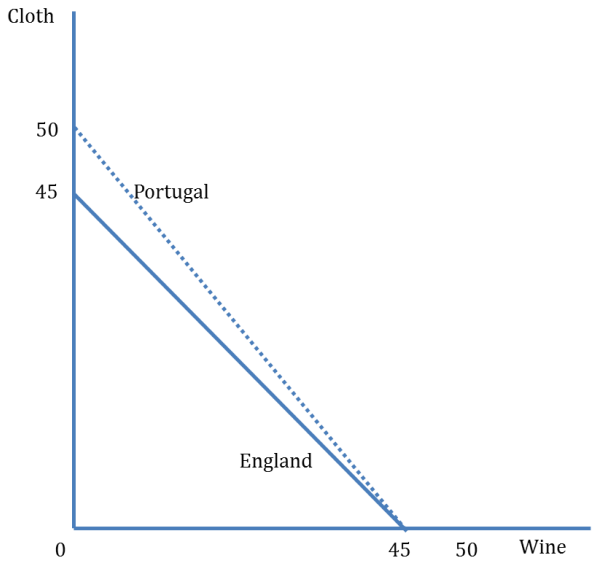

Figure 7: 2.3.3 Ricardo's absolute advantage – England invests in technology

Nevertheless, although the absolute advantage of Portugal has been eliminated, the trade relationship between the two countries can still exist based on the "comparative advantage". This case is described by Table 3 below:

	Number of men working for a year required to produce a given quantity of cloth and wine traded	
	Cloth	Wine
England	100	120
Portugal	90	80

Table 3: 2.3.3 Ricardo's comparative advantage

In this case, Portugal can produce both goods cheaper than England. Portugal has in both cases the "absolute advantage" and the trade-off between the two countries seems to collapse. However, there are still opportunities for trade if the relative labour cost is taken into account. Indeed Portugal can produce cloth cheaper than England. But if Portugal invests all its capital in the wine production and import cloth from England, it will be beneficiary for its economy because it will receive more cloth from England than the quantity that can be produced domestically (Drakopoulos & Karagiannis, p. 123-124, 2003). Ricardo supposes

that X is the amount of cloth that is actually traded by England for Y units of wine from Portugal. The annual labouring force that is required by the English economy to produce X units of cloth is 100 units while for the production of Y units of wine is 120 units. Portugal needs 90 and 80 units respectively for the production of the above quantities. Given the fact that the transfer of resources abroad is not possible, a possible trade-off can be useful for England as it saves the labor of 20 men by importing the wine and paying for it with the exportation of cloth. The same happens with Portugal as it saves the labour of 10 men by importing the cloth from England and purchasing it with its wine exports. In any case, for Portugal there are *de facto* benefits from this trade-off, as apart from the "comparative advantage", it also has the "absolute advantage".

To become more detailed about the "comparative advantage", Ricardo makes a comparison between the cost of importing a certain quantity of a good from another country with the real labor cost of producing the same quantity domestically. The cost of the imported goods always includes the real labour costs embedded in the commodities that the country is required to export in order to pay for its imports. Ricardo, through this cost comparison, consolidates in his theory the already known concept of specialization. In simple terms, it is advantageous for a country to import commodities from anywhere in exchange for exported ones whose the production requires less real cost than the domestic production of the same amount of the imported commodities. With this policy, under conditions of absolutely free trade, an economy can obtain all the necessary goods that consumes at the lowest cost in real terms and not in nominal. (Meoqui, p. 71-72, 2010). An empirical test on Ricardo's "comparative advantage" by Balassa in 1963 based on figures from U.S and U.K economy showed that indeed, there is positive, strong correlation between labour productivity and exports validating with this way the Ricardian theory on free international trade. Therefore, the higher is the specialization of labour, the higher will be the capacity for more exports for an economy and vice versa (Balassa, p. 234-235, 1963).

On the other hand, there has been a lot of literature today that criticizes the "comparative advantage" in free international trade and doubts about its bilateral benefits to the involved countries. Although the dominant trade theories declare

that any free exchange implies the transfer of equal values between the involved parties, there have been several critics which reveal that behind the apparent equal value exchange a hidden mechanism of labour value transfer exists. Such critics have been raised by Bauer (1907), Baran (1957), Frank (1967), Mandel (1969), Emmanuel (1972) and Amin (1974). More specifically, Bauer believes that the import of cheap goods due to low wage rates from less developed economies to the advanced ones offers an even larger surplus value to the capitalist who continues exploiting not only the domestic working class but the workers of weaker economies as well. Emmanuel states that from the moment that the wage rates globally are different, a trade exchange cannot be absolutely equal for the involved parties. What is more, Baran, Frank and Amin support that the logic of existence of external markets for a developed economy is to fulfill the needs of the domestic capital. For this reason, the capital of advanced economies tends to impose specific models of economic development to the less developed according to its needs, creating by this way a strong dependency between the two economies (Seretis & Tsaliki, p. 906-907, 2012).

Last variable in Ricardian theory which affects the process of capital accumulation and growth is technology. Although its effects in capital accumulation cannot be compared in terms of criticality to these of wages, population and international trade, it attracted his attention as far as its role in the growth process. First of all Ricardo, like Smith, could not perceive adequately the importance of technology in the growth process. For both of them technology is not a determinant of the production. However according to Ricardo technology relates to capital accumulation for a number of very important reasons. These reasons are:

a) Firstly, the use of new technology or machinery makes agriculture more productive so its diminishing returns tend to be less intense and the profit rate remains positive for a greater period (Kurz & Salvadori, p. 9, 2003)
b) On the other hand, technological progress lowers the production cost and the final price of the commodities, thus the producer can sell them at cheaper prices abroad and enjoy the benefits of international trade as they were mentioned in the previous paragraphs

c) Moreover, technological progress seems to push the labour cost downwards. Let suppose that one part of the workforce in an industrial unit focuses on the invention and the manufacturing of new machinery. When the construction of machinery is over, these workers stop being useful to the capitalist and they are replaced by technology which constitutes a fixed cost of production. A similar situation happens when the capitalist buys new machinery in order to substitute the human labour. Both cases cause "technical unemployment" (Rostow, p. 82, 1990)

d) From the previous argument it can be understood that the lower demand for labour in combination with higher unemployment pushes the subsistence wage even lower creating more profit opportunities for the producers (Sraffa, p. 399-400, 1951-73)

e) Finally, technical progress also makes rents to decline. This happens because the new machinery boosts productivity in agriculture and now less land is required for the same quantity of production in relation to previous situation when innovation was absent. Secondly, from the moment that machinery has replaced human labour, fewer workers per unit of land are required now. Thus, the lower demand for land leads the rent prices to fall (Ricardo, p. 70, 1821)

2.3.4. Main Conclusions

The conclusion from Ricardian theory is that for economic growth to exist, capital accumulation must be active in a cyclical process. However, it seems unavoidable this process to end when the profit rate declines to zero one day. That day the economy will pass into a stationary state and the growth of national income will stop. The only factors that can postpone that situation are international trade and technological progress and this was the reason that led Ricardo to pay special attention to them. For Ricardo, the economy consists of two sectors: the manufacturing sector with constant returns to scale and the agricultural sector with diminishing returns to scale. Capitalists are the productive class of the system because they reinvest their profits and sustain the capital

accumulation. However, the population growth and the wage rate increase remain an obstacle to the continuous capital accumulation. Without international trade and new technology, the last hope for new profit is the cultivation even of the less fertile lands which is limited due to the diminishing returns of agricultural sector. Thus, at the end nothing can prevent profit from falling to zero. Consequently, the inability of capitalists to reinvest profit brings the economy to a stationary state. Finally the entire surplus is absorbed by the landlords (Sardavdar, p. 10, 2011).

2.4. The Theory of Karl Marx

2.4.1. The Growth Equation and its Determinants

The economist who has become a usual matter of debate among numerous economists for his growth theory is Karl Marx. Although his views have been regarded heretic for over a century, many neo-Marxists economists believe that the Marxist Growth Theory always remains contemporary within capitalism. The main reason that explains the term "heretic" is his revolutionary and with mathematical precision, conclusion about the unavoidable collapse of capitalism at the end of the growth process. As a reminder, before Marx, both Smith and Ricardo had seen at some point a declining trend in the rate of profit with Ricardo to speak about the case of a stationary state in the economy, but they had never predicted the end of the capitalist system. However, for these three economists their main difference was the cause that brings the fall of the profit. According to Marx, the end of the growth process is due to crises associated with instability in the production process, overproduction of numerous goods that are partially consumed, unemployment and social turmoil (Heilbroner, p. 202, 2001). Before this situation, Marx believes that the increasing capital accumulation brings, apart from economic growth, important changes to the social life, development of the urbanism, immigration of labouring population and changes to the traditional family patterns (Bowles & Edwards, p. 62-63, 2001).

His growth model is not very different than these of his predecessors. The profit which drives the capital accumulation is replaced here by the **surplus value** but they are exactly the same. As far as the effects of population growth, he devotes a large part of his work in order to shoot down the Malthusian approach by giving a new dimension to the quantitative evolution of human kind that would follow in the coming decades. But above all, the rate of profit has always the long-term tendency to fall. Thus the total output is the function of three factors:

a) The variable capital (v) which refers mainly to wages
b) The constant capital (c) which is the necessary equipment and materials for the production
c) The surplus value or profit (s)

In other words, Marx's growth equation is: **Y = v + c + s**. As it can be understood, the capacity for capital accumulation is determined by the factors of variable capital and surplus value as the constant capital is fixed. Thus, the wage rate should be determined by the subsistence level which represents the minimum, necessary wage for the survival and the reproduction of the working class. On the other hand, the surplus value is the difference between the output per worker and the minimum wage per worker (Thirlwall, p. 129, 2006). The rate of surplus value is **s/v**. Thus, the rate of profit is given by the ratio of surplus value to total capital as it is shown by the equation below:

$$\frac{s}{(v+c)} = \frac{(\frac{s}{v})}{(1+[\frac{c}{v}])}$$

2-9

For Marx, the rate of surplus value (s/v) shows the degree of exploitation and the ratio of constant to variable capital (c/v) constitutes the "organic composition of capital" (Thirlwall, p. 129, 2006). Therefore, it becomes apparent here that the rate of profit in Marx's model depends positively on the rate of the surplus value and negatively on the organic composition of the capital. Given the fact that the fixed capital increases against variable capital, the profit rate declines because

there is a fall in the amount of the surplus value (Drakopoulos & Karagiannis, p. 171, 2003).

The statements above are presented mathematically in the following mathematical model given by T. Lianos (1979). Three basic assumptions are admitted here: Firstly, the working class does not save. Secondly, the capitalist always spends a part of the profit in order to consume and the rest part is reinvested. Thirdly, fixed capital remains stable so it can stay out of the growth equation. Hence, the degree of exploitation (r) is:

$$r = s / v$$

2-10

Furthermore, by removing for reasons of simplicity the fixed capital which is always stable, the total output can be written as:

$$Y = v + s$$

2-11

The equations 2-10 and 2-11 give the below equation for the surplus value:

$$s = \frac{r}{1 + r} Y$$

2-12

Moreover, the capitalists save a part of the surplus value which is transformed into new capital. For this reason:

$$Ac = \lambda * s$$

2-13

The equations 2-12 and 2-13 give:

$$Ac = \frac{\lambda r}{1 + r} Y$$

2-14

The second part of equation 2-14 symbolizes the marginal propensity to save or in simpler terms the saving function of the economy. Moving further now, the organic composition of capital is given by the equation below:

$$g = c / (c + v)$$

2-15

The transformation of equation 2-15 into equation 2-16 reflects the relationship between constant and variable capital while in equation 2-17 their rate of change:

$$c = \frac{g}{1 - g} v$$

2-16

$$\Delta c = \frac{g}{1 - g} \Delta v$$

2-17

Because when capitalists invest profit, they direct the funds both to constant and variable capital, the total investment can be written as:

$$I = \Delta c + \Delta v$$

2-18

By incorporating equation 2-17 into the last equation (2-18), the total investment is transformed into:

$$I = \frac{\Delta v}{1 - g}$$

2-19

From equations 2-11 and 2-12, the total output becomes:

$$Y = v + s = (1 + r)\, v$$

2-20

And therefore the rate of change is equal with:

$$\Delta v = \frac{\Delta Y}{1 + r}$$

2-21

By inputting now the equation 2-19 into the last equation (2-21), a new is derived and symbolizes the average productivity of investment:

$$\Delta Y / I = (1 - g)\,(1 + r)$$

2-22

However, for sustainable growth, it is compulsory the profit to be accumulated and transformed into new capital by the capitalist. Thus:

$$\lambda \frac{r}{1 + r} Y = \Delta c + \Delta v$$

2-23

Finally, by finding the rate of change of equation 2-23:

$$\frac{\Delta \Upsilon}{\Upsilon} = \lambda \frac{\mathrm{r}}{1+\mathrm{r}}(1-g)(1+r)$$

2-24

The final equation (2-24) shows that the growth rate of an economy depends on the proportion of surplus value which is accumulated, the degree of exploitation of labour which is usually decreasing or stable and the organic composition of capital which is usually ascending (Drakopoulos & Karagiannis, p. 181-182, 2003, Lianos, p. 407 – 410, 1979).

2.4.2. Capital Accumulation and its Variables

Marx does not seem to differentiate himself from Smith and Ricardo on the importance of capital accumulation in the growth process. For Marx, the non-stop capital accumulation is the only way for the capitalist to achieve higher output and survive in the market against the other competitors. But in an economy without any machinery introduced, this process requires more and more labour and this pushes higher the workers' wages. Thus, this will bring a decline in the profit (surplus value) and will have negative effects in the capital accumulation. The predecessors of the German philosopher believed that the higher wages will increase the population and the volume of the working class so it will be a matter of time, the wages to return back to the subsistence level (Heilbroner, p. 217-218, 2001). Marx is opposite to this argument. He believes that the working class has rationale and it is not eager to deplete every new conquest just in the name of reproduction. But for Marx, during the phase of profit reinvestment, the capitalist will prefer to invest in new and more machinery in order to keep the labour demand in the same level and therefore the wages too (Clarke, p. 443-445, 1990). Machinery is the only way for the capitalist to keep the wages low and increase productivity. Thus, the unit cost of production decreases while the higher labour productivity is leading to profit maximization. For this reason, with machinery being available, the capitalists prefer to invest their profits in fixed capital and not in labour (Tsaliki, p. 776-778, 2009). But the introduction of machinery can be

disastrous for workers' wages with an indirect way too. Apart from the fact that new machinery keeps the labour demand in the same level as before, it has the attribute to standardize the necessary labour. Many skills are not required any more by the workers as they have been substituted by the machines. In that way, the labour has the tendency to be subdivided, deskilled and repeated thus the capitalist starts hiring workers just to operate the machines without having special skills as they used to have in the past. Automatically, the demand for unskilled labour pushes the wage rate downwards (Tsaliki, p. 366-367, 2008).

From a first point of view, the investment in machinery seems to be a panacea in the race of capitalists for continuous capital accumulation. However, the replacement of human labour by machinery tends to lead in supply over-accumulation as the unemployment and the misery deprive from the working class the economic power to buy the goods that are produced within a market. The lacking demand for products signals the end of the capital accumulation and the growth process because the remaining supplies cannot be consumed and the capitalists cannot produce new ones (Higgins, p. 82-84, 1968). Certainly, this end is not definite. There will be a period of pause where "the big fish eats the little one". The capitalists who cannot afford the losses are obliged to sell their machinery to more powerful capitalists so now the available capital is gathered in fewer people. The workers are also obliged to accept lower wages in order to be able to buy the goods that are necessary to cover their basic needs. Thus, after this period of pause, the surplus value appears again and the capital accumulation begins until the next crisis which will be deeper than the previous and softer than the next one. The situation goes on until the point that all the capital is possessed by very few people while the rest of the population lives in misery and poverty (Black, p. 293, 2003). The figure below as it has been described by D. Fusfield at his book "The Age of the Economist" shows all the stages of capital accumulation from different perspectives. All of them conclude that social revolution is more than certain at the end as the wealth is possessed by a small amount of capitalists while the working class struggles against the problems of unemployment and survival:

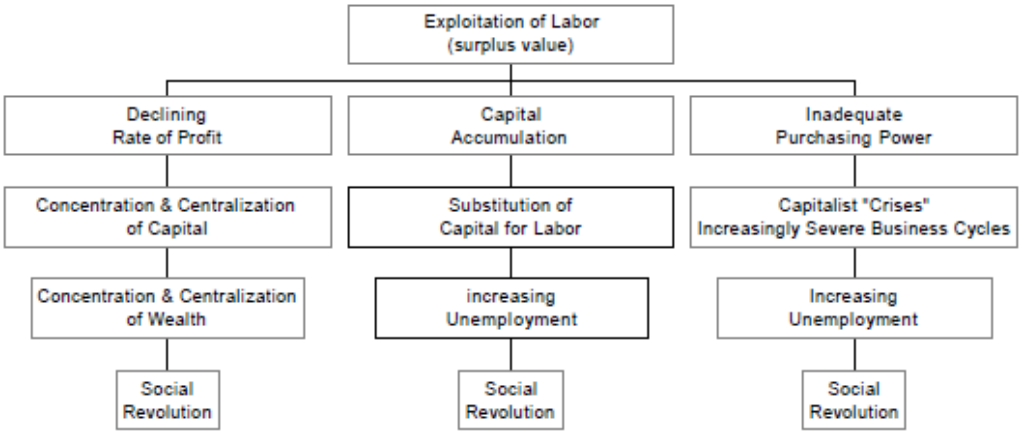

Figure 8: 2.4.2 Marx's stages from capital accumulation to social revolution

Source: Fusfield, p. 58, 1994

The point is that capital accumulation continues being the key force of the growth process. Thus, every capitalist's primary goal is to accumulate more and more. The profit is the source of the capital accumulation, but the factors which evaluate the depth and the length of the process are the wages and the use of machinery instead of human labour.

2.4.3. The Role of Technological Progress

As it has been clear in the previous paragraphs, technological progress is highly significant in the Marxist theory. Although, Marx could not predict how technology would transform the current system into a modern, industrial, capitalist economy, he clearly identified even in simple terms the bond between technology and capital accumulation (Bimber, p. 345-346, 1990). It is true that Marx recognizes and admits the contribution of machinery in the production process for the generation of higher output. With machinery, Marx sees intensification of labour, higher labour division and better specialization of the workers. This reduces all the costs and rises labour productivity and profit (Tsaliki, p. 366-367, 2008). But, for him technology was also a disastrous weapon against the wages of the working class initially and of the capitalism at the end as well (Rostow, p. 135-137, 1990).

Above all, there is something else very crucial that separates the Marxist theory from the Smithian and the Ricardian. Initially, for the period of transition from feudalism to capitalism, Marx could see the role of technology at the same way as Smith and Ricardo did. But as Marx lived later than the other two, he was able to analyze better the irreplaceable role of technology in the production process at the stage of the industrialization of capitalism. So, several modern Marxist economists today believe that Marx studied adequately the role of technological progress and it could be incorporated in the growth equation of his model (Peet, p. 25, 30-31, 1999). The equations below point out why technology is of utmost importance in Marx's growth model according to studies of several neo-Marxists economists. So, by incorporating the variable of technology, the growth function evolves into:

$$Y = f(K, L, R, T)$$

2-25

Where K is capital, L is labour, R is land and T is technology. As it has been mentioned in the section of capital accumulation, there is positive correlation between technology and investment because during the reinvestment process, the capitalists tend to spend more on new technology. Thus:

$$T = T(I)$$

2-26

But, investment is a dependent variable of the rate of profit because only the presence of profit can generate new investment. For this reason:

$$I = I(\pi)$$

2-27

The equation 2-9 in section 2.4.1 shows that the rate of profit is the ratio of surplus value to total capital:

$$\pi = s / (c + v)$$

2-28

Moreover, in the Marxist theory the wage rate depends on the levels of investment and employment and as it has been referred again previously, new investment requires more employment. So both of them push the wages higher:

$$W = W (I, L)$$

2-29

Employment is a dependent variable of the level of investment:

$$L = L (I)$$

2-30

One verified argument in Marx's theory is that less consumption than the expected will have negative effects in growth due to supplies over-accumulation. Marx believed that an investment cannot have the expected result if the level of consumption does not meet the level of production in order the new quantity of goods to be fully absorbed. But the largest part of consumption depends mainly on the level of wages of the working class. Thus:

$$C = C (W)$$

2-31

Although equation 2-28 shows the determinants of the rate of profit, it does not show any type of causality. Therefore, it is not evident what affects the surplus value and the rate of profit. As Smith declared first, the level of technology is major factor to the production of the same quantity of output with less labour. On the other hand, less labour means less quantity of available money in the working class for consumption of capitalist goods. These two statements imply that there

is strong, positive correlation between profit as dependent variable and technology and consumption as independent variables:

$$\Pi = \Pi (T, C)$$

2-32

The total output (Y) apart from a function of four variables in equation 2-25, can be also expressed as an equation of profits plus the wages:

$$Y = \Pi + W$$

2-33

Finally, the economy has two sectors of goods: final goods for consumption which are declared by the variable C and intermediary goods for the production of the final goods which are declared by the variable I. From this point of view, the total output could be equal with the summed amount of consumption plus investment goods (Higgins, p. 77-81, 1959):

$$Y = C + I$$

2-34

So, there are some conclusions from the above equations. Firstly, there is a cycle behind them. Starting from profit, it can be said that higher profits attract more competition and new investment. The result of new investment is the capitalist to invest in capital intensive technology in order to maintain the profits in the same level as before. However, more and tougher competition pushes the Capital – Output ratio higher and causes unemployment thus the profit will have the tendency to fall (Rostow, p. 137, 1990). Therefore, if the capitalists wish to maintain their market share, they ought to invest every time to new technology. This fact fosters the capital accumulation and the use of highly capital intensive techniques. More technology however, increases more and again the ratio of Capital (K) to Output (Y). Hence, the profit can avoid its declining trend only if the

gap between the output per worker and the wage rate does not close. The most common ways for the capitalist to keep the profit in the desired level can be:

- The reduction of the wage rate close to the subsistence level
- The increase of the hours of work
- The improvement of the existing labour saving techniques (Marx, p. 257-260, 1887)

It is clear therefore that the effects of technological progress in the profit behaviour are equally important to these of the labour cost (wage rate). Of course, these two factors must have opposite directions in order to maximize profit. This situation will be at the end the reason of the collapse of capitalism. This will happen because as it has been described again in section 2.4.2 the sustained technological progress requires a continuously increasing ratio of fixed capital to output which substitutes the need for labour. This causes overproduction of goods from the capitalists' side that cannot be fully consumed by the workers' side and therefore, the stationary state of the economy with no profit for the capitalists is inevitable (Sardadvar, p. 10, 2011).

2.4.4. The Role of Human Population and Competition

Another popular topic in Marxist theory but not new in the Classic Growth Theory is human population and its role in the growth process. Indeed, even today, the relationship between human population and economic growth remains a matter of debate for almost all the economists. The question that has conquered is whether economic growth brings a rise in human population or the growth of the second is against of the growth of the first. Focusing now on the classical economists, it is noticeable that Marx seems to follow a very different path from Smith and Ricardo, working on and contradicting the ideas of Malthus as far as the role of human population in the growth process. Marx rejects the Malthusian conclusion that human population increases geometrically while food unit arithmetically and as a result the largest part of humanity will be condemned to live in poverty (Kremmidas, p. 251-255, 2002).

The most important difference between Malthus and Marx is that the first treats the birth of children as a natural process dominated by uncontrollable passion especially in masses. On the other hand, Marx views the high birth rates in the lower classes as a kind of investment by the working class, a well-planned decision. From the moment that the only thing that can be accumulated by the working class is labour, these people want to give birth to more children as one day these children will bring more income to the family (Brezis, p. 11, 2011). However, a dreadful consequence of this plan by the side of the lower classes may be certainly the continuous rise of the working population. As the ratio of constant capital to output goes higher and the need for labour become less, high birth rates expand in the long run the reserve army of labour who is waiting under the problem of survival to work for a lower wage rate (Elwell, p. 36-37, 2005).

Marx believed that the population of every kind in this planet has its own law. But in an industrialized, capitalist society, the human population law is the law of a relative surplus population (Coontz, p. 103, 1961). For this reason, Marx never agreed with Malthus in the issue of overpopulation. For Malthus, it was inevitable that in the future the capacity of this planet would be full. On the other hand, Marx said that overpopulation would never be a problem for humanity if social change was going to happen (McQuillan, p. 110, 1982). What is more, Marx's general conclusion about overpopulation is that this phenomenon is not explained by the inadequate production of the means of subsistence as Malthusians believed. It is the result of the displacement of workers by the production because of the continuous capital accumulation. In this case overpopulation makes the competition between the workers more intensive (Basu, p. 1-2, 2012). This is the reason why the capitalists target to a high reserve army of labour in order to keep the wages far from rising in favour of profit. At the end, the basic conclusions of the Marxist approach on the topic of population are:

1. First of all, there is not causality between population growth and poverty. For Marx, the main cause of poverty is exploitation and oppression
2. Moreover, population increase affects economic growth through a higher reserve army of labour. Wages remain low and profit continues to be reinvested

3. On the other hand, economic growth seems to encourage the masses to improve their fertility rates as more members in a family mean more labour and available income at home
4. Overpopulation is caused by the continuous capital accumulation where production displaces the worker by technology
5. The problem of overpopulation can be solved through social change and poverty elimination (Clarke, p. 112-113, 1994)

Moving now to the issue of competition, Marx pays high attention to its role in the growth process. For this reason, he devoted a whole chapter in the third volume of Capital. For Marx, competition is not a booster of economic growth as Smith and Ricardo believed. He treats competition as a derivative of profit. Profit is the trigger which attracts more capitalists to invest. Thus, it is obvious that in Marxist theory there is strong, positive correlation between capital accumulation and competition. Under this trend, a cyclical process is created where the dependent and independent variable cannot be easily distinguished. However, it is undoubted that the higher the competition is the more capital accumulation will generate (Tsoulfidis, p. 13-14, 2011). For the capitalist, the competition exists in both labour and product market. Thus, the capitalist by pursuing a larger market share tries to keep the wages at the minimum point and the labour productivity at the maximum. When the wage rate and labour productivity reach these points and cannot overpass them, the capitalist seeks other ways to earn more and this is the investment in technical equipment. This proves why competition imposes the continuous investment in fixed capital (Tsaliki, p. 776, 2009).

Another remarkable point in Marx's competition theory was his approach on the meanings of strong competition and monopoly. In contrary to his predecessors, Marx does not treat these two meanings as totally opposite states. Like in the case of capital accumulation and competition, competition and monopoly are the two major points of the same, cyclical process. When continuous and increasing competition pauses capital accumulation and vanishes profit, the "big fish eats the little one" and the capital is gathered to few, powerful capitalists. When the crisis leaves and new opportunities arise, then new "players enter the game" and the economy quits monopolies and gets the characteristics of a

competitive state (Baskoy, p. 10-11, 2002). Apparently, Marx keeps a negative attitude towards the phenomenon of competition. Nevertheless, he places competition to the core ingredients for the reproduction of the capitalist mode of production. Its presence in a capitalist economy is highly necessary because it abolishes any kind of barrier or tariff and it channels capital into the most profitable sectors. On the other hand of course, competition is one of the most critical factors responsible for deep, capitalist crises (Gianmarco, p. 5, 2000).

2.4.5. Main Conclusions

Although Marx did not add any new productive forces in the growth equation (the surplus value is just the profit), he managed to penetrate very deeply to the forces which activate capital accumulation process and promote the growth of the total output. Hierarchically, the most important point in the Marxist Growth Theory is the clear role of technology in the growth process. Smith and Ricardo were unable to see clearly in what ways technology could affect the production and the growth process in general, because of its primitive character at their era. For this reason they gave less importance than Marx to this variable. On the other hand, Marx was able to forecast the beneficial and the destructive role of technology both for the capitalist and the worker. This explains why the majority of neo-Marxists economists have incorporated the variable of technology in the Marxian growth model. Moreover, Marx has followed a different path in the topics of population and competition than the other classical economists. He adds an economic background to the decision of the working class to give birth to specific number of children according to their needs and their financial condition. He believes that overpopulation is a problem of capitalist economy and under social change this phenomenon will disappear because the resources will be allocated more fairly. As far as competition, Marx perceives it as a result and not as a trigger. But from the moment that competition will be present, it will constitute a locomotive force of the capital accumulation and growth process, equally important to that of technological progress. But above all these conclusions that are mentioned in the previous lines, the most revolutionary concept of Marx

remains the moment when social and economic turmoil due to overproduction and deficient consumption cause a so deep crisis where capital accumulation freezes indefinitely and the collapse of capitalism is inevitable.

2.5. Conclusions

By closing now the chapter of Classical Growth Theory, there are some points that need to be summarized. For all the classical economists the growth process cannot continue indefinitely. Although Smith and Ricardo believed that there would be always the suitable means for an economy to recover from the stationary state, Marx stated clearly that the definite end of the growth process was more than certain. All of them had suggested different ways in order the profit to remain positive. For Smith this way was the quest of new investment opportunities which would offer a high margin of profit. For Ricardo was international trade which through imports, tended to keep the price of goods and wages in low levels and the profit positive. Finally for Marx, it was technical innovation that made a capitalist to differentiate from the competitors and absorb their market share.

Although their growth equations were simplified enough and exogenous, they were the beginning point for the development of the growth theory that today is a vital research topic for many academics. Undoubtedly, the use of Classical Growth Theory today can be applied exclusively in academic level only. However its core principles like the profit reinvestment and the division of labour constitute irreplaceable characteristics of a growing, capitalist economy. The next chapter reviews the Keynesian and post-Keynesian Growth Theory. Apart from Keynes, other notable members of this school were Nicholas Kaldor, Evsey Domar and Roy Harrod.

3. The Keynesian and Post-Keynesian Growth Theory

3.1. The Theory of John Maynard Keynes

3.1.1. Business Cycles and Investment

After the end of the Classical Growth Theory period, the interest of economists for the theory of economic growth diminished notably. This field remained dormant for around sixty years until Alfred Marshall and John Maynard Keynes revived in their work the topic of economic growth. Although Keynes is not regarded as a growth economist, his views about the growth of the total income of an economy constituted a milestone for the later evolution of growth economics. However, the most important effect was that his theory influenced deeply the Post-Keynesians economists such as Nicholas Kaldor, Roy Harrod and Evsey Domar to establish a new school of research in growth theory the so called Post-Keynesian Growth Theory.

Keynes starts dealing with the topic of growth economics in his works "A Treatise on Money" and "The General Theory of Employment, Interest and Money". In these books he analyzed widely the business cycles. Keynes based on the high unemployment and inflation of the Great Depression era wanted to prove that the markets are not self-correcting and therefore equilibrium cannot be achieved automatically as it had been implied in the Classical Growth Theory. For various reasons, he argued that prices, wages, and interest rates might be unable to change, or to change enough, in order to prevent the economy entering a period of low output and high unemployment (Miles & Scott, p. 364, 2005). Beyond that point, Keynes outlines in his theory three core facts that are met in an open economy with foreign sector:

1. Trade can determine the size of the domestic employment multiplier (Keynes, p. 120, 1936)
2. A decline in wages leads to a disadvantaged position of the domestic market towards the international market and reduces the real income although the balance of payments can have a positive behavior (Keynes, p. 263, 1936)
3. An enforcement of the domestic or foreign incoming investment can lead to a higher domestic employment rate (Keynes, p. 335, 1936)

However, although Keynes had been one of the most known supporters of free, open economies, he built his theory on a model based on a closed economy. He claimed that a widely export-based growth policy may have and negative effects such as the decline of nominal wages for lower unit labour costs and devaluation of the exchange rate. For this reason, he believed that the best way for the aggregate income to increase was the continuous, domestic investment often with the contribution of the government especially in periods of crisis (Davidson, p. 70-71, 2006). Keynes rejects not only the laissez-faire theories of Smith and Ricardo but Say's Law as well. Say believed that production is the source of demand and therefore a growing, without limitations production by the capitalists can offer adequate purchase power through wages to the working class to absorb the produced goods. Even so, Keynes validates the classical economists that there is positive correlation between economic and consumer activity. For this reason, he believes that the government can significantly contribute to the aggregate demand especially in periods of alternating business cycles. Thus, in periods of limited economic activity, the government should promote private investment and increase public expenditures even under the threat of higher budget deficits. On the other hand, in periods of high economic growth, the government should follow a tighter monetary policy in order to improve its budget deficits (Sayre, p. 178, 2008). However, either in periods of growth or recession, the government should follow all those necessary actions that inflict a prudent, business environment in order to control the "animal spirit" phenomenon shown by capitalists. This phenomenon has two sides: the first appears in periods of booms when the capitalists are led by a spontaneous optimism of profit-making to investment

decisions without having rationally quantified the actual hidden risk behind these decisions. The other side appears when the fear of a current or a possible, future recession prevents capitalists from investing. Both cases have a negative impact to aggregate demand and constitute major cause of a forthcoming or continuing recession (O' Hara, p. 16-17, 1999). Using the national income equation, the total amount of consumption, investment, government expenditures and net exports that constitute the aggregate demand should be equal to the aggregate supply. When the demand is lower than the supply, then part of the productive resources remain unemployed. It is therefore the aggregate demand that determines the behavior of the total output and employment. The aggregate supply just adapts to the aggregate demand (Bhattarai, p. 4, 2005). The problem is that a rise in aggregate demand is always harder than a rise in aggregate supply and this phenomenon tends to disrupt investment and cause unemployment. From this point of view, Keynes sets the continuous, private and public investment as the ultimate goal of any government (Tinh, p. 67, 2012).

By clarifying the importance of private investment in an economy and its contribution to economic growth, Keynes suggested various ways for its resurgence. These ways were:

a) Lower interest rates for financing private investment
b) Income redistribution through government intervention policies to population groups with higher propensity for consumption
c) By increasing money supply and public expenditures to create positive expectations for corporate profitability in the future
d) Prudent fiscal policy that allocates taxes fairly and does not disrupt consumption and investment (Tinh, p. 67, 2012, Tcherneva, p. 7, 2008)

3.1.2. The Theory of Aggregate Demand and Supply

According to Keynes, the aggregate income in an open economy with public sector is generated by the equation below (Krugman & Obstfeld, p. 28, 2000):

$$Y = C + I + G + Ex - Im$$

3-1

Equation 3-1 is presented by the graph below:

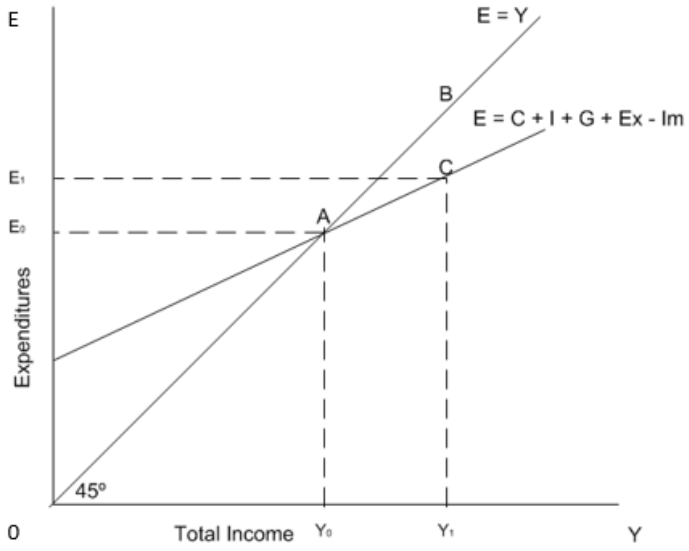

Figure 9: 3.1.2 The Keynesian Cross

Source: Samuelson, p. 259, 1948

The graph above known as "The Keynesian Cross" was developed by Paul Samuelson in 1948. It represents Keynes' equation of aggregate income in an open economy with public sector. The graph shows in the vertical axis the sum of the consumption demand plus the planned investment, public expenditures and net exports that constitute the planned expenditures (E). The horizontal axis shows the total income produced within the economy, the real expenditures in other words. In order equilibrium to exist within an economy, the planned expenditures (E) must be equal to the real expenditures (Y). When there is equilibrium there is no change in the supplies of the firms. However, if production goes at Y_1, then the planned expenditures $0E_1$ are less than the total production equal to BC and the firms are obliged to accumulate supplies and decelerate their production. Production has to be reduced until the point that the accumulation of supplies will get null. This will happen only when the total production will be Y_0 and the planned expenditures E_0 equal to Y_0 (Katseli & Magoula, p. 126-127, 2003). This

explains why Keynes encourages higher consumption, investment and public expenditures in order to generate new and higher aggregate demand under the crucial intervention of the government. The "Keynesian Cross" apart from its contribution to the Growth Theory, constituted the foundation for the development of the Hicksean IS-LM model which presents in one graph the effects of monetary and fiscal policy of the government. The latter point became a matter of debate for whether it reflects Keynes' ideas. For example, the IS-LM model has not incorporated Keynes' concepts for uncertainty and wage flexibility. Moreover, Hicks' model was rather static than dynamic and could not explain why a reduction in wage rate can vanish unemployment. In addition, the IS-LM model cannot give explanations why an economy becomes unstable and enters recession (Van den Berg, p. 3&7, 2013). Hicks also assumes that expectations always remain constant. Moreover, the IS-LM model can be used for comparative static analysis and not for policy change analysis (Pasinetti, p. 47, 1974). Finally, Hicks believes that a change in LM curve cannot affect the level of employment. On the other hand, Keynes believed that the quantity of money affects the total output and therefore unemployment too (Keynes, p. 80, 1936). Thus, it can be concluded that IS-LM model lacks some critical points of Keynes' views and it is a very simplified version of his major arguments.

3.1.3. The Theory of Investment and the Multiplier

The concept of Multiplier is a core part of Keynesian Theory of Income. According to Keynes, the aggregate demand is positively correlated to consumption and investment. The level of employment is affected by the level of consumption which in turn is determined by the marginal propensity to consume. The value of multiplier is always higher than 1. This means that for every new unit of aggregate demand, new investment is required. However, the change of investment must be always greater than this of aggregate demand because a small percentage is always directed to saving or taxation. The gap that is created has to be covered by new investment (Chendroyaperumal, p. 2, 2009).

From the scope of aggregate demand, the main points of the theory of multiplier are:

1. The multiplier is a nominal relation
2. The multiplier is not a constant
3. The impact on employment depends on the conditions of supply

The multiplier is derived by the equation below:

$$\Delta Y = \frac{1}{1 - c}\Delta I \qquad 3\text{-}2$$

where the ratio $\frac{1}{1-c}$ is the multiplier (m). The equation shows that the aggregate demand that is generated by any change in investment depends on the marginal propensity for consumption (c) (Black, p. 311, 2003). Of course, ΔI could be replaced by ΔT in case that the government would like to raise the aggregate demand through taxation cut or by ΔG through growing public expenditures. For Keynes, it is very important the marginal propensity to consume to be maintained close to the unit. When the marginal propensity to consume tends to unit, any change in investment will generate approximately the same quantitative change in aggregate demand so the economy will be close to full resource employment (Keynes, p. 159-160, 1936). Again, Keynes emanates the necessary participation of government in the market. From the moment that a high propensity for consumption is important for the sustainability of the aggregate demand, it implies that the individuals should be driven to consume rather than to save. However, the lack of savings pushes the interest rate higher and this discourages the financing of new investment. Moreover, higher interest rates start making saving more preferable than consumption. Therefore, the government must always keep the interest rate low by augmenting the money supply (Mankiw, p. 126, 2002).

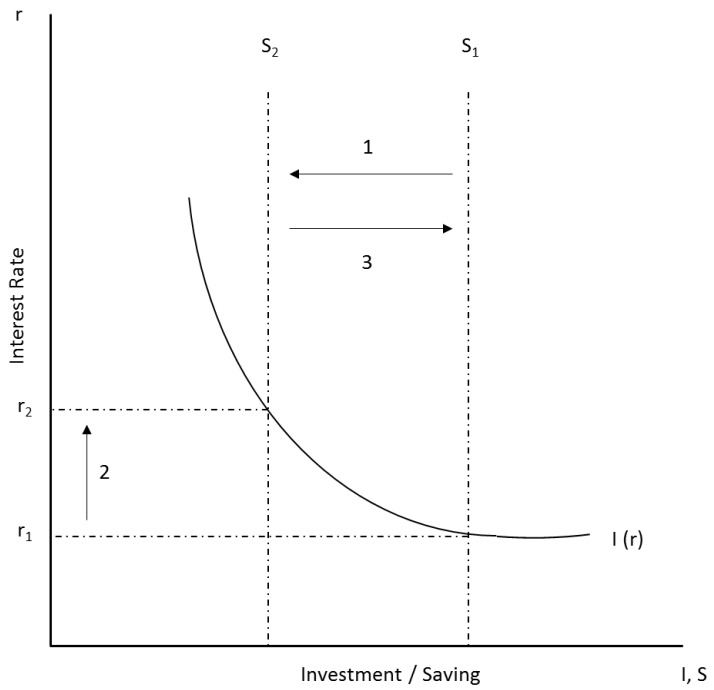

Figure 10: 3.1.3 Investment/Savings – interest rate curve

The graph above shows that a fall in savings raises the interest rate, a fact that undoubtedly can have disastrous effects in investment. The intervention of government however with public expenditures or a controllable inflationary monetary policy can keep the real interest rate back to the equilibrium level.

3.1.4. Conclusions

It is true that Keynes added new, significant knowledge in the field of Growth Economics. He admits the beneficial role of trade but he differentiates his position from these of Smith and Ricardo. First of all, he recognizes that trade can have positive effects in an economy only when the trade balance is positive and the exports are greater than imports. This means that he treats as invalid Ricardo's opinion that the continuous import of cheap goods can generate new growth. On the other hand, he rejects Adam Smith's "laissez-faire" theory as he gives a leading role to the government intervention in the growth process, especially during recession periods.

Therefore, Keynes concludes that the key force for the growth of total income is domestic investment, mainly the private but and the public as well. However, as the growth of total income is a continuous process always under the menace of disruption, every new unit of total income must be accompanied by an equivalent increase in investment, in consumption or in government spending. This condition is necessary in order the accumulation of supplies to be avoided, a fact that disrupts investment and freezes the growth of total output. But, as within an economy all the individuals act upon their personal interest, the government needs to intervene and coordinate efficiently the market and production.

Thus, as far as investment is concerned, the government should maintain business expectations in positive level in order new investment to be attracted. Moreover, interest rates must remain low in order to discourage saving and to promote new investment funding. However, the government must always guarantee adequate money liquidity in the market through a prudent fiscal policy and a controlled monetary policy. On the other hand, from the moment that consumption is an important variable in the growth process, the government should support in terms of income the population groups with a high tendency to consume in order the propensity for consumption to be maintained close to unit. As closer to unit is the propensity for consumption, the highest will be the incentive for private investment.

The last crucial point in Keynesian Theory is the topic of multiplier. According to Keynes, every new unit of income should be accompanied by an equal, cumulative increase in consumption, investment and government expenditures. However, this is impossible to happen as there is always a leakage to various other economic activities that do not promote new growth. These activities are often:

1. Saving. Individuals always tend to save a part of their income for the future
2. Taxation. Individuals are obliged to pay taxation to the government. Until today Keynes remains one of the most passionate foes of government policies which seek income through heavy taxation
3. Imports. Cheap imported goods constitute an attractive investment option as they offer high profit margin. Despite this fact, the income that flows out

of the domestic economy cannot be reinvested (David, p. 75, 1999, Nellis & Parker, p. 89, 2004)

Although Keynes' work added valuable, new knowledge to the theory of growth, it has never been characterized as part of it. However, it constituted the path for the transition from the classical theory to the neoclassical one. Above all, it inspired the so-called Post-Keynesians economists such as Roy Harrod, Evsey Domar and Nicholas Kaldor to develop their own growth models which were used widely by policy makers.

3.2. The Theory of Nicholas Kaldor

3.2.1. The Kaldor's Growth Laws and Stylized Facts

Nicholas Kaldor is one of the most known Post-Keynesian economists associated with the Cambridge School with great contribution to the field of growth theory. By examining very carefully the growth rates of developed economies after the Second World War, Kaldor managed to attract the interest of the academic community with his six "*stylized facts*" and his three "*Growth Laws*". Particularly, the three Kaldorian Growth Laws subsequently became one of the most interesting and challenging research subjects in the field of growth theory. Kaldor applied the three laws to many regions or countries of the world and found strong empirical evidence in the relationship between the living standards of many countries and their industrial activity. He found that in general there is a strong, positive correlation between the industrialization level and the total national income of an economy. Kaldor concluded that industrialized economies channel 20% to 50% of their resources to industry while for the poor countries the rate tends to zero. In addition, he concluded that GDP growth depends on the ratio of industry growth rate to GDP growth rate. This means that as this ratio increases, a more ascending trend will be observed to the rate of output growth (Kaldor, p. 177-179, 1961).

Based on this conclusion, Kaldor formulated six "stylized" facts or actual, observed conditions that summarized the major findings of Neoclassical Growth Theory until that moment. These facts were:

1. Labour productivity has shown a continuous ascending trend
2. The same tendency also holds true for capital per worker
3. The return on capital was stable
4. The ratio of capital to output was also stable
5. Capital and labour have equal quantitative effects to GDP growth
6. The fast growing economies have a small deviation in their growth rates of 2% to 5% approximately (Jones & Romer, p. 224, 2010)

Today, Romer and Jones state that these stylized facts have been validated empirically to such a degree that do not offer any challenge for further scientific investigation. The main research interest for Kaldor was to discover why industry can constitute the dominant factor of differentiation in the growth rates of developed and poor economies. Before presenting his three laws, he believed that two crucial factors make industry to differentiate the growth rates of economies. These two factors were already known by the period of the Classical Growth Theory and were: a) the increasing returns to scale and b) the division of labour which improves labour productivity (Ener & Arica, p. 60, 2011). Prior to Kaldor, A. Young had presented a key study on the relationship between increasing returns to scale and division of labour and the industrial production. In summary, Young had pointed out that:

1. The mechanism of increasing returns to scale is not observed in the effects of the variations in the size of an individual firm or a particular sector because the general process of division and specialization of these sectors is part of the process through which the increasing returns are implemented. The industrial operations should be seen as an interrelated whole
2. The solidification of increasing returns to scale depends on the gradual division of labour

3. The major economies of scale stemmed from the division of labour emerge in the production process through the use of intensification methods of labour productivity
4. The division of labour depends on the size of the market but the size of the market depends on the division of labour as well. This can constitute the basis for two kinds of progress: economic and technical (Young, p. 539, 1928, Vaitsos & Bartzokas, p. 272, 2004)

Returning to the second of the above points, the result of this relationship is better labour productivity. This is explained by the fact that when increasing returns to scale, both static and dynamic, exist in the economy, there is a positive correlation between output and labour productivity growth. Static economies of scale refer to economies that have adopted large-scale production methods and the massive production of goods leads to a low average cost. Dynamic economies of scale refer to economies where the new, produced output is not only accumulated to the existing capital but also adds technical progress and knowledge to it. Undoubtedly, the industrial output is always combined with mechanization and renewed technical equipment, therefore industrial activity is a sector with increasing returns to scale. It is already known that the higher is the mechanization of production, the higher will be the labour productivity as the production cost per worker falls (Thirlwall, p. 114, 2006).

3.2.2. The First Kaldor's Law

As it has been mentioned in the previous section, one of the stylized facts stated by Kaldor was the positive relationship between industrial and economic growth in developed economies after the Second World War. This observation led Kaldor to formulate his first law where the general conclusion is that there is robust, positive relationship between industrial output growth and GDP growth. Thus in mathematical terms, the First Kaldorian Law can be written as below:

$$g_{GDP} = f_1 (g_m)$$

3-3

where $(f_1)' > 0$. The positive correlation between the growth of industrial output and GDP is explained by the positive effects of the industrial output growth in the productivity of the economy. This can be achieved through two ways. The first way is the transfer of labour from less productive sectors or unemployment to the industrial sector where productivity is actually higher due to the positive economies of scale. The allocation of working force between industrial sector and other less productive sectors is the basic criterion of characterization of an economy as "mature" or "immature". By the term "immature" Kaldor characterizes an economy that still occupies the largest part of its working force to less productive sectors. The second way is the "learning by doing" process as the industrial sector uses more technical equipment than any other sector. It has been already recognized from the classical period that technology develops the knowledge and the skills of the working force and therefore its productivity (Drakopoulos & Theodossiou, p.1684-1685, 1991).

There has been a plethora of literature review based on the first Kaldor's Law and focused on various regions or countries. For example, Wells and Thirlwall collected data from forty five (45) African countries for the period 1980-96. They found that economic growth is highly dependent on the industrial output growth. So the slow development of the industrial and the rest sectors of the economy can explain empirically the slow growth progress of African countries (Wells & Thirlwall, p. 91 & 100, 2003). In another paper, Thirlwall and Lopez test a sample of eighty nine (89) developing markets from Africa, Asia and Latin America over the period 1990-2011 by classifying them as low-income, lower-middle income and upper-middle income economies. Their empirical results proved validity of Kaldor's law. However, in this paper the authors examine the effects of manufacturing output growth in GDP growth through another way: the exports. Their hypothesis is that if manufacturing output grows, there will be a rise in exports. Higher exports will permit more imports due to a better balance of payments. Both will affect positively the GDP growth. The test results showed strong, positive correlation between manufacturing output and export growth and strong, positive correlation between export and GDP growth (Lopez & Thirlwall, p. 7, 2013).

Moreover, Libanio examined eleven (11) Latin American economies for the period 1980-2006 arguing that the industrial sector constituted the major force of growth revealing significant increasing returns (Libanio, p. 10, 2006). Concerning Asian countries, Mamgain found that for two groups of Asian countries for the period 1960-88, the first Kaldorian Law remains valid at an acceptable degree (Mamgain, p. 305, 1999). On the other hand, a paper by Pons-Novell and Viladecans-Marshal for European regions for the period 1984-1992 indicates that the first law does not hold (although the second and third laws do) (Pons-Novell & Viladecans-Marsal, p. 449, 1999). In country level, Drakopoulos and Theodossiou accept at a satisfactory degree the validity of the first Kaldor's Law in Greek economy for the period 1967-89 (Drakopoulos & Theodossiou, p. 1688, 1991). Felipe, in his study for five (5) Southeast Asian countries, Indonesia, Malaysia, Philippines, Singapore and Thailand during the period 1967-1972 concluded that all the countries of the sample except Indonesia support the first Kaldor's Law (Felipe, p. 472, 1998). Cetin using annual data for the period 1981-2007 for fifteen (15) European countries found that the industrial growth had a significant effect in the GDP growth for eleven (11) of them (Cetin, p. 369, 2009). Only for the Turkish economy, Doruk, Kardaslar and Kandir studied for the period 1980-2010 the relationship between industry and agriculture. Their empirical results showed that the growth of agricultural sector was proportional to this of industry by proving a solid relationship between the two sectors and validating the first law (Doruk, Kardaslar & Kandir, p. 591, 2013). In addition, Hansen and Zhang by studying data from twenty eight (28) regions of China for the period 1985-1991, inferred the empirical existence of the first Kaldor's Law (Hansen & Zhang, p. 682, 1996). In another paper for China, Guo used data from the period 1949 – 2004 and also proved the validity of the Kaldorian Law (Guo, p. 149, 2013). Thus, the biggest part of the academic literature seems to validate in global level the first Kaldorian Law, especially for the period 1960-1990.

3.2.3. The Second Kaldor's Law

The second Kaldor's Law is also known as Vendoorn's Law, and states that there is robust, positive interdependence between the growth of manufacturing output and the growth of labour productivity in manufacturing activity. This relationship can be expressed in terms of equation as:

$$p_m = f_2 (g_m) \quad 3\text{-}4$$

where $(f_2)' > 0$. The term p_m symbolizes the labour productivity in manufacturing sector while the term g_m expresses the growth of manufacturing output (Thirlwall, p. 117, 2006). From this law, it is apparent why the manufacturing sector presents increasing returns to scale. Moreover, the second Kaldor's Law comes to provide extra validity to the first law as far as the general idea that the manufacturing sector is the major, pioneering force in the growth process. However, this law does not necessarily reject the possibility of existence of increasing returns to scale in other sectors of the economy (Leon-Ledesma, p. 56-57, 2000). Moreover, the second Kaldorian Law remains a very reliable method of testing endogenously growth in comparison to the most recent endogenous models where testing the factors of knowledge spillovers and learning by doing is a complex activity. However, the most important point is that this law can be a well-documented and verified recommendation for developing economies to move towards a more industrialized mode of production by transferring to industrial sector the largest part of their available resources (Mamgain, p. 297, 1999).

Similarly to the first law, the second Kaldorian Law has triggered the research interest of many academics who focused their empirical tests on various regions or countries of the global economy. Libanio, in the same paper for Latin American economies, proved the validity of the second Kaldorian Law. By using different techniques, he verifies that the industrial labour productivity is affected positively by the industrial output growth (Libanio, p. 11, 2006). Leon-Ledesma in a paper for Spanish regional growth within the period 1962-1991, found increasing

returns not only for manufacturing, but for the services sector as well confirming the second law (Leon-Ledesma, p. 55, 2000). Rayment, used data from nine (9) countries for the decades of 50's and 60's. He found solid and significant relationship between industrial labour productivity and industrial output growth (Rayment, p. 110-111, 1981). Drakopoulos and Theodossiou evaluated their empirical results as satisfactory for the validity of the second Kaldor's Law adapted on Greek economy (Drakopoulos & Theodossiou, p. 1684-1685, 1991). Similarly, Mizuno and Ghosh accept the second law in their paper for Japanese economy (Mizuno & Ghosh, p. 14, 1984). Ofria and Millemaci in a paper for Australia, Belgium, Italy and US confirm the presence of increasing returns to scale in the manufacturing sector and its positive effects in labour productivity for the period 1973-2006 (Ofria & Millemaci, p. 15, 2012). Castiglione used data from U.S economy for the period 1987 – 2007. The empirical results proved that there is positive association between industrial output and labour productivity growth. What is more, the author found bilateral causality so any change in one variable will affect the other to the same way (Castiglione, p. 172-173, 2011). Britto, tested the second law on a sample of 6027 Brazilian companies representing the 87% and 83% of the industrial total output and employment. The data were from the period 1996-2002 and there was clear evidence of significant increasing returns to scale in the Brazilian manufacturing companies (Britto, p. 24, 2008). Finally, Martinho studied five (5) different Portuguese regions for the period 1986-1994 using four (4) different testing methods and showed that all these methods named the manufacturing sector first in the increasing returns to scale (Martinho, p. 2-6, 2011).

On the other hand Wells and Thirlwall found only partial validity of the second law in African countries (Wells & Thirlwall, p. 91 & 100, 2003), while Mamgain concluded that the second law cannot be accepted for the majority of the Asian countries that formed the sample of the paper (Mamgain, p. 306, 1999). Moreover, in a paper based on the Italian economy, Lucidi and Kleinknecht used data for the period 2001 - 2003 from 4289 companies with more than ten employees and they found that through various mechanisms such as lower wages and flexible labour

relations, Italian companies achieved industrial output growth without this to lead to labour productivity growth (Lucidi & Kleinknecht, p. 538-539, 2010).

3.2.4. The Third Kaldor's Law

The last Kaldorian Law states that there is positive correlation between the industrial output growth and the productivity growth of the rest sectors of the economy excluding industry. The third Kaldor's Law can be symbolized as:

$$p_{nm} = f_3 (g_m)$$

3-5

where $(f_3)' > 0$. This law comes as a confirmation to the previous two ones which have as main concept that industry and industrial output constitute the engine of the growth process (Thirlwall, p. 117, 2006). However, the main meaning that springs from this law is that the faster industry grows, the more labour will be transferred from other sectors of the economy with diminishing returns to scale. These sectors tend to exhibit lower marginal product than the average. Thus when part of their working force is channeled to industry, the labour productivity of these sectors improves and the same happens for the overall labour productivity of the economy as well. On the other hand when the labour force is directed to sectors with diminishing returns to scale, it tends to obstruct the overall labour productivity. Wells and Thirlwall confirm this belief for the African countries (Wells & Thirlwall, p. 97, 2003). Pons-Novell and Viladecans-Marsal find that for European regions the third law is more valid than the other two laws do (Pons-Novell & Viladecans-Marsal, p. 451, 1999). In the same direction, the findings of Libanio confirm the positive implications of industrial output growth to overall labour productivity and economic growth in Latin America (Libanio, p. 11, 2006). In a study for five (5) Southeast Asian economies over a period of thirty years from Tuah and Mansor, the empirical results gave strong support to Kaldor's third law. There was massive transfer of labour force from other sectors to industry, a fact that improved the productivity of these sectors (Tuah & Mansor, p. 164, 2004).

Finally, Pieper concluded in strong and positive correlation between the rate of growth of industrial output and the labour productivity in nine other production sectors of the economy by testing a sample of thirty (30) developing countries from Sub-Saharan Africa, Latin America and South and East Asia for the period 1975-1993. The nine sectors were: (1) agriculture, (2) mining and quarrying, (3) manufacturing, (4) public utilities, (5) construction, (6) wholesale and retail trade and hotel and restaurants, (7) transport and communication, (8) finance, insurance and real estate and (9) social services (Pieper, p. 833, 2003).

3.2.5. Conclusions

The academic literature that has tested Kaldor's Laws has shown a high degree of validity. Today Kaldor's Laws and his six stylized facts tend to be trivial topics for research as the rich, existing literature review does not offer expedient field for new findings. Although Kaldor did not present a model of economic growth, his laws and stylized facts were used widely by economists who belonged to the neoclassical school of economic growth to study the economic growth activity of numerous regions or countries. He was also a pioneer in the idea of studying technology endogenously in the growth process. For the reasons above, Jones and Romer recently presented a group of new stylized facts that can be characterized as descendants of the original ones by Kaldor and can rekindle the interest of many specialists. These facts are:

1. The increase in the volume of goods, finance and labour force globally through globalization has expanded the size of the market for both workers and consumers
2. Population and GDP per capita growth have shown an accelerating trend from the beginning of the industrialization period until today
3. Intense volatility is observed in the growth rates of countries which are characterized as technologically immature. The countries that lack in terms of technology show higher volatility in their growth rates than the countries with advanced technical equipment

4. The difference in material inputs in the production process from country to country can affect less than the half their difference in their GDP per capita
5. Geometrical increase in human capital per worker globally
6. Long run stability of relative wages (Jones & Romer, p. 225, 2010). The addition of human capital to unskilled labour did not lead to a decline of its cost

3.3. The Harrod-Domar Growth Model

3.3.1. Introduction

The Harrod–Domar model is probably the most popular Post-Keynesian model of economic growth. It has been excessively used in development economics to explain an economy's growth rate in terms of the level of saving and productivity of capital. It suggests that there is no natural reason for an economy to have balanced growth. The Harrod–Domar model was the precursor to the exogenous neoclassical growth model that was developed later by Solow and Swan (Sato, p. 380, 1964). Harrod and Domar were the originators of the model although they worked independently each other as they used different methodology. However, their conclusions were the same and their common model has been used widely for the planning of growth policies by governments during twentieth century. The major question posed by Harrod and Domar was under which conditions an economy can achieve steady-state growth rates. Their model examines the consequences of fixed capital-labour ratios and savings propensities (Black, p. 207, 2002). The major purpose of the model was to estimate the necessary growth rate of income in order an expanding economy to be in long-term equilibrium by having its whole capacity fully employed. In other words, full employment can be achieved in long-term basis only if investment grows at a rate that can generate accurate demand to absorb the produced output by the new

investment. Otherwise, if the aggregate demand is less than the aggregate supply, no new investment will exist causing unemployment (Van den Berg, p. 176, 2012).

This model gained popularity as it tried to study long-term growth by using the tools of Keynesian Theory that had conquered the academic world at that period. It also confirmed the prevalent opinion of economists that if an economy wished to move from slow to fast growth, it should achieve sustainable increase of its saving and investment rates (Ruttan, p. 3, 1998). It constituted basic planning tool for countries that had recently gained their independence or for countries where there was strict central planning by the government like the socialist economies. The model is a dynamic extension of the Keynesian demand-driven macroeconomic model. It has both a demand and a supply side. This can be explained by the dual role of investment in the productive process. New investment affects the supply side by expanding the market capacity and the demand side through the multiplier (Van den Berg, p. 182, 2012). Its basic assumptions are:

1. There is an initial equilibrium point of income with full employment within an economy
2. No government intervention
3. The economy is closed therefore foreign trade is absent and investment is domestic
4. The marginal propensity to save remains constant
5. Fixed proportion of capital and labour in the productive process
6. The rate of capital stock to income is constant (Sato, p. 382-383, 1964)

Practically, the Harrod-Domar model seeks to find answers in the question whether steady-state growth is possible and which are the characteristics of this state. Moreover, the model examines under which conditions the steady-state growth can be disrupted (Rostow, p. 334, 1990).

3.3.2. Harrod's and Domar's Models

Harrod started working on Keynes' static equilibrium analysis where income and output can be in equilibrium only if planned investment is equal to planned

saving. Harrod tried to find the required rate of growth of income that ensures an equilibrium between planned investment and planned saving in a growing economy. Harrod distinguishes three different growth rates: the actual growth rate (g), the warranted growth rate (g_w) and the natural growth rate (g_n). The actual growth rate is:

$$g = \mathrm{s/c}$$

3-6

where s is the ratio of savings to income (S/Y) and c the ratio of new, accumulated capital to the flow of output that is produced (ΔK/ ΔY=I/ ΔY). The warranted growth rate refers to the ideal output growth that is generated by the necessary, required investment that matches the planned saving in order all the production resources to be fully used. Thus, from the Keynesian model, the equation of saving is:

$$S = s\mathrm{Y}$$

3-7

where s is the propensity to save. For Harrod, the demand for investment can be given by the variable *c* of equation 3-6. So, the demand for investment is equal to:

$$I = c\Delta\mathrm{Y}$$

3-8

Thus, the equilibrium between planned saving and planned investment can be given by the relationship below:

$$s\mathrm{Y} = c\Delta\mathrm{Y}$$

3-9

Finally, the required (warranted) rate of growth for equilibrium in a growing economy is equal to:

$$g_w = \Delta Y/Y = s/c$$

3-10

According to Harrod, the warranted rate of growth is this that describes a capital accumulation equilibrium where investors are satisfied as they use all the available productive capacity without keeping unsold supplies (Harrod, p. 16, 1939). Consequently, if the actual rate of growth is equal to the warranted, there is equilibrium in the economy. However if $g < g_w$, there will be a surplus of stock and investment will be disrupted and as a result the gap between the two growth rates will become even larger. On the other hand, in the case that $g > g_w$, the actual investment is less than the required to meet the increase in output. This will lead to lack of stock and the need for more investment. Thus, it will push the actual growth rate even higher than the warranted (Thirlwall, p. 131-132, 2006).

As it was mentioned in Harrod's model, Domar worked in a slightly different way from Harrod but there were not any differences in their final conclusions. Domar stated that investment affects positively demand through the multiplier and supply through the expanding capacity of the economy. So he tried to find the ideal rate of growth of investment in order supply and demand to grow proportionally under all resources of the economy being fully employed. The equation for demand change after new investment is:

$$\Delta Y_d = \Delta I/s$$

3-11

while the equation for supply change is:

$$\Delta Y_s = I\sigma$$

3-12

where σ symbolizes the capital productivity. So for equilibrium within the economy one of the two conditions below must hold:

$$\Delta \mathrm{I}/\mathrm{s} = I\sigma$$

3-13

or

$$\Delta \mathrm{I}/\mathrm{I} = s\sigma$$

3-14

The equations above reflect that the rate of growth of investment must be equal to the product of the savings ratio and capital productivity (Domar, p. 140-141, 1946). By replacing the variable σ of equation 3-14 with the ratio 1/c from equation 3-6, it is proved that both economists reached the same conclusion.

3.3.3. Criticism of the Model

As it was mentioned in the introduction of this chapter, the Harrod-Domar model has been treated as one of the most reliable and widely used planning tools for growth. However, its weakness to explain the slow growth rates of many developing economies led many economists to be critical of it. Solow posed some criticism in the Harrod-Domar model and this led him to the development of his own model. According to Solow, the Harrod-Domar model ignores the substitution of production factors and this constitutes a "knife-edge" situation where any fluctuation away from the warranted rate of growth can lead to depression and heavy unemployment (Solow, p. 65-66, 1956). Thus, Solow developed a model where he changed the fixed-factor proportion to a flexible-factor one between capital and labour. He showed that a flexible price system would align the warranted rate of growth with the natural rate which is determined by the population and technology growth assuring that any fluctuations between the two rates would be self-correcting (Hoover, p, 2, 2008). However, it has to be

mentioned that Solow accepts as valid all the rest basic assumptions of Harrod-Domar model except this of the fixed-factor proportion. Based on Solow's conclusions, Hagemann outlines that the very sensitive equilibrium point between the warranted rate and the natural rate of growth combined with the absence of any corrective mechanism by government would oblige economies to be almost always under long-term periods of unemployment and growth instability or decline (Hagemann, p. 72-73, 2009). Kaldor also criticized the Harrod-Domar model by placing the argument that the current model mostly describes the growth of an economy without business cycles and with full use of savings rather than the actual rate of growth of an economy that is not always in equilibrium (D'Agata & Freni, p. 32, 2003).

In additional, another weakness of Harrod-Domar model was mentioned for first time by Chenery and Strout and is known as the "Financing Gap". The case of "Financing Gap" is applicable to poor or developing economies and their efforts to achieve higher growth rates. Most of the times, the necessary investment rate could not be achieved by the available domestic savings. In poor countries the marginal propensity to save remains low, so saving cannot generate adequate investment. From this point of view, the poor or developing economies will be always condemned to experience long-term recessions (Easterly, p. 9-10, 1997). The gap between available savings and necessary investment in order the Harrod-Domar equilibrium to be achieved pushed the economists to suggest the idea of foreign aid. Foreign aid is necessary until the point that a poor economy has such a saving ratio adequate to move into "self-sustained" growth where it will finance its investment needs through its own savings. On the other hand, this weakness of the Harrod-Domar model transformed into a useful tool for the estimation of the quantity of foreign aid that is necessary for a poor country to achieve a target growth rate (Chenery & Strout, p. 679-735, 1966). However, even the proposal of the "Financing Gap" could not save the Harrod-Domar model from criticism. This can be explained by three reasons. Firstly, Easterly tested the significance of foreign aid in developing economies. For a sample of eighty eight (88) countries that received foreign aid during the period 1965-1995, he concluded that 60% of the countries showed a negative relationship between foreign aid and investment.

Moreover, only six countries of the sample showed positive and significant relationship between the two variables (Easterly, p. 16, 1997).

Coefficient of Investment and Foreign Aid	Number of countries	Percent of sample
Total	88	100%
Positive, significant and >=1	6	7%
Positive and significant	17	19%
Positive	35	40%
Negative	53	60%
Negative and significant	36	41%

Table 4: 3.3.3 Relationship between foreign aid and investment

Source: Easterly, p.17, 1999

This argument shows that the Harrod-Domar model cannot be used for forecasting the growth rate of developing countries. Secondly, by pursuing a target growth rate as estimated by the Harrod-Domar model and receiving foreign aid due to lack of adequate saving, many developing economies in Latin America and Africa suffered heavy debt crises. These crises were the result of continuous, accumulating foreign aid as these countries always relied on borrowing funds from developed economies and never managed to achieve self-sustained growth. On long-term basis, the high exterior debt disrupted the growth process (Hussain, p. 5, 2000). Thirlwall revealed that another reason for these debt crises was that the produced output had not been exported abroad in order the balance-of-payments equilibrium to remain sustainable. This led him to develop a model known as the "extended version of the dynamic Harrod trade multiplier result" (Thirlwall, p. 583, 2006). Thirdly, a higher saving ratio does not guarantee necessarily a higher growth rate. Although there has been important academic work which supports that higher saving rates have resulted in higher growth rates such as from Levine (1992), Solow (1956) and Romer (1987), there are cases where no causality is observed between saving and growth. One study against the proposition that higher saving promotes growth by using Granger causality tests was presented by Carrol and Weil. By using pooled five-year averages of saving

and GDP growth rates for a sample of countries from OECD, they found that only the growth of output affects saving and not vice versa (Carroll & Weil, p. 133-134, 1994). Furthermore, there have been examples of countries with lower saving rates than others which achieved a higher target growth rate as they channeled the available saving into more productive and effective investment (Thirlwall & Hussain, p. 17-18, 1999). The table and the graph below indicate that a high saving ratio cannot always guarantee a high growth rate. The sample includes data with the average gross domestic savings (% of GDP) and the average GDP growth (annual %) from fifty four (54) countries for the period 1960 – 2013. As it can been observed in the graph, there is only weak, positive correlation between the savings ratio and the annual GDP growth rates and many values of the sample are widely scattered in the graph.

Country	Gross domestic savings (% of GDP)	GDP Growth (annual %)	Country	Gross domestic savings (% of GDP)	GDP Growth (annual %)
Argentina	23	2.34	Fiji	15.84	2.79
Australia	26.05	3.3	France	20.67	2.32
Austria	25.47	2.56	Gabon	49.25	4.03
Burundi	-1.47	2.65	UK	17.63	2.29
Belgium	24.05	2.28	Ghana	7.81	3.77
Benin	5.04	3.64	Gambia, The	4.21	3.87
Burkina Faso	4.28	4.59	Guinea-Bissau	-2.06	2.35
Bangladesh	10.64	4.01	Greece	15.82	2.17
Bolivia	15.2	2.96	Guatemala	9.27	3.57
Brazil	20.25	4.09	Guyana	13.67	1.4
Barbados	12.98	1.79	Hong Kong	31.73	5.95
Botswana	33.21	8.78	Honduras	15.25	3.85
Central African Rep.	3.42	2.25	Kuwait	37.78	3.26
Canada	23.06	2.89	Luxembourg	39.07	3.65
Chile	22.62	4.35	Norway	32.08	3.04
China	39.15	9.35	Senegal	7.09	3.05

Cote d'Ivoire	21.09	2.6	Singapore	42.46	7.41
Cameroon	19.19	3.8	Sweden	23.87	2.21
Congo, Rep.	34.15	4.49	Swaziland	10.45	4.98
Colombia	18.99	4.11	Togo	11.16	2.69
Cuba	11.88	3.2	Thailand	29.11	5.95
Germany	22.64	2.05	Trinidad and Tobago	32.15	2.91
Dominican Rep.	13.55	5.52	Tunisia	22.06	4.87
Ecuador	21.49	4.12	Uruguay	16.91	2.56
Egypt	13.86	5.19	United States	20.08	2.9
Spain	23.1	2.74	Venezuela, RB	31.15	2.58
Finland	26.22	2.69	Zimbabwe	11	2.08

Table 5: 3.3.3 Savings ratio and annual growth rate relationship

Source: World Development Indicators 2013

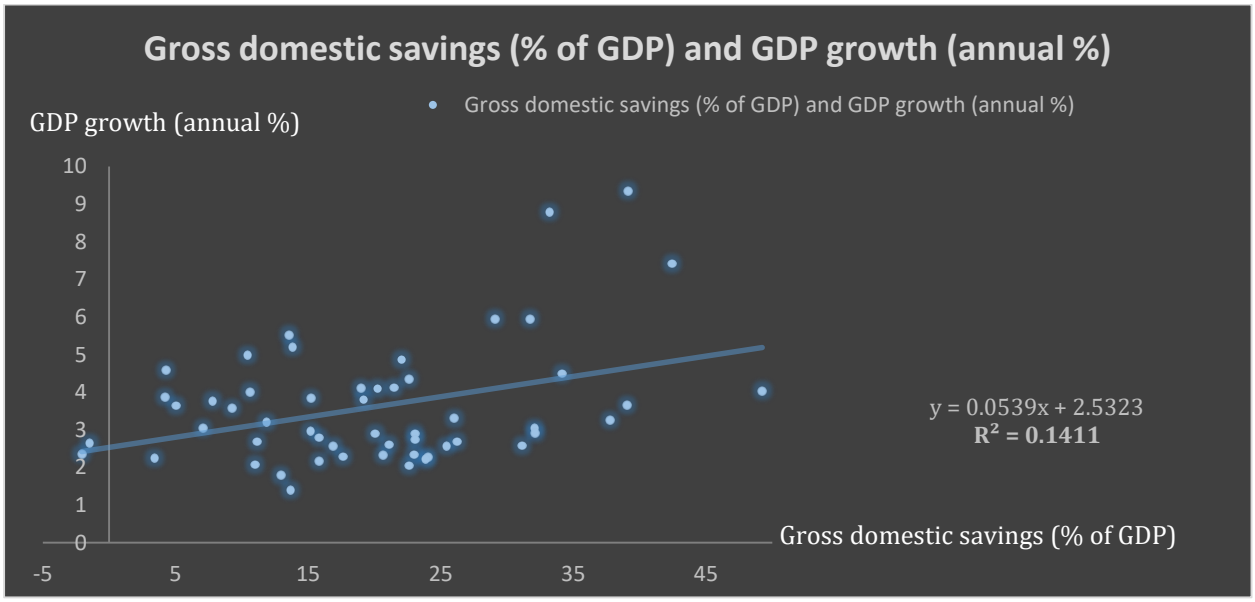

Figure 11: 3.3.3 Graph of Table 5

3.3.4. Conclusions

The Harrod-Domar model is regarded as one of the past, most widely-used and reliable aggregate models for growth projection or forecasting purposes. Its

advantage is that it estimates the necessary amount of new investment that will lead an economy either to the achievement of a specific output growth rate or to a situation with full employment of its labour force. From the moment that the basic principle of this model is the continuous investment, it assumes that there will be always adequate savings to be channeled into the economy through new investment. This principle usually makes Harrod-Domar model unsuitable as a planning tool of growth for poor economies which most of the time, they do not have the sufficient amount of savings to finance new investment.

However, even if this drawback is surpassed through the external borrowing from developed economies, the history has shown that most of the times, the economies which rely regularly on capital inflows from abroad, they suffer heavy debt crises with negative consequences in the growth process. On the other hand, there have been developing economies which achieved admirable growth rates by receiving external capital inflows. These economies had as priority the export of the largest part of their production in order to keep their overall balance of payments in equilibrium. Another group of countries with noticeable growth rates were these with strict, central, government planning. In conclusion, the Harrod-Domar model has been used in the past widely and successfully as a guideline for the planning of growth policies. From the opposite position, its shortcomings constituted a major field of debate for the neoclassical economists. This was the reason why later Solow and Swan, by working on the framework of Harrod-Domar model, they developed the Solow-Swan model which signals the beginning of Neoclassical Growth Theory.

4. The Neoclassical Growth Theory

4.1. The Solow – Swan Model

4.1.1. Introduction

The Solow-Swan model signals the beginning of Neoclassical Growth Theory. Practically, the Neoclassical Growth Theory and the Solow-Swan framework tend to be identical meanings today. Initially, the Solow-Swan model came as a response in order to eradicate critical deficiencies of the Harrod-Domar's model and for this reason the second is regarded as the predecessor of the first. According to Solow, the Harrod-Domar model studies long run problems using short-term methodology. Moreover, the extreme sensitivity of the model to prolonged periods of instability with high unemployment or labour shortage made the Harrod-Domar model to seem unrealistic (Hagemann, p. 68, 2009). The neoclassical growth model accepts all the basic assumptions of the Harrod-Domar's model apart from that of the fixed proportions. This is due to the fact that there is not functionality of substituting labour for capital in production (Solow, p. 65-66, 1956).

The key foundation of the Neoclassical Growth Theory is the neoclassical aggregate production function which makes the basic assumptions below:

1. Constant returns to scale
2. Positive and diminishing returns for each unit of added capital or labour
3. Positive elasticity of substitution between the inputs (Barro & Sala-i-Martin, p. 17, 2004)

The neoclassical aggregate production function is:

$$Y = AK^{a}L^{1-a}$$

The Neoclassical Growth Theory ends up in three key conclusions:

1. In the long run steady state, the factors which determine the growth of total output are: the growth rate of the labour force plus the growth rate of labour productivity (exogenous variable in the model). Therefore, saving to GDP and investment to GDP ratios do not have any contributing role in the long-term growth process. The responsible force for this phenomenon is the diminishing returns of capital which constitute a basic assumption of the theory. This force makes the positive effects a higher savings / investment to GDP ratio to be waived by the negative effects of a higher capital-output ratio or a lower capital productivity
2. However, the current level of output per capita is affected positively by the saving to GDP and investment to GDP ratios and negatively by the growth rate of population
3. Keeping constant all the external variables, the theory predicts a **conditional** convergence of per capita income globally. This is due to the inverse relationship between the capital-labour ratio and the capital productivity. Thus, poor economies with low levels of capital per worker should grow faster than economies with high levels of capital per worker (Thirlwall, p. 136, 2006)

The Neoclassical Growth model has been developed by Solow (1956) and Swan (1956) and indicates a way through which an economy can achieve higher growth rates by motivating individuals to increase their savings. Consequently, capital accumulation has a dominant position in the model. However, the model implies that positive growth rates cannot last forever. In long-term basis, the country's growth rate will revert to the rate of its technological progress, which neoclassical theory treats it as being independent of economic forces, or exogenous. The main cause for the cease of the growth process is the principle of diminishing marginal productivity which decelerates the quantity of output produced by an individual who uses increasing capital under constant technology (Aghion & Howitt, p. 21, 2009).

4.1.2. The Solow-Swan Framework

The model uses a Cobb-Douglas production function with constant returns to scale, diminishing returns to each input and some positive and smooth elasticity of substitution between the inputs. This combined with a constant saving rate rule presents an extremely simple general equilibrium model of the economy (Barro & Sala-i-Martin, p. 17, 2004). The model is based on the key assumptions below:

1. The labour force grows at a constant exogenous rate, *l*
2. Capital, labour and technology (initially ignored in the model) constitute the output function which is expressed as Y = F(K,L) assuming constant returns to scale, diminishing returns and elasticity of substitution between the production factors
3. All saving is invested. This along with the use of equation 4-2 creates the triple equation: S = I = sY
4. Technological change, population growth, saving and depreciation rates are constant and exogenous

The success factor of this model is its simplicity; the growth process is described by only two equations. The first is a Cobb-Douglas production equation where the total output is generated by a function of given capital and labour:

$$Y = AK^{a}L^{1-a}$$

4-1

In the above equation, $\boldsymbol{A}$ is a productivity variable and $\boldsymbol{a}$ gets a value between 0 and 1 indicating the decreasing returns of capital. The second equation is a law of motion that shows how capital accumulation depends on investment (equal to aggregate savings) and capital depreciation:

$$\dot{K} = sY - \delta K$$

4-2

where $\boldsymbol{sY}$ denotes aggregate savings and $\boldsymbol{\delta K}$ denotes aggregate depreciation of capital. Both $\boldsymbol{s}$ and $\boldsymbol{\delta}$ get values from 0 to 1.

However, the point that contributes to the evolution of growth theory is the implication of the model that in the long run, growth is not affected by economic variables and therefore, there is not any particular policy that can sustain the endless growth of an economy. Long-term growth can be positively affected only by the rise of productivity variable $\boldsymbol{A}$ which is also known as "technical progress" according to Solow. This explains why in the long run, growth is not affected by economic conditions and policies (Aghion & Howitt, p. 13, 2009).

In Solow-Swan model, capital (K) represents the durable physical inputs. Capital is a rival good as it cannot be used by more than one user simultaneously. The second input to the production function is labour (L) and refers to all those characteristics of labour that contribute to the output growth such as: manpower, work hours, skills and quality of the working force. Labour is also a rival input, because a worker cannot be devoted to more than one activity (Barro & Sala-i-Martin, p. 24, 2004). By proceeding now to variable $\boldsymbol{A}$ and what Solow called "technical progress", it includes technology and technical knowledge. In the Solow-Swan model, a basic assumption is that technology is free and publicly available as a non-excludable, non-rival good. Technology is a non-excludable, non-rival good because from the moment that is used by a company which increases its output, there is not any obstacle to prevent the rest of the companies from using this knowledge for their own benefit at no cost (Acemoglu, p. 28, 2009).

The purpose of this model is to show how a market will achieve a long run capital-labour ratio (k^*) equilibrium where output per capita (q^*) is also in equilibrium and therefore output, capital and labour will grow at the same rate l. The model forecasts long run growth equilibrium at the natural rate (Thirlwall, p. 136-137, 2006). From the introduction of this chapter, it has been mentioned that the model is based on the standard neoclassical Cobb-Douglas production function:

$$Y = AK^{a}L^{1-a}$$

where ***a*** is the elasticity of output to capital, ***1-a*** is the elasticity of output to labour and apparently a + (1-a) = 1. This means that an 1% increase in labour and capital will lead to an equal increase in output by demonstrating in this way the constant returns to scale. By dividing equation 4-1 with labour, the respective equation is transformed to per capita:

$$\frac{Y}{L} = \frac{AK^{a}L^{1-a}}{L} = A(\frac{K}{L})^{a}$$

4-3

and in short-term:

$$q = A(k)^{a}$$

4-4

The above 'labour-intensive' version of the neoclassical production function is reflected in the schema below. The curve has a diminishing slope as it simulates the marginal product of capital (Thirlwall, p. 136-137, 2006):

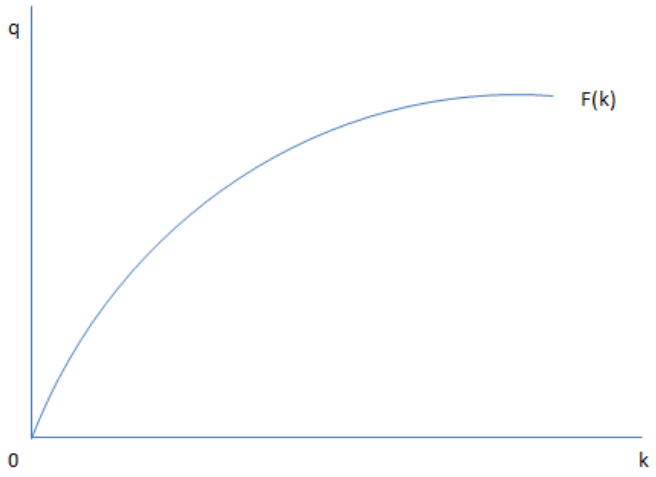

Figure 12: 4.1.2 Labour-intensive version of neoclassical production function

Source: Thirlwall, p.137, 2006

By adding in the above schema a 45º straight line where the capital growth rate is equal to the labour growth rate and therefore both capital – labour and capital – output ratios are constant, the new schema transforms into:

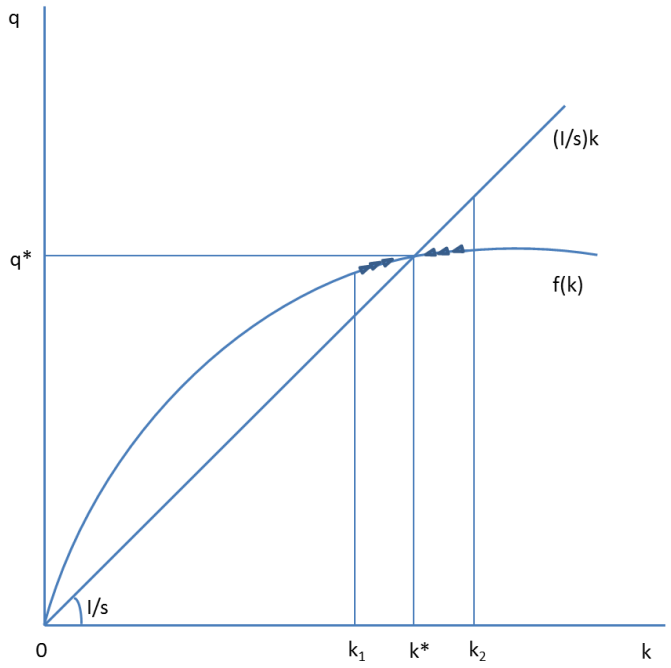

Figure 13: 4.1.2 Labour-intensive version of neoclassical production function with capital growth rate equal to labour growth rate

Source: Thirlwall, p.137, 2006

In the new schema, the straight line with slope *l/s* demonstrates the necessary level of *q* required to keep the capital per head constant and the level of k that will keep the output per head constant. Practically, the above schema shows that:

1. If capital (k_1) is lower than *k**, the output is more than the required in order *k* to remain constant and therefore there is more capital accumulation relative to labour growth so more capital-intensive techniques are required within the steady growth process
2. On the other hand when capital (k_2) is more than *k**, the output is less than the required to keep *k* constant. This has as a result a slower growth of capital accumulation than the respective growth of labour force thus the steady growth process requires more labour-intensive techniques
3. When capital is in equilibrium (*k**), the output is also in equilibrium and this implies that the output grows at the same pace as labour does. In this state, output, labour and capital must be growing at the same rate *l* which

symbolizes the natural rate of growth given that the capital – output ratio remains constant (Thirlwall, p. 136-137, 2006)

4.1.3. Empirical Evidence on the Solow-Swan Framework

According to Mankiw, Romer and Weil (1992), the Solow-Swan model is very accurate in the explanation of the various international standards of living. Therefore, although the steady-state can be maintained only when output, labour and capital grow at the same pace, in the long run, the steady-state level of income per capita is determined by the exogenous variables of saving and population growth. Thus, higher saving rates can lead to a richer economy while higher population growth rates can lead to a poorer economy. The authors by testing data from a big sample of capitalist economies for the period 1960-1985, they found that saving and population growth rates affect the total output in the directions predicted by Solow for more than the 50% of the sample. However, they disagree with Solow and Swan in the magnitude of the effects as they were found to be sharper than the expected. According to them, this is due to the fact that the model ignores the variable of human capital accumulation. The absence of human capital in the model made the estimated results larger for two reasons:

1. For any given rate of human capital accumulation, a higher rate in savings or a lower in population growth, result in a higher level of income and the same applies to human capital too. Thus, physical capital accumulation and population growth can have deeper impact in income when the variable of human capital accumulation is added in the model
2. It is possible human capital accumulation to be associated with both saving and population growth rates. By ignoring human capital from the model, the calculated coefficients of saving and population growth may be skewed (Mankiw, Romer & Weil, p. 408, 1992).

For this reason, they modified the neoclassical model into an augmented Solow-Swan model by incorporating the variable of human capital accumulation. Their

results showed that the addition of human capital accumulation lowers the previously estimated effects of saving and population growth. Furthermore, now the model explains the 80% of the income differences of the sample (Mankiw, Romer & Weil, p. 407-412, 1992).

A study by Barro (1991) focuses on the issue of convergence. By using data from ninety eight (98) countries from 1960 to 1985, he concludes that the growth rates of the output per capita have very low correlation with their initial level. Actually, he verifies the models of Lucas (1988) and Rebelo (1991) where the growth rate of the output per capita is independent of its starting level. On the other hand, he is aligned with the conclusions of Mankiw, Romer and Weil regarding the significance of human capital accumulation. He also supports the argument of Romer (1990) that human capital accumulation adds new knowledge in the research field and brings technical progress, implying that there is strong, positive correlation between human capital accumulation and output growth rates within an economy. What is more, he adopts Lucas' sayings that more human capital tends to drop fertility rates because it is devoted to produce new human capital rather than children. This last argument is vindicated below by citing a study from Becker, Murphy and Tamura (1990) who focused on the contribution of human capital in economic growth. Consequently, the global, absolute convergence seems to be impossible in practical terms although the conditional convergence is proved correct academically (Barro, p. 408-409, 1991). The argument for conditional convergence seems true because it treats several variables as exogenous, stable and equal between the compared economies in a sample. In samples of countries with similar economic policies or institutions, production methods, geographical position, history and culture, it is implied that they will also have and a similar steady-state level of output. For these samples, it is expected the poorer economies to grow faster and finally to catch up to the richer ones. Therefore, at the end, all these economies will have converged to a similar level of GDP per capita. For example, the figure below presents the average growth rates and the real GDP per capita from eighteen (18) founding economies of OECD between 1960 and 2000. Actually, the less developed economies achieved higher growth rates than the more developed ones:

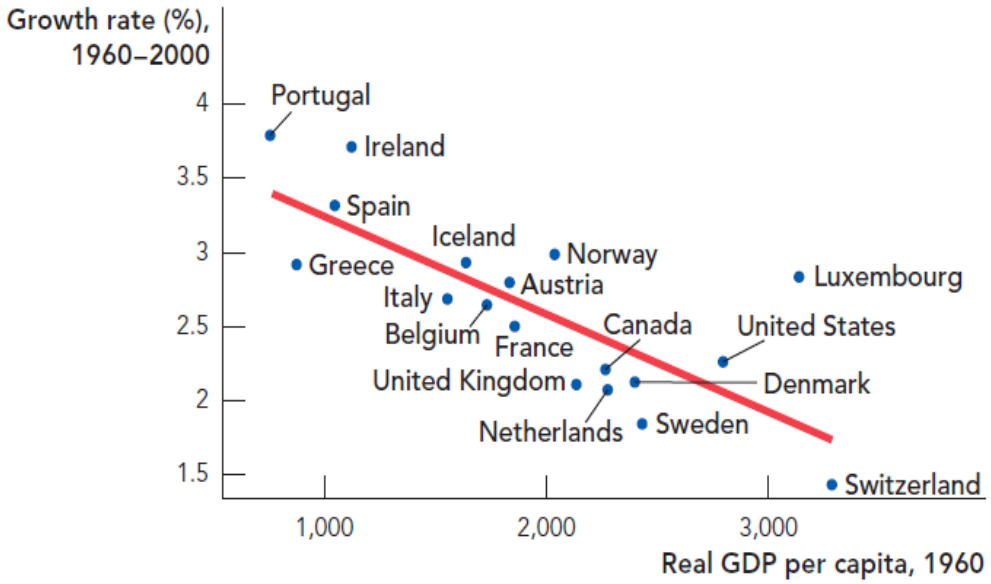

Figure 14: 4.1.3 Average growth rates and real GDP per capita from 18 founding economies of OECD between 1960 and 2000

Source: Penn World Tables 7.0 (2011)

The figure above explains that the less developed economies by achieving higher growth rates than the developed ones will finally catch up to them in terms of real GDP per capita. However, this kind of convergence is conditional as it refers to countries with similar steady-state levels of output ignoring for example the African economies that have shown inexplicable fluctuations in their growth rates (Cowen & Tabarrok, p. 128, 2011).

Another study which highlights the impact of the variables of human capital and population growth was issued by Becker, Murphy and Tamura. Their model assumes an endogenous fertility rate and an increasing rate of return on human capital as the level of human capital rises. Thus, in societies with advanced human capital, it is noticed that the new, generated income is preferred to be invested in new human capital rather than in human reproduction. Exactly the opposite happens to societies with limited human capital. This tends to create two stable steady states that cannot converge. The one has high fertility rates and low human capital while the other the opposite. Actually, these two steady states have the tension to go to opposite directions because:

1. Families within societies with upper-level human capital have recognized the importance and the cost of human capital for their children. They keep the number of their children in that level where they can afford the cost of the investment in their education. Therefore, as the fertility rates tend to be stable, the competition pushes the investment in human capital higher and higher
2. Families within societies with low human capital cannot afford the cost of education for their children so even if they drop their fertility rates, they cannot invest in human capital
3. In economies where human capital is limited, it is condemned to remain stable because even people who invested in that they prefer to immigrate to countries which can compensate them better (Becker, Murphy & Tamura, p. 12-14 & 32-33, 1990)

Barro and Sala-i-Martin state that the preference for the development of human capital against increased fertility seems to reject one basic assumption of Solow-Swan model: the growth at a constant rate of the population and the labour force. Apart from the advanced economies, even the poorer ones seem to have declining, long-term fertility rates. Another issue stressed by the authors is that historically, the vast majority of the economies which achieved solid economic growth they had in parallel increasing saving and investment to GDP ratios. This comes to conflict with another core assumption of Solow and Swan who treat saving and investment to GDP ratios as constant and exogenous (Barro & Sala-i-Martin, p. 16, 2004). Additionally, by using cross-country data from 1960 to 2000, they found that:

1. the average annual growth rate of real GDP per capita for 112 countries was 1.8% and their average ratio of gross investment to GDP was 16%
2. Thirty eight (38) sub-Saharan African countries achieved an average annual growth rate equal to 0.6% with an average investment to GDP ratio equal to 10%
3. Nine (9) East Asian economies had an average annual growth rate 4.9% and an average investment to GDP ratio 25%

From a first point of view and very generally, the core argument of Solow and Swan that growth and saving / investment rates are positively related is proved to be correct. But, another 23 OECD economies achieved 2.7% lower average annual growth rate than the nine East Asian economies having equal average investment to GDP ratios. The authors outline that the necessity of higher investment rates for more growth must be accompanied by a set of other factors which make the investment more or less productive. These factors are all these variables that have been studied exogenously in the model or are totally ignored like human capital accumulation (Barro & Sala-i-Martin, p. 23, 2004).

4.1.4. Conclusions

The Solow-Swan framework is regarded as a benchmark in Growth Economics as it signaled the passage from the Classical to Neoclassical Growth Theory. At the same time, it provided for all the contemporary academics a deep source of interest for further research which led to the development of the endogenous growth model. By studying all the critical deficiencies of Harrod-Domar model, Solow and Swan presented an improved growth model which accepted all the main assumptions of Harrod and Domar apart from that of the fixed proportions. The new model could explain the output growth rates of an economy in the long run given its available physical capital and labour. Theoretically, their notion for conditional convergence has been verified by the majority of academics. Moreover, the argument that in the long run, economic growth is affected only by the exogenous variable of technical progress is an axiom today. What is more, the conclusion that in long-term basis, the saving / investment and the population growth rates do not affect the growth rate of the output but affect the level of its steady-state has been also tested with success.

However, the model treats as constant and exogenous several crucial variables and ignores others equally significant. The fact that the saving and investment rates, the physical capital depreciation rate, the population growth and the technological progress are all of them treated as constant in the model make it impossible to explain adequately cases such as:

1. Economies with equal investment rates achieved noticeably different output growth rates
2. Absolute convergence never took place in the global economy as developed economies which invested widely in human capital accumulation enhanced the gap in comparison to the poor economies
3. Technological progress that determines the long run growth seems to be significantly and positively affected by human capital accumulation which restricts the poor economies from developing it

Given the reasons above, several well-known academics have presented during the last thirty years research papers which have studied endogenously all the constant and exogenous variables of Solow-Swan model. These papers led to the endogenous AK model which can explain with great sensitivity the differences in the national growth rates around the world.

4.2. Financial Liberalization

4.2.1. Introduction

Until now, it has been described how savings constitute a crucial factor of the growth process as they are the prerequisite source of investment. However, the basic assumption of all the growth models previously discussed in this thesis was that all saving is invested. Therefore, the equation where saving is equal to investment is a principal. In actual terms, this cannot be realistic. Firstly, the factors that affect the level of savings are not analyzed in detail. Secondly, what is saved, it is not invested necessarily if it is not channeled appropriately in the market. The most common cause which obstructs the effective channeling of savings into the economy in order to be invested is the government control which tries to regulate the financial sector but finally tends to lead to financial repression (Arestis & Sawyer, p. 2-3, 2005). The term “financial repression” was introduced for the first time in 1973 in the work of McKinnon and Shaw where they criticized the government policies that targeted the restriction and control of the financial

markets. According to McKinnon and Shaw, financial repression in a market is caused by:

1. Caps or ceilings on interest rates
2. Government ownership or control of domestic banks and financial institutions
3. Creation or maintenance of a captive domestic market which favors the funding of the government
4. Restrictions on the entry of any institution in the financial industry
5. Directing credit to specific industries (Reinhart & Sbrancia, p. 6, 2011)

The distortions in the market due to financial repression led the two economists to outline the importance of financial liberalization. By liberalizing the financial markets, investment becomes more efficient and leads to higher growth rates of the economy.

The major arguments that have been posed in support of financial liberalization of capital markets and its positive effects in economic growth are:

1. Competition in the banking sector increases the saving interest rates in order the financial institutions to attract more deposits. This leads to higher availability of capital for investment. Higher savings rates combined with loose restrictions in corporate lending will contribute to higher economic growth
2. On the other side, competition will cause a downward trend to the profit margin of the banks and will oblige them to reduce the lending interest rates. The lower lending rates reduce the risk of an investment so more investors will borrow in order to invest
3. Moreover, competition pushes the financial institutions to become more efficient and flexible. They aim to minimum operational costs, better bank and risk management and a wider range of services in order to achieve higher returns on investment and so on higher growth rates in the economy (Burman, Hermes & Lensink, p. 4, 2012)

On the other hand, since 1973 until today, the analysis of several national or global crises showed that the uncontrollable financial liberalization constituted a critical factor for prolonged periods of recession. The asymmetric information and the

incentive for profit of the financial institutions overpassed the rationale for efficient fund allocation in investment leading financial markets to shrink. In these cases, it seems that government intervention is necessary to save the banks from bankruptcy and to set regulatory policies in order the market to get stabilized (Burman, Hermes & Lensink, p. 4, 2012). Therefore, the argument that financial liberalization could be an extra positive factor of differentiation in the global income growth rates has triggered the interest of the academic world to study empirically:

1. if the relationship between financial liberalization and economic growth is positive or negative
2. at what extent of financial liberalization, the above relationship turns into positive from negative and vice versa
3. the sign of the relationship for developed and developing economies
4. the sign of the relationship in various time periods

4.2.2. The McKinnon – Shaw argument

As discussed in the previous section, McKinnon and Shaw were the inspirers of the idea for maximum financial liberalization. Their model affected deeply the global institutions and organizations in the planning and development of financial restructuring programs. Although McKinnon and Shaw worked independently and gave emphasis to different points, both of them reached the same conclusion: the need for absolute financial liberalization with the government to abolish any control on the market interest rates. McKinnon's argument treats money assets and capital accumulation as the one linked to the other in the growth process. Positive, real interest rates are a prerequisite in order the institutions to attract the individuals to save their money and to gather adequate funds for covering the demand and financing investment. On the other side, the investment will come when the real rate of return on investment surpasses the real rate of interest. Shaw's argument focuses majorly on the lending part of the process. High real interest rates are necessary for capital accumulation but above all, they can constitute an obstacle in low-yielding investments and a way through which the

available savings will be channeled to more productive and efficient opportunities (Thirlwall, p. 424, 2006). The schema below presents graphically the McKinnon-Shaw argument. It is a typical savings – investment schema where real interest rate affects positively the saving function and negatively this of investment. The intersection point of the two functions is the equilibrium point that assumes no interest rate controls by the government.

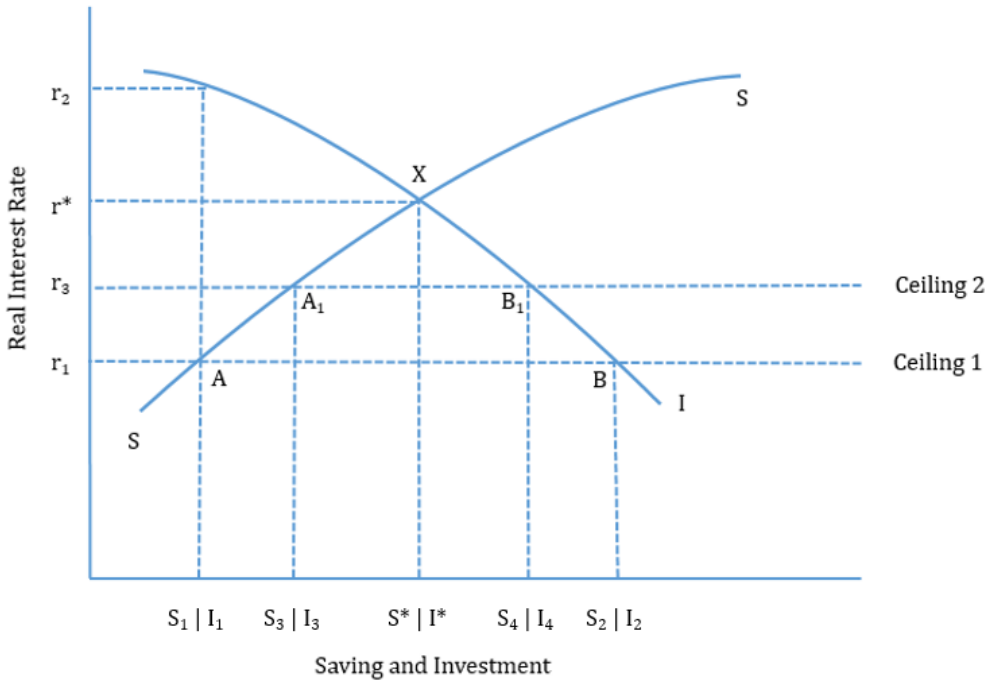

Figure 15: 4.2.2 The McKinnon – Shaw argument

Source: Thirlwall, p. 427, 2006

If the government intervenes and puts a ceiling on the nominal saving interest rates, the real saving interest rate will go to r_1. In this real interest rate, saving is S_1. From the moment that what is saved it is invested, it means that investment is also in I_1. If there is not a ceiling in borrowing interest rate, the banks can lend the investors at rate r_2 and this will constitute the profit for the bank. At this rate, all the demand for borrowing is covered. However, if there was a ceiling to borrowing rates, the saving would remain at S_1 but investment would go now to I_2. Here, the part AB reflects the missing amount of necessary capital for satisfying the investment demand. Under this situation, the banks prefer to channel their

resources to safer, low-yielding projects and the overall productivity remains lower than the potential. As the interest rate tends to meet the interception point X, saving becomes more attractive, the available funds for borrowing now are more and as a result more challenging and risky projects can be funded. The overall productivity is affected positively. At point X, the market operates under conditions of perfect competition because bank profit has been minimized, no controls exist in interest rates, and all the available funds deposited in the bank are fully utilized for investment (Thirlwall, p. 427, 2006).

4.2.3. Empirical Evidence on the Relationship of Growth and Financial Liberalization

The beneficial role of financial markets in the growth process had been outlined much earlier than the McKinnon-Shaw framework. Bagehot (1873) and Hicks (1969) recognized the contributing role of the financial system in the industrialization of England by facilitating the mobilization of capital. Schumpeter (1912) also, by focusing on the technological innovation part, admitted that a rationally operating financial system promotes the technical progress as it identifies and funds the investors who present the most innovative and consequently, the highest return rate investment projects. It is clear therefore the major role of financial markets in the capital accumulation process. However, what led the academic community in dispute was the extent to which the development of a financial system should be liberalized and free of any government intervention (Capasso, p. 356, 2003). Levine (1997) presented a very analytical work on the relationship between financial systems and economic growth. He focused mainly on how the various activities performed by financial systems affect economic growth. These activities aim to the facilitation of risk trading, the rational capital allocation and the easier mobilization of savings, traded goods and services. As these operations remain constant across countries and time, Levine examines the quality of the financial services and systems which provide this kind of services in order to conclude why economies with more

developed financial markets seem to achieve higher growth rates (Levine, p. 689-690, 1997). Through this methodology, Levine treats the contribution of finance to economic growth endogenously as the success of the financial sector can be a function of many other key variables such as the economic activity, the technological progress and innovation, the legal and the political system, the social stability and the culture of the population. In the graph below, Levine presents how through specific market frictions the need for financial markets and intermediaries arises and how these institutions facilitate five financial operations that contribute to more efficient saving and fund channeling leading into economic growth.

Figure 16: 4.2.3 Levine's concept about contribution of finance to economic growth

Source: Levine, p. 691, 1997

According to the graph, there are costs during the investment process which make individuals actually incapable of tracking the opportunities with the highest rate of return as they do not have access to all the prerequisite resources and information. This gap is bridged by the financial markets and institutions and the range of services that they provide. All these services lead to growth through two already discussed processes: capital accumulation and technological innovation (Levine, p. 691, 1997). King and Levine (1993) took a sample of eighty (80) countries over the period 1960-1989. They tested the relationship between the long run growth of the real GDP per capita and four indexes of financial development. They quantified financial development with four ways: i) the ratio of liquid liabilities of the financial system to GDP, ii) the ratio of deposit money bank domestic assets to deposit money bank domestic assets plus central bank domestic assets, iii) the ratio of claims on the non-financial private sector to total

domestic credit and iv) the ratio of claims on the non-financial private sector to GDP. For all variables, they got their average value over the same time period. Their results showed robust correlation between those four indexes and the rates of GDP growth and physical capital accumulation. In addition, those indexes affected positively the efficiency of capital allocation. What is more, they concluded that the initial value of the four indexes in 1960 seems to affect future GDP growth rates in a timespan of thirty years (King & Levine, p. 718-721, 1993). Levine and Zervos (1998) studied the effects of stock market development and liquidity in the current and future rates of economic growth, capital accumulation and productivity. They used as independent variables six indicators of the stock market development in order to measure the stock market size, liquidity, volatility and its integration with the rest capital markets around the world. As dependent variables and indicators of economic growth they got the real per capita GDP growth, the real per capita physical capital stock growth, the productivity growth and the ratio of private savings to GDP. For a sample of forty seven (47) countries during the period 1976-1993, they concluded that there is positive and robust correlation between stock market development and all the indexes of economic growth apart from the ratio of private savings to GDP (Levine & Zervos, p. 537-539, 554, 1998). Rajan and Zingales (1998) tried to perform an analysis in a more microeconomic level by doing a cross-industry comparison in a set of countries. Their major hypothesis was that industries that are more dependent on external finance they will achieve higher growth rates in countries with more developed financial systems. Their dependent variable was the average annual real growth rate of output per industry and per country. In a sample of thirty six (36) industries in forty two (42) countries, they found strong, positive relationship between financial development and output growth in industries that are more dependent on external finance (Rajan & Zingales, p. 562, 1998). Quinn and Toyoda (2008) examined the effects of capital account liberalization in economic growth for a set of ninety four (94) countries during the period 1950-1999. They found a direct, positive and robust effect in the economic growth for the majority of the sample even for the emerging economies (Quinn & Toyoda, p. 1403-1404, 2008). Bekaert, Harvey and Lundblad (2011) tested the contribution of financial

openness not only to investment but to total factor productivity as well. They got a sample of ninety six (96) countries for the period 1980–2006. They concluded that financial openness affects positively and permanently both capital stock growth (investment) and total factor productivity growth. This means that financial liberalization boosts growth not only through the investment channel of the Shaw-McKinnon framework but and through the channel of total factor productivity, the only factor that can maintain growth in the long run. Another very interesting finding is that financial openness does not seem to increase the possibilities for a banking sector crisis (Bekaert, Harvey & Lundblad, p. 14, 2011). However, before Bekaert et al., Bonfiglioli (2008) had made a similar effort to examine the impact of financial integration on investment and total factor productivity. By getting a sample of seventy (70) countries for the period 1975–1999, the author verifies that total factor productivity is positively associated with financial integration. On the other hand, no evidence was found for investment. Regarding the possibility of a banking sector crisis, Bonfiglioli concludes that a liberalized financial market may be more subject to a banking crisis but to a limited extent (Bonfiglioli, p. 337, 2008).

On the other hand, there is plenty of literature that does not confirm the beneficial role of financial liberalization in the economic growth results of several economies. Gupta (1987) examined twenty two (22) Asian and Latin American countries over the period 1967-1976 and found that the positive effect of high, real interest rates is waived by a possible negative income effect. Practically, the author finds that if the GDP per capita is low, savings cannot be strengthened by any liberalized interest policy. Therefore, the available funds for investment remain inadequate. He concludes therefore that the most significant, positive determinant of savings is the real income and not the saving interest rate by verifying Keynes' major argument in the Theory of Income, Output and Employment (Gupta, p. 303-306, 1987). Bandiera, Caprio and Honohan (2000) developed an index with eight dummy variables representing the various dimensions of financial liberalization. Such variables were the interest rates, the pro-competition measures, the reserve requirements, the directed credit, banks' ownership, the prudential regulation, the capital account and the exchange rate

liberalization. In a group of eight (8) developing economies for a period of 25 years, they did not find any support on the argument that financial liberalization increases savings (Bandiera, Caprio & Honohan, p. 258-259, 2000). There are also papers which confirm the positive effect of financial liberalization in savings through higher saving interest rates but find a negative effect in the investment side of the Shaw-McKinnon framework. Warman and Thirlwall (1994) examined the case of Mexico for the period 1960-1990 and found that the liberalization of interest rates boosted savings and increased the supply of credit from the banking to the private sector. However, the level of investment was affected negatively due to the high, borrowing interest rates (Warman & Thirlwall, p. 629-630, 1994). At the same direction, Demetriades and Devereux (1992) in a sample of sixty three (63) developing economies over the period 1961-1990 found that the negative effect of the cost of capital in investment due to high, borrowing interest rates was dominant in comparison to the positive effects of the supply of credit by the financial institutions (Demetriades & Devereux, p. 9-10, 1992). Furthermore, Greene and Villanueva (1991) by using a sample of twenty three (23) developing economies during the period 1975-1987, showed again that investment was affected negatively as the higher interest rates discouraged the demand for borrowing credit and investing (Greene & Villanueva, p. 33-36, 1991). Abiad, Oomes and Ueda (2008) chose a sample of five (5) emerging economies (India, Jordan, Korea, Malaysia and Thailand) and tried to measure both the qualitative and quantitative effects of financial liberalization in the levels of savings and investment. Although, they did not find positive effect of financial liberalization in the quantity of savings and investment, the allocative efficiency improved significantly. Therefore, although the level of investment seems to remain unaffected, it gives higher returns as the available funds are invested to high-yielding projects (Abiad, Oomes & Ueda, p. 280, 2008). Christiansen, Schindler and Tressel (2009) evaluated the relationship between economic growth and three forms of liberalization: in domestic finance, in trade and in capital account. They used a sample of ninety (90) countries for the period 1974-2004. Although the reforms in the first two sectors seem to have positive effects for middle-income economies, they do not find any positive relationship between growth and

capital account liberalization (Christiansen, Schindler & Tressel, p. 13, 23, 2009). Last, Tressel and Detragiache (2008) used a sample of ninety one (91) countries for the period 1973-2005. They found that financial liberalization cannot have positive effects unless it is combined with a prudent political environment able to protect the society from the exploitation of the financial institutions targeting to profit maximization (Tressel & Detragiache, p. 20, 2008).

4.2.4. Conclusions

The liberalization of the financial markets during the last decades attracted intensively the academic interest regarding its contribution to economic growth. The abolishment of any government intervention in the lending and borrowing interest rates of the financial institutions set the necessary foundations for the optimization of the markets. This behavior was part of a wider market deregulation that started from the developed economies and was adopted by the developing ones and had as a result the increase of the inbound and outbound capital flows. More specifically, this fact created the right basis for an investment boom in economies that faced lack of savings. As it had been already referred that savings and investment are strongly and positively correlated, financial liberalization seemed to have a dominant role in the factors which promote growth.

However, the empirical results from studies on the liberalization of the financial markets of developed and developing economies are mixed regarding the core aspects of McKinnon – Shaw argument. The vast majority of the academic literature, focusing on the effects of financial liberalization in economic growth, has been led to three major conclusions: i) increase in both savings and investment, ii) increase in savings with investment to remain unaffected due to several reasons such as the discouragement of borrowing because of the high interest rates and iii) both savings and investment remained unaffected due to the low income per capita that causes lack of funds for saving. Financial liberalization tends to benefits mainly the developed economies while most of the examples with failed cases of financial liberalization which led to deep crises referred to

developing economies. These mixed results were due to the fact that a set of critical factors necessary for the success of financial liberalization were absent during the market deregulation. Indicatively, low income per capita, tendency of the financial institutions to finance risky projects for higher profits, social and political instability and reluctance of the investors to borrow under high interest rates can lead to market destabilization and economic recession. The inconclusiveness at the conceptual ground is substantially mirrored in the empirical evidence that suggests not a unique outcome, but a set of results reporting again both positive and negative effects of financial liberalization in growth. When looking more precisely on the results, it seems that the direction and the strength of the influence partly depends on the precise spatial and time dimension of investigation and on the measurement methods related to the indicators of financial liberalization and development. The graph below reflects exactly what was mentioned above about the mixed findings of the academic research regarding financial liberalization and growth. During the period 1992 – 2002 when most of the markets globally had been already deregulated, the capital inflows did not have always an upward trend even in the developed economies.

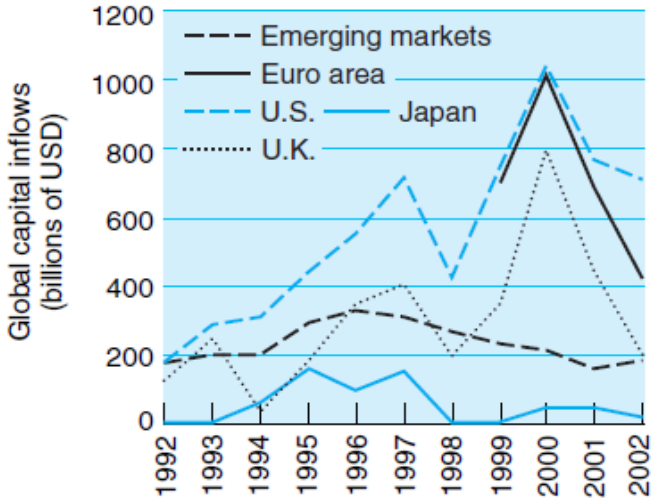

Figure 17: 4.2.4 Global capital inflows during the period 1992 – 2002

Source: IMF, Global Financial Stability Report (2003)

4.3. The Endogenous AK Model

4.3.1. Introduction

During the last four decades, as the academic world tried increasingly to analyze and explain the global variations in the growth rates of total output and income per capita, it was quite obvious that the Solow-Swan model was not accurate to explain the growth process in long run level. This was due to the fact that the Solow-Swan model examined only the process of capital accumulation ignoring the factors which led to technological progress. From the moment that technological progress is the only factor that sustains long-term growth, the need for a model that would study technological progress endogenously was necessary for more reliable academic conclusions regarding the different growth rates around the world and their possible convergence. The first endogenous neoclassical growth models were developed by Robert Lucas (1988) and Paul Romer (1986, 1990) and they were extension of the so-called AK model (Miles & Scott, p. 113-114, 2005).

The major characteristics of the endogenous, neoclassical AK model are: i) the absence of diminishing returns to capital and ii) the aggregate study of physical, human and intellectual capital accumulation together. Lucas and Romer assumed that there are positive externalities originated by human and intellectual capital that in long run, they will maintain the marginal product of capital and the capital-output ratio in their short-term equilibrium levels by waiving in that way the long-term decreasing tendency of marginal product. This happens because human and intellectual capital accumulation foster the technological progress through the learning-by- doing process (Thirlwall, p.154, 2006). The formal version of the AK model is the neoclassical model without diminishing returns:

$$Y = AK^{a}$$

4-5

Where A is a positive constant that represents the level of technology, K symbolizes all types of capital and α = 1. Therefore, the output per capita is:

$$y = Ak \tag{4-6}$$

The average and marginal product of capital is constant at the level A > 0.

4.3.2. Romer's Model with Knowledge Spillovers

Romer's purpose was to consolidate the factor of knowledge accumulation in the growth process. By proving the augmenting marginal productivity of this factor, his model would be able to explain the continuous, positive and increasing growth rates of developed economies over enhanced periods and the differences in the growth rates between rich and poor economies. Romer proposed a model where total output can increase without decelerating over time with the rate of investment and the rate of return on capital to follow the same rising trend. Convergence in the level of output per capita between developed and poor economies is not assumed here and the second ones may continue growing slower than the first ones. Above all, technological change is studied endogenously in this model (Romer, p. 1002-1003, 1986). In Romer's model, knowledge accumulation is the major determinant of long run growth. The process of knowledge accumulation is continuous and triggered by companies which aim to profit maximization. The knowledge accumulation process has three key characteristics:

1) Positive externalities as new knowledge is absorbed by competitors which increase their productivity
2) Decreasing returns in the production of new knowledge as knowledge will bring always new knowledge but at a less degree than the previous time
3) Increasing returns in the production of new output because of the augmenting marginal productivity due to new technology

The basis of Romer's model are the Ramsey-Cass-Koopmans (1965) and Arrow (1962) models treating knowledge as a form of capital with increasing marginal

product. This is because when new knowledge is produced by a firm, the rest of competitors take advantage of using it and increase their production. Thus the production of goods based on new knowledge demonstrates increasing returns (Romer, p. 1003-1006, 1986).

The basic idea of Romer is that as knowledge accumulates, less cost is required for the invention of new products, *N*. If total labour is *L*, one part (*1-λ*) is used for research and development and *λ* for productive activities. So the rate of change in the production of new products is affected positively by the portion of research and development to the total labour divided by (*η/N)* where *η* is the cost for R&D:

$$(\dot{N}/N = (1 - \lambda) * L/\eta)$$

4-7

In other words, Romer's analysis constitutes a learning by doing model, where the production effectiveness rises depending the cumulated experience. Practically the producers learned to produce more efficiently by investing to more productive ways, equipment and technology. Moreover, this knowledge has been available immediately to any other competitor so that every company's productivity to depend on the aggregate level of knowledge (Barro & Sala-i-Martin, p. 310, 2004).

4.3.3. Lucas' Model with Human Capital Accumulation

Lucas states in his paper (1988) that the incentive to seek for a reliable model of economic growth was the random, unexpected and large fluctuations in the growth rates of poor economies in opposite to these of the developed ones which tended to show a stable pattern. By eliminating the factor of political or social instability, Lucas tried to distinguish which cases were just possibilities and which normal aftereffects. Therefore, he attempted to include the effects of human capital accumulation adapted on the neoclassical Solow-Swan growth model and he focused on the interaction between physical and human capital accumulation

(Lucas, p. 3-6, 1988). At the end, Lucas concluded that the pioneer of long run growth is human capital because as it accumulates, it augments both labour and physical capital productivity.

Lucas's model contains workers who choose to divide their time between productive and training activities where the second ones develop skills that they will increase the workers' future productivity. Thus if h gives the existing human capital stock and u the ratio of working time to the total labour time, the production function can be written as below:

$$Y = AK^{a}(uhL)^{1-a}$$

4-8

The above function can transform into per capita terms as:

$$y = Ak^{a}(uh)^{1-a}$$

4-9

The equation 4-9 can be seen as a constant return to scale production function in k and uh and presents how human capital impacts on the production output. On the other hand, the equation:

$$\dot{h} = \delta h(1-u), \text{where } \delta > 0$$

4-10

shows how training time has effects in human capital accumulation. By assuming that human capital accumulation involves constant returns to the current quantity of human capital, it can be concluded that there is a positive growth rate in steady state equal to:

$$g = \delta(1-u^{*})$$

4-11

where u^* denotes the optimized allocation of the workers' available time between productive and training activities (Aghion & Howitt, p. 293, 2009). Actually, both Romer's and Lucas' models describe how knowledge spillovers can affect positively in the long run the output growth rate of an economy but through different ways. In Romer's model, this is done through physical capital externalities and the creation of new technology that make capital more productive while in Lucas' model, the knowledge spillovers are generated through human capital accumulation where the working population becomes more productive through new and more specialized acquired skills (Acemoglu, p. 522, 2009).

4.3.4. Empirical Results

Romer's and Lucas' models inspired several researchers to study the endogenous role of technical progress in the growth process and the factors which boost innovation. Some of the pioneer studies that tried to explain the cross-country growth rate differences based on the endogenous growth theory were published by Barro (1991), Mankiw, Romer and Weil (1992), Knigth, Loyaza and Villanueva (1993), Barro and Wha Lee (1993), Levine and Renelt (1992) and Levine and Zervos (1993). In all of them, the wider educational sector has a significant role in the differences of the growth rates of the countries in their samples. Barro (1991) took a sample of ninety eight (98) countries for the period 1960-1985. His results proved that the growth rate of GDP per capita is positively affected by the starting level of human capital per capita. Moreover, in countries with more advanced human capital, there was a tendency for lower fertility rates but for more investment in human capital (Barro, p. 407, 1991). Mankiw, Romer and Weil (1992) formulated an augmented version of Solow-Swan growth model including the variable of human capital. Their sample included almost all the capitalist economies (98 non-oil producing economies, 76 developing economies and 22 OECD economies with population higher of one million citizens) for the period 1960-1985. Their results showed that the augmented Solow-Swan model, including human capital accumulation and combined with physical capital

accumulation, could explain adequately the 80% of the cross-country differences regarding the level of per capita income (Mankiw, Romer & Weil, p. 407-408, 1992). Knight, Loyaza and Villanueva (1993) assume in their paper that the rate of technological progress is affected positively by two factors: the foreign trade exposure and the current level of investment in technological infrastructure. Foreign trade affects the technological progress through the import of the latest production methodologies and technological equipment. They tested a sample of seventy six (76) developing and twenty two (22) OECD economies and found that the steady-state level and the transitional growth path of GDP per capita depend positively on the savings ratio and negatively on the population growth. The initial stock of human capital is significant and affects positively the physical capital productivity (Knight, Loyaza & Villanueva, p. 512, 536, 1993). Barro and Wha Lee (1993) picked a sample of one hundred sixteen (116) countries during the period 1960-1985 and used as index of human capital measurement the ratio of secondary education graduates to the total population. They conclude that there is very strong, positive dependency between GDP per capita and a) its initial stock when it is very low and b) the initial levels of secondary education attendance and life expectancy (Barro & Wha Lee, p. 38, 1993). Levine and Renelt (1992) examined data from one hundred nineteen (119) countries over the period 1960-1989. They proved that the countries which achieved growth rates higher than the average, they had higher ratios of exports and investment to GDP, lower inflation rates and larger percentages of primary and secondary education graduates (Levine & Renelt, p. 948, 1992). Levine and Zervos (1993) examined the growth rates of GDP per capita for one hundred (100) countries over the period 1960-1989 dependent on a set of variables similar to these used by Levine and Renelt. Their results support the findings of Levine and Renelt regarding the positive relationship between the size of educated population and the growth rates of an economy (Levine & Zervos, p. 427, 1993).

Given the fact that the major academic research inspired by the initial works of Romer and Lucas, validated the positive dependency between human capital accumulation and the growth process, the after research activities focused on the mechanisms through which human capital accumulates and affects growth. Stern,

Porter and Furman (2000) tried to identify the factors that are responsible for the differences in the level of R&D across developed economies. They used data from member-countries of OECD for the period 1973 – 1993 and defined as measurable, dependent variable of R&D the annual international developed patents. They concluded that the initial stock of research, the size of the R&D workforce and the allocated resources by the government and private companies for R&D constitute the major determinants of new, generated knowledge (Stern, Porter & Furman, p. 32-33, 2000). In the same direction, a study of Riddel and Schwer (2003) by using data from various states of U.S validated the results of Stern, Porter and Furman. Their empirical results showed that the initial level of knowledge and human capital, the funding of R&D activities and the number of high-tech employees determined sufficiently the rate of change of innovation for those areas during the examined period (Riddel & Schwer, p. 73, 2003).

Glaeser et al. (1992) examined the role of technological spillovers in the growth process in urban areas as the big cities tend to gather more research activities. They used data from one hundred seventy (170) U.S cities for the period 1956-1987 and they concluded that the growth of most industries was affected mainly by the competition between the involved corporations in these industries and less by the specialization developed within every industry separately. However, they found strong evidence in the positive relationship between the knowledge spillovers across all those industries and their average cross-industry growth rates (Glaeser et al. p. 1126 &1151, 1992). Similarly, Van Stel and Nieuwenhuijsen (2002) attempted to conclude which type of knowledge spillover is more effective in growth process by dividing knowledge spillovers into two types: intra-sectoral spillovers and inter-sectoral spillovers. They used three possible determinants of regional, sectoral growth: specialization, diversity and competition. Specialization is the process of transmitting spillovers between firms within the same sector, while diversity is the transmission of spillovers between firms from different sectors. Competition is the factor that leads a local firm to produce and use new knowledge in order to remain competitive and key player in the market. They used data from forty (40) Dutch regions for the period 1987-1995 and they found that local competition and diversity affect positively the

growth of industrial sector but they did not find any evidence for positive or negative effects of specialization in the process. Therefore, similarly to the paper of Glaeser et al, Van Stel and Nieuwenhuijsen conclude that local competition and inter-sectoral knowledge spillovers affect positively the growth of industrial sector while intra-sectoral knowledge spillovers seem to have no effect (Van Stel & Nieuwenhuijsen, p. 5, 20, 2002).

Anselin, Varga and Acs (1997) analyzed the spillovers of local university research on the innovative activities of the private organizations in that area. They used data from forty three (43) states and one hundred twenty five (125) metropolitan areas in USA. They confirmed a positive and significant relationship between university research and innovative activity in regional level directly and indirectly through the positive effects in R&D sector of private firms. Moreover, there is only one-way causality from the first to the second. This implies that universities can supply regional companies with high-skilled resources who can satisfy the demand for specialized and technologically advanced labour force (Anselin, Varga & Acs, p. 424 & 400, 1997). Audretsch and Feldman tried to find possible geographical correlation between innovative activity, knowledge spillovers and manufacturing activity. They used as measure for the innovative activity the 8,074 commercial innovations which were introduced in the United States in 1982. Their empirical results demonstrate that innovative activity tends to develop more in industries where knowledge spillovers constitute a productive advantage. In other words, industries that set as a prerequisite input in production the corporate R&D, university research and skilled workforce are these which gather the highest percentage of new generated knowledge. What is more, these industries tend to gather geographically the largest part of the productive activity especially in the manufacturing sector contributing more than any other area within the same region to the growth process. However, their results did not show any causality between new knowledge and industrial output. This led them to conclude that it seems to be a circular process where both human capital and output accumulate the one after the other (Audretsch & Feldman, p. 631 & 639, 1996).

4.3.5. Conclusions

During the last two decades, the academic research has concluded both theoretically and empirically that human capital possesses a crucial role in the total output growth process and constitutes a core factor of long-term growth rate maintenance. Therefore, this implies that the long run growth of output per capita will be determined only by the total factor productivity growth. The human capital affects productivity through two ways as were proven by Romer and Lucas: knowledge spillovers and human capital accumulation. Both of them, they are developed through individual, corporate or government investment in education and research, specialization in production methods and intensification of the competition within the markets. All these are summarized under the term "technical progress" that was used to be exogenous in all neoclassical growth models before Lucas and Romer introducing their endogenous models. The schema below reflects how technical progress waives the negative effects of the diminishing marginal product of capital and clarifies the reason for which all new investment is not channeled to the poorest countries and convergence has not been yet achieved between rich and poor economies. For rich economies being at their steady-state, as human capital rises, it generates new growth in output and in investment in physical and human capital.

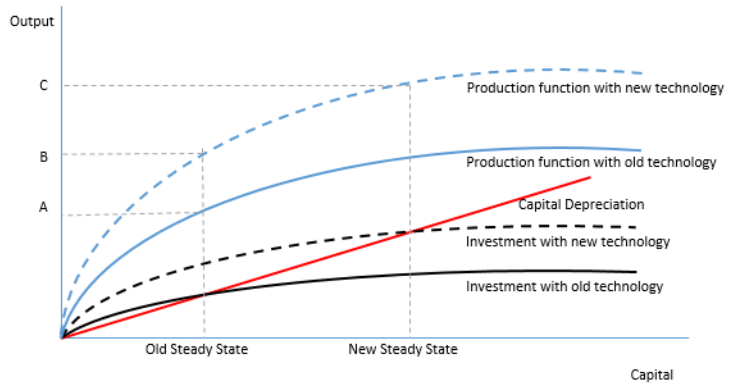

Figure 18: 4.3.5 How technical progress waives the negative effects of diminishing marginal product of capital

Source: Miles & Scott, p. 87, 2005

The graph explains that by keeping the level of physical capital constant, technical progress shifts the production function upwards as higher productivity enables more output to be produced (from point A goes to point B). From this statement it can be derived that the differences in labour and physical capital productivity are the reason for which economies with similar labour and physical capital input can have remarkable differences in their GDP per capita growth rates. Economies that can be characterized as highly technically progressive have always the capacity to produce more output than the less ones. One the other hand, the above graph indicates that in economies with higher productivity, an investment in physical capital will have a higher return ratio than in economies with lower, as depreciation will be slower. Therefore, this enables a higher steady-state level of capital that can be maintained in long-term periods (from point B goes to point C). The table below can be used for the derivation of useful conclusions about the contribution of education to the output per worker.

Country	Capital	Education	TFP	Output per worker
Canada	1.00	0.90	1.03	0.93
Italy	1.06	0.65	1.21	0.83
France	1.09	0.67	1.13	0.82
U.K	0.89	0.81	1.01	0.73
Spain	1.02	0.61	1.11	0.68
Japan	1.12	0.80	0.66	0.59
Mexico	0.87	0.54	0.93	0.43
Korea	0.86	0.76	0.58	0.38
Iran	0.98	0.47	0.64	0.30
Chile	0.99	0.66	0.40	0.26
Peru	0.94	0.62	0.41	0.24
Egypt	0.45	0.58	0.72	0.19
Pakistan	0.58	0.39	0.57	0.13
India	0.71	0.45	0.27	0.09
Sudan	0.84	0.34	0.23	0.07
Lesotho	0.68	0.48	0.19	0.06

Kenya	0.75	0.46	0.17	0.06
Rwanda	0.44	0.34	0.29	0.04
Uganda	0.36	0.39	0.22	0.03

Table 6: 4.3.5 Output per worker dependent on physical capital per worker, education and total factor productivity

Source: Hall & Jones, p. 114-116, 1999

This table makes the variable of output per worker in each country dependent on three contributing factors: physical capital per worker, human capital per worker (education) and total factor productivity. All values are compared to the equivalent of U.S which are measured as 1.00. For example, Chile although used the same quantity of physical capital per worker comparable to that of U.S, achieved only the 25% of the U.S output per worker as human capital and total factor productivity were obviously much lower.

In conclusion, by having realized the benefits of technical progress in the growth process, the rich economies tend to allocate more resources in education, training of the working population and research than the poor ones. This fact has multiple consequences in human and physical capital accumulation process:

1. Higher human capital is correlated with lower fertility rates and more investment in new human capital
2. Higher invention and use rates of the most advanced technologies and production methods
3. As higher as is the current stock of research, size of the R&D workforce and the allocated resources for R&D, the higher will be the innovative activity
4. More enhanced use of knowledge spillovers in inter- and intra-industry production level through competition, specialization and diversity
5. Geographical clustering of innovation-related activities on regions where there is extended use of knowledge spillovers by local industries and intense productive activity (especially for manufacturing and industrial sectors)

5. Labour Productivity Determinants

5.1. Introduction

5.1.1. The Growth Equation and its Determinants

The discussion in the previous chapters indicated that long-term economic growth does not depend on economic conditions. Instead of that, the neoclassical endogenous growth theory argued that growth can be sustainable only by raising the productivity parameter ***A*** which in Solow-Swan model is defined generally as technical progress. This parameter includes all those factors that contribute to the technological progress of an economy, affect labour and total factor productivity and waive the diminishing returns of capital investment. Apart from that, this parameter remains the critical reason for which convergence between the GDP per capita of developed and poor economies has not been achieved yet and possibly is not expected to be done in the future (Mankiw, Romer & Weil, p. 407, 1992). Existing academic literature has identified a range of factors which affect labour productivity and its superset, total factor productivity.

Labour (LP) and Total Factor Productivity (TFP) are used by academics and policy makers in order to measure productivity. In other words, these two indexes can be used for measuring and evaluating the endogenous productivity parameter ***A*** of the Solow-Swan model. Their main difference is that labour productivity is based on the output per work hour while the total factor productivity measures the productivity net of the contribution of capital. In general, the question about which of these two indexes can give more reliable conclusions has been one of the latest most challenging matters of debate in the academic world (Sargent & Rodriguez, p. 41, 2000). The supporters of TFP believe that LP is not such a detailed measurement of productivity such as TFP. On the other hand, the supporters of LP outline that TFP is based on very subjective assumptions and LP measurement is more realistic regarding the current living standards, in which a society is

interested (Sargent & Rodriguez, p. 41, 2000). In mathematical terms, it is known from the previous chapter that the endogenous neoclassical production function is:

$$Y = AK^{a}L^{1-a}$$

5-1

TFP is the parameter ***A*** that determines the relationship between physical capital, labour and output. If the above equation is divided with labour (L), it transforms into:

$$\frac{Y}{L} = \frac{AK^{a}L^{1-a}}{L} = AK^{a}L^{1-a}L^{-1} = AK^{a}L^{1-a-1} = AK^{a}L^{-a} = A\frac{K^{a}}{L^{a}} = A(\frac{K}{L})^{a}$$

5-2

So the typical Cobb – Douglas production function can be written as:

$$y = Ak^{a}$$

5-3

where all inputs are measured in terms of labour so *y* is labour productivity and *k* is the level of capital intensity or the capital–labour ratio. If the above equation is differentiated it becomes as below:

$$\dot{y} = \dot{A} + \mathrm{a} * \dot{k}$$

5-4

where the dot symbols are the rates of growth per variable. Therefore, Labour Productivity growth rate is equal to the Total Factor Productivity growth rate plus *a* times the growth rate of capital intensity. By knowing that the capital cannot grow forever, in the long run, it cannot determine the output growth rate and it does not constitute a productivity index. Therefore, it is concluded that LP and TFP

are practically the same and affected by the same factors (Sargent & Rodriguez, p. 3-4, 2001).

In spite of the academic findings, most of the economies globally did not manage to achieve a high and sustainable economic growth. For the developing economies, with only exception of some Asian ones, there was a period of economic boost with remarkable growth rates which was suddenly disrupted. On the other hand, the developed ones confronted with long periods of very low but positive growth rates which were an indication that they had reached their full long-term productive capacity. One such case was the European Union area. Greece, one of the oldest EU members followed the same trend. In the next chapters, there will be an empirical study that will conclude if productivity was the main cause for this poor performance and which factors were responsible for this situation.

5.1.2. Economic Growth Policies in EU

Since the Treaty of Rome in 1958, economic growth constituted the ultimate long-term goal of the main objectives that were set during the formation of European Union. These objectives targeted to:

- an area of freedom, security and justice without internal frontiers
- an internal market where competition is free and undistorted
- sustainable development, based on balanced economic growth and price stability, a highly competitive social market economy, aiming to full employment and social progress, and a high level of protection and improvement of the quality of the environment
- the promotion of scientific and technological advance
- the combating of social exclusion and discrimination, and the promotion of social justice and protection, equality between women and men, solidarity between generations and protection of the rights of the child
- the promotion of economic, social and territorial cohesion, and solidarity among Member States (Article I-3)

The above objectives have been defined by the academic literature of growth economics as necessary conditions for short-term and long-term growth. Since then, the main volume of European governments' development policies that were planned and applied, aimed to achieve and maintain long-term economic and productivity growth through the increase in supply of goods and services and in the efficiency of their production. Usually, these policies included prerequisite measures such as:

- Promoting the incentive for investment and capital accumulation
- Improving the quality of factors of production such as labour skills and used technology
- Increasing Total Factor Productivity (TFP)
- Allocating productive resources from industries with declining marginal productivity to industries with increasing returns to scale (Uppenberg, p. 19, 2011)

Proceeding now to the establishment of EMU and the introduction of Euro currency as a single currency between a group of European economies, the Maastricht Treaty had set since 1992 several basic criteria-rules that should be fulfilled by all the candidate members. These rules were designed to ensure that all the members would aim successfully to sound public finances and coordinate their fiscal policies. Part of these rules was of preventive nature while others had a corrective one. The compliance with these rules should lead into a government deficit of 3% of GDP and a public debt of 60% of GDP in order homogeneity to exist among all the members of the union. This set of rules was strengthened later in 1997 with the Stability and Growth Pact that referred mainly to the period after the introduction of the new currency. The purpose for all these rules was the achievement of macroeconomic stability that would be a necessary condition for long-term economic growth. However, all these rules seemed to have an inhibitory character in the growth process. The first reform that made the rules more flexible took place in 2005. The target values of deficit and debt remained unaffected, but the decision that would define if a country had overpassed its budgetary limits depended now on the parameters below:

- the behaviour of the cyclically adjusted budget

- the level of debt
- the duration of the slow growth period
- the possibility the deficit to be related to productivity-enhancing procedures (Senior Nello, p. 250, 2009)

However, the global recession of 2008 led several countries to neglect their budgetary discipline and increase their public debts in order to inject stimulus into a recessionary economy and keep unemployment in manageable levels. In the subsequent sovereign debt crisis that began in 2009, debt and deficit levels of each country were examined and there was intense doubt about the ability of the Maastricht Treaty and the Stability and Growth Pact to prevent such crises and ensure growth stability.

5.1.3. Economic Growth in EU

Although the positive long-term growth stability had a core position in the agenda of European countries since 1958, the figures show a very different reality. Despite the growth boost of 1950s and 1960s and the convergence in terms of growth rates with the U.S, EU had on average a noticeable slowdown (Estevao, p. 4-5, 2004). As the same downfall was observed in the case of U.S as well, the observers tended to believe that it was a global phenomenon regarding the western economies. However, while the situation improved for U.S, Europe never managed to recover. That was the first indication about a gap between the two sides in terms of productivity (Estevao, p. 4-5, 2004). The above statement can be graphically reflected in the graph below where it is obvious that U.S achieved higher growth rates after 90's. This raised the question whether the EU policies were targeting only to short-term higher growth rates rather than to long-term ones by increasing overall productivity. Given the fact that both areas were equally technologically competitive, there were severe concerns about the European productivity.

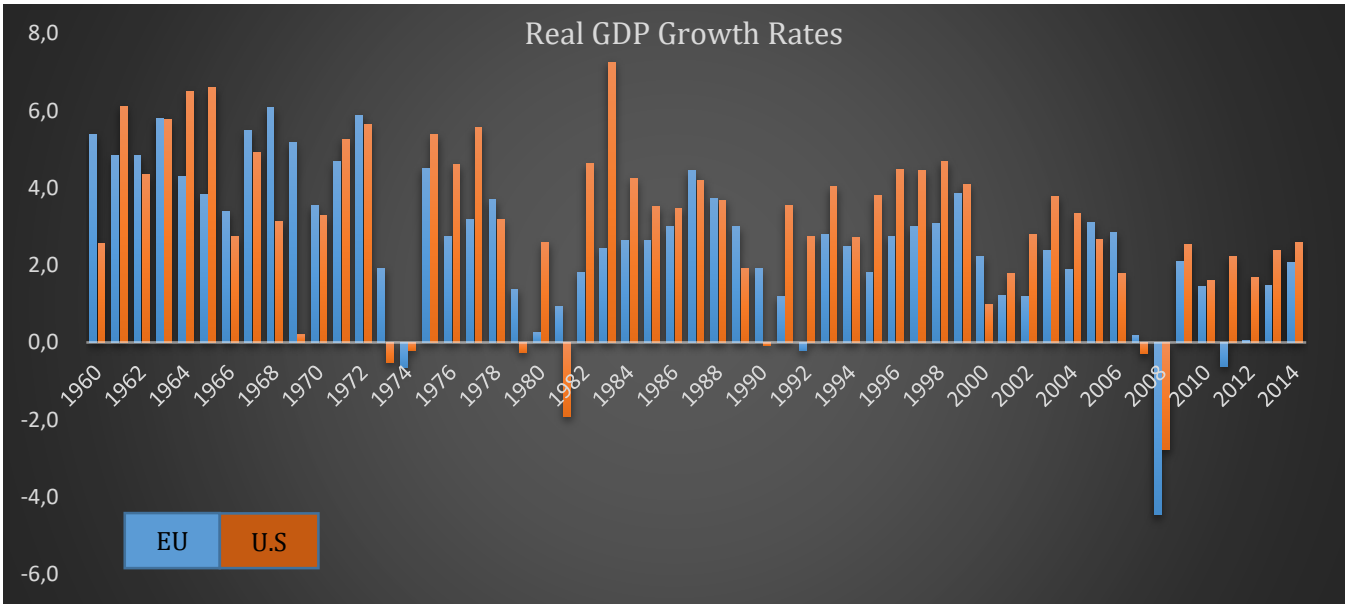

Figure 19: 5.1.3 Real GDP Growth Rates in EU & US

Source: OECD (2017)

Focusing now exclusively on some of the first members of EU and later of EMU, it can be seen that the low, positive growth rates tended to be a rule. By analyzing the graph below, three conclusions can be derived:

- Despite the efforts of the European policy makers for sustainable economic growth, the average growth rates for the twenty eight (28) members of EU between 2004 and 2015 were constantly low and even negative between 2008 - 2010
- Moreover, it seems that their trend was close to the average for the whole union
- Another striking point is that both average and individual negative growth rates start simultaneously in the second middle of 2008 with the outbreak of the U.S banking crisis. This indicates that any open economy will be always exposed to external factors that can disrupt its economic growth stability. On the other hand, the fact that the majority of these countries recovered back to their older, low growth rates, it can be an extra indication that they had already touched their ceiling before the crisis of 2008

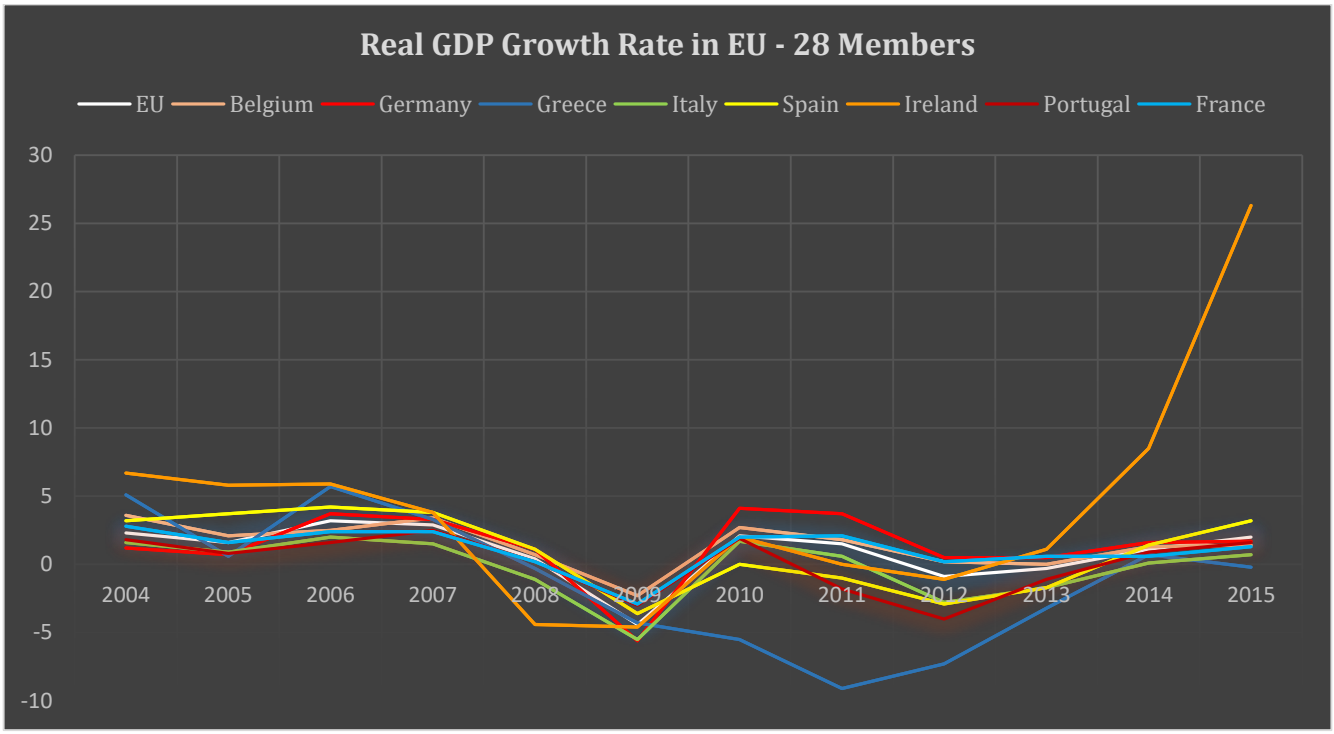

Figure 20: 5.1.3 Real GDP Growth Rate in EU - 28 Members

Source: OECD (2017)

All the above warned that there are critical reasons to make EU anxious about its long-term growth and labour productivity performance.

In theory, labour productivity is measured as the percentile annual change of the generated total output per hour worked in constant prices. The graph below shows that the traditional largest economies of EU, Germany, France and UK have a constantly declining labour productivity for more than 40 years. Another interesting point is that during 70's, the three European economies performed far better than U.S in labour productivity. Moreover, after 90's the gap between U.S and the strongest European economies has been bridged and convergence is observed. However, the key point here is that while U.S has managed to maintain stable its labour productivity over the last 40 years, for European economies, an inexorable slowdown seems to have condemned the sustainable long-term economic growth.

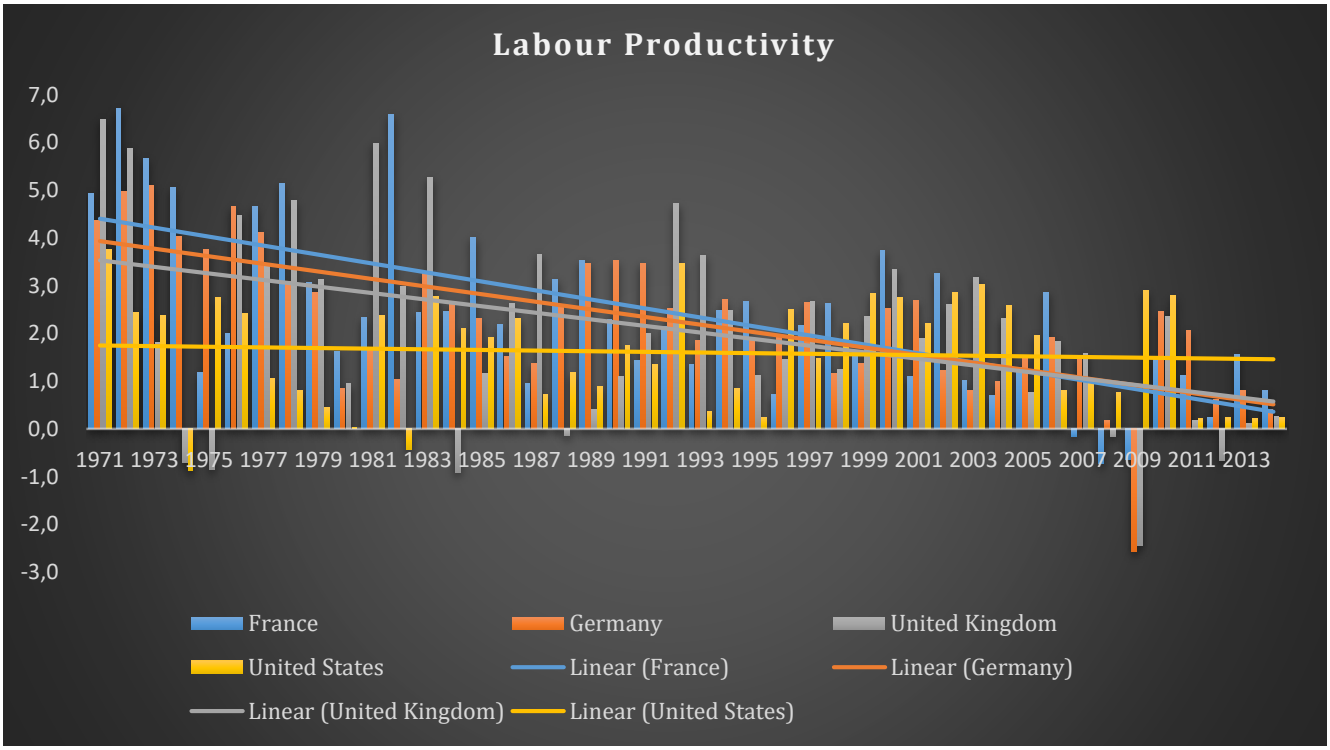

Figure 21: 5.1.3 Labour Productivity in France, Germany, UK & USA

Source: OECD (2017)

It is admitted that the strongest European economies were always pioneers in the invention and usage of the latest technological infrastructure. Moreover, the technical skills of the workforce developed constantly through the increasing inflow of individuals in universities and training programs during the last 40 years. Therefore, the slowdown of labour productivity could be justified by factors with negative effects that tend to revert the beneficiary role of technological progress and human capital.

5.1.4. The Case of Greece

Greece is a member of EU since 1981. In 2001, Greece also gained its admission in EMU having achieved all the prerequisite criteria for the admission of a country in the union. From the graph below, it can be seen that Greek growth rates between 1961 until 2015 can be divided into four discrete periods:

- 1961 – 1978 when Greece achieved significantly higher growth rates than the average of the first fifteen (15) EU members

- 1979 – 2000 where a convergence is observed between the growth rates of the two sides. This period coincides with the admission of the country in EU
- 2000 – 2006 where Greece performed better than the compared fifteen (15) EU countries. From a first point of view, this significant difference could be justified by the huge investment projects that took place for organizing the Olympic Games of 2004
- 2007 – 2015 where Greek growth rates, affected by the global financial and the internal debt crisis, shrunk even to negative

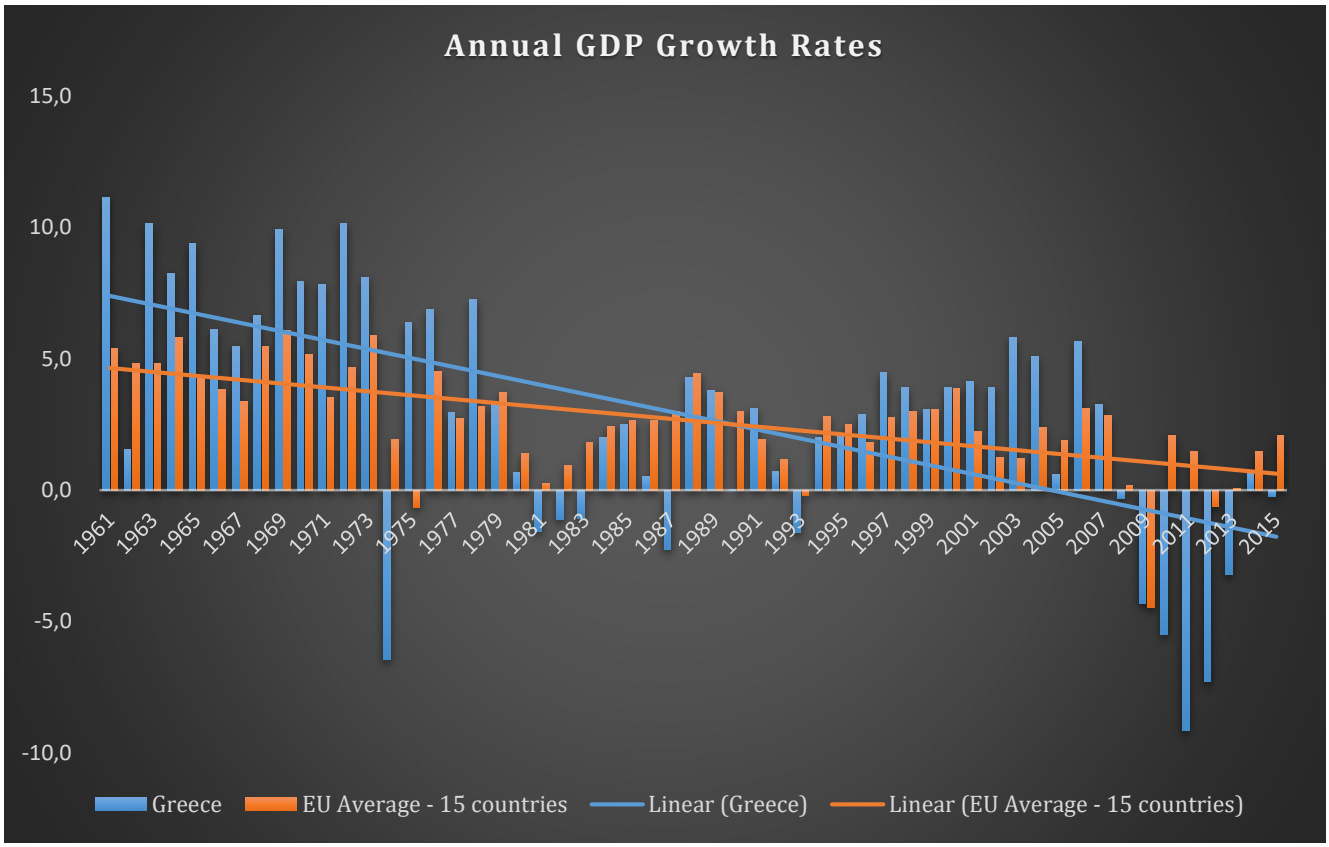

Figure 22: 5.1.4 Annual GDP Growth Rates for Greece and EU (15 countries average) 1961 - 2015

Source: OECD (2017)

Moreover, from 1961 until 2015 the average Greek growth rate was 2.8% while the average for the first fifteen (15) EU members was 2.6%. By leaving outside the

period before the admission in EU and the period after the crisis, Greece achieved an average growth rate 2.1% for the years 1981 – 2008 (OECD, 2017).

Proceeding now to labour productivity, for the period 1984 – 2015, it demonstrates an intensively volatile trend as it can be seen by the graph below:

Figure 23: 5.1.4 Greek labour productivity 1984 - 2015

Source: OECD (2017)

In this period, the average labour productivity growth rate was just 1.1 %. For the same period, the first fifteen (15) EU members had an average labour productivity growth rate of 1.7%, not significantly higher than this of Greece.

5.1.5. Labour Productivity Determinants

By now, the academic literature has identified a wide range of factors that affect positively and negatively labour productivity. Depending on the economy sector, the importance of every factor may vary. However, some factors remain fundamental regarding their contribution to labour productivity. These factors are:

- Technology and infrastructure
- Technical skills of the workforce
- Other demographic characteristics such as average age of the workforce, average age of new entrants in production and ratio of urban to total population
- Macroeconomic variables such as minimum wage, unemployment rate and current living standards
- Social variables such as political and economic stability, corruption, market competition, labour law and quality of the health system
- Structure of the production such as allocation of the resources to more or less productive sectors, size of the public sector and total working hours
- R&D and innovations (Simion, Toba & Siminica, p.197 – 199, 2011, Gallup, Sachs & Mellinger, p. 180-214, 1999)

The above determinants may have stronger or weaker impact between developed and developing economies or between rich and poor ones. Moreover, for single countries, there may be other, more significant determinants that affect labour productivity but without having being proved academically in a wider country sample.

5.2. Scope & Methodology of the Empirical Part

5.2.1. Scope

The scope of the empirical part of this thesis is divided into two parts. Firstly, it will review the work of Drakopoulos and Theodossiou (1991) who analyzed the validity of the three Kaldorian Laws in the Greek economy for the period 1967 – 1988 and will test them on more recent data. The researchers examined for the Greek economy:

1. The positive relationship of the growth rates between GDP and manufacturing output

2. The positive relationship between the growth rates of productivity and output in manufacturing sector
3. The positive relationship between the growth rates of productivity in all the rest sectors of the economy and this of manufacturing sector

The incentive for this review is like this of Drakopoulos and Theodossiou. For them, the reason for research was the transformation of Greek economy from an agricultural economy into an industrial one over the period 1960 – 1990. Consequently, they tried to find out the effects of this transformation in the growth structure of the Greek economy. Here, the reason is the transformation of the Greek economy from a developing industrial economy into a mixed economy with a declining industrial sector and a continuously developing tertiary (services) sector. The initial paper had validated only the first and the second law while it found some moderate to weak evidence for the third one. The broad contribution of the tertiary sector to the growth of the Greek economy and the recession of the industry the last twenty five years trigger the assumption that the results of this thesis may be different than these of the authors.

By ending the empirical review of the paper of Drakopoulos and Theodossiou, this thesis will move a step deeper. Influenced by the core idea of the second Kaldor's law, it will modify it and adapt it on business services sector and will investigate which factors are hidden behind the trend of productivity ratio in business tertiary sector. This will be achieved through a gradual decomposition process of the labour productivity ratio of business tertiary GDP to total hours worked in business services sector. Initially this process will reveal if the business tertiary sector is labour or capital intensive. Depending the result, a set of factors will be analyzed regarding their effects in labour productivity ratio. The variables that will be found to be robustly significant and correlated to tertiary labour productivity, they will form a multiple regression model that can explain adequately the business tertiary labour productivity in Greece the last two decades. The reason behind this direction is that the last twenty-five years the Greek economy evolved into a mainly tertiary economy having its agricultural and industrial sectors constantly declining. Apart from that, there was a transformation of the productive forces and policies with more skilled human

capital, advanced technical infrastructure, improved living standards, financial liberalization and trade openness. In theory, these forces have been proved to have positive effects in growth through a higher labour productivity. On the other hand, unemployment, socioeconomic instability, uncontrollable government debts or deficits and corruption have been proved as condemnatory for productivity.

The ultimate purpose of the empirical part of this thesis is to reflect if the factors which contribute to the total output growth have only short-term or and long-term effects as well through a higher level of productivity. The findings of this thesis may be used as an indication for pitched improvements in the variables that were tested and found to be significant for the growth of Greek economy.

5.2.2. Methodology and Data

As it was mentioned in the previous section, the empirical part will be divided into two parts: the validity review of the three Kaldorian Laws adapted to the Greek economy based on the previous work of Drakopoulos and Theodossiou and the decomposition of the business tertiary labour productivity ratio in order to unveil which macroeconomic variables are determinants of its behaviour.

Beginning with the Kaldorian approach, the data sample will be collected from the period 1995 – 2016. This period is the continuity of the tested period in the original paper. The applied methodology will be the same that was followed by Drakopoulos and Theodossiou. The first law will be tested under four different independent variables: the growth of manufacturing product (g_m), the growth of industrial product (g_i), the growth of agricultural product (g_a) and the growth of the services product (g_s). In all cases, the dependent variable will be the growth rate of total output (g_{GDP}). The method of Ordinary Least Square (OLS) will be used for the export of the estimated equations along with the calculation of the coefficient of determination (R^2) which is the proportion of the variance in the dependent variable that is predictable from the independent variable. In other words, the value of R^2 will show how well the dependent variable can be predicted by the independent one. On top of that, for every regression, an F-Test will be

conducted under a significance level α = 0.05 (95%) to prove if the relationship between the dependent and independent variables is statistically significant. Finally, the Durbin – Watson criterion will be preferred to test the hypothesis for autocorrelation existence. In case of autocorrelation (positive or negative) existence, the Cochrane – Orcutt method will be applied for correction of the estimated regression. Therefore, the following linear regressions will be analyzed as part of the 1st law:

1st Kaldor's Law

$$g_{GDP} = b_0 + b_1 (g_m) \quad (5\text{-}5)$$

$$g_{GDP} = b_0 + b_1 (g_i) \quad (5\text{-}6)$$

$$g_{GDP} = b_0 + b_1 (g_a) \quad (5\text{-}7)$$

$$g_{GDP} = b_0 + b_1 (g_s) \quad (5\text{-}8)$$

The aforementioned methodology will be also followed for the second and third laws. For the second law, the productivity in manufacturing sector (p_m) will be regressed against the growth of manufacturing product. As an enhancement, based on the work of Stoneman (1979) and Mizuno and Ghosh (1984), the growth of manufacturing and industrial output will be also regressed against the volume of the total exports. As far as the third law, two dependent variables will be checked: the total productivity growth and the GDP growth. Both of them, they will be regressed against sectoral employment growth. Consequently, in the context of the 2nd and 3rd law, the following regressions below will be estimated:

2nd Kaldor's Law

$$p_m = b_0 + b_1 (g_m) \quad (5\text{-}9)$$

$$g_m = b_0 + b_1 (x)$$

5-10

$$g_i = b_0 + b_1 (x)$$

5-11

3rd Kaldor's Law

$$g_{GDP} = b_0 + b_1 (e_m)$$

5-12

$$g_{GDP} = b_0 + b_1 (e_i)$$

5-13

$$g_{GDP} = b_0 + b_1 (e)$$

5-14

$$g_{GDP} = b_0 + b_1 (e_a)$$

5-15

$$g_{GDP} = b_0 + b_1 (e_s)$$

5-16

$$p = b_0 + b_1 (g_m)$$

5-17

$$p = b_0 + b_1 (g_m) + b_2 (e_{nm})$$

5-18

$$p = b_0 + b_1 (g_m) + b_2 (e_a) + b_3 (e_s)$$

5-19

The next step will focus on the effect analysis of the macroeconomic variables which determined the trend of business tertiary labour productivity for the period 1995-2016. The term "business tertiary labour productivity" is defined as the ratio of total output per hour worked in aggregate in the sectors:

- Wholesale and retail trade, repair of motor vehicles and motorcycles (VG)
- Transportation and storage (VH)
- Accommodation and food service activities (VI)

- Information and communication (VJ)
- Financial and insurance activities (VK)
- Professional, scientific and technical activities (VM)
- Administrative and support service activities (VN)

The categorization of the sub-sectors has been done based on the global standards of organizations which maintain macroeconomic statistics such as OECD and Eurostat. Therefore, the analysis starts with the business tertiary labour productivity ratio:

$$LP = \frac{GDP}{Total\ Hours\ Worked}$$

5-20

The ratio 5-20 indicates that the rate of change of labour productivity is affected positively by GDP and negatively by total hours worked. However, depending the country, the sector and the time period is not necessary both of the above variables to have statistical significant impact in labour productivity. Therefore, the above ratio generates two new regressions:

$$LP_{TER} = b_0 + b_1 GDP_{TER}$$

5-21

$$LP_{TER} = b_0 + b_1 TotalHoursWorked_{TER}$$

5-22

The analysis of the two equations provides details about if:

- The investigated sector is labour or capital intensive
- Investment in technical progress has real effects
- Investment aims to short-term growth or to long-term through pushing upwards and keeping stable the productivity

By going one level lower, this thesis will evaluate the impact of a set of variables to GDP and total hours worked supposing that both of them have been

found statistically significant in their relationship with business tertiary labour productivity. Therefore, the factors for analysis will be:

- Gross Fixed Capital Formation: Gross fixed capital formation (GFCF) is defined as the acquisition (including purchases of new or second-hand assets) and creation of assets by producers for their own use, minus disposals of produced fixed assets. The relevant assets relate to products that are intended for use in the production of other goods and services for a period of more than a year (OECD, 2018). In simple terms, this variable includes the investment in machinery, transportation system, ICT equipment, intellectual property products and infrastructure and is indicative of the technological progress of a market
- Labour Input: The size of the employed workforce. The analysis of this factor defines if the sector is labour intensive and if there is substitution of labour by capital
- Gross Wages and Salaries: The labour compensation for the employees of the tertiary sector. In the income approach of GDP measurement, it reflects the investment in labour or the labour cost in other words
- Unemployment Rate: Unemployed graduates with tertiary education. The reason behind this selection is the assumption that people with tertiary education prefer to be occupied in the services sector and are reluctant to get involved in sectors that require manual labour. Therefore, the fear of unemployment could lead the employees of tertiary sector to produce more output in less working hours
- Profit: It determines the level of investment in gross fixed capital or labour input and the level of labour compensation
- Minimum Annual Salary: Similarly to profit, it can be used as a benchmark for quantifying the labour input needs. It is closely correlated with the total hours worked
- Total Hours Worked: As in the case of labour input, the trend of total hours worked is an indication of investment in technology, machinery and infrastructure

- Unit Labour Cost: Measures the average cost of labour per unit of output and is calculated as the ratio of total labour costs to real output. It shows if advanced technical methods are incorporated in the production

For both dependent and independent variables, their **growth rates** values will be taken for the period 1995 – 2016.

All regressions will be estimated under OLS method. There will be tests for overall significance with F-Test methodology for 95% confidence intervals while for every single independent variable, the t-test method will be used to determine which of these variables are statistically significant. Finally, in order the results under the OLS methodology to be unbiased, consistent and efficient, the prerequisite tests for multicollinearity and autocorrelation will be performed. More specifically, for multicollinearity, the variance-inflation factor (VIF) and the tolerance coefficient will be used while the Durbin-Watson criterion will be preferred to unveil if there is positive or negative first order autocorrelation. Multicollinearity problems will be fixed by eliminating the variables which cause it while autocorrelation will be solved with the Cochrane-Orcutt method.

At the end, in order to be able to predict the behavior of business tertiary labour productivity in the future, the time dimension will be added. For this reason, a first order autoregressive model will be analyzed where the growth rate of business tertiary labour productivity will be regressed against its previous year value:

$$LPTer = b_0 + b_1 LPTer_{t-1} + \varepsilon_t$$

5-23

If the results are poor, an extra lag will be added. The model will be estimated again under the OLS method. However, these results can be valid only if the variables are found to be stationary. This will be proved by conducting a unit root test for stationarity and more specifically the Augmented Dickey-Fuller test. In case of non-stationarity, the growth rate values will be replaced by their first differences. At the end of this chapter, the major findings will present: a) which factors affect tertiary labour productivity b) if future tertiary labour productivity

can be predicted by its past values and c) a multiple regression model that may be used as a guide for the improvement of the tertiary labour productivity in Greece.

5.3. Empirical Results

5.3.1. General Statistics

The revision of the Kaldorian laws starts with the provision of some basic descriptive statistics that give a first image of the progress and the structure of the Greek GDP growth during the period 1995 – 2015. In Table 7, it seems that the Greek GDP had a mixed trend during the last twenty years. The highest growth rate was 5.79% in 2003 and the lowest -9.13% in 2011. The average value was 0.91%. The highest and lowest values can be explained by two crucial incidents in Greek economy. For the first, the key responsible factor was the Olympic Games of 2004 in Athens which triggered an investment boom in manufacturing and construction services. It can be seen during the period 1997-2004 that Greece achieved brilliant growth rates. On the other hand, the lowest value can be found within a prolonged period of recession due to the strict measures that were imposed after the uncontrollable rise of the external public debt in 2009.

Year	GDP Growth	Year	GDP Growth	Year	GDP Growth
1995	2.10	2002	3.92	2009	-4.30
1996	2.86	2003	5.79	2010	-5.48
1997	4.48	2004	5.06	2011	-9.13
1998	3.89	2005	0.60	2012	-7.30
1999	3.07	2006	5.65	2013	-3.24
2000	3.92	2007	3.27	2014	0.35
2001	4.13	2008	-0.34	2015	-0.22

Table 7: 5.3.1 Greek GDP Growth Rates 1995 – 2015

Source: World Bank 2017

Regarding the main productive sources of Greek GDP, the tertiary sector is dominant with contribution from 70% to 80%. Moreover, the industrial sector presents a noticeable declining trend from 21.56% to 15.69% which means a reduction of 27%. It is also important to be mentioned that in 1986, the contribution of industrial sector was 30.7% while for services just 55.1%. What is more, the main trend for industrial sector is downward while for the period 1967-1988 was mainly rising.

Year	Agriculture	Industry	Services		Year	Agriculture	Industry	Services
1995	8.11	21.56	70.34		2006	3.61	22.56	73.83
1996	7.27	20.84	71.89		2007	3.44	20.40	76.15
1997	6.92	19.89	73.19		2008	3.18	17.72	79.10
1998	6.59	20.10	73.31		2009	3.14	17.13	79.74
1999	6.45	21.33	72.22		2010	3.27	15.66	81.08
2000	6.08	20.99	72.93		2011	3.36	15.57	81.07
2001	5.84	21.72	72.44		2012	3.66	16.21	80.13
2002	5.59	21.79	72.61		2013	3.62	16.53	79.85
2003	5.57	22.87	71.56		2014	3.72	15.94	80.35
2004	4.74	22.55	72.71		2015	4.12	15.69	80.19
2005	4.77	19.84	75.39		2016	4.37	15.93	79.70

Table 8: 5.3.1 Contribution per sector to Greek GDP

Source: World Bank 2017

It is obvious therefore that the Greek economy had already transformed twenty years ago into a mainly tertiary economy with the recession of the industrial sector to be obvious from the beginning of the examined period.

5.3.2. 1st Kaldorian Law

Initially the growth rate of GDP was regressed against that of the manufacturing product. As growth rate of manufacturing product was used the

annual growth rate for manufacturing value added based on constant local currency. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. The OLS method gave a moderate coefficient of determination equal to 45% which means that less than half of the movements of GDP growth are explained by the movements in the growth of manufacturing output. This comes in contrast to the findings of Drakopoulos and Theodossiou for the period 1967-1988 where R^2 was 81%. In spite of that, the coefficients of manufacturing output are almost the same in both cases (0.52 and 0.517). The generated regression was:

$$g_{GDP} = 0.996 + 0.517 g_m$$
$$(0.776)\ (0.134)$$

5-24

The F-test value was 14.81 (critical value = 4.41) which indicates that the relationship of the two variables is statistically significant. The Durbin-Watson hypothesis for first order autocorrelation was rejected (d = 1.45 & 4-d = 2.55 | d_L = 1.20 & d_U = 1.41). It is concluded that between the two growth rates there is moderate, positive relationship and therefore the 1st Kaldor's law is partially verified in the case of manufacturing output.

Results summary for manufacturing output			
R Square	0.451	F Critical Value	4.41
Standard Error	3.423	DW Value for Pos. Autocor.	1.446
F Value	14.814	DW Value for Neg. AutoAcor.	2.554
Intercept Coefficient	0.996	d_L	1.2
g_m Coefficient	0.517	d_U	1.41

Table 9: 5.3.2 1st Kaldor's Law: GDP regressed against manufacturing output

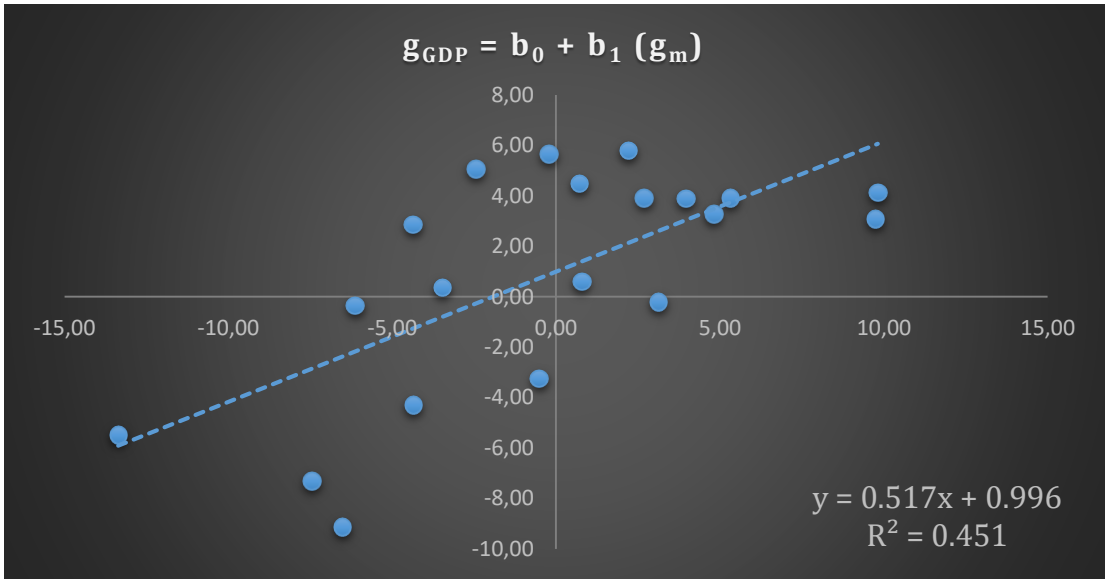

Figure 24: 5.3.2 1st Kaldor's Law: GDP regressed on manufacturing output

Next, the first law is adapted to the regression of the growth rate of GDP against that of the industrial output. The findings are similar with these of the manufacturing output and conflicting to these of Drakopoulos and Theodossiou. As growth rate of the industrial output was used the annual growth rate for industrial value added based on constant local currency. The coefficient of determination was 56%, far lower than this of the period 1967-1988 (89%). The coefficient of the industrial output was 0.427, close enough to the 0.503 of the compared period. The estimated regression was:

$$g_{GDP} = 1.017 + 0.427 g_i$$
$$(0.688)\ (0.089)$$

5-25

The F-test value of 22.67 makes the relationship significant while the DW value of 1.49 rejects the hypothesis for first order autocorrelation. As in the case of manufacturing product, between the growth rates of GDP and industrial output there is a moderate, positive and significant relationship.

Results summary for industrial output			
R Square	0.557	F Critical Value	4.41
Standard Error	3.075	DW Value for Pos. Autocor.	1.496
F Value	22.668	DW Value for Neg. AutoAcor.	2.504
Intercept Coefficient	1.017	d_L	1.2
g_i Coefficient	0.427	d_U	1.41

Table 10: 5.3.2 1st Kaldor's Law: GDP regressed against industrial output

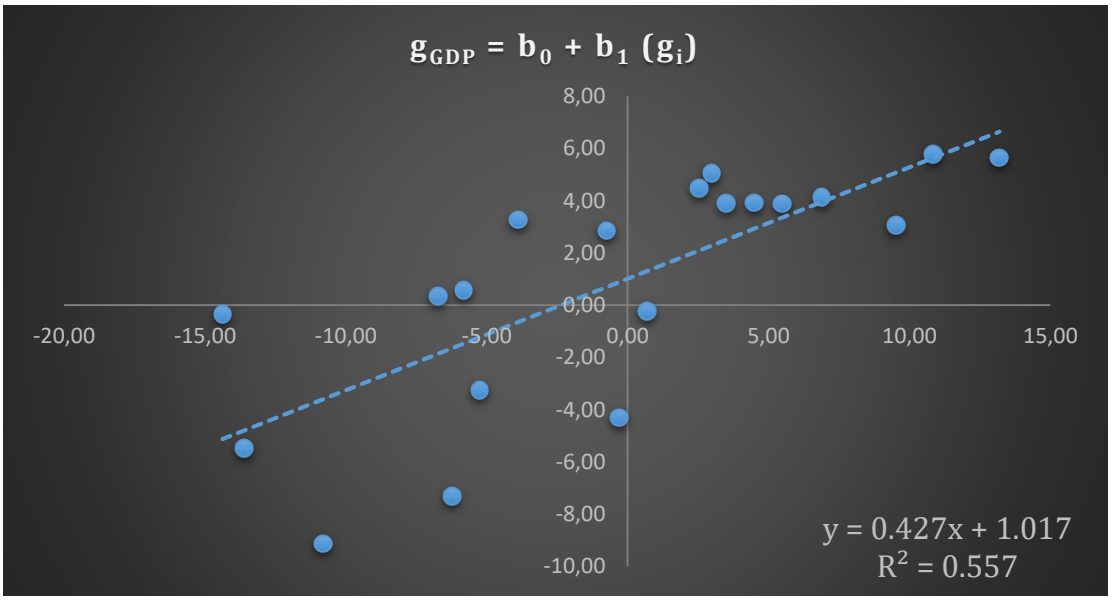

Figure 25: 5.3.2 1st Kaldor's Law: GDP regressed against industrial output

Following the original paper, the total output is also regressed against the growth rates of agricultural and tertiary GDP. Here the results verify the findings of the period 1967-1988. For agriculture, R^2 is equal to 15% while the agricultural growth rate coefficient is -0.301. The only difference with the original paper is that here the relationship is weak and negative while there, it was weak and positive (4% & 0.124). In addition, the F-test value of 3.19 shows that the relationship is not significant. The calculated equation for agricultural output was:

$$g_{GDP} = 0.703 - 0.301 g_a$$

$$(0.956)(0.169)$$

5-26

For the case of tertiary sector, the situation is totally different. An R^2 equal to 89%, combined with the coefficient value of 0.96 of tertiary GDP growth rate, an F-test value equal to 150.8 and the absence of first order autocorrelation show that for the period 1995-2016, there was robust, positive and statistically significant relationship between GDP and tertiary sector growth rates.

$$g_{GDP} = -0.296 + 0.960g_s$$
$$(0.350)\ (0.078)$$

5-27

Results summary for agricultural output			
R Square	0.150	F Critical Value	4.41
Standard Error	4.260	DW Value for Pos. Autocor.	0.511
F Value	3.187	DW Value for Neg. AutoAcor.	3.489
Intercept Coefficient	0.703	d_L	1.2
g_a Coefficient	-0.301	d_U	1.41

Table 11: 5.3.2 1st Kaldor's Law: GDP regressed against agricultural product

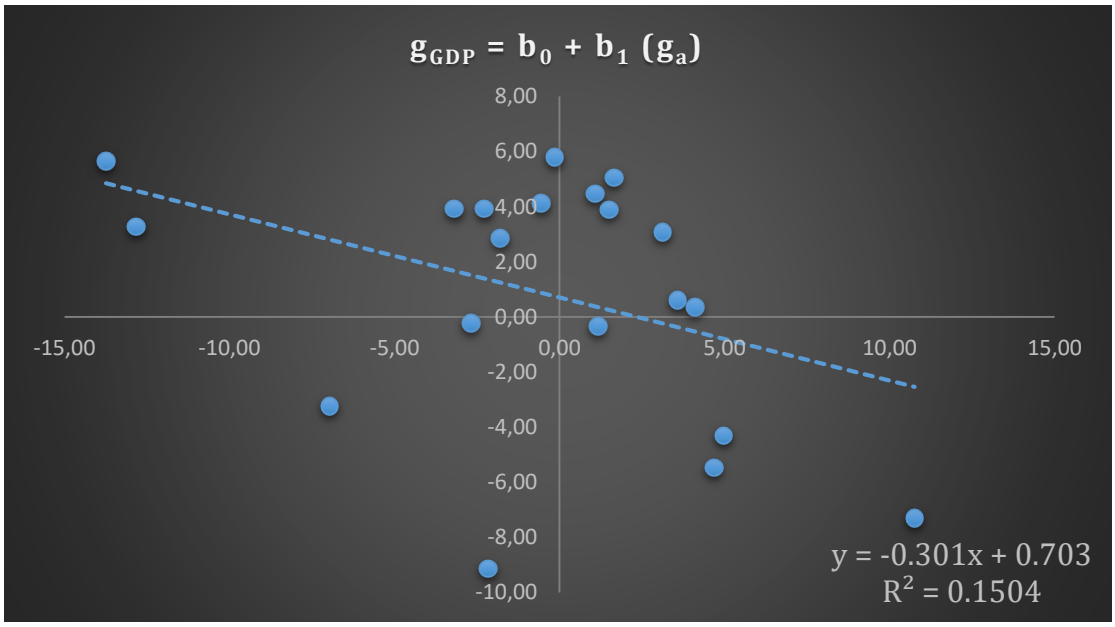

Figure 26: 5.3.2 1st Kaldor's Law: GDP regressed against agricultural output

Results summary for services output			
R Square	0.893	F Critical Value	4.41
Standard Error	1.509	DW Value for Pos. Autocor.	2.099
F Value	150.8	DW Value for Neg. AutoAcor.	1.900
Intercept Coefficient	-0.296	d_L	1.2
g_s Coefficient	0.960	d_U	1.41

Table 12: 5.3.2 1st Kaldor's Law: GDP regressed against services output

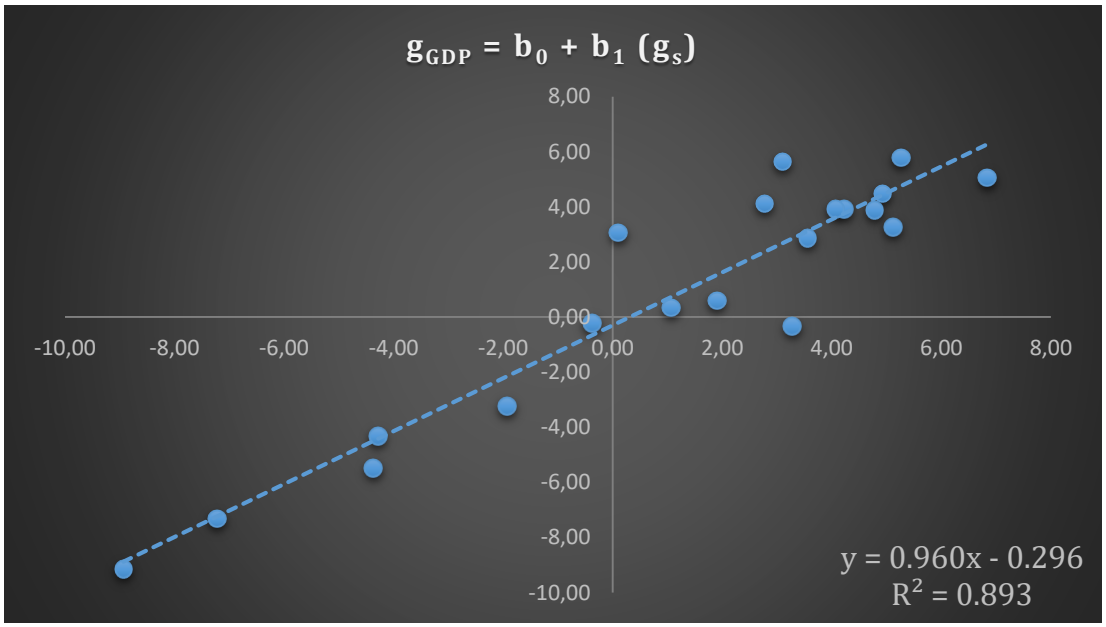

Figure 27: 5.3.2 1st Kaldor's Law: GDP regressed against services output

The conducted tests proved that the 1st Kaldorian Law is moderately validated in the case of Greek economy for the period 1995-2016 and come to contrast with the findings of Drakopoulos and Theodossiou. However, there is strong evidence that during that period, the performance of the tertiary sector was a barometer for the growth of the Greek economy.

Period 1995 - 2016						Period 1967 - 1988				
Variable	1	2	3	4		Variable	1	2	3	4
Constant	0.99 (0.77)	1.02 (0.69)	0.70 (0.96)	-0.30 (0.35)		Constant	1.410 (3.179)	1.686 (5.247)	3.843 (4.951)	-1.026 (2.644)
g_m	0.52 (0.13)					g_m	0.506 (9.138)			
g_i		0.43 (0.09)				g_i		0.503 (12.427)		
g_a			-0.3 (0.17)			g_a			0.124 (1.001)	
g_s				0.96 (0.08)		g_s				1.149 (15.60)
R^2	**0.45**	**0.56**	**0.15**	**0.89**		**R^2**	**0.81**	**0.89**	**0.04**	**0.92**
DW	1.446	1.496	0.511	2.099		DW	2.292	2.618	1.176	1.723

Table 13: 5.3.2 1st Kaldor's Law findings summary

5.3.3. 2nd Kaldorian Law

Turning now to the second law, the relationship between the growth rates of manufacturing output (g_m) and manufacturing productivity (p_m) was analyzed. As manufacturing productivity was defined the ratio between the total manufacturing output and the total hours worked in manufacturing sector. The results do not add validity to the second law as the calculated equation was:

$$p_m = 1.671 + 0.555 g_m$$
$$(0.802)\ (0.140)$$

5-28

with R^2 equal to 46%, obviously lower than the 82% of the period 1967-1988. The g_m coefficient was 0.555 while for the previous period was 0.804. The relationship was found statistically significant while the DW value proves no existence of first order autocorrelation. It is concluded that between the two variables there is again moderate, positive and significant relationship.

Results summary for manufacturing labour productivity			
R Square	0.465	F Critical Value	4.41
Standard Error	3.581	DW Value for Pos. Autocor.	1.833
F Value	15.625	DW Value for Neg. AutoAcor.	2.167
Intercept Coefficient	1.671	d_L	1.2
g_m Coefficient	0.555	d_U	1.41

Table 14: 5.3.3 2nd Kaldor's Law: manufacturing labour productivity regressed against manufacturing output

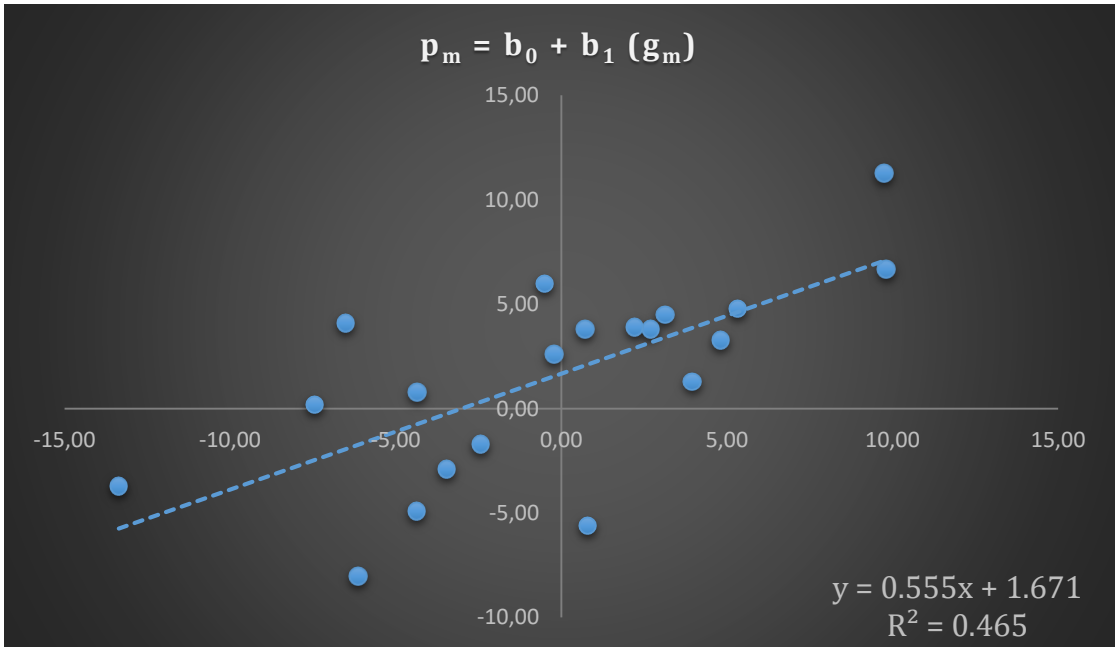

Figure 28: 5.3.3 2nd Kaldor's Law: manufacturing labour productivity regressed against manufacturing output

Apart from the main test regarding the validity of the second law, Drakopoulos and Theodossiou tested also the relationship between the growth rates of manufacturing output and the volume of manufacturing exports. This was due to the fact that the growth of manufacturing output is demand determined, possibly by export demand, which is itself exogenous to the economic system (Stoneman, p.314, 1979). Initially, this attempt had been done by Stoneman (1979) and later

by Mizuno and Ghosh (1984). Specifically, for the data sample of the period 1995-2016, the OLS method reverted the estimated regression below:

$$g_m = -1.055 + 0.138x$$
$$(0.802)\ (0.140)$$

5-29

The R^2 was only 6% which shows very poor evidence in comparison to the 41% of the previous period. The F-test value of 1.151 adds that there is no statistical significance. The export growth coefficients between the two studies are very close (0.138 & 0.302). However, the DW value (1,263) fell in the range 1.2 – 1.41 and the results were inconclusive for positive, first order autocorrelation. By using the Cochrane - Orcutt procedure, the generated regression was:

$$g_m = 0.786 - 0.061x$$
$$(2.868)\ (0.110)$$

5-30

Now, the R^2 fell from 6% to 2% and verified again that the growth pattern of the manufacturing product cannot be explained by the growth of exports.

Results summary for export growth in manufacturing output			
R Square	0.06	F Critical Value	4.41
Standard Error	5.828	DW Value for Pos. Autocor.	1.263
F Value	1.151	DW Value for Neg. AutoAcor.	2.737
Intercept Coefficient	-1.055	d_L	1.2
x Coefficient	0.138	d_U	1.41

Table 15: 5.3.3 2nd Kaldor's Law: manufacturing product growth regressed against exports growth

Results summary for export growth in manufacturing output with Cochrane – Orcutt method			
R Square	0.02	F Critical Value	4.41
Standard Error	5.322	DW Value for Pos. Autocor.	2.266
F Value	0.309	DW Value for Neg. AutoAcor.	1.734
Intercept Coefficient	0.786	d_L	1.2
x Coefficient	-0.061	d_U	1.41

Table 16: 5.3.3 2nd Kaldor's Law: manufacturing product regressed against exports with Cochrane – Orcutt method

The effects of the growth of exports were also analyzed in the growth pattern of the industrial product. The regression analysis gave the results below:

$$g_i = -1.158 + 0.138x$$
$$(2.031)\ (0.176)$$

5-31

The coefficient of determination, like in the case of manufacturing product, was very low at 3%. The F-test value was just 0.613 and the DW value 1.515. Under the absence of any autocorrelation issues, it is concluded that similarly to manufacturing product, there is non-significant, very weak, positive relationship between the growth of industrial product and exports. Again, this comes in contrast to Drakopoulos and Theodossiou who found a somehow more satisfactory R^2 equal to 30%.

Results summary for export growth in industrial output			
R Square	0.033	F Critical Value	4.41
Standard Error	7.947	DW Value for Pos. Autocor.	1.515
F Value	0.613	DW Value for Neg. AutoAcor.	2.485
Intercept Coefficient	-1.158	d_L	1.2
x Coefficient	0.138	d_U	1.41

Table 17: 5.3.3 2nd Kaldor's Law: industrial product growth regressed against exports growth

Although the original paper proceeds further by regressing the growth of agricultural product against the growth rates of exports and agricultural labour, the evidence that was found was very weak. Therefore, there is not any academic interest in the current study to repeat those tests. The applied tests showed that the 2nd Kaldorian law is moderately validated for the Greek economy during the period 1995-2015, the same that had been also proved for the first law. Again, the conclusions of the period 1967-1988 are not repeated as for that period the estimated coefficient of determination was noticeably higher. Regarding the effects of exports in the growth rates of manufacturing and industrial output, the empirical findings were very poor and did not show any correlation between the dependent and the independent variables. This means that the manufacturing and industrial production was not influenced by the export demand. This is rational however as Greece had never been a traditional exporter of manufacturing and industrial goods and the main volume of exports consisted of agricultural products.

5.3.4. 3rd Kaldorian Law

The review of the paper of Drakopoulos and Theodossiou continued with the analysis of the third law. In the context of testing the validity of the third law, two variables were used as dependent: the growth rates of productivity and GDP. The first was regressed against the growth rate of manufacturing output either one to one or combined with the growth rate of a sectoral employment (non-manufacturing, agricultural, tertiary). The second was regressed against total and sectoral employment growth. Beginning with the case of the total productivity of the economy, it is known from the existing literature that as the manufacturing output grows, the respective sector attracts workforce from other sectors with diminishing returns to scale. Therefore, labour productivity outside manufacturing sector will improve and the same will happen for overall productivity due to the increasing returns of manufacturing sector (Drakopoulos & Theodossiou, p. 1685, 1991). However, when the relationship between total

productivity and manufacturing output was examined for the period 1995-2016, the results were remarkably different than these of the compared period.

When the rate of growth of total productivity was regressed against the growth rate of manufacturing product, the estimated regression was:

$$p = 1.206 + 0.213g_m$$
$$(0.568)\ (0.099)$$

5-32

The R^2 was only 20% far inferior to the 73% of the previous period. The g_m coefficient was 0.213 and relatively close to the 0.555 of the original paper while the F-test value was 4.566 marginally higher than the critical value of 4.41. Therefore, the relationship between overall productivity and manufacturing product is characterized as positive, significant but weak.

Results summary for manufacturing output in productivity			
R Square	0.202	F Critical Value	4.41
Standard Error	2.538	DW Value for Pos. Autocor.	2.19
F Value	4.566	DW Value for Neg. AutoAcor.	1.81
Intercept Coefficient	1.206	d_L	1.2
g_m Coefficient	0.213	d_U	1.41

Table 18: 5.3.4 3rd Kaldor's Law: productivity regressed against manufacturing output

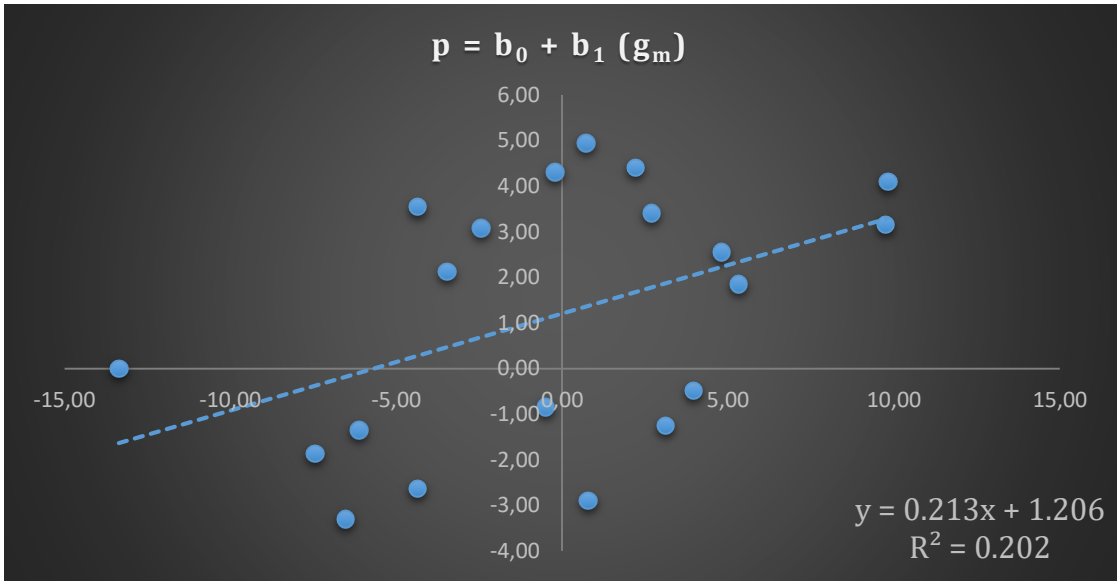

Figure 29: 5.3.4 3rd Kaldor's Law: productivity regressed against manufacturing output

As second step, total productivity growth was regressed against the growth of manufacturing product and this of non-manufacturing employment. The results are alike to the previous case and different enough from the period 1967-1988. The returned estimated regression was:

$$p = 1.142 + 0.106g_m + 0.329e_{nm}$$
$$(0.547)\ (0.116) \quad (0.207)$$

5-33

The coefficient of determination was again low (31%) while in the compared paper was 74%. Although the coefficients of manufacturing product are not far (0.106 & 0.544), the coefficients of non-manufacturing employment have different sign (0.329 & -0.054) which means that affect total productivity in the opposite direction. The F-test value was 3.733 (F critical value = 3.592) and the DW was 2.309. As in the case where the only independent variable was the manufacturing output, the relationship is significant and weak. By checking the significance of the independent variables separately based on their t-value, the calculations gave a t-test value equal to 0.905 for manufacturing product and a t-test value for non-

manufacturing employment equal to 1.586. With the critical value to be 2.11 both variables were found to be non-significant.

Results summary for manufacturing output and non-manufacturing employment in productivity			
R Square	0.305	F Value	3.733
Standard Error	2.437	F Critical Value	3.592
Intercept Coefficient	1.142	T Critical Value	2.11
g_m Coefficient	0.106	DW Value for Pos. Autocor.	2.309
e_{nm} Coefficient	0.329	DW Value for Neg. AutoAcor.	1.691
g_m t-statistic	0.905	d_L	1.1
e_{nm} t-statistic	1.586	d_U	1.537

Table 19: 5.3.4 3rd Kaldor's Law: productivity regressed against manufacturing output and non-manufacturing employment

By closing the part of total productivity, the above regression was repeated with agricultural and tertiary employment growth to replace the non-manufacturing employment. The results again had identical behavior with the previous tests and remain deeply contradictory compared to these of the reviewed paper. The returned estimated regression was:

$$p = 0.952 + 0.108g_m + 0.307e_a + 0.036e_s$$
$$(0.667)\ \ (0.119)\quad (0.196)\quad (0.134)$$

5-34

The R^2 again remains low at 31% in comparison to the initial 82%. The manufacturing coefficients are somehow different, but both positive (0.108 & 0.49). However, as previously, a noticeable difference is found for the other two independent variables. Here, both of them have a positive sign (e_a coeff. = 0.307 & e_s coeff. = 0.036) while in period 1967-1988 they had a negative (e_a coeff. = -0.288 & e_s coeff. = -0.424). The F-test value was 2.378 which makes the regression non-significant (F critical value: 3.239). By checking the significance of every variable

individually, the t values were: t_{gm} = 0.904, t_{ea} = 1.566 and t_{es} = 0.271. As all of them were smaller than the critical value (2.12), it is concluded that none of the independent variables has been found to be significant.

Results summary for manufacturing, agricultural employment and services employment in productivity			
R Square	0.308	g_m t-statistic	0.904
Standard Error	2.506	e_a t-statistic	1.566
F Value	2.378	e_s t-statistic	0.271
F Critical Value	3.239	T Critical Value	2.12
Intercept Coefficient	0.952	DW Value for Pos. Autocor.	2.297
g_m Coefficient	0.108	DW Value for Neg. AutoAcor.	1.703
e_a Coefficient	0.307	d_L	0.998
e_s Coefficient	0.036	d_U	1.676

Table 20: 5.3.4 3rd Kaldor's Law: productivity regressed against manufacturing output, agricultural employment and services employment

Finally, it seems that total productivity is not significantly affected neither by the growth of manufacturing product nor by the rate of change of labour in non-manufacturing sectors. However, this can be explained by two reasons:

1. From what has been shown in the introduction of the empirical chapter and proved academically, during the last thirty years, overall productivity has followed a declining trend for the majority of the developed economies globally. Many of them were advanced manufacturing economies. If the growth of manufacturing product was the panacea for higher productivity, all those economies would channel increasingly more investment and labour to manufacturing sector. However, even today economists and policy-makers are unable to explain what has condemned the western economies in declining and low productivity rates
2. The above fact has led a plethora of neoclassical economists to conclude that there may be other more critical factors which determine the behaviour of total productivity

Period 1995 - 2016					Period 1967 - 1988			
Variable	1	2	3		Variable	1	2	3
Constant	1.206 (0.568)	1.142 (0.547)	0.952 (0.667)		Constant	0.553 (0.921)	0.544 (0.883)	1.432 (1.552)
g_m	0.213 (0.099)	0.106 (0.117)	0.108 (0.119)		g_m	0.555 (7.419)	0.544 (6.247)	0.490 (7.008)
e_{nm}		0.329 (0.207)			e_{nm}		-0.054 (0.266)	
e_a			0.307 (0.196)		e_a			-0.288 (2.075)
e_s			0.036 (0.134)		e_s			-0.424 (1.574)
R^2	**0.20**	**0.31**	**0.31**		**R^2**	**0.73**	**0.74**	**0.82**
DW	2.190	2.309	2.297		DW	2.440	2.402	2.469

Table 21: 5.3.4 3rd Kaldor's Law findings summary in total productivity

The tests in the context of the third Kaldor's law continued by regressing the GDP growth against the growth rates of various sectoral employment types. By starting with the relationship between GDP and employment in manufacturing sector, the OLS method calculated the regression below:

$$g_{GDP} = 2.565 + 0.671e_m$$
$$(0.711)\ (0.123)$$

5-35

The R^2 was 62% however the DW was equal to 1.387 and fell within the inconclusive area for first order positive autocorrelation. With the usage of Cochrane-Orcutt method, the situation changed noticeably. The new estimated regression was:

$$g_{GDP} = 0.689 + 0.241e_m$$
$$(2.328)\ (0.141)$$

5-36

Now the R^2 value fell in 15.5% and very close to the 8% of Drakopoulos and Theodossiou. The manufacturing employment coefficient value here was 0.241 while in the compared paper 0.369. The F-test value was 2.938 obviously lower than the critical value which characterizes the relationship statistically non-significant. In the case of manufacturing employment, the findings of the period 1967-1988 are verified. The relationship between the growth rates of GDP and manufacturing employment is positive, weak and non-significant.

Results summary for manufacturing employment after Cochrane - Orcutt method			
R Square	0.155	F Critical Value	4.41
Standard Error	2.570	DW Value for Pos. Autocor.	1.913
F Value	2.938	DW Value for Neg. AutoAcor.	2.087
Intercept Coefficient	0.689	d_L	1.2
e_m Coefficient	0.241	d_U	1.41

Table 22: 5.3.4 3rd Kaldor's Law: total output regressed against manufacturing employment after Cochrane-Orcutt method

Moving now to the industrial employment, the situation remains similar as far as the findings of the previous period. The coefficient of determination increases as in 1967-1988 but in a higher proportion. The returned regression under OLS method was:

$$g_{GDP} = 2.231 + 0.614e_i$$
$$(0.544)\ (0.082)$$

5-37

As it was mentioned above, R^2 increases at 75% while in the original paper moved to 31%. In terms of percentile change, by replacing manufacturing employment with industrial employment, here it was 487% while in the original paper 387%. The coefficients of industrial employment growth are close: 0.614 here and 0.940 in the former period. The F-test value was 55.46 which makes the regression

significant. Therefore, the relationship between the two variables is regarded positive, robust and significant.

Results summary for industrial employment			
R Square	0.755	F Critical Value	4.41
Standard Error	2.288	DW Value for Pos. Autocor.	1.916
F Value	55.462	DW Value for Neg. AutoAcor.	2.084
Intercept Coefficient	2.231	d_L	1.2
e_i Coefficient	0.614	d_U	1.41

Table 23: 5.3.4 3rd Kaldor's Law: total output regressed against industrial employment

Thirdly, the industrial employment was replaced by total employment. The initial estimated regression gave an R^2 equal with 74% and was:

$$g_{GDP} = 1.102 + 1.122e$$
$$(0.529)\ (0.157)$$

5-38

However, as the DW value (1.41) fell again within the inconclusive area, under the usage of Cochrane – Orcutt method, R^2 declined dramatically and approached that of the initial study. The new estimated equation was:

$$g_{GDP} = 0.609 + 0.670e$$
$$(1.450)\ (0.217)$$

5-39

Now, R^2 was 37% which is low in general but not so much compared to the 7% of the previous period. The major difference was found again on the signs of the employment coefficients between the two studies: 0.670 and -0.728 respectively. The F-test value was 9.868. This means that the regression is positive, weak and

significant while in the original paper the equivalent regression was negative, weak and non-significant.

Results summary for total employment after Cochrane - Orcutt method			
R Square	0.374	F Critical Value	4.41
Standard Error	2.307	DW Value for Pos. Autocor.	2.014
F Value	9.548	DW Value for Neg. AutoAcor.	1.986
Intercept Coefficient	0.609	d_L	1.2
e Coefficient	0.670	d_U	1.41

Table 24: 5.3.4 3rd Kaldor's Law: total output regressed against total employment after Cochrane-Orcutt method

The tests continued by regressing GDP on agricultural employment. Contrary to theoretical assumptions but as already found for the period 1967-1988, it seems that there is not any correlation between the two variables. The data were processed under the Cochrane – Orcutt method as with OLS methodology there was first order positive autocorrelation (DW value = 0.392). Even in that case, the R^2 was very poor (2%). The corrected estimated regression under Cochrane – Orcutt method was:

$$g_{GDP} = -0.073 - 0.026e_a$$
$$(3.505)\ (0.105)$$

5-40

Here the situation between the two studies is almost identical. An R^2 less than 10%, a negative coefficient for the independent variable and a very low F-test value make the regression negative, very weak and non-significant.

Results summary for agricultural employment after Cochrane - Orcutt method			
R Square	0.004	F Critical Value	4.41
Standard Error	2.767	DW Value for Pos. Autocor.	1.611
F Value	0.061	DW Value for Neg. AutoAcor.	2.389
Intercept Coefficient	-0.073	d_L	1.2
e_a Coefficient	-0.026	d_U	1.41

Table 25: 5.3.4 3rd Kaldor's Law: total output regressed against agricultural employment after Cochrane-Orcutt method

Closing now with the tertiary employment, the estimation of the regression gave a very different image from that of the earlier period. The R^2 of 72% is diametrically in opposite direction in comparison to the 3% of the sample from 1967-1988. The F-test value equal with 46.086 makes the regression strongly significant while the DW value of 1.559 excludes the possibility of first order autocorrelation. Regarding the services coefficients, here it is equal with 1.051 while in the reviewed paper is -0.362. So, it seems that employment in services has opposite effects in GDP growth in the two samples.

$$g_{GDP} = -0.222 + 1.051e_s$$
$$(0.570)\ (0.155)$$

5-41

Results summary for tertiary employment			
R Square	0.719	F Critical Value	4.41
Standard Error	2.449	DW Value for Pos. Autocor.	1.559
F Value	46.086	DW Value for Neg. AutoAcor.	2.441
Intercept Coefficient	-0.222	d_L	1.2
e_s Coefficient	1.051	d_U	1.41

Table 26: 5.3.4 3rd Kaldor's Law: total output regressed against tertiary employment

The table below presents the comparison of the results between the two studies:

Period 1995 - 2016						Period 1967 - 1988					
Variable	1	2	3	4	5	Variable	1	2	3	4	5
Constant	0.689 (2.328)	2.231 (0.544)	0.609 (1.450)	-0.073 (3.505)	-0.222 (0.570)	Constant	3.387 (3.786)	2.580 (3.216)	4.490 (5.545)	3.430 (4.075)	4.970 (3.408)
e_m	0.241 (0.141)					e_m	0.369 (1.369)				
e_i		0.614 (0.082)				e_i		0.940 (3.006)			
e			0.670 (0.217)			e			-0.728 (1.475)		
e_a				-0.026 0.105		e_a				-0.346 (1.475)	
e_s					1.051 (0.155)	e_s					-0.362 (0.725)
R^2	**0.155**	**0.755**	**0.374**	**0.004**	**0.719**	**R^2**	**0.08**	**0.31**	**0.07**	**0.10**	**0.03**
DW	1.913	1.916	2.014	1.611	1.559	DW	1.279	1.816	1.451	1.635	1.273

Table 27: 5.3.4 3rd Kaldor's Law findings summary

Regarding the tests for the third law and the relationship between the growth rates of GDP and sectoral employment, the results were mixed comparatively with these of Drakopoulos and Theodossiou. They are aligned as far as manufacturing and agricultural employment but disagree for tertiary and industrial employment. For the case of total employment, the results of this thesis tend to moderately agree with these of the compared period. However, as the coefficient of determination for manufacturing employment is very low while for services is extremely high it can be concluded that the 3rd Kaldorian law is not confirmed for the period 1995-2016. However, the same general conclusion applies to the paper of Drakopoulos and Theodossiou for the period 1967 – 1988 as well. Table 28 integrates the main findings for every law for both periods.

			1995 - 2016			1967-1988		
Law	Dependent variable	Independent Variable	R^2	Coefficient Sign	Significance *	R^2	Coefficient Sign	Significance *
1st	g_{GDP}	g_m	Medium	+	Y	Strong	+	Y
1st	g_{GDP}	g_i	Medium	+	Y	Strong	+	Y
1st	g_{GDP}	g_a	Weak	-	N	Weak	+	N
1st	g_{GDP}	g_s	Strong	+	Y	Strong	+	Y
2nd	p_m	g_m	Medium	+	Y	Strong	+	Y
2nd	g_m	x	Weak	-	N	Medium	+	Y
2nd	g_i	x	Weak	+	N	Medium	+	Y
3rd	g_{GDP}	e_m	Weak	+	N	Weak	+	Y
3rd	g_{GDP}	e_i	Strong	+	Y	Medium	+	Y
3rd	g_{GDP}	e	Medium	+	Y	Weak	-	N
3rd	g_{GDP}	e_a	Weak	-	N	Weak	-	N
3rd	g_{GDP}	e_s	Strong	+	Y	Weak	-	N
3rd	p	g_m	Weak	+	Y	Strong	+	Y
3rd	p	$g_m + e_{nm}$	Medium	+ +	**Y** - N - N	Strong	+ -	**Y** - Y - N
3rd	p	$g_m + e_a + e_s$	Medium	+ + +	**N** - N - N - N	Strong	+ - -	**Y** - Y - N - N

*: For significance, the first letter in every cell shows the overall significance of the regression and the next ones the significance per independent variable separately

Table 28: 5.3.4 Kaldor's Laws findings summary: R^2, coefficient sign and significance

5.3.5. Labour Productivity in Services Sector

As per third Kaldor's law, the growth of manufacturing output seems to have beneficial role in both total and intra-sectoral productivity as it attracts labour from other sectors. Thus, labour productivity in these sectors improves. However, the performed tests in case of Greek economy for the period 1995-2015 did not validate this statement. For this reason, as it was mentioned in the section of scope and methodology, a group of other macroeconomic variables will be tested regarding their impact in labour productivity ratio of tertiary sector and more specifically in business services.

In section 5.3.1 it was shown that the tertiary GDP had a share of 70% to 80% of the total GDP for the period 1995-2016. In combination with the determination coefficient of 89% that was found in the regression analysis between these two variables in the performed tests for the 1st Kaldorian Law (Table 12), it is expected their growth rates to have a similar trend and this can be visualized in the graph below. Total and Services GDP have 0.9% and 1.2% average annual growth rates while their highest values are 5.8% and 6.8% and their lowest values are -9.1% and -8.9%. It seems that the small changes of the tertiary GDP growth rates keep in the same levels and the total GDP growth rates regardless the wide changes of the rest sectors and especially these of the constructive sector.

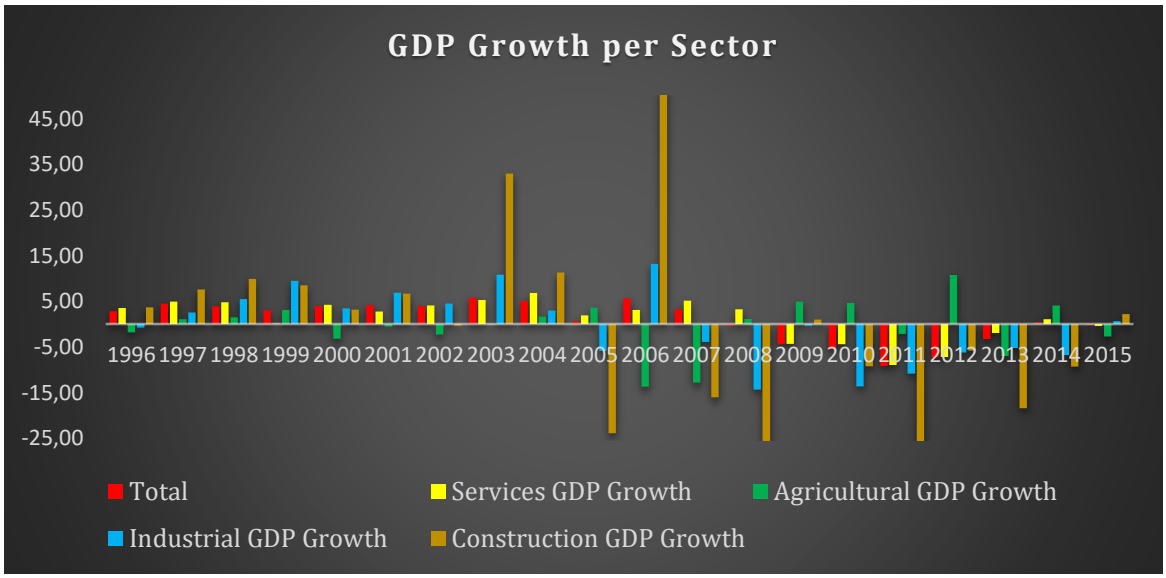

Figure 30: 5.3.5 GDP growth per sector 1995 – 2015

Source: OECD (2017)

However, the basic question here is if the same dependence exists in terms of labour productivity growth for the two sectors. Thus, for the examined period, the average productivity growth was 1.1% for the whole economy and 0.5% for the tertiary sector. The highest values were 4.8% and 6.9% while the lowest values were -3.1% and -8.7% respectively. Similarly to the case of GDP, these two variables tend to have the lowest volatility. Again, there is evidence that the tertiary sector seems to have causal effects in the whole economy in terms of labour productivity. Thus, total labour productivity was regressed against tertiary

labour productivity. The regression analysis gave an R^2 equal to 61% which means that the volatility of total labour productivity is satisfactorily explained by the fluctuations of tertiary labour productivity. The output regression was:

$$LP_{TOT} = 0.955 + 0.428LP_S$$
$$(0.369)\ (0.083)$$

5-42

The F-test value was 26.9 which proves that the above relationship is statistically significant. The DW criterion rejected the hypothesis for autocorrelation (d = 2.28 & 4-d = 1.72 – d_L = 1.20 & d_U = 1.41).

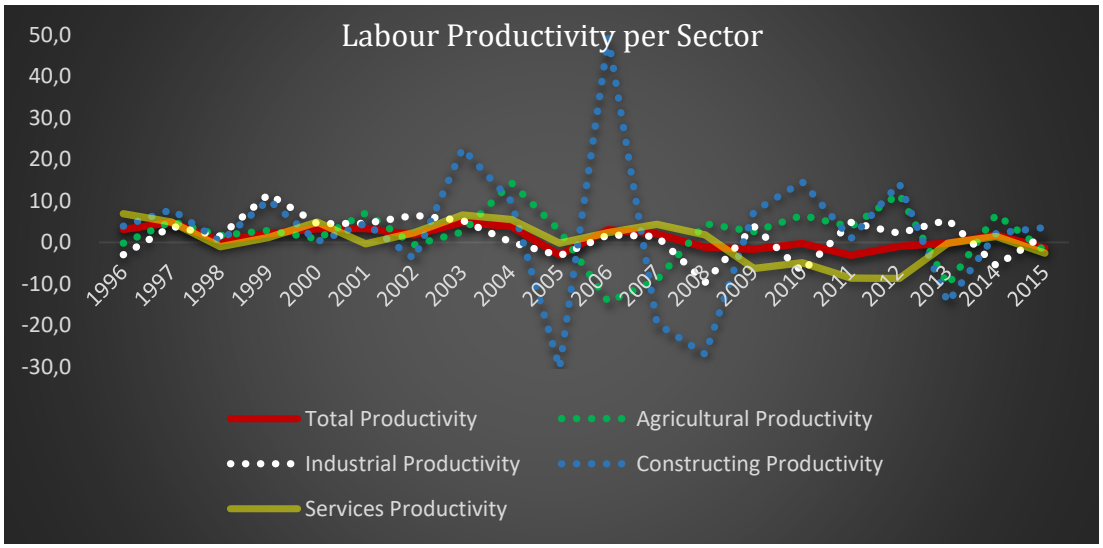

Figure 31: 5.3.5 Labour productivity per sector 1995 – 2015

Source: OECD (2017)

Results summary for Total against Tertiary Labour Productivity			
R Square	0.613	F Critical Value	4.41
Standard Error	1.607	DW Value for Pos. Autocor.	2.28
F Value	26.903	DW Value for Neg. AutoAcor.	1.72
Intercept Coefficient	0.955	d_L	1.2
LP_s Coefficient	0.428	d_U	1.41

Table 29: 5.3.5 Total labour productivity regressed against tertiary labour productivity

Thus, it is indicated that in a mainly tertiary economy, the boost of services labour productivity will have positive effects in total productivity too. From this perspective, there is academic interest to investigate which are the crucial determinants of tertiary labour productivity.

5.3.6. Decomposition of Labour Productivity in Business Services Sector and its Determinants

Although there are various measures of labour productivity depending the research subject and needs, officially is defined as the GDP per hour worked. It measures how efficiently labour input is combined with other factors of production and used in the production process. Labour input is calculated as the total hours worked by all occupied employees in production. However, it is a quantitative measure as it counts the productivity of labour based on the personal capacities of workers or the intensity of their effort. So, it does not provide any information about other factors which affect it such as capital, intermediate inputs, technical, organizational and efficiency change and economies of scale (OECD). From the above, the mathematic term of labour productivity is:

$$LP = \frac{GDP}{Total\ Hours\ Worked}$$

5-43

The above equation implies that GDP should grow proportionally faster than labour input. This requires labour intensification and optimization techniques. In the effort of finding the hidden factors behind this ratio, as a first step, it should be defined if the labour productivity of the Greek business tertiary sector is affected significantly by both variables. Therefore, tertiary labour productivity is regressed separately against tertiary GDP and total hours worked in services sector:

$$LP_{TER} = b_0 + b_1 GDP_{TER} + \varepsilon_t$$

5-44

$$LP_{TER} = b_0 + b_1 TotalHoursWorked_{TER} + \varepsilon_t$$

5-45

The OLS method gave the below results:

Variable	1	2	3 (C.O)
Constant	-1.572 (0.410)	-0.313 (0.948)	-0.961 (1.216)
GDP	0.589 (0.052)		
Total Hours Worked		0.889 (0.356)	0.728 (0.372)
R^2	**0.873**	**0.247**	**0.184**
DW	1.764	**1.264**	1.519
dL - dU	1.221 - 1.420	1.221 - 1.420	1.221 - 1.420
t_{value} | Sig	11.417 | 0.000	2.499 | 0.022	1.957 | 0.067

Table 30: Analysis of the relationship between labour productivity and GDP – Total Hours Worked

As it can be seen in the table above, for the period 1995 – 2016, the relationship between Greek business tertiary labour productivity and:

- Services GDP, is robust, positive and significant
- Total hours worked in tertiary sector, is weak, positive and non-significant

Therefore, the analysis of the empirical part should focus now on the factors behind the rate of change of Services GDP.

One major criterion of differentiation of the factors that affect the GDP and the productivity of a sector of the economy is the definition of this sector as labour intensive or capital intensive. An economy sector which is labour intensive means that there is more investment in labour rather than in capital. In contrary, a capital intensive sector is this where the largest part of investment is allocated into gross fixed capital formation. Therefore, as a next step, the tertiary GDP is expressed as a regression of physical and human capital plus the profit:

$$GDP = b_0 + b_1 GFCF + b_2 LabourCompensation + b_3 Profit + \varepsilon_t$$

5-46

where GFCF reflects the Gross Fixed Capital Formation and Labour Compensation is the gross wages and salaries for labour. All variables refer to the sectors of business services. The regression analysis gave the results below:

Model Fit Summary

	R	R^2	Adj. R^2	S.E	DW	dL - dU	F	Sig
Values	0.973	0.946	0.937	1.9285	1.593	1.026 – 1.669	99.430	0.000

Table 31: 5.3.6 Model Fit Summary of regression 5-46

As the DW value fell within the inconclusive area for autocorrelation, the Cochrane-Orcutt methodology was used for definite results. For multicollinearity, the Tolerance and VIF criteria were preferred.

Model Fit Summary

	R	R^2	Adj. R^2	S.E	DW	dL - dU
Values	0.963	0.927	0.907	1.864	1.684	1.026 – 1.669

Table 32: 5.3.6 Model Fit Summary of regression 5-46 after Cochrane-Orcutt

Anova

	Sum of Squares	df	Mean Square
Regression	659.471	3	219.824
Residual	52.112	15	3.474

Table 33: 5.3.6 Summary Output of regression 5-46 - Anova

Regression Coefficients

	Unstandardized Coefficients		Standardized Coefficients		
	B	SE	Beta	t	Sig
Constant	0.092	0.597		0.155	0.879
GFCF	0.006	0.027	0.020	0.236	0.817
Labour Compensation	0.465	0.069	0.527	6.709	0.000
Profit	0.393	0.048	0.658	8.263	0.000

Table 34: 5.3.6 Regression 5-46 Coefficients

Collinearity Statistics

	Tolerance	VIF
GFCF	0.543	1.840
Labour Compensation	0.628	1.592
Profit	0.668	1.498

Table 35: 5.3.6 Regression 5-46 Collinearity Statistics

The conclusions from the analysis above are:

- The relationship between GDP and Gross Fixed Capital Formation, Labour Compensation and Profit is robust and significant
- All the VIF values of the independent variables are less than 5 so multicollinearity is absent
- GDP is significantly and positively affected only by labour compensation and profit
- Thus, for the period 1995-2016, the sector of services in Greece was labour intensive

The last conclusion aligns with academic literature as traditionally the tertiary sector is a market where services are provided by people and investment in capital is occasional.

Based on the above conclusions, it is understood that the Greek business tertiary sector is labour intensive so its productivity should be explained by

factors which promote labour intensification and optimization. On the other hand, there is a range of factors that do not refer to technical progress but affect the labour cost of production in tertiary sector. Therefore, as last part of this section, the labour cost will be regressed against a set of determinant variables that will define if the investment in labour targets to a higher productivity or to short-term profit. As labour cost will be used the variable of labour compensation (LC) from equation 5-46 which includes the gross wages and salaries of business tertiary sector. The independent variables will be:

- Gross Fixed Capital Formation as GFCF
- Profit as PROFIT
- Employees with tertiary education as EDU
- Minimum market salary as SALARY
- Unemployment rate as UNEMPLOYMENT
- Unit Labour Cost as COST
- Total Hours Worked as HOURS

Based on the above, the relationship between the labour cost and its determinants is defined as:

$$LC = b_0 + b_1 GFCF + b_2 PROFIT + b_3 EDU + b_4 SALARY + b_5 UNEMPLOYMENT + b_6 COST + b_7 HOURS + \varepsilon_t \quad 5\text{-}47$$

The OLS method gave the results below:

Model Fit Summary

	R	R^2	Adj. R^2	S.E	DW	dL - dU	F	Sig
Values	0.945	0.893	0.835	3.269	1.882	0.637 – 2.290	15.450	0.000

Table 36: 5.3.6 Model Fit Summary of regression 5-47

In cases with so many variables, the OLS method is possibly subject to autocorrelation issues. So, from Table 37, the only value that is reliable is the $F_{0.05,}$

$_{7, 13}$ = 15.450 which shows that the above relationship in statistically significant. Proceeding now with the Cochrane-Orcutt methodology for fixing the autocorrelation issues and the Tolerance and VIF criteria for detecting multicollinearity, the results were:

Model Fit Summary

	R	R^2	Adj. R^2	S.E
Values	0.938	0.879	0.791	1.747

Table 37: 5.3.6 Model Fit Summary of regression 5-47 after Cochrane-Orcutt

Anova

	Sum of Squares	df	Mean Square
Regression	244.366	7	34.909
Residual	33.585	11	3.053

Table 38: 5.3.6 Summary Output of regression 5-47 - Anova

Regression Coefficients

	Unstandardized Coefficients		Standardized Coefficients		
	B	SE	Beta	t	Sig
Constant	-1.003	0.828		-1.212	0.251
GFCF	-0.025	0.027	-0.131	-0.959	0.358
Profit	0.692	0.109	1.804	6.378	0.000
Education	0.469	0.508	0.201	0.923	0.376
Minimum Salary	-0.374	0.125	-0.482	-2.985	0.012
Unemployment	-0.044	0.057	-0.150	-0.779	0.452
Unit Labour Cost	0.576	0.163	0.728	3.521	0.005
Hours Worked	0.753	0.268	0.447	2.804	0.017

Table 39: 5.3.6 Regression 5-47 Coefficients

Collinearity Statistics

	Tolerance	VIF
GFCF	0.440	2.272
Profit	0.281	3.557
Education	0.128	7.841
Minimum Salary	0.450	2.224
Unemployment	0.182	5.500
Labour Cost	0.428	2.335
Hours Worked	0.357	2.799

Table 40: 5.3.6 Regression 5-47 Collinearity Statistics

The brief conclusions from the analysis above are:

- The relationship between labour cost in business tertiary sector and its determinants is robust and significant. All the VIF values of the independent variables are less than 10 so multicollinearity is absent. According to Christou (p. 207, 2004), there are not standard critical values for tracking multicollinearity. The general rule is that as higher as the VIF value gets, the more intense can be the problem of multicollinearity between two independent variables. For the author, variables with VIF values higher than 10 should be definitely removed by the regression. In more conservative approaches, the VIF value should be less than 5 or 3. In the case of tolerance coefficient, the closer the estimated value gets to zero, the most possible is for that independent variable to be auto-correlated with another. As in this case there are several independent variables (7) the limit of 10 is acceptable
- The labour cost is significantly and positively affected in order of significance by Profit, Unit Labour Cost and Total Hours Worked
- The labour cost is significantly and negatively affected by Minimum Annual Salary as when it gets lower more labour can be attracted

- The Gross Fixed Capital Formation and the employment of people with tertiary education which are indexes of technical progress do not have significant effects in labour cost. However, both of them have a correct coefficient sign according to theory (GFCF: -, Education: +). As GFCF increases, LC declines as less labour is required. In opposite, more skilled labour raises the wages and the labour cost
- Thus, for the period 1995-2016, the business tertiary labour productivity is driven mainly by the level of profit and the minimum annual salary
- The previous statements explain why tertiary labour productivity has been in general low during the examined period with intense volatility and negative values during the years 2009 – 2013 when Greek economy was under the impact of the heavy external debt crisis

5.3.7. The Autoregressive Model of Labour Productivity

As it was described previously in section 5.2.2, a first-class autoregressive model would be used and analyzed for concluding if business tertiary labour productivity can be predicted by its past values. That autoregressive model was:

$$LPTer = b_0 + b_1 LPTer_{t-1} + \varepsilon_t$$

5-48

The OLS method for the above regression gave the results below:

Regression Statistics	
Multiple R	0.61
R Square	0.37
Adjusted R Square	0.34
Standard Error	3.809
Observations	20

Table 41: 5.3.7 Summary Output - Regression Statistics (1 Lag)

Anova

	df	SS	MS	F	Significance F
Regression	1	155.12	155.1201	10.689	0.004
Residual	18	261.199	14.511		
Total	19	416.32			

Table 42: 5.3.7 Summary Output – Anova (1 Lag)

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-0.488	0.854	-0.572	0.575	-2.282	1.305
Lagged Variable	0.597	0.183	3.269	0.004	0.214	0.981

Table 43: 5.3.7 Summary Output – Estimated variables (1 Lag)

The calculations for the estimated regression gave an R_2 equal to 0.37 which means that only 37% of the movements of business tertiary labour productivity growth rate can be explained by their previous year movements. In addition, the relationship is positive (b_1 = 0.597) and significant for 95% confidence level (F value = 10.689 | $F_{0.05,\,1,\,19}$ = 4.38).

For getting better results, an extra lag was added in the model so it transformed into a second-class autoregressive model:

$$LPTer = b_0 + b_1\, LPTer_{t-1} + b_2\, LPTer_{t-2} + \varepsilon_t$$

5-49

Again, the results were similar as previously:

Regression Statistics

Multiple R	0.59
R Square	0.35
Adjusted R Square	0.27
Standard Error	3.976
Observations	19

Table 44: 5.3.7 Summary Output - Regression Statistics (2 Lags)

Anova

	df	SS	MS	F	Significance F
Regression	2	134.875	67.438	4.265	0.033
Residual	16	252.982	15.811		
Total	18	387.86			

Table 45: 5.3.7 Summary Output – Anova (2 Lags)

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-0.467	0.923	-0.506	0.619	-2.423	1.305
1 Lag Variable	0.667	0.249	2.68	0.016	0.139	0.981
2 Lags Variable	-0.153	0.242	-0.633	0.536	-0.666	0.359

Table 46: 5.3.7 Summary Output – Estimated variables (2 Lags)

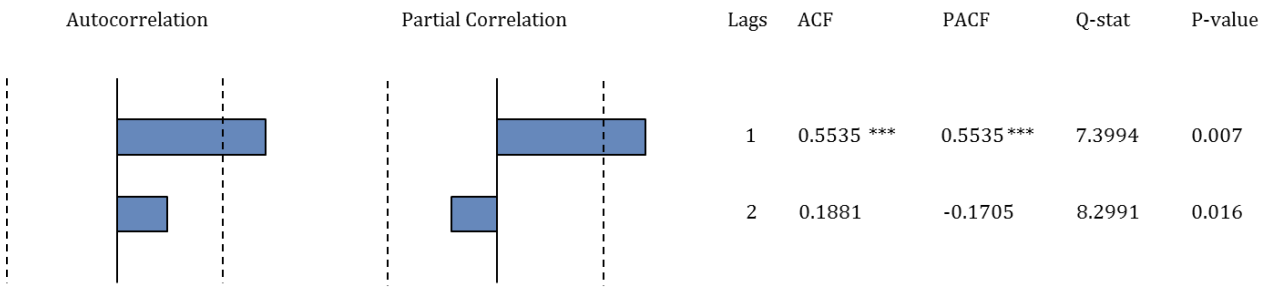

Figure 32: 5.3.7 Autocorrelation and Partial Correlation with 1 and 2 Lags

The above analysis shows that with two lags the R^2 value remains very low (35%) while only the variable of $LPTer_{t-1}$ is statistically significant.

The above results can have a real econometric value only in case that the examined autoregressive model is found to be stationary. For this reason, an Augmented Dickey-Fuller test was executed with the hypothesis for test to be:

$$H_0: b_1 = 1$$

5-50

Augmented Dickey-Fuller Test Results

Including 1 lag for (1-L) tertiary labour productivity (max was 1, criterion AIC) - Test with constant term

Sample size	20
Null hypothesis for unit root existence	$b_1 = 1$
Model	$(1-L)y = b_0 + (b_1-1)*y(-1) + \varepsilon$
Estimated value of $(b_1 - 1)$	-0.403
Test statistic: tau_c(1)	-2.203
p-value	**0.2112**
1st order autocorrelation coefficient for ε	0.074

Table 47: 5.3.7 Augmented Dickey-Fuller Test Results

In ADF tests, in order the null hypothesis to be accepted, the p-value must be higher than the significance level. In this case, there is not stationarity in the time serie. In opposite, if p-value is lower than the significance level, the null hypothesis is rejected and the time serie is stationary. As 0.211 is larger than 0.05, the null hypothesis is accepted and the time-serie of tertiary labour productivity with one lag is proved to be non-stationary. In other words, the annual growth rate of tertiary labour productivity for the last twenty years cannot be used to forecast next year's value. The above results are also verified by the graph below, where there is not any normal trend in the behavior of tertiary labour productivity.

Figure 33: 5.3.7 Tertiary labour productivity trend

The existence of a unit root in the model raised the need for using the first difference of the business tertiary labour productivity growth rates. This approach transformed the autoregressive model with one or two lags into stationary. However, again the results were poor:

	Coefficients	Standard Error	t Stat	P-value
Intercept	-0.585	1.017	-0.575	0.573
d_LP_1	0.072	0.241	-0.302	0.767

Table 48: 5.3.7 Summary Output – Estimated variables for the first difference of the growth rates (1 Lag)

OLS with the first difference of the tertiary labour productivity growth rates and 1 lag

Mean of dependent variable	0.542	Stand. Deviation	4.279
Sum of squared residuals	327.85	Stand. Error	4.392
R^2	0.005	Adjusted R^2	-0.053
$F_{(0.05, 1, 17)}$ Test Value	0.091	P-value (F)	0.767
Log-likelihood	-54.017	Akaike Criterion	112.034
Schwarz criterion	113.922	Hannan-Quinn	112.354
ρ	-0.061	DW	2.025

Table 49: 5.3.7 Summary Output - Regression Statistics (1 Lag)

	Coefficients	Standard Error	t Stat	P-value
Intercept	−0.504	0.888	−0.5678	0.5786
d_LP_1	−0.140	0.206	−0.6819	0.5057
d_LP_2	−0.528	0.211	−2.506	0.0242 **

Table 50: 5.3.7 Summary Output – Estimated variables for the first difference of the growth rates (2 Lags)

OLS with the first difference of the tertiary labour productivity growth rates and 2 lags

Mean of dependent variable	-0.239	Stand. Deviation	4.188
Sum of squared residuals	207.968	Stand. Error	3.724
R^2	0.303	Adjusted R^2	0.209
$F_{(0.05, 2, 15)}$ Test Value	3.253	P-value (F)	0.067
Log-likelihood	-47.564	Akaike Criterion	101.496
Schwarz criterion	103.799	Hannan-Quinn	101.496
ρ	-0.067	Durbin's h	0.587

Table 51: 5.3.7 Summary Output - Regression Statistics (2 Lags)

5.4. Empirical Conclusions

5.4.1. Manufacturing Sector Effects in Greek Economy Growth

The paper of Drakopoulos and Theodossiou concluded that manufacturing sector has been a driving force of growth for the Greek economy. By testing the three Kaldorian laws, they found that the 1st and the 2nd law are strongly verified for the period 1968 - 1989. Analytically, in the context of the 1st law, they found that the GDP is positively and strongly affected by manufacturing, industrial and tertiary output while for agricultural output the relationship was weak. The empirical part of this thesis was in accord for the cases of tertiary and agricultural output but found moderate support for these of manufacturing and industrial. Regarding the 2nd law, this thesis found a moderate, positive relationship between manufacturing output and manufacturing productivity while the original paper had concluded that this relationship was robust.

For the 3rd law, this thesis does not find any evidence between overall productivity and manufacturing output. The same happens when the variables of

non-manufacturing employment or jointly these of agricultural and services employment are added in the relationship. Drakopoulos and Theodossiou had found satisfactory findings. On the other hand, when GDP was regressed against various types of employment, the results between the two studies were similar for the cases of manufacturing, total and agricultural employment (low R^2) but contrary for these of industrial and services employment. However, both studies seem to reject the 3rd law regarding the relationship of total GDP and sectoral employment.

In a similar study but with different approach (ARDL method) and a larger sample, Katrakilidis, Tsaliki and Tsiakis (2013) found that for the period 1970 - 2006 all Kaldorian laws are accepted for Greece. Apart from its beneficial role in growth, the expansion of manufacturing sector attracts more labour improving in that way the productivity of the rest sectors as well. Moreover, demand is a key force in the growth process thus the design of economic policies should contain measures that foster the demand side of the economy and boost the manufacturing production (Katrakilidis et al., p. 70-71, 2013). In another paper, Tsaliki and Alexiou (2010), for a set of five (5) Mediterranean economies including Greece during the period 1975 - 2006, verify again the three Kaldorian laws reaching the same conclusions with the paper of Katrakilidis et al. What is more, they outline that their study analyzed data during a gradual deindustrialization period. The latter constitutes a major reason of differentiation with the results of this thesis. The sample of this thesis was taken from the period 1995 - 2016 when the deindustrialization of Greece was almost over and the economy had already transformed into a tertiary economy (Tsaliki & Alexiou, p. 144–145 & 153, 2010). Paschaloudis and Alexiadis (2001) tested the 2nd Kaldorian law on thirteen (13) administrative Greek regions for the period 1974 - 1998. They found increasing returns to scale in the manufacturing sector verifying that the respective sector is an engine of growth. However, they also found the same evidence for services sector. This conclusion was of utmost importance because it proved that the tertiary sector can be a leading sector of growth. From the moment that Greece has transformed into a tertiary economy, this means that a productivity boost in

services sector can have the same beneficial effects as manufacturing sector has been proved to have (Paschaloudis & Alexiadis, p. 468, 2001).

5.4.2. Determinants of Labour Productivity in Business Services Sector in Greece during 1995 - 2016

Until now, there has been limited to non-existent academic literature about labour productivity determinants of business tertiary sector. However, as the tertiary sector has gathered the largest part of the labour and is responsible for more than 75% of the total GDP in the vast majority of western developed economies, it is rational its labour productivity trend to constitute the main force that directs the overall productivity of the economy. Therefore, the low and intensively volatile productivity rates of most European economies could be ascribed to the productivity performance of their tertiary sector.

One reason for the limited academic literature is that this sector consists of several disparate sub-sectors. Moreover, the academic interest has focused more on manufacturing sector which has been proved to have increasing returns to scale. In addition, business services are a heavily labour intensive sector where technical progress facilitates human labour but does not substitute it. Therefore, depending the level of physical and human capital, it is the quality and not the quantity of the services that is mainly affected and this cannot be measured accurately. What is more, the most valuable aspect of tertiary sector is its contribution under an indirect way to economic growth by generating knowledge and productivity spill-overs for other industries.

In the empirical part of this thesis, it has been found that the business services labour productivity of Greece for the period 1995 – 2016 is affected significantly and positively only by the volatility of the generated GDP within this sector. On the other hand, the total hours worked in the sector did not have any significant effect in its labour productivity. Technically, under these findings, the 2nd Kaldorian law adapted on business tertiary sector is accepted. By validating the second law, the empirical part tried to decompose gradually the GDP variable. Initially, it is proved

that the business tertiary sector is labour intensive and this is in line with the theoretical background. The growth rate of labour productivity in business services sector is affected positively and significantly only by the growth rates of investment in labour (labour compensation) and profit. In contrary, gross fixed capital although it has the correct coefficient sign, is found to be non-significant (Table 34). Thus, it is concluded that the investment in labour constitutes the main factor which defines the sold price of total provided services (GDP) and therefore, the labour productivity behaviour of business tertiary sector.

Through this decomposition process, it is revealed that labour compensation is the main determinant of labour productivity in business tertiary sector. As it is known, the labour cost is incorporated in the final price of the sold services and their difference gives the profit. Consequently, at the end, the empirical part examined the relationship of investment in labour against seven (7) other variables. The purpose was to discover if factors of long-term, sustainable labour productivity determined the level of labour compensation. The results showed that the level of labour compensation is affected significantly and positively by the rate of profit, unit labour cost and total hours worked while negatively by annual minimum salary (Table 39). Contrariwise, gross fixed capital, education and unemployment do not have significant effects. The variable of total hours worked is ignored as it is normal to affect positively and significantly the labour cost as more working hours presuppose more workforce and more salaries. Similarly, the results for unit labour cost do not have any value for conclusions as labour compensation is the numerator part of the unit labour cost ratio and is rational a positive significant relationship to exist between the two variables. For both variables however, their results were in accord with theory and an indication that the applied methodology did not export random calculations.

However, the most important finding is that labour compensation is determined positively by the rate of profit, negatively by the annual minimum salary but not significantly by the investment in gross fixed capital, the educational level of the workforce and the unemployment rate. However, all three non-significant variables had the correct coefficient sign. This leads to the conclusions below:

- The rate of profit constitutes a principal factor of the cyclical behaviour of business tertiary labour productivity. In times of high profitability, the need for investment in more labour arises. In contrary, in periods of crisis, the demand for labour reduces
- The minimum annual salary allows the corporations to attract more employees. This pushes upwards total labour compensation but increases the rate of profit as more employees provide more services but at a lower unit cost
- The non-significance of gross fixed capital in the relationship (5-47) implies that there is not substitution of labour by machinery. So technical progress through machinery is absent in this case. Moreover, the capacity of productivity remains unaffected and long-term labour productivity cannot be sustained. The **minus** coefficient in the results correctly showed that as the investment in gross fixed capital grows the labour cost drops as less labour in terms of working hours or wages is required
- The non-significance of education in the relationship (5-47) can be explained by various reasons. Firstly, from the beginning of the examined period, the tertiary education was already a prerequisite for most of the new employees in the majority of business services sub-sectors. Furthermore, the last two decades, the admission of young people in the various types of tertiary education became a usual state after graduation from secondary education. It is concluded therefore, that today the positive effects of better educated and skilled human capital can be realized mainly in developing economies. In the developed ones, it is treated as a prerequisite for a young person to work in business services sector. What is more, as tertiary education can be met to the vast majority of employees in business tertiary sector, it is rational not to constitute a labour compensation determinant. However, the **plus** coefficient confirms that tertiary education raises the labour cost through better a better wage rate
- All the above statements offer an accurate explanation why business tertiary labour productivity and overall labour productivity present low and intensively volatile growth rates the last twenty years. Profit remains

the main determinant of business tertiary labour productivity both directly and indirectly through the variable of labour compensation. Thus long-term, high and sustainable GDP growth rates cannot be achieved. Above all, this justifies and the attribute of the cyclical behaviour in tertiary labour productivity growth rates

- Finally, the forecast of future values of labour productivity in business services sector based on its past values seems to be impossible for the Greek example. However, as most of the developed economies remain tertiary ones and they have confronted with low, GDP growth rates for prolonged periods probably it can be assumed that the policymakers have stopped paying the same attention for the ratio of labour productivity as in the past. Moreover, this creates the doubt if labour productivity can constitute a contemporary reliable index of competiveness of tertiary economies especially from the moment that there is provision of services and not of products.

The results about the effects of profit in wages and productivity are in compliance with the findings of Maniatis and Passas (2014) for Greek economy from 1958 until 2010. Although their study focuses on the general private economy, they conclude that profit behaviour has been a key force of determination of growth in productivity and wages in all three sub-periods ('Golden Age': 1958 – 1972, Stagflation crisis: 1973 – 1984, Neoliberalism: 1985 – 2010). More specifically, for the last period which overlaps with the sample period of this thesis, they state that the limited capacity of government and private companies to apply offensive, neoliberal policies achieved a slight increase in profitability based mainly on the exploitation of labour. The most important consequence in this occasion was a very slow productivity growth (Maniatis & Passas, p. 108 – 109 & 126, 2014). What is more, in another work of Maniatis and Passas (2014) again for Greek economy for the period 1986 – 2008, it is stated that as labour productivity grows, the same stands for wages but to a less extent by increasing in that way the wage – productivity gap and possibly the profit share. This leads to two conclusions: firstly, although the empirical results showed that a fall in minimum wage raises labour cost by attracting more labour and affects

positively labour productivity, the paper of Maniatis and Passas concludes that a higher labour productivity pushes upwards wages but not proportionally. The findings of the two studies cannot be regarded contradictory as the causation in these two cases goes to opposite direction and this thesis analyzes labour productivity only for business tertiary sector. However, it allows to assume that a bilateral causality can exist between labour productivity on the one hand and wages and profit on the other (Maniatis & Passas, p. 63, 2014). In the same context, Mariolis, Rodousakis and Tsoulfidis (2006), analyzed the behaviour of labour productivity, wages, profit and wage – profit ratio during the period 1988 - 1997 for Greek economy in overall measured in terms of market prices, labour values and prices of production. They decomposed the rate of profit into its two constituent components, the profit-wage ratio and the capital productivity. They were also based on the theoretical assumption that the profit-wage ratio depends inversely on wages and directly on labour productivity while capital productivity is inversely affected by capital intensity. In terms of market prices, they found that for more the 55% of the sample, labour productivity, profit and wages moved altogether to the same direction with profit to change proportionally more than wage in all cases. In terms of prices of production, they found that for the 77% of the sample, labour productivity, profit and wages moved altogether to the same direction with profit to change proportionally more than wage in all cases except than one. Again, it can be assumed that between labour productivity and profit there may be a bi-causational relationship (Mariolis et al., p. 197 & 181, 2006).

6. Conclusions

Through the theoretical and empirical analysis of the main growth theories and models in the previous chapters, it can be stated with certainty that reality remains far from the academic predictions. Technical progress was unable to maintain growth in satisfactory levels. Moreover, it could not lead to real convergence between developed and developing economies. In addition, it can be said that growth was sacrificed by the efforts of the policymakers of the developed economies for general stability in several other key macroeconomic variables such as inflation, debt, unemployment, bank liquidity etc. Of course, most of the existing growth models had not predicted the heavy de-industrialization of the western world and the labour transfer into tertiary sector which is majorly labour intensive. Thus mechanization cannot substitute labour but only to support it. Obviously, the inability to replace human by machines was a reason for the private sector to abolish the normal shift of eight hours of work in order to avoid to occupy more workforce.

By using the example of Greek business tertiary sector with data from the period 1995 - 2016, this thesis showed that the labour productivity of a tertiary economy is driven by the rate of profit and wages so it cannot achieve sustainable high growth rates. This is rational because the tertiary sector sells humans who provide services, not products. Therefore, the profit will be always a priority against wages. Another significant conclusion of this thesis is that labour productivity in tertiary economies seems to be weak to describe adequately their performance and competitiveness as it is just a ratio of the total price of sold services which incorporate the labour cost and the profit to the total hours worked which are proportional to the labour cost. Probably, this is the reason for which the developed economies have pointed out the urgent need for the development of the scientific areas of artificial intelligence and machine learning. When the fixed investment in machines that will be able to provide the same quality of services as labour substitutes humans, the productivity of tertiary sector and the economy in general will boost as happened with the manufacturing sector.

However, this may signal the beginning of a new global crisis as unemployment and insufficient demand for services and products will make profit to evaporate.

By closing this chapter, it must be mentioned that the approach of this thesis was a primitive attempt to decode the labour productivity of such a wide sector like business services which consist of seven (7) sub-sectors. The most severe limitations in this research were the sample of one country and the short time period of available data. A larger country sample and timeframe or the analysis of a specific sub-sector separately are possible to give different results. What is more, it must be highlighted that a big part of the data sample referred to a period of deep crisis for Greek economy. In such cases most of the macroeconomic variables are violated and all the policies turn exclusively to the immediate profit recovery. However, if it is actually critical for Greek business services labour productivity to grow this requires continuous investment in gross fixed capital. Tertiary sector should not be solely labour-intensive and the investment in modern technology and infrastructure should have two main goals: the facilitation of the employees to provide the same service at same quality but at less time and the capability any bureaucratic procedures which are part of the provision process of new services or products to be automatically executed by information technology applications. Furthermore, the revival of the manufacturing, industrial and construction sectors should become again a primary goal in the agenda of the government by focusing in sub-sectors where Greece has been traditionally highly competitive and indicate opportunities for exports.

At the end, as the scientific interest about growth never depletes, the most challenging part of the future academic literature will be the search of specific ways which can boost the labour productivity of the tertiary economies by keeping unaffected all the fundamental social rights of the workforce such as employment, minimum wage, working hours and pension age limits.

7. References

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