The Effects of Saving on Economic Growth

Does more saving lead to more growth?

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ABSTRACT

The central theme of this thesis is the relationship between saving and economic growth and aims at providing a thorough analysis of this relationship, both theoretically and empirically. Towards this aim, I start with a general discussion of economic growth theory, with special attention to the role of saving in these models. Furthermore, I present several empirical analyses with often relatively large data sets. The empirical part of this thesis contains a Granger causality study and different panel data studies. Regarding the causality part, I find that a majority of the countries in the data set show a causal relation between gross domestic saving and real per capita economic growth, but the direction is ambiguous. Results indicate that the direction of causality might depend on a country's income level. The panel data studies show that saving does have a positive significant effect on economic growth. I find that the gross domestic saving rate positively affects the real per capita economic growth rate. When I divide the saving rate into private and public saving, the results indicate that public saving has a positive significant effect on economic growth. I cannot find a significant effect for private saving on real per capita economic growth.

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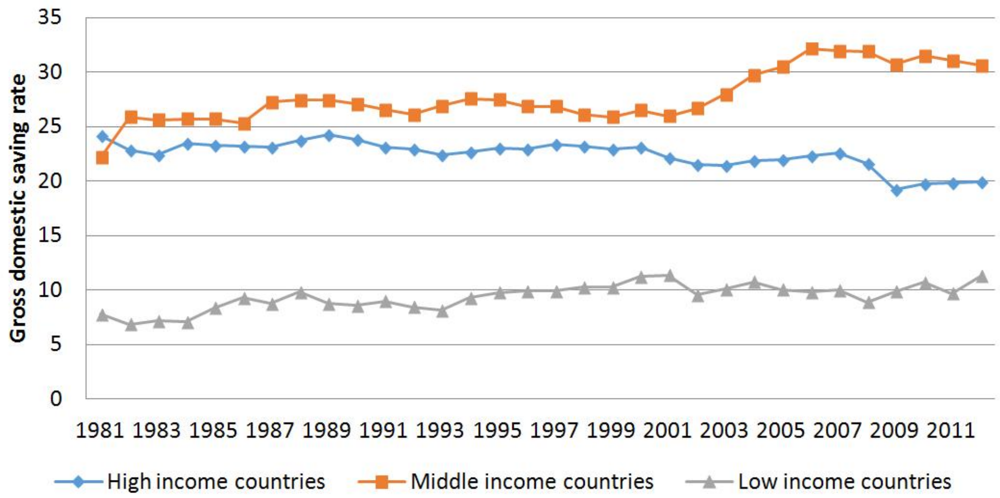
1. Introduction

In the world we live in today, significant differences in saving rates can be found between countries. Not only between poor and richer countries, differences have risen between rich countries as well (IMF, 2014). The differences in saving rates between rich and poor countries can clearly be seen in Figure 1. From this graph it becomes apparent that middle income countries (as classified by the World Bank) have the highest saving rates, followed by high income countries. There is a clear gap between the saving rates of low income countries, and high and middle income countries. Based on this graph one could raise the question whether a country can grow more by saving more?

Figure 1: Gross domestic saving rates in high, middle, and low income countries



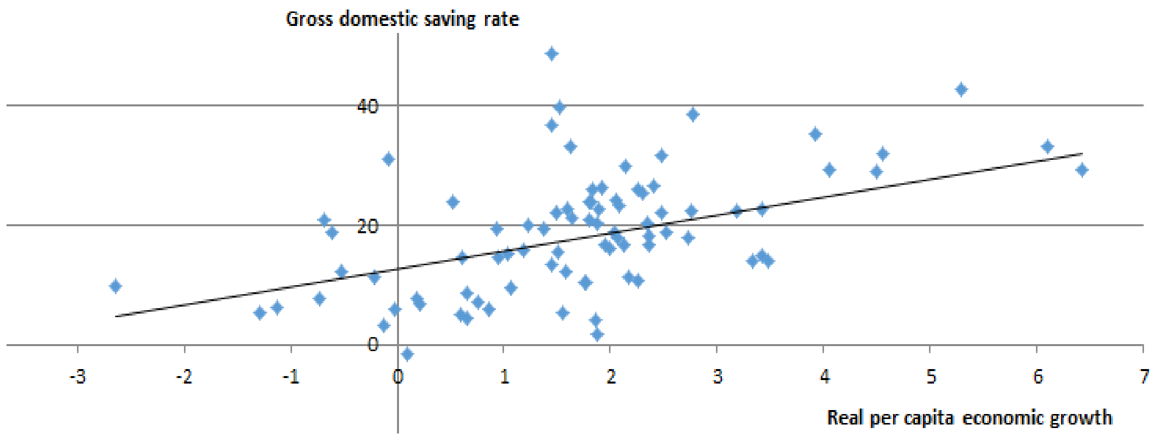
Source: World Bank Indicators Database

In order to answer this question, one must look at the relation between saving and economic growth. Figure 2 shows the average real per capita economic growth rate and the average gross domestic saving rate for a country between 1970 and 2010. The data is coming from a data set used in this thesis, which includes 84 countries.[1] Based on this graph one can conclude that there exists a weak positive relation between the two variables, given the positive slope of the linear time trend. The relationship between economic growth and saving will be the central theme of this thesis, which aims at providing a thorough analysis of the relation between saving and economic growth. Towards this aim, I will give an overview

[1] See Section 3.2.

of general economic growth theory, followed by an empirical analysis which consists of causality tests and panel data studies.

Figure 2: Relation between economic growth and saving



Source: World Bank Indicators Database

The relationship between saving and economic growth has been a key issue of economic growth theory for many decades now. In the early neoclassical economic growth models – such as the ones from Solow (1956) and Swan (1956) – saving played an important role. The saving rate is the main determinant for overall investment, which is a crucial component for economic growth. Although the saving rate was important, it was exogenously given and not derived within the model. This unsatisfactory characteristic of the early neoclassical models, led to an endogenous saving rate in the new economic growth models of Ramsey (1928), Cass (1965), and Koopmans (1965). The saving rate is now determined by optimizing households and firms that interact on competitive markets. Although the saving rate still is an important factor within this economic growth model, the main driver was technological change, which is exogenously determined. So long run per capita growth still could not be explained by the model. Mankiw, Romer and Weil (1992) extended the old neoclassical growth models and added human capital formation in the growth equation, which could be determined endogenously. This addition of human capital meant a shift from a focus on the saving rate as the main determining component in the economic growth models. Although it always has been present – sometimes indirectly – up until recent years it has not been the main subject of economic research. However, recently Aghion, Comin, Howitt and Tecu (2009) have extended the existing economic growth models with direct saving variables again. They argue that saving plays a key role in adapting new technology, which drives economic growth. So over the years the saving rate has been an important component in economic growth models.

In the empirical literature a clear corresponding view on the effect of saving on economic growth is not present. An influential paper of Carroll and Weill (1994) states that economic growth causes domestic saving, but not vice versa. Although this research has gotten some acclaim from other studies, it has also been questioned. Most prominently, Attanasio, Picci and Scorcy (2000) question the results of Carroll and Weil. They provide evidence for the hypothesis that saving has a positive effect on economic growth and could not find any evidence that causation is running from growth to saving. Other, mostly smaller studies present differing results regarding the causality between saving and growth and the effect of saving on growth.

The empirical analysis of this thesis consists of both Granger causality tests and panel data studies. In the causality part, the main data set covers a 40-year period between 1970 to 2010 and contains 84 countries. For over 50% of the countries a causal effect is found, but the direction of the causation is not uniform. In almost a quarter of the countries gross domestic saving Granger causes economic growth and in almost one fifth of the countries the causation runs the other way around. 14% of the countries have a bi-directional effect. Some studies suggest that the direction of causation depends on the income level of a country, but my empirical evidence only partially provides support for this theory.

The second part the empirical analysis contains three different panel data studies, differing in the type of saving that is being used as the main explanatory variable. The estimation technique that will be used in all three panel data studies is the Arellano-Bond estimator, also known as the differenced Generalized Methods of Moments (GMM). The first and largest study uses a sample of 83 countries, with data available over a period between 1971 and 2011. I find that gross domestic saving has a positive significant effect on real economic growth per capita. Based on this result, I specify the saving rate and distinguish between private and public saving. This requires more detailed data sets, which limits the sample. For a period of 23 years and for 25 countries, I find that only public saving has a positive significant effect on real economic growth. Private saving does not have a significant effect on real economic growth. The third and last panel data study makes a distinction between household, corporate, and public saving. I find that household and corporate saving do not have a significant effect on real economic growth, which is consistent with the result from the second panel data study, as they are components of the insignificant private saving variable. Public saving also shows an insignificant effect which is contradictory to the results found earlier. However, it is likely that this opposite results can be explained by the composition of the different data sets used in each study.

This thesis proceeds as follows. Section 2 contains a literature overview, starting with an elaboration on theoretical economic growth models, followed by an overview of the different empirical findings in the existing literature. Section 3 provides the empirical framework, including a discussion of the data and an explanation of the methodology. This section is divided into four parts, each section describes one particular part of the empirical analysis. In Section 4 I will present the main results and interpret these results. Finally, Section 5 provides my conclusions and suggestions for further research.

2. Literature Overview

In the following literature overview a wide range of the existing literature on economic growth will be discussed. I will start with a discussion of the main theoretical models on economic growth in general, followed by a more in-depth discussion regarding the role of savings in these models. The second part of this overview consists of a discussion of the existing empirical literature regarding the causality and the relationship between savings and growth.

2.1 Theoretical models

Although there exist models on economic growth from before, 1956 is used as a starting point for this overview. In this year, both Robert Solow and Trevor Swan published a theoretical model on economic growth which can be seen as an important contribution to today's thinking. Both economists independently developed a similar growth model, which will be referred to as the Solow-Swan model in this thesis. The basics of this model will be explained, as this model will serve as a building block for other growth models discussed later.

The Solow-Swan Model

In the Solow-Swan model of long-run growth there is only one commodity: output as a whole. Production is determined by two factors: capital and labor. So the production function can be written as:

$$Y(t) = F(K(t), L(t)) \tag{1}$$

As this is a neoclassical model, we assume constant returns to scale, and positive and diminishing returns to private inputs. A fraction of output is consumed and the rest is saved. The fraction of output that is saved is denoted by *s*. The model assumes that *s* is constant and given exogenously. The amount that is being saved is therefore *sY(t)*. As we consider an economy that is closed, saving must equal investment and so it follows that the saving rate equals the investment rate. Net investment (the increase in capital stock *K)* equals the rate of saving minus depreciation:

$$\dot{K}(t) = sF(K(t), L(t)) - \delta K(t) \tag{2}$$

In this equation $\dot{K}$ denotes the time derivative of the capital stock, i.e., the change of the stock over time. On the right hand side the variable $\delta K(t)$ gives the depreciation of the already available capital. Using the saving rate, we know how much of output will be saved (and thus invested). After reducing this increase in capital with the depreciation of the current capital stock, we can add this to the already accumulated capital stock. This gives the capital available for the next period. This process can be repeated for every period.

When we divide both sides of equation (2) by *L*, we get:[2]

$$\dot{K}/L = sf(k) - \delta k \tag{3}$$

All terms on the right hand side are now in per capita terms[3], where *f(k)* equals *F(k,1)* and *k* is capital per worker or the capital-labor ratio. In order to get the left hand side in per capita terms as well, we can take the derivative of *k* with respect to time, which leads to:[4]

$$\dot{k} = sf(k) - (n + \delta)k \tag{4}$$

Here the term $(n + \delta)k$ can be seen as the effective depreciation rate or the break-even investment rate, this is the rate of investment that is necessary to keep the capital stock per worker constant, where $n = \dot{L}/L$. A decline in capital per person can be caused by a depreciation of capital at rate δ and/or an increase in the number of persons (n). Equation (4) can be considered as the fundamental equation of the Solow-Swan model. With this equation we can see what happens to economic growth in the long run.

In the long run gross investment $(sf(k))$ will equal effective depreciation $((n + \delta)k)$, resulting in $\dot{k} = 0$. We have now arrived at the long run equilibrium, also known as the steady state. This is the condition in which the per capita terms *k, y* and *c* do not grow because K, Y and C grow at the rate of population growth, *n* (Barro & Sala-i-Martin, 2004, p. 34). This long run equilibrium is stable because when gross investment is higher than effective depreciation, the capital-labor ratio (*k)* will increase and when gross investment is lower than effective depreciation, *k* will drop. So any initial value of *k* will lead to the long

[2] From now on I will not use time subscripts anymore to simplify notation.
[3] Denoting variables in per capita values is necessary to compare countries with each other. If you do not use per capita terms, then a country with a larger population is also likely to have a higher GDP than a country with less citizens. However, it is possible that the smaller country has a higher GDP per capita than the larger one.
[4] This is a mathematically simplified notation. It is however not the aim of this thesis to give a full understanding of the underlying mathematics. In order to check all steps one should read Solow (1956).

run equilibrium value. At this point there is no growth per capita, due to the assumption of positive diminishing returns to capital. This implies that an additional unit of capital has a positive effect on output, but this effect decreases as the amount of capital rises.

The main prediction of the Solow-Swan model that per capita growth must cease in the end is not consistent with observations in the real world. Data show that countries can maintain positive per capita growth rates over more than a century, without clear signs that these rates will become negative in the near future (Barro & Sala-i-Martin, 2004). In order to fit these observations in the model, we have to make another assumption. The production function can shift upwards if there is technological progress and we assume in the model that this progress is exogenous. Technological progress is considered to be labor-augmenting, so the production function takes the form of:

$$Y = F(K, AL) \tag{5}$$

In this equation A is the index of technology and multiplies the production function, which leads to a higher equilibrium capital-labor ratio. As said before, this variable is exogenous. The fact that the main explanatory variables of long run growth in this model are exogenously given is unsatisfactory, because the rate of population growth is exogenous as well.

To summarize the findings above, we can conclude that the Solow-Swan model was a pioneering model, despite some unsatisfactory elements. The first shortcoming is the exogenously given saving rate. This rate determines overall investment, which is a crucial element in the model. Second, the main prediction that per capita growth must cease when the steady state is reached does not reconcile with observations in the real world: countries are able to maintain a positive per capita growth for over a century. Assuming that exogenously given technical progress can positively affect the production function solves this problem, but the fact that the long run per capita growth rate is solely determined by a variable from outside the model is not satisfying. Despite these shortcomings, the Solow-Swan model is a great building block for extensions of the model.

The Ramsey-Cass-Koopmans Model

One of the most important and leading neoclassical successors of the Solow-Swan model is the Ramsey-Cass-Koopmans model. In this model, Cass (1965) and Koopmans (1965) use

Ramsey's analysis of consumer optimization from his *A Mathematical Theory of Saving* from 1928. A huge improvement (in terms of modeling optimal behavior of the economy) is that in the Ramsey-Cass-Koopmans model the saving rate is determined within the model, so it is endogenous. Again we consider a closed economy with a homogeneous output that is produced by labor and capital. We assume constant returns to scale and diminishing returns of labor and capital. The model can be seen as an extension of the Solow-Swan model, except for the endogenous saving rate. The saving rate is determined by optimizing households and firms that interact on competitive markets. As the saving rate is a fraction of output and the other fraction is consumption, they therefore also determine consumption in an optimizing way. Equation (6) shows the function of the saving rate.

$$s = \frac{y-c}{y} \tag{6}$$

In the Solow-Swan model it was not possible to optimize consumption, because the saving rate (and thus consumption) was exogenous there. However, the main differential equation in the Ramsey-Cass-Koopmans model is similar to equation (4), there is only a slight difference:

$$\dot{k} = f(k) - c - (n + g + \delta)k \tag{7}$$

The change in capital per worker over time $\dot{k}$ depends on output per capita minus per capita consumption and effective depreciation, where *g* stands for the constant growth rate of technology. As technology progress is considered here to be labor-augmenting, *gk* stands for the necessary investments that have to be made to keep up with the increasing efficiency of labor. In the steady state the per capita variables, *k, c,* and *y* grow at the rate of technical progress (*g),* while level variables K, C, and Y, grow at the rate (*n +* g). These conclusions are similar to those in the Solow-Swan model.

Golden Rule of Capital

With an endogenous saving rate we have to determine which rate leads to a steady state that maximizes consumption. To do this, we use the so-called Golden Rule of capital (Phelps, 1961). In the Solow-Swan model the Golden Rule steady state is the level of capital per worker where the difference between output and depreciation is maximized, i.e., where consumption is maximized. Because the capital stock is not changing in the steady state, investment equals depreciation. Per capita consumption in the steady state equals:

$$c^* = f(k^*) - \delta k^* \tag{8}$$

This equation reveals two effects of an increase in capital: an increase in output and an increase in depreciation because more output must be sacrificed to replace capital. As long as the increase in output is higher than the extra depreciation that is necessary, an increase in capital leads to higher consumption. This is the case until the marginal productivity of capital (MPK) equals the depreciation rate:

$$MPK = \delta \tag{9}$$

In the Ramsey-Cass-Koopmans model the Golden Rule of capital is a little bit different. Optimal consumption in the steady state is now determined by:

$$c^* = f(k^*) - (n + g + \delta)k^* \tag{10}$$

So now the marginal productivity of capital must equal not only the depreciation rate, but also population growth and technological progress to get to the Golden Rule steady state.

$$MPK = n + g + \delta \tag{11}$$

When equation (11) holds, the economy is at the Golden Rule steady state in the Ramsey-Cass-Koopmans model. The mechanism that is being used to direct the capital stock towards the Golden Rule value is practically the same as in the Solow-Swan model.

<u>The Saving Rate in the Neoclassical Model</u>

The effect that the saving rate can have on economic growth and on output depends whether the capital stock is below or above the Golden Rule level. When the capital stock is currently below the Golden Rule level (i.e., MPK – δ > 0), an increase in capital leads to a higher level of consumption until the Golden Rule level is reached. This can be achieved by increasing the saving rate. An increase in the saving rate leads to an immediate decrease in consumption, because a larger fraction of output is saved and invested. However, this fall in consumption is only temporary. Higher investment increases the capital stock and the accumulation of capital leads to an increase in output and eventually a new steady state is reached. As consumption is a fraction of output, consumption will rise as well in the long run. When the capital stock is above the Golden Rule level (i.e., MPK – δ <0) a decrease in capital will lead to an increase in consumption. The saving rate must fall in order to lower investment, which declines the capital stock until the Golden Rule steady state is reached.

The saving rate does not have a permanent effect on economic growth in the neoclassical model. Although an increase in the saving rate will lead to a positive short run effect, this effect will disappear in the long run. However, an increase in saving will lead to an increase in output in the long run. So saving has a permanent effect on the level of output, but does not have a permanent effect on the growth rate of output.

The gross saving rate was assumed to be constant in the Solow-Swan model. This had as a consequence that there could be inefficient oversaving. This is not possible in the Ramsey-Cass-Koopmans model, because households optimize their saving rate and oversaving would make households reduce their saving rate. However, this does not mean that the optimizing household applies a saving rate that leads to the Golden Rule steady state. The reason is that households value current consumption more than future consumption (i.e., they are impatient) and therefore need to be compensated in the form of an interest rate. When this interest rate is not high enough to compensate the delay of consumption, households will reduce their saving rate and thus increase their current consumption, even though a higher saving rate could lead to the Golden Rule steady state and higher consumption in the future.[5]

Including Human Capital: Mankiw, Romer & Weil

Although the Ramsey-Cass-Koopmans model was an extension that improved the Solow-Swan model, it still could not explain the long run per capita growth within the model; that was still driven by the exogenously given technological change. Mankiw, Romer and Weil (1992) examined whether the original neoclassical growth model of Solow was consistent with real world evidence. They look in particular at the predictions about the influence of the saving rate and population growth on economic growth. They show that the higher the saving rate, the richer the country and the higher the rate of population growth the relatively poorer the country (Mankiw et al., 1992).

[5] An extensive, more mathematical model can be found in Barro & Sala-i-Martin (2004).

However, the magnitudes they have found are too large to be realistic, although the direction of the effects was the same as predicted by Solow. Mankiw et al. (1992) argued that these unrealistically high estimates can be explained by the exclusion of human capital in the Solow-Swan model, for two reasons. Firstly, when accumulation of human capital is taken into account, accumulation of physical capital and population growth have a larger impact on income. Secondly, they have found that accumulation of human capital is correlated with saving rates and population growth. So omitting human-capital accumulation leads to biased estimates of the coefficients on saving and population growth (Mankiw et al., 1992).

They adjust the Solow-Swan model in several ways. First, they include the stock of human capital *H* in the Cobb-Douglas production function:

$$Y = K^{\alpha} H^{\beta} (AL)^{1-\alpha-\beta} \quad (12)$$

In this production function, α is the physical capital's share of income, and β is the human capital's share of income. Mankiw *et al*. (1992) make three important assumptions: i) human capital depreciates at the same rate as physical capital, ii) one unit of consumption can be transformed into either one unit of physical capital or one unit of human capital, iii) there are decreasing returns to both physical and human capital (i.e., $\alpha + \beta < 1$). Because capital is now split into two components, where s_k is the fraction of income that is invested in physical capital and s_h is the fraction invested in human capital. Just like in the two previous models, there is a fundamental equation that determines the change in capital stock over time. However, as a result of the subdivision of capital, there are two of these equations:

$$\dot{k} = s_k y - (n + g + \delta)k \quad (13a)$$

$$\dot{h} = s_h y - (n + g + \delta)h \quad (13b)$$

All terms are expressed in per capita values. In this model the steady state is defined as:

$$k^* = (\frac{s_k^{1-\beta} s_h^{\beta}}{n+g+\delta})^{1/(1-\alpha-\beta)} \quad (14a)$$

$$h^* = (\frac{s_h^{1-\alpha} s_k^{\beta}}{n+g+\delta})^{1/(1-\alpha-\beta)} \quad (14b)$$

When substituting these equations in the production function (12) and take logs, one gets the steady state income per capita:

$$\ln(y(t)) = \ln(A(0)) + gt - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta) + \frac{\alpha}{1-\alpha-\beta}\ln(s_k) + \frac{\beta}{1-\alpha-\beta}\ln(s_h) \quad (15)$$

Equation (15) shows how population growth, and physical and human capital accumulation influence income per capita. Higher population growth lowers income per capita because the capital stock must be spread over more people. Both physical and human capital have a positive effect on the level of income per capita and human capital accumulation also increases the impact of physical capital accumulation on income.[6]

To conclude, Mankiw et al. (1992) state that the Solow-Swan model is consistent with the real-life observations if human and physical capital are included in the model. The presence of human capital results in a larger impact of physical capital accumulation on income per capita than the Solow-Swan model suggests. Population growth also has a larger effect on income per capita, because capital must be spread more thinly over the population.

Endogenous Technological Progress and Quality Ladders

All the models mentioned above have a similar starting point in modeling economic growth. However, from the 1980s onwards a new, quite different approach got a lot of attention which deviates from the standard neoclassical economic growth models. In the models that followed from this approach, product innovation (R&D) or technological progress is the exclusive source of economic growth (e.g., Romer, 1990; Segerstrom et al., 1990; Grossman & Helpman, 1991; Aghion & Howitt, 1992). In the model developed by Mankiw et al. (1992) human capital accumulation was mainly driven by education. However, in this approach R&D investment is the key to economic growth. The model is based on Schumpeter's idea of creative destruction, where new and better products destroy old ones and this is the essential process that 'keeps the capitalist engine in motion' (Schumpeter, 1942, p. 83). I will refer to these models as R&D based or original endogenous growth models.

The basic model consists of the following elements. There are three sectors in the economy: producers of final output, research firms, and consumers. Final output is produced with the

[6] In the standard Cobb-Douglas production function without human capital, the coefficient on ln(s_k) would be α/(1-α). Due to the presence of human capital, the coefficient on ln(s_k) is larger in equation (15). As higher saving leads to higher income, it leads to a higher steady-state level of human capital. Including of human capital increases the impact of physical capital accumulation on income (Mankiw et al., 1992).

help of intermediate goods provided by the research firms. Each intermediate good can improve in quality and research firms invest their resources in an attempt to improve their goods. A new intermediate good is considered to be an improvement if final output is produced more efficiently than before. If the improved product is successful the researcher can sell his goods at a monopoly price during the next period. The duration of this period depends on the time needed to develop a new and better product which replaces the current one. The shorter the expected duration of the monopoly period, the smaller the expected gains from the research. This can lower the incentive for a research firm to invest in R&D. On the other hand, there is still the (prevailing) creative destruction effect, which is a transfer of profits from the current leading firm to the newcomer (Aighon & Howitt, 1992). Because research firms always have an incentive to improve their intermediate goods in an attempt to achieve monopoly profits in the next period, final output will be continuously produced more efficiently. This process is the driving force behind long term economic growth in these endogenous growth models.

Although endogenizing the main source of long-term growth can be considered as a step forward, it comes at a price. These R&D-based models predict scale effects: if the level of resources devoted to R&D is doubled, the per capita growth rate will also double. The explanation given for this effect is that a larger population stimulates the supply of R&D workers and the demand for their services. The combined effect of these two forces on growth is called the scale effect (Howitt, 1999). However, Jones (1995a) shows empirically that this is not true. The prediction of scale effects can therefore be seen as a serious deficiency of these endogenous growth models, because it affects all implications of these R&D-based models. Jones (1995b) proposes a slightly adapted model with what he calls semi-endogenous growth.

To see what Jones means, take a look at the two main equations of the original endogenous growth models. The production function can be written as follows:

$$Y = K^{1-\alpha}(AL_{\gamma})^{\alpha} \tag{16}$$

where *Y* is total output, *K* is capital and *A* is the stock of technology or knowledge[7]. Labor can be used for two purposes: to produce output (L_Y) or to discover new knowledge (L_A). The variable *A* is determined by the so-called R&D equation, which describes the growth of the stock of knowledge:

$$\dot{A}/A = \theta L_A \tag{17}$$

Here θ denotes the efficiency of the search for new knowledge, also called the arrival rate of innovations. Equation (17) introduces the scale effect: it implies that growth will be proportional to the number of units of L_A (Jones, 1995b). This means that an increase in the labor force (assuming a constant share of labor devoted to R&D) automatically results in a proportional increase in per capita economic growth. This is empirically easy to reject.[8]

In an attempt to get rid of the scale effects, Jones (1995b) adapts equation (17). Firstly, he argues that the rate at which new ideas are discovered is a function of the stock of knowledge in the economy. There might be positive spillovers in the production of knowledge, so the amount of knowledge positively affects the arrival rate. On the other hand, one can argue that the most obvious ideas are discovered first so it is harder to discover new ideas when there is more knowledge already present. This means that the probability of new discoveries is decreasing in the stock of knowledge. In equation (18) below, φ is used to parameterize these influences, where φ < 0 corresponds to the case in which the arrival rate decreases with the stock of knowledge and φ > 0 is the case with positive spillover effects. Secondly, it is quite likely that there might be an overlap of research, so there will be duplications present. This reduces the actual amount of innovations produced by L_A units of labor. In other words, there are diminishing returns at a point in time. This is denoted by the term $l_A^{\lambda-1}$ with $0 < \lambda \leq 1$. Incorporating these changes into the R&D equation, we get:

$$\dot{A} = \theta L_A A^{\varphi} l_A^{\lambda-1} \tag{18}$$

[7] Knowledge is defined as the accumulation of ideas or the number of designs for a new good, and it is considered to be non-rivalrous (Romer, 1990).
[8] Jones (1995a & 1995b) shows e.g., that in the US the amount of labor devoted to R&D is five times bigger in 1988 than in 1950, but the growth rate remained relatively constant. A similar pattern is also observed in other developed countries.

When $\varphi = 1$ and $\lambda = 1$, equation (18) is the same as the R&D equation (17) in the original endogenous growth models. Jones argues that the assumption of $\varphi = 1$ is arbitrary and only introduced to generate endogenous growth in the model. This assumption is also rejected by Jones' empirical evidence (1995a). When assuming that $\varphi < 1$ the scale effects are eliminated, so the growth rate does not depend on the level of the labor force anymore. In the steady state the growth rate depends only on the growth rate of the labor force and φ and λ. This balanced growth path can be written as:

$$g = \frac{\lambda n}{1-\varphi} \tag{19}$$

Here n stands for the labor force growth rate. When we again assume $\varphi = 1$, no balanced growth path exists. The adjustments proposed by Jones are appealing because the scale effects are eliminated and unlike the original models, a balanced growth path is possible. Another major implication of this adjusted model is that government policies, such as R&D subsidies, do not have growth effects (equation (19)). This is, however, contrary to the conclusion of the original endogenous models where the steady state growth rate depends endogenously on policy variables (Jones, 1995b). Again, this follows directly from the assumption that $\varphi = 1$. To summarize: economic growth depends fully on the discovery of innovations through R&D and individuals are the critical input into the discovery of these innovations. This means that long run economic growth depends on the growth rate of the labor force, which is given exogenously.

The Influence of Government Policy: Empirical Evidence

The implication of Jones (1995a) that government policies cannot have persistent effects on the long run growth rates is in sharp contrast with the endogenous growth model, in which the result that government policies can affect long-run growth is one of the key features.[9] Kocherlakota and Yi (1997) have done an empirical assessment of these contradictory results. They developed a growth model which includes both tax revenues and public capital accumulation and estimated the following regression, using ordinary least squares (OLS):

$$\Delta y_t = \alpha + \sum_{i=0}^{I} \omega_{gi} g_{t-1-i} + \sum_{i=0}^{I} \omega_{\tau i} \ln(1 - \tau_{t-1-i}) + v_t \tag{20}$$

[9] Remember that also the neoclassical growth models (Solow and Ramsey-Cass-Koopmans) predict that government policy changes cannot affect long run growth rates.

In this regression the output growth rate is expressed as a finite number of lags of public capital (g) and tax rates (τ), with a constant (α) and the error term (v_t), which is the moving average of a productivity shock. This error term is assumed to be stationary and independent of the process that generates the policy variables. The central finding of Kocherlakota and Yi (1997) after estimating equation (20) is that the results are inconsistent with endogenous growth, as long as both the spending side (g) and the revenue side (τ) are included in the model. Permanent changes in public capital accumulation that raise growth rates come with permanent changes in tax rates that lower growth rates, so growth-raising investments are followed by growth-reducing taxes. This offsetting effect of the policy variables was considered to be very unlikely by Jones (1995b), but is consistent with the empirical results of Kocherlakota and Yi (1997).

The papers of Jones from 1995 received more replies, resulting in a new series of adjusted endogenous growth models, but this time without scale effects. Young (1998) and Howitt (1999), among others, presented new R&D based growth models. The main deviation from the original endogenous growth models is the assumption that there are two kinds of innovation, namely horizontal and vertical innovation (Young, 1998). Both kinds of innovation are subsidized in order to give an incentive to invest in R&D (Howitt, 1999). In the steady state, the growth rate depends positively on population growth, the subsidy rate, productivity of vertical R&D and the size of vertical innovations. The interest rate has a negative effect on the steady state growth rate. This is in contrast to the growth rate as determined by Jones (1995b), which only depended on population growth. In these new models government policies do affect long-run growth by creating an incentive to invest in R&D. By adding horizontal innovations with diminishing returns, the problem of scale effects is resolved as well. Howitt's model is therefore consistent with the implication from the original endogenous growth models, but without the undesirable scale effects.

Saving in Endogenous Growth Models

With the elimination of the scale effects the endogenous growth models can be seen as accurate models for determining economic growth. However, the role of savings is not as explicitly described in these models, as it was in the neoclassical growth models. This does not mean that saving does not play a role anymore in the determination of growth. Aghion, Comin, Howitt and Tecu (2009) developed a model which includes once again saving variables. The main feature of this model is the technology frontier. Relatively poor countries that are far away from the technological frontier benefit from domestic saving. Higher domestic savings make it possible for local entrepreneurs to invest in projects that could bring the country closer to its technological frontier. Here, the presence of a foreign investor who is familiar with the frontier technology is essential. The foreign investor relies on local entrepreneurs who are familiar with the local business environment and to overcome any agency problems. So these co-financed projects can improve a country's position with respect to the technological frontier.

More developed countries that are already close to the technological frontier, do not benefit from higher domestic saving, so in those countries domestic saving does not affect economic growth. This result is in line with other studies that examine the effect and the direction of saving on economic growth. Multiple studies have been conducted that examine the causality of saving and growth, with different results. Some conclude that saving does affect growth, others say that growth affects saving. This causality issue will be addressed in the section below (2.2).

2.2 Empirics

The question whether saving leads to economic growth or vice versa, is often asked and answered. Unfortunately, the answers differ a lot and are often discordant with one and other. In this section I will give a short overview of the wide variety of studies that have been conducted regarding the relationship between savings and economic growth.

I begin this overview in the early 1990s, when both Bacha (1990) and DeGregorio (1992) find that savings positively affect economic growth. Bacha developed a macroeconomic model, and DeGregorio examined a panel of 12 Latin American countries during the period 1950-1985, both using OLS. A few years later Jappelli and Pagano (1994) find that the higher the domestic saving rate, the higher economic growth. In their analysis they prove that household liquidity constraints raise the saving rate. This increase in the saving rate leads to an increase in the economic growth rate. Their sample consists of 22 OECD countries from 1960 to 1987. In that same year, Carroll and Weil (1994) present a paper in which they find that growth Granger causes saving, but not vice versa. They use data of 64 countries at the aggregate level and the effect of growth on saving is positive. Using data at the aggregate level was a reason for Attanasio, Picci and Scorcy (2000) to question the results of Carroll and Weil. Attanasio *et al.* (2000) show that the findings of Carroll and Weil are not robust and the effects found are often weak. Moreover, when moving from the five-year averages that Carroll and Weil use to annual data, significance and causation of the estimates often changes. Using annual data also leads to more precision and robustness of the estimates. In their own analysis, Attanasio *et al.* (2000) conclude that lagged saving rates are positively related to investment rates. These investment rates negatively Granger-cause growth rates. Granger-causation from growth to saving was not found by Attanasio *et al*. (2000).

In 2002 Krieckhaus conducted a study to see whether there is a link between public saving and economic growth in developing countries. He used a sample of 32 countries during the period 1960-1980 and included a case study of Brazil in his research. He found evidence that suggests that more public saving leads to higher economic growth. An increase in public sector savings affects national saving and national investment, which ultimately leads to economic growth (Krieckhaus, 2002). Governments can mobilize and allocate resources to efficient industrial sectors to stimulate growth. Mason (1988) draws a similar conclusion that a higher saving rate is important for developing countries. For those countries it might be harder and undesirable to attract foreign capital, as they do not want to increase their foreign debt in the light of possible international debt crises. Again, a higher saving rate leads to a higher investment rate, which increases the growth rate. The paper of Aghion *et al.* (2009) that I have discussed in Section 2.1 also included an empirical assessment of their model. They find that in developing countries the saving rate has a positive effect on economic growth. However, in developed countries no effect was found.

Although the last three papers that I have discussed above argue that the causality goes from savings to growth, there are studies that claim that the opposite is true. Sinha (1998, 1999, 2000) has conducted a series of empirical studies in developing countries, with the most common result that economic growth Granger-causes saving growth. This result holds in Pakistan (1998) and the Philippines (2000). Sinha and Sinha found this result in Mexico (1998) and India (2007) as well. However, the same research performed on Sri Lanka concludes that saving growth Granger-causes economic growth (Sinha, 1999). Mavrotas and

Kelly (2001) also investigated India and Sri Lanka. They found no causality between income growth and private saving in India, but found bi-directional causality in Sri Lanka. Their results differ from the Sinha (1999), and Sinha & Sinha (2007) research. This may be the result of the different method that Mavrotas and Kelly used, namely the Toda and Yamamoto method, which can be seen as an augmented Granger causality test.

Saltz (1999) used a different approach while studying the causality issue. With the use of a Vector Error Correction (VEC) model and a Vector Auto Regressive (VAR) model, Saltz found that for most countries in his sample (nine out of seventeen) causality ran from economic growth rate to growth rate of saving. However, for two countries the opposite result was identified, for four countries no causality was detected, and in the remaining two countries bi-directional causality was found. Saltz argued that higher per capita income leads to both higher consumption and higher saving rates.

Baharumshah et al. (2003) used a VEC model to investigate the behavior of the saving rate in five Asian countries. Based on data from 1960 until 1997, only in one country the saving rate Granger-causes the economic growth rate. The same model was used by Anoruo and Ahmad (2001), who investigated the causality in seven African countries. In four of these countries, the direction goes from economic growth to domestic saving growth rate. In Congo the opposite result was found: the domestic saving growth rate Granger caused economic growth. In Cote d'Ivoire and South Africa a bi-directional causality was found. A study performed by Katircioglu and Nartaliyeva (2006) found that domestic saving Granger-causes economic growth in Kazachstan during the period 1993-2002.

Income Differences

The findings above show mixed results regarding the relationship between saving and growth. However, it seems that they imply a difference between the effect in developing and developed countries. So income heterogeneity between countries could be an influential factor in the direction of causality. Mohan (2006) therefore divided his sample of 25 countries into different income groups: low, lower-middle, upper-middle, and high income. He used a VEC or VAR model and found that in the lower-middle and in the high income group the causality goes from economic growth to growth of the saving rate and not vice versa. However, in the upper-middle income group bi-directional causality was found and the low income group showed mixed results. An explanation for the bi-directional effect could be that these countries are in a transition phase to reach a steady state similar to the high-income countries (Mohan, 2006, p.6).

In a recent study Misztal (2011) also made a distinction between countries based on their GDP. He had a sample size of 29 countries, with data available from the period between 1980 and 2010. He found that both in developed and developing countries changes in gross domestic saving Granger-caused changes in GDP.

Although the overview given above is obviously not complete, it shows the variety of results that have been found by several studies. A clear corresponding view on the effect of savings on economic growth is not present. In the next sections I will add another empirical research to the existing literature in an attempt to give more insight in the relationship between savings and economic growth.

3. Empirical analysis: data and methodology

The empirical analysis of this thesis consists of four different parts. Each part has its own data set and methodological approach. This section describes the four different data sets and approaches and tries to justify the choices made in each part of the study. Section 3.1 focuses on the Granger causality test, where Sections 3.2 to 3.4 will discuss the different panel data studies. In total, three different panel regressions will be estimated, differing in time range and types of saving that are used as the main explanatory variables.

3.1 Granger causality test

3.1.1 Data

The first part of the empirical analysis is a large causality test to check whether the causality runs from savings to growth or vice versa. The data comes from the World Bank Indicators Database and covers a 40-year period from 1970 until 2010. For this time period data is available for 84 countries. Although the World Bank delivers data from 1960 onwards, using an earlier starting point would seriously limit the sample size. Choosing a later starting point (e.g. 1980) would increase the number of countries but the time period is shorter. As a longer time period is important when performing Granger causality tests, the main data set will cover the period between 1970 until 2010 and includes data of 84 countries. However, in order to assure robustness I will use a second sample with 1981 as starting point to exploit the availability of data from more countries. This second data set covers a 30-year period of 1981 until 2011 and includes 113 countries. The variables that will be used in this part are the real per capita GDP growth rate and the domestic saving rate. Domestic saving is calculated as GDP minus final consumption expenditure and are then expressed as a percentage of GDP in order to obtain the domestic saving rate. Both variables are available as annual data.

As described in Section 2, it is possible that the causality runs differently depending on the income level of the country. For example, several papers show that there might be a difference between developed and developing countries. Both Mohan (2006) and Misztal (2011) have conducted studies that investigate the effect of income heterogeneity between countries on the direction of causality. Unfortunately, the samples they use are rather small, with sample sizes of respectively 25 and 29 countries. In Section 4.1 I will conduct a similar approach as Mohan and Misztal, but with a much larger sample. This should enhance the credibility and validity of the results. The sample will be split in different income groups, based on the division already made by the World Bank. The sample will be split in four different income groups: low, lower-middle, upper-middle, and high income. Tables with the countries per group can be found in Appendix F.

3.1.2: Methodology

In order to test for Granger causality I will construct a Vector Autoregressive (VAR) model. It is important to check whether the data is suited to generate reliable estimates. To test if there are unit roots present in the data, I will perform the Augmented Dickey-Fuller Test. For countries that have two variables that contain a unit root the Johansen Co-integration Test will be conducted. If the two variables are non-stationary but are co-integrated, then it is safe to test for Granger causality for this country without taking first differences. When in a country only one of the variables is non-stationary, first differences will be taken of this variable. It is not useful to use the co-integration test with one or more stationary variables. In contrast to other studies, I will not use the Johansen Co-integration test to construct a VECM for variables. The reason for this is that performing a Johansen test to decide whether to use a VAR or VECM model, lowers the power and validity of the ultimate causality test. The second test is biased by the first test, i.e. the co-integration test. So the test statistic of the causality test is not the actual test statistic, but one that is influenced by the outcome of the first test, including its possible errors (Toda & Yamamoto, 1995). Several studies, such as those of Zapata and Rambaldi (1997) and Clarke and Mirza (2006) show that using a VECM model based on a co-integration test leads to inefficient estimates compared to statistics produced using a VAR model when estimating Granger causality.

The VAR model that I will use can be written as follows:

$$\begin{bmatrix} \Delta lnGDP \\ GDS \end{bmatrix} = \begin{bmatrix} \beta_1 \\ \beta_2 \end{bmatrix} + \sum_{p=1}^{\omega} \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} \Delta lnGDP_{t-p} \\ GDS_{t-p} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} \tag{21}$$

In this VAR model Δ*lnGDP* is the natural logarithm of real GDP per capita, *GDS* is the gross domestic saving rate, and ω the optimal lag length, obtained from the Schwarz Bayesian Criterion. Based on this model, the Granger causality test will be performed for each country.

3.2 Panel data: Gross Domestic Saving

3.2.1: Data

The first of the three panels that will be estimated has the largest data set. The effects of the gross domestic saving rate on economic growth will be estimated using a sample of 83 countries (N) covering a 40-year-period (T) from 1971 up until 2011. Besides the main variables real economic growth per capita and the gross domestic saving rate, there are also five control variables included; all are annual observations and are coming from the World Bank Indicators Database. However, for different variables one or two years were missing in some countries. When it was appropriate, I constructed these values using linear interpolation. Countries with more than two observations missing in a row were eliminated from the sample.

Real per capita economic growth is the dependent variable in all of these panel studies and is calculated as the difference of natural logarithm of real per capita GDP between period *t-1* and *t*. The main independent variable in this panel study is the gross domestic saving rate . Gross domestic saving is calculated as GDP minus final consumption expenditure and the gross domestic saving rate is gross domestic saving expressed as a percentage of GDP.

In all panel data studies of this thesis I will use the same set of control variables. The set contains the following variables: initial level of real per capita GDP, a measure for trade openness, the fertility rate, life expectancy and government consumption as a ratio to GDP. By including the first variable, I follow the widely accepted convergence literature originating from the standard neoclassical growth theory. In short, the convergence theory states that countries with lower capital per capita grow at a faster rate than countries with more capital per capita due to diminishing rates of return on capital. Therefore the rates of return for poorer countries are higher, so these countries converge to their steady state level of capital (Barro & Sala-i-Martin, 2004). The initial level of real per capita GDP is therefore a good determinant of economic growth. Including the fertility rate is also a result of the neoclassical growth theory. This variable is expected to have a negative effect on the per capita growth rate, as a higher fertility rate would not only imply that the available capital must be divided over more workers, but also that resources must be devoted to raising children (Becker & Barro, 1988). Changes in trade policy can have their effect on economic growth. Therefore a measure of trade openness is included as a control variable. Trade openness, measured as the sum of exports and imports of goods and services as a share of GDP, can raise real GDP if more openness leads to a change in domestic employment and output (Barro, 1996). Life expectancy is a measure of the population's health status and is believed to have a positive effect on economic growth. The variable gives the expected years a newborn infant would live at the start of each year, keeping the expected patterns of mortality the same. The last control variable that will be included in the panel study is government final consumption expressed as a share of GDP. Barro (1996) shows that this ratio has a significantly negative effect on growth, concluding that more (nonproductive) government spending – and its taxation – reduces the growth rate.

3.2.2 Methodology

The first regression that will be estimated is a relatively general one, with the gross domestic saving rate as the main explanatory variable. The standard equation that I will use looks as follows:

$$\Delta lnY_{i,t} = \alpha_{i,t} + \beta Y_{i,t-1} + \gamma_i GDS_{i,t} + +\delta' X_{i,t} + \theta_t + \lambda_i + \varepsilon_{i,t} \qquad (22)$$

where $\Delta lnY_{i,t}$ is the real per capita GDP growth rate, $Y_{i,t-1}$ is the lagged value of GDP per capita, $GDS_{i,t}$ is the gross domestic saving rate, $X_{i,t}$ is a vector of control variables, θ_t and λ_i are respectively time and country fixed effects, and $\varepsilon_{i,t}$ is the error term. Including a lagged value of GDP per capita might lead to biased results when using fixed-effects estimations, also known as the dynamic panel bias or Nickell bias (Nickell, 1981). According to Nickell there is a positive correlation between the fixed effects and the lagged dependent variable. Nickell (1981) shows that the bias becomes smaller when T gets bigger and will disappear when T goes to infinity. In this case my sample has a T of 40 and such a big T makes it plausible that unbiased estimates will be produced.

In order to assure robustness, I will not only use the fixed-effects estimator, but I will also use two different estimators: the pooled mean-group (PMG) estimator (Pesaran, Shin, and Smith, 1999) and the Arellano-Bond estimator (Arellano & Bond, 1991), also known as the differenced Generalized Methods of Moments (GMM). The Arellano-Bond estimator will be used in all the estimations as main estimator, as it is able to produce consistent estimates for models with lagged endogenous variables and country fixed effects. The fixed-effects estimation technique will be performed as a baseline estimator in all three estimations, with the risk of generating biased estimates due to the dynamic panel bias. The PMG estimator will only be used for estimating the relation between economic growth and gross domestic saving, because here my T is big enough to overcome the dynamic panel bias.

The Arellano-Bond estimator[10] is a panel data technique that provides a solution for the dynamic panel bias by taking first differences in order to eliminate individual fixed effects. Lagged values of the variables are used as instruments and this instrumental variable approach solves both the dynamic panel bias and the problem of endogeneity (Roodman, 2009). As with all macroeconomic variables, it is unlikely that they are completely exogenous, so endogeneity is likely to be present in my sample as well.

A disadvantage of the Arellano-Bond estimator is that intercepts can only differ across groups, so it assumes slope homogeneity. However, multiple studies have found that this assumption is incorrect (Pesaran & Smith, 1995; Pesaran, Shin, and Smith, 1999). As a robustness check I will not only use the Arellano-Bond estimator, but also the pooled mean-group (PMG) estimator[11]. This estimator allows for slope heterogeneity, but does not provide a solution for the dynamic panel bias. However, with a T of 40, it is safe to assume that this bias does not lead to inadequate estimates. As my other samples have a smaller time dimension, the PMG estimator will only be used as a robustness check in this section.

Before using the estimators, I will test on the presence of unit roots with the Levin-Lin-Chu (LLC) test statistic, which is a panel data unit root test based on the Augmented Dickey Fuller test. When the null hypothesis of panel contains unit roots is rejected, it can be assumed that it is safe to work with these data. If a series does have a unit root, I will first difference these series so that they will become stationary.

Besides these unit root tests, I will also test for the presence of autocorrelation in the data set. The Arellano-Bond estimator assumes that the error term in levels (so before first differencing) is not autocorrelated. To test this, I will use the Arellano-Bond autocorrelation test. To find first-order autocorrelation in levels, I will look at second-order autocorrelation in differences. When I cannot reject the null hypothesis of zero autocorrelation in first-

[10] This estimator can be used by the *xtabond* command in Stata (Roodman, 2009).
[11] This estimator can be used by the *xtpmg* command in Stata (Blackburne III & Frank, 2007).

differenced errors at second order, one can conclude that the error term in levels is not autocorrelated (Roodman, 2009).

The last diagnostic test that I will conduct when applying the AB-estimator is the Sargan test for overidentifying restrictions. These overidentifying restriction can produce more efficient estimates. With this test I can check whether the instruments are exogenous, which is a crucial assumption when using differenced GMM. The null hypothesis of this test states that the overidentifying restrictions are valid (Roodman, 2009).

The two estimation techniques that are included as a robustness check, the PMG-estimator and fixed-effects estimator, cannot use the Arellano-Bond autocorrelation test. So I will use the Wooldridge test for autocorrelation in panel data (Wooldridge, 2010). The null hypothesis states that there is no autocorrelation present. When applying the fixed-effects estimator, I will also use the Baltagi-Wu LBI test statistic to test for the presence of autocorrelation in the error process[12]. It is not possible to use this test with the PMG-estimator. When the test statistic has a value below 1.5 it is an indication that there is positive autocorrelation present. A value approximating 2 implies that there is no autocorrelation.

3.3 Private and Public Saving

3.3.1 Data

The existing literature suggests that the effect of private and public saving on economic growth might differ. Therefore, it might be interesting to make a distinction between these two types of saving. Again I will use data from the World Bank Indicators Database. However, due to the limited availability of the data the sample size is much smaller than in the previous estimations. This dataset consists of 25 countries and data is available over a period of 23 years, from 1990 until 2012.

The World Bank Indicators Database does not provide the private and public saving rates directly. However, I will determine these rates using data on government revenues and

[12] As reported by the *xtregar* command in Stata

expenses, as well as the already mentioned gross domestic saving rate. Private and public saving rates are calculated as follows:

Public Saving = Government Revenue – Government Expenses
Private Saving = Gross Domestic Saving – Public Saving

All variables are given as a percentage of GDP. *Government revenue* is income from taxes, social contributions and other sources of income such as fines and fees. *Government expenses* measures all payments done by the government, e.g., wages, interest, subsidies and social benefits. The private saving rate is calculated as the difference between the gross domestic saving rate and the public saving rate. Private saving includes household and corporate saving. The last part of the empirical analysis of this thesis also provides an estimation of the effect of household and corporate saving separately on economic growth.[13]

When estimating the effects of private and public saving on economic growth, I will use the same set of control variables as I have used before. A comprehensive elaboration on these variables can be found in Section 3.2.

3.3.2 Methodology

The basic equation that will be used in this part of the analysis is as follows:

$$\Delta lnY_{i,t} = \alpha_{i,t} + \beta Y_{i,t-1} + \gamma SPRIV_{i,t} + \eta SPUBL_{i,t} + \delta' X_{i,t} + \theta_t + \lambda_i + \varepsilon_{i,t} \qquad (23)$$

where the dependent variable is the real per capita economic growth rate, *SPRIV* is the private saving rate and *SPUBL* is the public saving rate. $X_{i,t}$ is the same vector of control variables as used in Equation (22) of Section 3.2.2. Again, θ_t and λ_i are respectively time and country fixed effects, and $\varepsilon_{i,t}$ is the error term.

The methodology of this section is based on that of the previous panel data estimation described in Section 3.2.2. However, this time I will only use the Arellano-Bond (AB) estimator and fixed-effects estimation. This means that I will not use the PMG-estimator, as the time period covered in this sample is too short. As this sample has a T of 22, the dynamic panel bias will likely influence the outcomes, so the robustness of results coming from the

[13] See Sections 3.4 and 4.4

PMG-estimator could not be guaranteed. Again, the standard fixed-effects estimation will be used as a baseline estimation, but it is likely that the AB-estimator will generate more reliable results.

I will perform the same diagnostic tests as in the previous panel data estimation. This means that I will start with testing for the presence of unit roots in the sample using the Levin-Lin-Chu (LLC) test. I will then check for the presence of autocorrelation using the AB-test for autocorrelation and lastly I will perform the Sargan test to see if the overidentifying restrictions from the AB-estimator are valid. I will follow the same estimating procedure as described in Section 3.2.2 when applying the fixed-effects estimator.

3.4 Household, Corporate and Public Saving

3.4.1 Data

The last part of the empirical analysis in this thesis focuses on the distinction between not only private and public saving, but also on the difference between household and corporate saving. Again, the more specific the requested variables are, the more limited the data availability is. It is therefore not surprising that the World Bank could not provide data regarding household or corporate saving. Therefore, I will use a different source, meaning that all data mentioned in this part is coming from the United Nations National Accounts Database. This database provides information on private, public and household saving. With data on these variables, I can calculate corporate saving myself:

Corporate Saving = Private Saving – Household Saving

Unfortunately, the UN National Accounts Database is not very consistent in using the same measure when providing this data. E.g., a lot of variables are measured in different currencies. A significant number of countries have experienced currency changes during the sample period (e.g. the introduction of the Euro), which made it necessary to convert several observations to get values expressed in the same currency within a country. All variables are expressed in constant local currency and contrary to the data coming from the World Bank, these variables are not given in percentages of GDP but in levels. For consistency reasons, I will calculate the saving ratios myself.

The sample size is limited due to the small time period and the relatively small number of countries that have the necessary data available. However, this is not surprising given the fact that this data is very specific and therefore harder to construct or to measure. In the end, the sample contains 32 countries and covers a 16-year period, from 1995 to 2010. The same set of control variables will be used, although now these variables are coming from the UN National Accounts Database. Growth of real per capita GDP is again the dependent variable, with household, corporate, and public saving as the main explanatory variables.

3.4.2 Methodology

Starting point of the analysis is again setting up the basic equation that I want to estimate, which is now Equation (24) below.

$$\Delta Y_{i,t} = \alpha_{i,t} + \beta Y_{i,t-1} + \gamma HHDS_{i,t} + \eta CRPS_{i,t} + \eta SPUBL_{i,t} + \delta' X_{i,t} + \theta_t + \lambda_i + \varepsilon_{i,t} \qquad (24)$$

In this equation is *HHDS* the rate of household saving, *CRPS* is the rate of corporate saving and *SPUBL* is the rate of public saving in a country. Because there is still a lagged value of the dependent variable present in the equation, it is again possible that fixed-effects OLS estimation might produce biased estimates. Hence, I will use the Arellano-Bond estimator to overcome the dynamic panel bias. Moreover, the Arellano-Bond estimator performs well when working with a small-T large-N panel, which is the case in this estimation (Roodman, 2009).

The same diagnostic tests from the previous sections will be used, which are described extensively in Section 3.2.2. This means that I start with testing for unit roots using the Levin-Lin-Chu test for panel unit root testing, followed by the Arellano-Bond test for autocorrelation and the Sargan test for the validity of overidentifying restrictions. The estimating procedure from Section 3.2.2 will be followed when running the fixed-effects estimator.

4. Results

This section provides the most important results found in the empirical analysis of this thesis. Similar to the sections above, a distinction will be made between the different parts of this analysis. Section 4.1 will discuss the findings of the Granger causality tests, where Sections 4.2 to 4.4 focus on the estimates using panel data. Although the essential information is provided in multiple tables in this section, I will often refer to Appendices which include tables with more information.

4.1 Granger causality test results

In an attempt to find the direction of causality between saving and economic growth, I designed a dataset with 84 countries over a period of 40 years, between 1970 and 2010. As mentioned in Section 3.2.2, the first test conducted is the Augmented Dickey-Fuller test. For countries where both variables contain a unit root, I performed the Johansen co-integration test. When non-stationary variables are co-integrated, it is not necessary to take first-differences of these variables. When a country has only one non-stationary variable, first differences are taken of this variable.

The existing literature suggests that the income level of a country can influence the causal relation between savings and economic growth. Therefore my sample is divided into four different groups, based on their income. A summary of the results can be found in Table 1, full results can be found in the tables of Appendix A1. The second column shows the number of countries where gross domestic saving Granger causes economic growth. In the third column, it is the other way around. This means that economic growth Granger causes gross domestic saving. The fourth column gives the number of countries that show a bi-directional causation, which means that saving Granger causes economic growth, and vice versa.

The outcomes of the Granger causality analysis do not give clear information on the direction of the relation between saving and economic growth. One of the results that immediately draws attention is the relatively high number of countries that show no effect at all. Especially in the upper-middle income group, this percentage is quite high (70%). In all income groups there are countries present that show a relationship between saving and economic growth. In the lower-middle income group only 5 countries show no relation at all, which is 23% of the lower-middle income group. This group has the highest share of countries where the gross domestic saving rate Granger causes economic growth (41%). In 18% of the lower-middle income countries the effect is the other way around, and the same number of countries has Granger causality running both ways.

Table 1 – Summary Causality Results with sample 1970-2010

Income group	**Saving → Growth**	**Growth → Saving**	**Bi-directional**	**No effect found**	**Total**
High	7 (25%)	7 (25%)	2 (7%)	12 (43%)	28
Upper-middle	2 (12%)	3 (18%)	0 (0%)	12 (70%)	17
Lower-middle	9 (41%)	4 (18%)	4 (18%)	5 (23%)	22
Low	1 (6%)	2 (11%)	5 (27%)	10 (56%)	18
Total	*19 (23%)*	*15 (18%)*	*11 (14%)*	*39 (46%)*	*84*

As discussed in Section 2.2 it could be possible that a country's income level influences the direction of causality. The results do provide evidence that this suggestion might be correct, as there are significant differences between the different income groups. However, some of these findings contradict findings from previous studies. For example, both the high and lower-middle income group has a relatively high share of saving to growth Granger causation, which is at most partly in line with the existing literature. Mohan (2006) argues that in the lower-middle income group causation runs from growth to saving, which contradicts with these results. He also claims that upper-middle income countries show bi-directional causality. Both claims are not supported by the results in Table 1. These differences can be explained by the samples used. My sample is bigger (84 countries compared to 25 countries) and I have included more recent observations.

The theory of Aghion *et al.* (2009) which claims that in developing countries the causality runs from saving to growth is partially supported by the results in Table 1. Indeed I find that a relatively high share of lower-middle income countries have causality running in this direction, but the opposite and the bi-directional effect are also found. Moreover, Aghion *et al.* (2009) claim that in developed (i.e. high income) countries there is no causation present between saving and income, a statement that is clearly rejected by my results.

So the results from the Granger causality test show no clear direction and they also do not provide strong evidence for the influence of income heterogeneity on the causality between the gross domestic saving rate and economic growth.

4.1.2 Robustness checks

The available data allows me to check what happens to the results if I reduce the time span, but increase the number of countries. In order to investigate if adding more countries has consequences for the overall findings, I will perform the procedure as described in Section 3.1.2 again for the larger sample. In total, 29 countries are added to the sample and the sample period is reduced with ten years, so now covers a 30-year period between 1981 and 2011. From the 113 countries, 18 of them had a variable with a unit root, but this was removed after taken first differences. None of the countries had variables which both contained a unit root, so there was no need to perform the Johansen Co-integration Test.

The full results of this extra Granger causality test can be found in Appendix A2, I will discuss the main differences here which are also shown in Table 2. Overall, one can conclude that with more countries in the sample and a shorter period covered, the share of countries with a Granger causality of economic growth to saving has increased to 33%. This increase mainly comes from a decrease in the share of countries with causality running from saving to growth. The percentage of countries where no effect is found remained roughly the same.

Table 2: Summary Granger Causality Results with sample 1981-2011

Income group	**Saving → Growth**	**Growth → Saving**	**Bi-directional**	**No effect found**	**Total**
High	2 (5%)	17 (45%)	6 (16%)	13 (34%)	38
Upper-middle	6 (21%)	5 (18%)	4 (14%)	13 (46%)	28
Lower-middle	5 (19%)	8 (31%)	4 (15%)	9 (35%)	26
Low	2 (10%)	7 (33%)	0 (0%)	12 (57%)	21
Total	*15 (13%)*	*37 (33%)*	*14 (12%)*	*47 (42%)*	*113*

In the high income group, the share of countries that have Granger causality going from saving to growth has declined, whereas the other way around this percentage has increased from 25% to 45%. So almost half of the high income countries in the sample have Granger causality running from economic growth to saving. These results are more in line with results from other studies, such as Mohan (2006). The most prominent change in the upper-middle income group is the increase in countries with a bi-directional effect (from 0 to 4). In the low income group the number of countries with a bi-directional effect declined from 5 countries in Table 1 to 0 countries in Table 2.

So including more countries over a shorter time period changed some of the results. Especially the share of countries where economic growth Granger-causes gross domestic saving has increased, accompanied by a decline in the share of countries where the Granger causality runs the other way around. The percentage of countries where no effect is found remains relatively high (42%) and the share of countries with a bi-directional effect also stayed the same.

4.2 Effect of Gross Domestic Saving

In this section I will describe and interpret the results of the estimation of the relation between real economic growth per capita and gross domestic saving. I follow the procedure as described in Section 3.2.2, so I start with the outcomes of the unit root tests, followed by a discussion of the autocorrelation test outcomes and a discussion and interpretation of the main results of the estimation of Equation (22) from the Methodology part in Section 3.2. As only the main results will be discussed in this text, full results of all tests can be found in Appendix B and E.

Running the Levin-Lin-Chu unit root test for panel data, I find that all variables are stationary. This means that there is no need to first difference variables. To test for the presence of autocorrelation, I will use the Arellano-Bond autocorrelation test. It is important not to look at first-order, but at second-order autocorrelation. With a p-value of 0.6 and a null hypothesis of no autocorrelation at second-order, I can conclude that there is no need to worry about the presence of autocorrelation. The last diagnostic test that I perform is the Sargan test to test if there the overidentifying restrictions are valid. The test statistic clearly indicates that we cannot reject the null hypothesis stating that the overidentifying restrictions are valid.

Now that I have conducted all necessary diagnostic tests, it is time to perform the actual Arellano-Bond estimator to find the relation between economic growth and gross domestic saving. The main results can be found in Table 3. All variables are significant except *life expectancy*. The variable *l.ΔGDP per capita* is the first lag of the dependent variable real per capita economic growth and has a positive significant effect. The gross domestic saving rate has a comparable effect, meaning that a one percentage point increase in the gross domestic saving rate leads to an increase of 0.002 percentage points of real per capita economic growth. An increase in *trade openness* has a negative significant effect and *log(Fertility Rate)* and *log(Initial GDP)* have a positive significant effect on real economic growth per capita. These three findings are in contrast with other studies, e.g., Barro (1996), who found opposite effects. The sign of the remaining control variable is again in line with the theory and existing literature, with the *government consumption ratio* having a negative significant effect. E.g., a one percentage point increase in the *government consumption ratio* leads to a 0.0025 percentage points decrease in real economic growth per capita.

Table 3: Effect of Gross Domestic Saving on Real Economic Growth Per Capita: AB-estimator

Variables	**Coefficient**	**Std. Err.**
l.ΔGDP per capita	.1924466***	.0179377
Gross Domestic Saving Rate	.193824***	.0178993
Trade openness (% of GDP)	-.0155413**	.0071456
log(Fertility Rate)	.4814843**	.2194144
Government Cons. (% of GDP)	-.2482273***	.0318237
Life Expectancy	.0044058	.0420741
log(Initial GDP)	2.606685***	.5986805
Constant	-20.34704***	5.359913

Note: l. denotes the first lag of the variable. Significance levels are denoted as follows:
* : significant at a 10% significance level
** : significant at a 5% significance level
*** : significant at a 1% significance level

4.2.1 Robustness check: PMG-estimator and fixed-effects estimator

The Arellano-Bond estimator is a good estimator when working with dynamic panel data, but has a disadvantage: it assumes homogeneous intercepts. However, several studies have shown that this assumption is incorrect. The PMG-estimator allows for slope heterogeneity and is therefore estimated as well as a robustness check. Besides the PMG-estimator, I will also use the fixed-effects estimator.

Concerning the diagnostic tests, the unit root test results remain valid with these estimators, so again I have a data set with only stationary variables without first differencing. The Wooldridge test for autocorrelation in panel data rejects the null hypothesis of no first-order autocorrelation. Therefore, I add an extra lag to the dependent variable. Running the test again, it is not possible anymore to reject the null hypothesis. So I will add an extra lag of the dependent variable to overcome autocorrelation. The results of estimating Equation (22) from Section 3.2 can be found in Table 4.

Table 4: Effect of Gross Domestic Saving on Real Economic Growth Per Capita: PMG-estimator & fixed-effects estimator

	PMG estimator		Fixed-effects estimator	
Variables	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**
Gross Domestic Saving Rate	.10748***	.0146428	.12564***	.013399
Trade openness (% of GDP)	.01131**	.0054756	.00574	.004124
log(Fertility Rate)	-.91280*	.4789976	-.8838*	.469335
Government Cons. (% of GDP)	-.13901***	.0266215	-.12482***	.020175
Life Expectancy	-.20110	.0360581	.02896	.022986
log(Initial GDP)	1.3712***	.5203656	-1.7686***	.380068
Constant	3.3446***	.4769702	14.891***	3.37440

Note: Significance levels are denoted as follows:
* : significant at a 10% significance level
** : significant at a 5% significance level
*** : significant at a 1% significance level

The effect of the gross domestic saving rate on real economic growth is still positive and significant, both with the PMG-estimator and fixed-effects estimator. With the PMG-estimation, a one percentage point increase in the gross domestic saving rate leads to a 0.0011 percentage points increase in real per capita economic growth. This effect is smaller than the 0.002 percentage points increase estimated using the AB-estimator. The variable *life expectancy* is again not significant, and *trade openness* now has a positive significant effect on real economic growth per capita, instead of the negative effect found in Table 3. The sign of the *log(Fertility Rate)* also changed, making the effects of both variables now in line with the theory. The effects of the *government consumption ratio* and the log of *initial GDP* both became smaller but remained significant.

The results from the fixed-effects estimator also indicate a positive significant effect of gross domestic saving on real economic growth per capita. A one percentage point increase in the gross domestic saving rate now leads to a 0.0013 percentage points increase in economic growth. Of the control variables, the *government consumption ratio, log(Fertility rate),* and *log(Initial GDP)* have a significant effect. Full results of the fixed-effects estimation can be found in Appendix B.

The main conclusion that can be drawn from these tests is that gross domestic saving does have a positive significant effect on real economic growth per capita. All three estimators produce estimates that show that this positive effect is present. Although this is an interesting result it might be insightful to further specify the domestic saving rate. It is likely that some components contribute to this positive effect, while others do not. The next sections will give more insights on this issue.

4.3 Private and Public Saving

The Levin-Lin-Chu unit root test shows that all variables are stationary (I(0)), except *Life expectancy*.[14] After first differencing, the null hypothesis of a unit root is present can be rejected. The main findings of the Arellano-Bond estimation can be found in Table 5 below. The data set suffered tremendously from autocorrelation issues. Only after adding a fourth lagged dependent variable, the Arellano-Bond test for autocorrelation could not reject the null hypothesis of no autocorrelation anymore. This reduced the timespan of the sample, so now my T is 18. The first four variables in Table 5 are lagged values of real economic growth per capita.

Table 5: Effect of Private and Public Saving on Real Economic Growth per Capita

	Arellano-Bond estimator		Fixed-effects estimator	
Variables	**Coefficient**	**Std. Err.**	**Coefficient**	**Std. Err.**
L1.ΔGDP per capita	.309218***	.0580112	-.400969***	.0416884
L2.ΔGDP per capita	-.1197417***	.0439883	-.393948***	.0426201
L3.ΔGDP per capita	.1115544***	.0338712	-.126236***	.0415667
L4.ΔGDP per capita	-.1050958***	.0372707	-.175580***	.0397191
Private Saving Rate	.0334828	.0354159	.033965	.0352717
Public Saving Rate	.5351049***	.1030946	.546904***	.0791997
Trade openness (in % of GDP)	.0088826	.020633	.028274**	.0140178
log(Fertility Rate)	-4.773785*	2.731871	-3.16415	3.70048
d.Life Expectancy	.9994519	.7987232	.1798278	.7174888
Government Cons. (in % of GDP)	-.0340355	.1242725	-.0456307	.1160842
log(Initial GDP)	2.079546	1.861864	1.73029***	2.21231
Constant	-10.64174	14.20276	-12.9942***	5.26158

Note: l. denotes the first lag of the variable and d. denotes the first differences of the variable. Significance levels are denoted as follows:
* : significant at a 10% significance level
** : significant at a 5% significance level
*** : significant at a 1% significance level

[14] Test results can be found in Table E3 of Appendix E.

The particular variables of interest are the private and the public saving rate. Following from this estimation, no significant effect is found for the private saving rate. However, the test results show that the public saving rate has a positive significant effect on real economic growth. A one percentage point increase leads to an increase of 0.0054 percentage points of the real economic growth rate. This finding is in line with earlier studies, e.g. Krieckhaus (2002). He also found a positive relationship between public saving and economic growth. This finding can also be explained intuitively. Governments have the ability to mobilize and allocate resources to more growth stimulating sectors, meaning that public saving can be used to stimulate growth. This intuition is thus supported by the results in Table 5.

However, for multiple reasons one should be careful when drawing conclusions from these results. Firstly, the sample is relatively small (28 countries over a period of 18 years)[15], especially compared to the dataset used in Section 4.2. Moreover, the distribution of countries in this sample is far from random. Most countries in this sample are classified as high or upper-middle income country and the reason countries are in the sample is because they belong to the small share of countries that can provide the necessary data, not because they are of any particular or economically relevant interest. Secondly, most control variables are insignificant although it can be expected that they should be significant. Only the *log(Fertility Rate)* has a significant impact, meaning that a one percentage point increase in the fertility rate, leads to a 0.04 percentage point decrease in the economic growth rate. This effect seems rather high, given effects estimated by other studies (e.g. Barro (1996)). Thirdly, by calculating the private and public saving rate on my own, I cannot prevent measurement errors from entering the estimation. It is possible that without these errors the magnitude of the coefficients will change. Nonetheless, these results add support to the hypothesis that saving can positively affect economic growth.

The fixed-effects estimation also provides evidence that supports the positive significant effect that public saving has on real per capita economic growth. The magnitude of the effect is similar to the one found in Table 5, i.e., a one percentage point increase leads to an increase of 0.0055 percentage points of the real economic growth rate. *Trade openness* and

[15] As a result of autocorrelation I had to add four additional lags of the dependent variable, which reduced the time span to 18 years.

log(Initial GDP) are the only two control variables with a significant effect on the dependent variable. Full results of the fixed-effects estimation can be found in Appendix C.

4.4 Household, Corporate and Public Saving

As I did in the previous analyses, I will start with the unit root tests. All results can be found in Appendix E. None of the variables contain a unit root according to the Levin-Lin-Chu test, so it is not necessary to take first differences of one of the variables. The Arellano-Bond autocorrelation test showed that autocorrelation is present with only one lagged value of the dependent variable. Adding another lag solves this issue.

The main results of running this estimator can be found in Table 6. None of the main explanatory variables – *household, corporate,* and *public saving rate* - have a significant effect on real economic growth per capita. Most control variables have a theoretically normal and significant effect, although the effect of *log(Fertility Rate)* is again rather high. A one percentage point increase of that variable leads to a 0.24 percentage point decrease of real economic growth per capita. The signs of the effects of the control variables are all in line with the existing literature, except for the sign of *log(Initial GDP)*. One would expect a negative sign, as the convergence literature predicts catching-up effects (Barro, 1996).

Table 6: Effect of Household, Corporate and Public Saving on Economic Growth

	Arellano-Bond estimator		**Fixed-effects estimator**	
Variables	**Coefficient**	**Std. Err.**	**Coefficient**	**Std. Err.**
L1.ΔGDP per capita	.1829233	.1308483	-.268087***	.0459773
L2.ΔGDP per capita	-.2467929***	.0754107	-.2927938***	.0581746
Household Saving Rate	-.0145644	.0277072	-.0232487	.0251747
Corporate Saving Rate	-.019429	.0457474	.0017101	.034597
Public Saving Rate	-.0074788	.1021631	.0375992	.036309
Trade openness (in % of GDP)	.1799323***	.0341795	.1892634***	.0225199
log(Fertility Rate)	-24.77134***	6.561993	-2.51462***	.5154667
Life Expectancy	-1.819523	.6425649	-.2365994***	.4725138
Government Cons. (in % of GDP)	-.5480263*	.3139881	-.4890756***	.1587824
log(Initial GDP)	9.922216***	3.079596	2.149312***	.2994074
Constant	56.60717	36.10401	-8.209722	1.196865

Note: l. denotes the lag of the variable. Significance levels are denoted as follows:
* : significant at a 10% significance level
** : significant at a 5% significance level
*** : significant at a 1% significance level

The lack of significance of the three main explanatory variables is partially in line with the results found earlier in this thesis. Considering the fact that in Section 4.3 no significant effect is found for private saving and given that household and corporate saving are components of private saving, it is not entirely surprising that these two variables do not have a significant effect on real economic growth. However, the insignificance of public saving is contradicting the significant effect found in Section 4.3. This could be explained by the relatively small time period (T = 13) and differences in the sample of this section. Due to the limited availability of data regarding this subject, countries differ between the two sections.[16] Therefore it is not possible to make a reliable comparison between the different sections and their findings.

The findings of the fixed-effects estimation can be found in Appendix D. Again, none of the main explanatory variables has a significant effect. All control variables do have a significant effect, but the variables *life expectancy* (negative) and *log(Initial GDP)* (positive) have a sign reversed to what is expected based on the existing literature.

[16] An overview of all the countries included in each sample can be found in Appendix F.

5. Conclusions

The central theme of this thesis is the relationship between saving and economic growth. In the past decades the number of studies conducted regarding this relationship has grown, but so has the disagreement. Not only theoretically, but also empirically different and often even contradictory results have been presented, raising confusion about this relationship. This thesis does not attempt to fully clarify this widespread confusion, but aims at contributing another relevant study to the existing literature. Towards this aim, this thesis contains empirical analyses with often relatively large data sets, conducting both Granger causality tests and panel data studies. After two relatively general analyses, more detailed panel data analyses including different types of saving have been conducted.

The first part of the empirical analyses consists of a Granger causality test with a dataset of 84 countries over a time period of 40 years. The Granger causality test has also been conducted with another dataset, which includes 29 more countries, but a ten-year shorter time period. In both data sets, for approximately 45% of the countries no causal effect is found between gross domestic saving and real economic growth per capita. In the main data set, almost a quarter of the countries have causality running from saving to economic growth and in one fifth of the countries economic growth Granger causes saving. The remaining share of the countries (14%) have a bi-directional effect. In the second data set the proportion of countries with saving Granger causing economic growth is much smaller and the share of countries with the causal effect running the other way around has increased to one third of the sample. However, due to the longer time period the results from the main Granger causality test are preferred over results from the robustness data set. The results do support the hypothesis that the direction of causality depends on a country's income level, as is suggested by some studies.

The second part of the empirical section contains several panel data studies, differing in the types of saving that are used as the main explanatory variables. As I follow the widely accepted convergence literature, all growth equations include lagged values of the dependent variables which introduces a dynamic panel bias. Standard fixed-effects OLS estimations would lead to inconsistent and biased results, so besides this estimator I also use the Arellano-Bond estimator, also known as the differenced Generalized Methods of

Moments (GMM). The first panel data study investigates the relationship between the gross domestic saving rate and real economic growth per capita. I use a data set that consists of 83 countries and covers a time period of 40 years. Using this relatively large data set, I find that the gross domestic saving rate has a significant and positive effect on real economic growth per capita. As a robustness check, I also perform the pooled mean-group estimator on the same data set, leading to similar results. Again, a positive significant effect is found but the magnitude of the effect is somewhat smaller.

To further specify this positive effect, I distinguish two types of saving: private and public saving. As a consequence of the more specified data, the sample has reduced a lot in size: it now consists of 25 countries and a time period of 18 years. Running again the Arellano-Bond estimator leads to the conclusion that public saving has a positive significant effect. This is in line with results found in other studies on this matter. For private saving no significant effect can be found. The results of the fixed-effects estimator support these findings: a similar effect is found for public saving on economic growth.

The last panel data study that I conduct makes a distinction between household saving, corporate saving, and again public saving. As household and corporate saving are components of private saving, it is not surprising that these variables also do not have a significant impact on real economic growth. However, the insignificance of the public saving variable contradicts the findings of Section 4.3. This different result could be explained by the limited time period of the last, more detailed estimation. Also the composition of the sample is different, as the data sets of Section 4.3 and 4.4 contain different countries. A full and reliable comparison cannot be made, so different results do not by definition have to be inconsistent.

Unfortunately, this thesis cannot provide the reader with clear, unambiguous results regarding the relationship between saving and economic growth. Although most results clearly indicate that there exists a positive relation between saving and growth, the evidence is not strong enough to remove existing doubts regarding this subject. There is also some weak evidence that public saving has a positive effect, which might be useful information for policy makers. By mobilizing and allocating resources, governments could stimulate economic growth. However, it must be noted that this effect could not be found in a different data set with a smaller time period, so further research is necessary in order to make strong conclusions. So although it is clear that there is a relationship between saving and economic growth, the more detailed the analyses are, the harder it is to draw clear and unambiguous conclusions.

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Appendix A: Granger Causality Test Results

Appendix A1: Granger Causality Test Results – Sample 1970-2010

Table A1.1: High Income Countries

Saving to growth		**25%**
Finland *** (54.089; 10.441)	Puerto Rico *** (33.494; 10.895)	Spain*** (23.843; 8.675)
Japan *** (21.709; 6.700)	Portugal ** (16.675; 6.971)	United Kingdom * (13.5246; 3.372)
Israel ** (14.344; 4.9158)		
Growth to saving		**25%**
Australia ** (.2507;5.614)	Italy *** (8.9851; 12.684)	Luxembourg*** (6.875; 19.549)
Chile ** (9.302; 34.384)	Korea, Rep. *** (5.922; 29.639)	Singapore ** (.3485; 22.789)
Greece** (3.7279;15.064)		
Bi-directional effect		**7%**
Belgium* (15.348; 12.134)	United States ** (7.6994; 7.5843)	
No effect found		**43%**
Austria (.04298; .00109)	France (.00211; .0716)	Netherlands (.2815; 2.463)
Barbados (1.3194;.20235)	Hong Kong SAR (3.919; .4823)	Saudi Arabia (.7751; .0424)
Canada (5.4095; 10.872)	Iceland (.3848; .9919)	Sweden (3.896; 1.968)
Denmark (2.1403; 1.235)	Norway (9.4193; 6.4011)	Uruguay (.0142; 2.579)

Note: the Chi^2-test statistic is denoted within the parentheses, where the first value is the Chi^2-test statistic when testing for causality from saving to growth, and the second value denoting the Chi^2-test statistic when testing for causality from growth to saving. Significance levels are denoted as follows:

*   : significant at a 10% significance level
**   : significant at a 5% significance level
***   : significant at a 1% significance level

Table A1.2: Upper-middle Income Countries

Saving to growth		**12%**
Algeria** (9.189; .3515)	Hungary * (4.6926; 2.779)	
Growth to saving		**18%**
Turkey * (1.9725; 6.3364)	Tunisia *** (2.6897; 11.6874)	South Africa** (.05749; 7.6461)
Bi-directional effect		**0%**
No effects found		**70%**
Brazil (.0063; 1.021)	Fiji (.01634; .11957)	Thailand (.0186; .21558)
Colombia (.13099; 3.1078)	Gabon (.0875; 1.2449)	Venezuela (39496; 1.5659)
Costa Rica (.12821; 1.1578)	Malaysia (.8557; 2.349)	
Dominican Rep. (3.2446; 4.4032)	Mexico (.0428; .2385)	
Ecuador (.05586; .16557)	Peru (1.8875; .8661)	

Note: the Chi^2-test statistic is denoted within the parentheses, where the first value is the Chi^2-test statistic when testing for causality from saving to growth, and the second value denoting the Chi^2-test statistic when testing for causality from growth to saving. Significance levels are denoted as follows:

*   : significant at a 10% significance level
**   : significant at a 5% significance level
***   : significant at a 1% significance level

Table A1.3: Lower-middle Income Countries

Savings to growth		**1%**
India** (8.667; .6019)	Mauritania** (3.543; 1.9678)	Pakistan** (8.173; 2.1194)
Indonesia** (6.670; 2.327)	Morocco* (3.758; .95306)	Philippines*(5.1455; 3.8263)
Lesotho*** (20.599; .24333)	Nicaragua* (2.8188; .64371)	Zambia** (8.5575; 2.5956)
Growth to saving		**19%**
Cameroon*** (2.708; 30.984)	Sri Lanka* (.00205; 3.2026)	Sudan** (.85428; 7.7363)
Ghana*** (11.52; 16.101)		
Bi-directional effect		**19%**
Congo, Dem. Rep.*** (4.5535; 16.291)	El Salvador* (.82981; 4.6732)	Honduras*** (23.332; 25.238)
No effects found		**24%**
Bolivia (3.503; 3.962)	Egypt, Arab Rep. (.2592; .02569)	Guyana (.00458; .05822)
Cote d'Ivoire (.6578; .93204)	Guatemala (.188; .160)	

Note: the Chi^2-test statistic is denoted within the parentheses, where the first value is the Chi^2-test statistic when testing for causality from saving to growth, and the second value denoting the Chi^2-test statistic when testing for causality from growth to saving. Significance levels are denoted as follows:

* : significant at a 10% significance level
** : significant at a 5% significance level
*** : significant at a 1% significance level

Table A1.4: Low Income Countries

Saving to growth		**6%**
Burkina Faso*** (29.206; 9.7449)		
Growth to saving		**11%**
Benin** (.1948; 7.5748)	Sierra Leone*** (1.379; 19.564)	
Bi-directional effect		**22%**
Bangladesh** (17.813; 11.347)	Nepal*** (16.808; 23.645)	Togo*** (17.614; 25.613)
Botswana** (14.961; 29.684)	Niger** (12.613;.16.937)	
No effects found		**56%**
Burundi (8.0139; 7.0779)	Kenya (.77463; 1.9849)	Rwanda (1.2988; .75212)
Central African Republic (.04154; 4.4122)	Madagascar (.16545; .773)	Zimbabwe (3.8368; 4.3424)
Congo, Rep. (.0221; 1.009)	Malawi (.00105; .388485)	
Gambia, The (.19459; 3.7598)	Mali (1.0327; .59394)	

Note: the Chi^2-test statistic is denoted within the parentheses, where the first value is the Chi^2-test statistic when testing for causality from saving to growth, and the second value denoting the Chi^2-test statistic when testing for causality from growth to saving. Significance levels are denoted as follows:

* : significant at a 10% significance level
** : significant at a 5% significance level
*** : significant at a 1% significance level

Appendix A2: Granger Causality Test Results – Sample 1981-2011

Table A2.1: High Income Countries

	Saving to Growth	**5%**
Italy** (4.3939; .26219)	Saudi Arabia** (6.0393; 2.8069)	United Kingdom** (8.436; 3.451)
	Growth to Saving	**45%**
Australia*** (.33824; 7,008)	Cyprus*** (.25565; 6.6713)	Norway** (.67135; 4.5427)
Austria** (8,0625; 7.0087)	Denmark*** (.94535; 8.392)	Singapore*** (4.0162 ; 19.422)
Bahrain*** (.00066; 5.2113)	Germany** (1.4562; 6.3295)	Spain* (3.3086; 5.2967)
Barbados*** (7.6567; 35.884)	Greece*** (4.134; 15.983)	Sweden* (2.0176; 5.33)
Belgium** (1.8466; 6.6411)	Ireland*** (.58169; 21.987)	Switzerland* (4.2503; 5.189)
Chile ** (2.1327; 5.9799)	Luxembourg *** (.32535; 11.79)	Uruguay* (1.0147; 7.2758)
	Bi-directional effect	**16%**
France** (10.473; 8.5959)	Netherlands ** (17.104; 7.0016)	Puerto Rico *** (17.039; 16.436)
Korea, Rep.***(19.623;16.821)	Portugal * (5.2019; 5.876)	United States * (7.1942; 7.4834)
Latvia ** (6.4372; 3.8699)		
	No effect found	**34%**
Antigua and Barbuda (.4333; 2.5894)	Hong Kong SAR,(2.0983; .03025)	Japan (.891; 1.571)
Bahamas, The (,39733; 1,3396)	Iceland (7.4165; 5.9507)	Malta (.10325; .5415)
Canada (1.4533; 1.6913)	Israel (.13069; .09882)	New Zealand (4.422; 2.8775)
Finland (2.8751; .79311)		

Note: the Chi^2-test statistic is denoted within the parentheses, where the first value is the Chi^2-test statistic when testing for causality from saving to growth, and the second value denoting the Chi^2-test statistic when testing for causality from growth to saving. Significance levels are denoted as follows:

* : significant at a 10% significance level
** : significant at a 5% significance level
*** : significant at a 1% significance level

Table A2.2: Upper-middle Income Countries

	Saving to Growth	**21%**
Costa Rica ** (6.08; 1.6329)	Namibia * (8.3225; 1.9618)	Peru ** (5.9679; 1.751)
Malaysia ** (8.3889; .63896)	Panama *** (29.076; 2.3267)	Thailand * (2.9775; .30225)
	Growth to Saving	**18%**
Gabon * (.22999; 7.4877)	Tunisia ***(1.1117;	Venezuela, RB * (1.0735; 3.2399)
Hungary *(1.9409; 4.5783)	Turkey * (2.477; 6.772)	
	Bi-directional effect	**14%**
Albania ** (24.114; 7.6585)	Mexico ** (11.98; 19.739)	South Africa ** (3.4523; 4.1372)
Cuba ** (8.0332; 5.8276)		
	No effect found	**46%**
Algeria (1.9993; .25995)	Colombia (1.8326; 7.3248)	Fiji (.04457; .00885)
Belize (.90208; .16247)	Dominica (.00166; .20669)	Grenada (1.6002; .01818)
Botswana (1.735; .21489)	Dominican Republic (1.2523; .42601)	Jordan (.2276; .90743)
Brazil (.30878; 1.4036)	Ecuador (.53521; .04264)	Mauritius (.00496; .37645)
Bulgaria (1.2016; 2.0613)		

Note: the Chi^2-test statistic is denoted within the parentheses, where the first value is the Chi^2-test statistic when testing for causality from saving to growth, and the second value denoting the Chi^2-test statistic when testing for causality from growth to saving. Significance levels are denoted as follows:

* : significant at a 10% significance level
** : significant at a 5% significance level
*** : significant at a 1% significance level

Table A2.3: Lower-middle Income Countries

Saving to Growth		**19%**
Egypt *** (18.794; 4.3364)	Indonesia *** (25.609; .00038)	Pakistan *** (7.4691; .16225)
Georgia *** (9.9202; 4.3408)	Lesotho ** (4.1458; 1.0523)	
Growth to Saving		**31%**
Cameroon ** (.30466; 7.6053)	Philippines *** (.62373; 9.2069)	Swaziland *** (5.1859; 62.774)
Cote d'Ivoire * (4.08; 7.8623)	Senegal *** (2.6742; 22.426)	Zambia ** (7.2395; 14.134)
India ** (1.0008; 7.3169)	Sri Lanka *** (.05338; 8.5803)	
Bi-directional effect		**15%**
Bolivia * (13.134; 7.961)	Morocco * (7.4397; 7.5252)	Nicaragua *** (61.321; 44.472)
Honduras *** (61.582; 42.374)		
No effect found		**35%**
Bhutan (2.0959; 2.6078)	Ghana (3.7345; 3.8352)	Mauritania (.9952; 2.2887)
Congo, Rep. (1.4089; .06988)	Guatemala (.18559; .19339)	Mongolia (.62198; 1.7654)
El Salvador (.07991; 1.1758)	Guyana (.03339; .0558)	Nigeria (.10539; .19706)

Note: the Chi^2-test statistic is denoted within the parentheses, where the first value is the Chi^2-test statistic when testing for causality from saving to growth, and the second value denoting the Chi^2-test statistic when testing for causality from growth to saving. Significance levels are denoted as follows:

*	: significant at a 10% significance level
**	: significant at a 5% significance level
***	: significant at a 1% significance level

Table A2.4: Low Income Countries

Saving to Growth		**10%**
Ethiopia ** (8.8096; .22117)	Kenya ** (5.5999; .25667)	
Growth to Saving		**33%**
Benin *** (5.3362; 74.045)	Mozambique ** (.08675; 4.5169)	Sierra Leone ** (.66826; 4.9547)
Burundi ** (.02457; 3.8881)	Rwanda ** (2.381; 6.1509)	Sudan * (.0003; 2.7387)
Mali ** (1.9626; 10.154)		
Bi-directional effect		**0%**
No effect found		**57%**
Bangladesh (4.6505; 1.0045)	Gambia, The (.59224; .22117)	Niger (.59095; .27947)
Burkina Faso (.74064; .67717)	Madagascar (.13599; .21789)	Togo (1.5919; 6.2984)
Central African Republic (.12364; .0002)	Malawi (.94426; 2.6463)	Zimbabwe (2.2335; .39046)
Comoros (.32356; 1.9345)	Nepal (2.1814; .11985)	

Note: the Chi^2-test statistic is denoted within the parentheses, where the first value is the Chi^2-test statistic when testing for causality from saving to growth, and the second value denoting the Chi^2-test statistic when testing for causality from growth to saving. Significance levels are denoted as follows:

*	: significant at a 10% significance level
**	: significant at a 5% significance level
***	: significant at a 1% significance level

Appendix B: Gross Domestic Saving

Table B1: Effect Gross Domestic Saving on Real Economic Growth per Capita (Equation 22)

	Arellano-Bond estimator		PMG estimator		Fixed-effects estimator	
Variables	**Coefficient**	**Std. Err.**	**Coefficient**	**Std. Err.**	**Coefficient**	**Std. Err.**
l.ΔGDP per capita	.19244***	.01793			.16436***	.017018
Gross Domestic Saving Rate	.19382***	.01789	.10748***	.0146428	.12564***	.013399
Trade openness (% of GDP)	-.01554**	.00714	.01131**	.0054756	.00574	.004124
log(Fertility Rate)	.48148**	.21941	-.91280*	.4789976	-.8838*	.469335
Government Cons. (% of GDP)	-.24822***	.03182	-.13901***	.0266215	-.12482***	.020175
Life Expectancy	.004406	.04207	-.20110	.0360581	.02896	.022986
log(Initial GDP)	2.6066***	.59868	1.3712***	.5203656	-1.7686***	.380068
Constant	-20.347***	5.3599	3.3446***	.4769702	14.891***	3.37440
Number of observations	3237		3237		3320	
Number of countries	83		83		83	
Number of years per country	39		39		39	
First-order autocorrelation p-value	.000		.2694		.3947	
Second-order autocorrelation p-value	.6109					
Baltagi-Wu LBI test statistic					1.6446	
Sargan test of overid. rest.	1.000 (81.73)					
Number of instruments	787					
F-statistic	61,2587***				43,63***	

Note: L. denotes the first time lag of a variable. Standard errors are clustered. The autocorrelation test used with the AB-estimator is the *Arellano-Bond test for autocorrelation,* the autocorrelation test used with the PMG-estimator and the fixed-effects estimator is the *Wooldridge test for autocorrelation.* The Sargan test denotes the P-value and the Chi^2-test statistic in the parentheses. Significance levels are denoted as follows:

* : significant at a 10% significance level

** : significant at a 5% significance level

*** : significant at a 1% significance level

Appendix C: Private and Public Saving

Table C1: Effect Private and Public Saving on Real Economic Growth per Capita (Equation 23)

	Arellano-Bond estimator		Fixed-effects estimator	
Variables	**Coefficient**	**Std. Err.**	**Coefficient**	**Std. Err.**
L1.ΔGDP per capita	.309218***	.0580112	-.400969***	.0416884
L2.ΔGDP per capita	-.1197417***	.0439883	-.393948***	.0426201
L3.ΔGDP per capita	.1115544***	.0338712	-.126236***	.0415667
L4.ΔGDP per capita	-.1050958***	.0372707	-.175580***	.0397191
Private Saving Rate	.0334828	.0354159	.033965	.0352717
Public Saving Rate	.5351049***	.1030946	.546904***	.0791997
Trade openness (in % of GDP)	.0088826	.020633	.028274**	.0140178
log(Fertility Rate)	-4.773785*	2.731871	-3.16415	3.70048
d.Life Expectancy	.9994519	.7987232	.1798278	.7174888
Government Cons. (in % of GDP)	-.0340355	.1242725	-.0456307	.1160842
log(Initial GDP)	2.079546	1.861864	1.73029***	2.21231
Constant	-10.64174	14.20276	-12.9942***	5.26158
Number of observations	450		450	
Number of countries	25		25	
Number of years per country	18		18	
First-order autocorrelation p-value	0.000		0.3273	
Second-order autocorrelation p-value	0.3278			
Baltagi-Wu LBI test statistic			1.93056	
Sargan test of overid. rest.	1.000 (17.1)			
Number of instruments	233			
F-statistic	33.99***		23.83***	

Note: L. denotes the time lag of a variable. Standard errors are clustered. The autocorrelation test used with the AB-estimator is the *Arellano-Bond test for autocorrelation,* the autocorrelation test used with the fixed effects-estimator is the *Wooldridge test for autocorrelation.* The Sargan test denotes the P-value and the Chi^2-test statistic in the parentheses.
Significance levels are denoted as follows:

* : significant at a 10% significance level

** : significant at a 5% significance level

*** : significant at a 1% significance level

Appendix D: Household, Corporate and Public Saving

Table D1: Effect Household, Corporate and Public Saving on Real Economic Growth per Capita (Equation 24)

	Arellano-Bond estimator		Fixed-effects estimator	
Variables	**Coefficient**	**Std. Err.**	**Coefficient**	**Std. Err.**
L1.ΔGDP per capita	.1829233	.1308483	-.268087***	.0459773
L2.ΔGDP per capita	-.246792***	.0754107	-.2927938***	.0581746
Household Saving Rate	-.0145644	.0277072	-.0232487	.0251747
Corporate Saving Rate	-.019429	.0457474	.0017101	.034597
Public Saving Rate	-.0074788	.1021631	.0375992	.036309
Trade openness (in % of GDP)	.1799323***	.0341795	.1892634***	.0225199
log(Fertility Rate)	-24.7713***	6.561993	-2.51462***	.5154667
Life Expectancy	-1.819523	.6425649	-.2365994***	.4725138
Government Cons. (in % of GDP)	-.5480263*	.3139881	-.4890756***	.1587824
log(Initial GDP)	9.922216***	3.079596	2.149312***	.2994074
Constant	56.60717	36.10401	-8.209722	1.196865
Number of observations	416		416	
Number of countries	32		32	
Number of years per country	13		13	
First-order autocorrelation p-value	0.003		0.2134	
Second-order autocorrelation p-value	0.1415			
Baltagi-Wu LBI test statistic			1.81801	
Sargan test of overid. rest.	1.000 (30.3817)			
Number of instruments	113			
F-statistic	31,94***		31.39***	

Note: L. denotes the time lag of a variable. Standard errors are clustered. The autocorrelation test used with the AB-estimator is the *Arellano-Bond test for autocorrelation,* the autocorrelation test used with the fixed effects-estimator is the *Wooldridge test for autocorrelation.* The Sargan test denotes the P-value and the Chi^2-test statistic in the parentheses.
Significance levels are denoted as follows:

*   : significant at a 10% significance level
** : significant at a 5% significance level
*** : significant at a 1% significance level

Appendix E: Unit Root Test Results

Table E1: unit root tests outcomes – Granger Causality Test

Sample 1970-2010: Countries with a non-stationary variable

Bangladesh	India	Puerto Rico
Bolivia	Italy	South Africa
Burkina Faso	Japan	United Kingdom
Dominican Republic	Morocco	United States
Greece	Pakistan	Zimbabwe
Guatemala	Philippines	

Note: for all countries holds that after taking first differences of the non-stationary variable, the variable became stationary.

Sample 1981-2011: Countries with a non-stationary variable

Algeria	Dominican Republic	Portugal
Bahamas, The	Greece	Puerto Rico
Bangladesh	Italy	Saudi Arabia
Barbados	Japan	South Africa
Comoros	Kenya	United Kingdom
Cyprus	Luxembourg	United States

Note: for all countries holds that after taking first differences of the non-stationary variable, the variable became stationary.

Table E2: unit root tests outcomes – Gross Domestic Saving

Variable	Levin-Lin-Chu test
GDP growth per capita	0.000 (0.4661)
Gross Domestic Saving Rate	0.000 (-5.8002)
Trade Openness	0.000 (-30.3601)
log(Fertility Rate)	0.000 (-30.0807)
Life Expectancy	0.000 (-26.3649)
Government Cons.	0.000 (-6.1982)
log(Initial GDP)	0.004 (-3.3747)

Note: given are the P-values for unit root test and adjusted t-test statistics are shown in parentheses. First differences are taken from the variables where the null hypothesis of panel contains unit root could not be rejected by one of the tests. d. denotes the first difference of a variable.

Table E3: unit root tests outcomes – Private and Public saving

Variable	Levin-Lin-Chu test
GDP growth per capita	0.000 (0.4661)
Private Saving Rate	0.000 (-3.9691)
Public Saving Rate	0.000 (-7.0895)
Trade Openness	0.000 (-5.3293)
log(Fertility Rate)	0.000 (-11.4585)
Life Expectancy	0.872 (1.1380)
d. life expectancy	0.000 (-18.9817)
Government Cons.	0.000 (-6.1276)
log(Initial GDP)	0.000 (-3.9453)

Note: given are the P-values for unit root test and adjusted t-test statistics are shown in parentheses. First differences are taken from the variables where the null hypothesis of panel contains unit root could not be rejected by one of the tests. d. denotes the first difference of a variable.

Table E4: Unit root test outcomes - Household, Corporate and Public saving

Variable	Levin-Lin-Chu test
GDP growth per capita	0.000 (-6.5803)
Household Saving Rate	0.000 (-3.2816)
Corporate Saving Rate	0.003 (27.7235)
Public Saving Rate	0.000 (-4.0414)
Trade Openness	0.000 (-4.5165)
log(Fertility Rate)	0.000 (-16.4617)
Life Expectancy	0.000 (-4.7586)
Government Cons.	0.000 (-3.3292)
log(Initial GDP)	0.000 (-4.1699)

Note: given are the P-values for unit root test and adjusted t-test statistics are shown in parentheses. First differences are taken from the variables where the null hypothesis of panel contains unit root could not be rejected by one of the tests. d. denotes the first difference of a variable.

Appendix F: List of countries per study

Table F1: Granger Causality Tests – Sample 1970-2010

High Income Countries			
Australia	Finland	Japan	Saudi Arabia
Austria	France	Korea, Rep.	Singapore
Barbados	Greece	Luxembourg	Spain
Belgium	Hong Kong SAR	Netherlands	Sweden
Canada	Iceland	Norway	United Kingdom
Chile	Israel	Portugal	United States
Denmark	Italy	Puerto Rico	Uruguay
Uppermiddle Income Countries			
Algeria	Ecuador	Malaysia	Thailand
Brazil	Fiji	Mexico	Tunisia
Colombia	Gabon	Peru	Turkey
Costa Rica	Hungary	South Africa	Venezuela
Dominican Rep.			
Lowermiddle Income Countries			
Bolivia	Ghana	Indonesia	Philippines
Cameroon	Guatemala	Lesotho	Sri Lanka
Congo, Dem. Rep.	Guyana	Mauritania	Sudan
Cote d'Ivoire	Honduras	Morocco	Zambia
Egypt, Arab Rep.	India	Nicaragua	
El Salvador	India	Pakistan	
Low Income Countries			
Bangladesh	Central African Republic	Malawi	Sierra Leone
Benin	Congo, Rep.	Mali	Togo
Botswana	Gambia, The	Nepal	Zimbabwe
Burkina Faso	Kenya	Niger	
Burundi	Madagascar	Rwanda	

Table F2: Granger Causality Tests – Sample 1981-2011

High Income Countries			
Antigua and Barbuda	Denmark	Japan	Saudi Arabia
Australia	Finland	Korea, Rep.	Singapore
Austria	France	Latvia	Spain
Bahamas, The	Germany	Luxembourg	Sweden
Bahrain	Greece	Malta	Switzerland
Barbados	Hong Kong SAR, China	Netherlands	United Kingdom
Belgium	Iceland	New Zealand	United States
Canada	Ireland	Norway	Uruguay
Chile	Israel	Portugal	
Cyprus	Italy	Puerto Rico	
Uppermiddle Income Countries			
Albania	Costa Rica	Grenada	Panama
Algeria	Cuba	Hungary	Peru
Belize	Dominica	Jordan	South Africa
Botswana	Dominican Republic	Malaysia	Thailand
Brazil	Ecuador	Mauritius	Tunisia
Bulgaria	Fiji	Mexico	Turkey
Colombia	Gabon	Namibia	Venezuela, RB
Lowermiddle Income Countries			
Bhutan	Georgia	Lesotho	Philippines
Bolivia	Ghana	Mauritania	Senegal
Cameroon	Guatemala	Mongolia	Sri Lanka
Congo, Rep.	Guyana	Morocco	Swaziland
Cote d'Ivoire	Honduras	Nicaragua	Zambia
Egypt, Arab Rep.	India	Nigeria	
El Salvador	Indonesia	Pakistan	
Low Income Countries			
Bangladesh	Congo, Dem. Rep.	Mali	Sudan
Benin	Ethiopia	Mozambique	Togo
Burkina Faso	Gambia, The	Nepal	Zimbabwe
Burundi	Kenya	Niger	
Central African Republic	Madagascar	Rwanda	
Comoros	Malawi	Sierra Leone	

Table F3: Gross Domestic Saving – Sample 1971-2011 (Equation 22)

Algeria	Dominican Republic	Korea, Rep.	Saudi Arabia
Australia	Ecuador	Lesotho	Senegal
Austria	Egypt, Arab Rep.	Luxembourg	Sierra Leone
Bangladesh	El Salvador	Malawi	Singapore
Barbados	Finland	Malaysia	South Africa
Belgium	France	Mali	Spain
Benin	Germany	Malta	Sri Lanka
Bolivia	Ghana	Mauritania	Sudan
Botswana	Greece	Mexico	Swaziland
Brazil	Guatemala	Morocco	Sweden
Burkina Faso	Honduras	Netherlands	Switzerland
Burundi	Hong Kong SAR, China	New Zealand	Thailand
Cameroon	Hungary	Nicaragua	Togo
Canada	Iceland	Niger	Tunisia
Central African Republic	India	Norway	Turkey
Chile	Indonesia	Pakistan	United Kingdom
Colombia	Ireland	Peru	United States
Congo, Rep.	Israel	Philippines	Uruguay
Costa Rica	Italy	Portugal	Venezuela, RB
Cuba	Japan	Puerto Rico	Zambia
Denmark	Kenya	Rwanda	

Table F4: Private and Public Saving – Sample 1990-2012 (Equation 23)

Bahamas, The	Czech Republic	Jordan	Peru
Belarus	Egypt, Arab Rep.	Kenya	Singapore
Belize	Ethiopia	Korea, Dem. Rep.	Slovenia
Bhutan	Guatemala	Mongolia	Sri Lanka
Canada	India	Nicaragua	Tunisia
Congo, Dem. Rep.	Indonesia	Pakistan	Uruguay
Croatia			

Table F5: Household, Corporate and Public Saving – Sample 1995-2010 (Equation 24)

Armenia	Egypt, Arab Rep.	Kyrgyz Republic	Republic of Moldova
Azerbaijan	Estonia	Latvia	Romania
Belarus	Finland	Lithuania	Slovak Republic
Belgium	France	Netherlands	Slovenia
Brazil	Hungary	Niger	Spain
Chile	Italy	Norway	Sweden
Cyprus	Japan	Poland	Ukraine
Czech Republic	Kazakhstan	Portugal	United Kingdom