

Södertörn University | Institution of Life Sciences
Bachelor Thesis 15 hp | Utveckling and Internationellt Samarbete |
Spring 2012

What factors affect economic growth in China?

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Abstract

The objective of this thesis is to find out what factors have been the main sources of economic growth in China in 2003 and 2010. It also aims to find out whether the Solow model can be used to explain growth in China, if factors of growth are the same in rich and poor regions, whether the factors are the same in 2003 and 2010 and if the results are in line with previous research.

The theoretical framework is the Solow model. Empirical tests are performed using econometrics, and therefore this thesis has a quantitative approach. Factors used are growth in GDP per capita which is tested against investments, household savings, the level of GDP per capita, population growth, healthcare and education.

The results show that the Solow model can explain economic growth in China. Investments, the level of GDP per capita and population growth are the factors most significant to growth. In poor regions, both investments and population growth are more significant than in rich regions, whereas healthcare is more significant in rich regions. Investments and population growth also have a smaller impact in 2010 than 2003. Healthcare is more significant in 2010 and than 2003, and education is only significant in 2010. Previous research shows a wide range of results, and the results of investments and population growth are consistent with those.

Keywords: Solow, economic reform, GDP per capita, GDP growth

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1. Introduction

In 1978, the leader of the Chinese Communist Party (CCP), Deng Xiaoping, initiated the open door policy, a free-market reform. The reform took two decades to finalize and brought China from being a poor and introverted country controlled by the state, to being an open free market economy. The reform included accepting foreign direct investments, allowing for entrepreneurs to start their own businesses, privatizing state-owned enterprises and removing price controls. The free-market reform was the beginning of extreme economic growth. From 1978 to 2010 the economy grew by an average of 9,4% a year, according to official Chinese statistics.¹ Because China is the world's largest developing economy, this has led to over 500 million people having been lifted out of poverty.² The World Bank expects China to be the world's largest economy by 2030, even if growth rates slow down.³

The reform was also the beginning of several other transitions currently in progress; the country is moving from a developing economy to a developed one, rural productivity is being replaced by urban industrialization, the centrally planned society is becoming an open market economy. The one-child policy has caused the soaring population growth to slow down but also laid the foundation for a society where a decreasing number of young people will have to provide for a huge ageing population.

China is still a rather poor country in terms of GDP per capita, and regional inequalities are large. With so many transitions as once, it is difficult to estimate the exact causes of growth. Therefore, this thesis will try to determine the main factors of growth in China using the Solow model as a starting point.

¹ Ding and Knight, *Can the Augmented Solow Model Explain China's Economic Growth?*, 2008, p. 2.

² The Word Bank, *China 2030*, 2012, p. xv.

³ Ibid.

1.1 Research objective

The objective of this thesis is to find out what factors have been the main sources of economic growth in China in 2003 and 2010. The factors included are investments, household savings, the level of GDP per capita, population growth, healthcare and education. They are all based on the Solow model of growth, which have lead to the following research questions being formulated:

- Can the Solow model be used to explain economic growth in China 2003 and 2010?
- What factors are the main determinants of growth in China?
- Are the factors of growth the same in rich and poor regions?
- Are the factors of growth the same in 2003 and 2010?
- Are the results in line with previous research?

1.2 Delimitation

The scope of this thesis has been limited to the years 2003 and 2010. There are several reasons for this. First, collecting and analyzing data is very time consuming and therefore a wider approach would not be feasible. Second, statistical data regarding China from the 1990's and before is hard to find and is not always reliable (more on this in section 5.4.1). Third, since there was a recession in Asia in the late 1990's, and again in the late 2000's, the economy has had a long term development that is too complex for this thesis. That is why I have chosen to include only a few years where data is available and where the scope of the analysis fits the time frame of a bachelor thesis.

1.3 Outline

In the following section is a brief background of modern Chinese history of society and economic growth. In section 3 is the literature review followed by section 4, the theoretical framework, which explains the Solow model. Section 5 defines the method and data used and other factors that might have affected the data. In section 6 is the empirical result, followed by a discussion around the result and a conclusion. Last is the bibliography and appendix.

2. Background

Figure 1: Map of China⁴

Administrative Divisions of China



2.1 Provinces, municipalities and autonomous regions⁵

Provinces: Anhui, Fujian, Gansu, Guangdong, Guizhou, Hainan, Hebei, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Jilin, Liaoning, Qinghai, Shaanxi, Shandong, Shanxi, Sichuan, Yunnan, Zhejiang.

Municipalities: Beijing, Chongqing, Shanghai, Tianjin.

Autonomous regions: Guangxi, Inner Mongolia, Ningxia, Tibet, Xinjiang.

⁴ Wikipedia. *China Provinces*. 2010-03-29.

⁵ From here on only called regions.

2.2 Modern history and society

The People's Republic of China was established in 1949 after the country had suffered through a long civil war. Mao Zedong, as the leader of the Chinese Communist Party (CCP), was very close to the Soviet Union and wanted China to become a powerful socialist state too. He implemented some drastic changes to the Chinese society, mainly to help the huge rural population. Public schools were introduced in order to decrease high illiteracy rates, and the whole countryside was collectivized, culminating with the people's communes, i.e. large rural collectives. Each commune had thousands of residents with their own schools, medical facilities, industries etc. The commune leaders supplied childcare and care for old people, and assigned everyone in the countryside a job. Private ownership of land was banned as everyone worked for the commune, not for him- or herself.

In connection with the people's communes, the movement the Great Leap Forward was launched.⁶ The movement was an attempt to industrialize China in one "great leap" in order to compete with industrialized western countries. Farmers were ordered to produce iron and steel to help industrialization, but the result was disastrous. The iron and steel produced was of bad quality and could not be used. Still, it was given priority, which led to deterioration of agriculture. This caused around 40 million people to starve to death.⁷

The enormous failure of the Great Leap Forward caused tensions within the CCP, which in turn led to the beginning of the Cultural Revolution in 1966, a political campaign in which Mao tried to spread his revolutionary ideals.⁸ Young party members were mobilized in order to destroy everything capitalist and promote socialism. Intellectuals such as teachers, specialists and even high-level party members, were harassed and sent to the countryside for re-education of socialist ideals. The revolution only came to a stop after Mao died in 1976 and Deng Xiaoping seized power. Beside economic reforms, Deng introduced some social reforms. People's communes were abolished and jobs, schools and healthcare for rural residents were no longer automatically provided by the state. Urban residents had been paying for their own welfare all along, but now both urban and rural residents had to provide for themselves.

⁶ Kjellgren, *Kinakunskap*, 2000, p. 76.

⁷ Eklund, *Kina: den nygamla supermakten*, 2011, p. 50.

⁸ Kjellgren, p. 77.

The one-child policy was introduced in the late 1970's under Deng Xiaoping. The policy only allows married couples to have one child as a measure to stop China's soaring population growth. The policy has been implemented with some extreme methods, like forced sterilization and fines for those who have more than one child. The policy has since then been relaxed and now allows for those born under the one-child policy to have two children. Minorities are also exempt from the policy and those who have one girl are allowed to have one more child.

Another debated issue in China is the hukou system, a system of national registration of the population. Ever since the 1950's, people have been registered as either rural or urban residents. Originally, the hukou system was used to register the distribution of food stamps in urban areas in order for everyone to receive equal benefits.⁹ Today, it is used to stop rural residents from moving to the cities, as the cities do not have the capacity to provide for everyone. Only registered urban residents are allowed to live in cities and you need to prove your residency to get a job in the city.¹⁰ Because jobs are hard to find in rural areas, many people move to the cities and work illegally, called the floating population.

In 2001 there was a relaxation of the migration laws and the hukou system is being revoked in smaller cities.¹¹ Rural residents are allowed to buy temporary urban residence permits that allow them to work legally in the cities. The fees were initially very high but are now reasonably affordable. The line of inheritance of hukou was also changed to allow succession through both parents, as opposed to only the father.¹²

⁹ Han, "The Hukou System and China's Rural Development", 1999, p. 358.

¹⁰ Macleod, "China reviews 'apartheid' for 900m peasants", 2001.

¹¹ Ibid.

¹² Au, *Women migrant workers under the Chinese social apartheid*, 2007, p. 1.

2.3 History of trade and economic growth

China was not always a closed economy, even before the reforms in the 1970's. In 1949-1960 China was open to trade but their only trading partner was the Soviet bloc.¹³ The trade was very important to the Chinese economic development, they imported steel and machinery and exported textiles and food. International trade was even encouraged under the period of the Great Leap Forward, as China was in great need of machinery to become industrialized.

When the Great Leap Forward turned out to be a failure and the country faced an economic crisis, China started retreating into isolation. Trade stagnated and only covered the most important goods such as grain imports, which was crucial to overcome the great famine. The early 1970's was the worst period in time in terms of international relations as China strived for complete self-reliance.¹⁴

In the late 1970's, China started to recover from the Cultural Revolution and began exporting textiles again. At the same time, China's main oil field in Daqing was becoming profitable and China started exporting oil.¹⁵ The income from foreign trade was desperately needed to import new technology from the West and Japan. However, it wasn't long before the oil resources were not enough to pay for imports. It was clear that China needed to do something about its economic system to keep up the economic development. Hence, opening up to trade was the best solution.

Another reason for the economic reform was to restore people's faith in the CCP. After the economic stagnation that followed the Great Leap Forward and Cultural Revolution, there needed to be an improvement in the standard of living to restore the political support for The CCP. Promoting economic growth was a way of providing legitimacy to the party.¹⁶

China had also witnessed the economic success of the West and other Asian countries and regions, such as Taiwan, Hong Kong and South Korea.¹⁷ They had reached economic growth by using a free market and open economic policies. If it worked for other countries, the CCP figured it should work for China.

¹³ Naughton, *The Chinese economy: transitions and growth*, 2007, p. 379.

¹⁴ Ibid., p. 379.

¹⁵ Ibid., p. 380.

¹⁶ Ding and Knight, *China's Remarkable Economic Growth*, 2012, p. 44.

¹⁷ Ibid.

3. Literature review

There have been few quantitative studies on economic growth in China and most of those that do exist only focus on one or two factors. They also show a wide range of results. There have been many analyses on economic growth that include countries all over the world but none of them include China. However, despite different approaches and different countries investigated, they still form a base for discussion.

Ding and Knight examine if the Solow model can explain the difference in economic growth between China and other countries.¹⁸ They do so by using panel data, i.e. econometrics, on 146 countries during 1980-2000. The foundation for their research is the simple Solow model, the Solow model augmented with human capital and the Solow model augmented with structural change. The result shows that the model augmented with both human capital and structural change best explains economic growth in China. They find that capital accumulation is most important to growth along with structural change, conditional convergence and slower population growth rate. They also find that the level of education in China has been crucial to the growth difference between China and other developing countries in Sub-Saharan Africa and South Asia.

Ek investigates the impact of foreign direct investments, FDI, on economic growth in China in 1994-2003.¹⁹ The theoretical base is the Solow model, and data for 30 regions in China is analyzed with the help of econometrics. The result is that investments show a positive but insignificant impact on economic growth for all 30 regions. When the regions receiving least FDI are omitted, the result is both positive and statistically significant.

Wang and Yao focus on human capital in China and whether economic growth is caused by accumulation of human capital, physical capital and labor, or an increase in total factor productivity.²⁰ They use data on human capital stock from 1952 to 1999 and find that China has had a rapid accumulation of human capital and that it contributes to growth and welfare. The conclusion is that China's declining rate of human capital is a problem to continued growth.

¹⁸ Ding and Knight, *Can the augmented Solow model explain Chinas economic growth?*, 2008.

¹⁹ Ek, *Utländska direktinvesteringars påverkan på ekonomisk tillväxt*, 2007.

²⁰ Wang and Yao, *Sources of China's Economic Growth, 1952-99*, 2001.

Li also investigates human capital in China and estimates the economic gains from education in urban China in 1995.²¹ He finds that previous tests have underestimated the gains from education and that gains have increased as China has been through the economic transition. He also concludes that economic gains are higher in the less-developed regions of China.

Lundblad and Rosenqvist research the factors that affect growth in developing countries, excluding China.²² The variables included are health, education, GDP per capita, level of corruption, FDI, economic freedom, change in population growth and system of government. Their data only includes the year 2003 and they also use an econometric model. The results show that the factors that have the greatest impact on growth are a democratic system of government and a large share of FDI per GDP. The population variable is also significant but positive, which is contrary to the Solow model.

Hoeffler uses data for 98 countries, excluding China, to find out if the Solow model can explain the poor growth in Africa in 1960-1990.²³ The variables included are initial GDP, the investment to GDP ratio, population growth rate and average years of schooling. The result is that the Solow model augmented with human capital can explain Sub-Saharan Africa's low growth performance, and that the lack of growth is due to low investment ratios and high population growth.

Wixe studies the effect of globalization, real capital, human capital and FDI on economic growth in Sweden 1980-2050. The performance of these variables is once again compared to the Solow model augmented with human capital, but also augmented with globalization.²⁴ Using econometrics, Wixe's result is that globalization is, and will continue to be, a source of growth in Sweden. The effect of FDI is positive and significant but very small. Real capital and human capital are also positive and significant and have a bigger impact on growth.

²¹ Li, *Economic transition and returns to education in China*, 2002.

²² Lundblad and Rosenqvist, *Utvecklingsländers ekonomiska tillväxt*, 2012.

²³ Hoeffler, "The augmented Solow model and the African growth debate", 2002.

²⁴ Wixe, *The Effect of Globalization on Swedish Growth*, 2009.

4. Theoretical Framework

The following is a very simplified version of the Solow model, as it contains expressions and mathematical functions that might be complicated for those unfamiliar with national economics. For the mathematically inclined, more thorough explanations can be found in Appendix 1.

4.1 The Solow model of growth

The Solow model is a theory developed by Robert Solow in 1956 as an extension of the Harrod-Domar model, and for which Solow was awarded the Nobel Prize in Economics.²⁵ The model attempts to explain economic growth in an economy. It does so by looking at how capital, labor and population growth determine the short run level of GDP per capita, and how technological progress and human capital affect long run economic growth.

4.1.1 The simple Solow model

The simple version of the model describes how an economy's level of GDP per capita, or standard of living, is determined using only capital and labor.

Capital (physical capital, machines, roads etc.) is created by savings and investments.

Households, firms and governments save some of their income, which is borrowed by others for investments. If, for example, a firm invests in new machines, GDP increases, which in turn raises future savings and investments. The Solow model assumes a closed economy where all savings are used for investments. Therefore, these two factors are considered as one.

Capital does not only grow with investments; it can decrease due to depreciation, for example when machines and roads wear out and need to be replaced. Because capital depreciates, savings and investments need to be equal or larger than the depreciation rate to keep a steady level of GDP per capita.²⁶

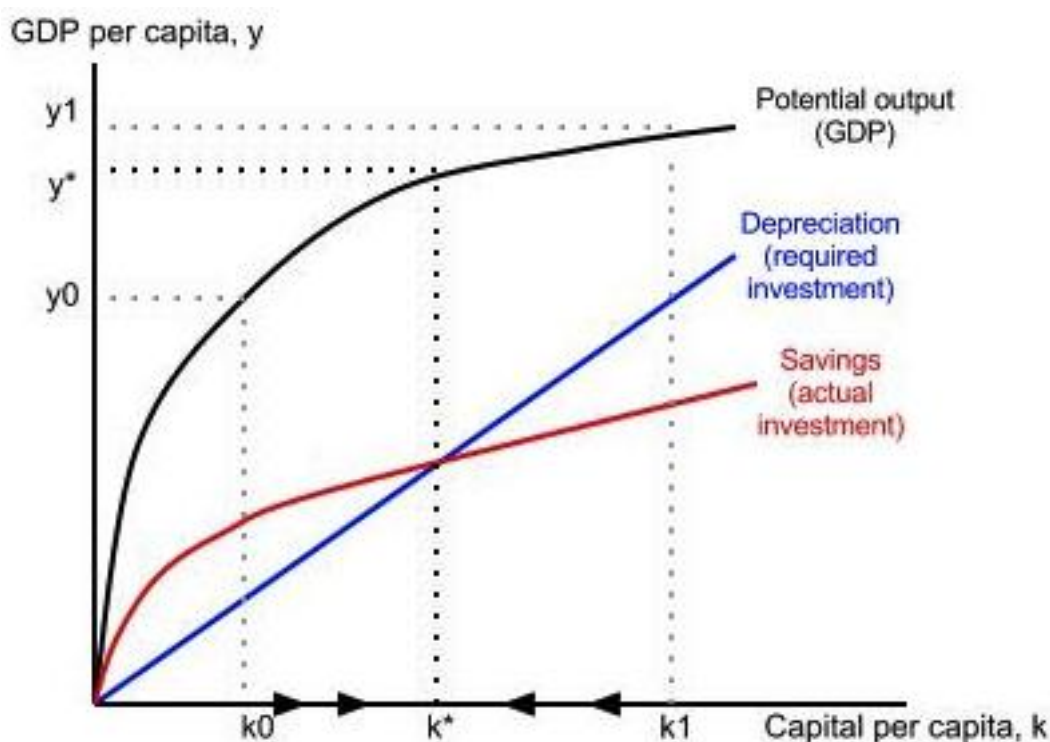
²⁵ Todaro and Smith, *Economic development*, 2006, p. 122.

²⁶ Ibid., p. 50.

Labor is the other factor that creates output in an economy, as labor is needed to work with the given capital. The original Solow model differs between labor and population but in this simplified version labor and population are used synonymously. The reason for this is partly because data for labor is hard to find but mainly because a large population usually implies a large labor force.

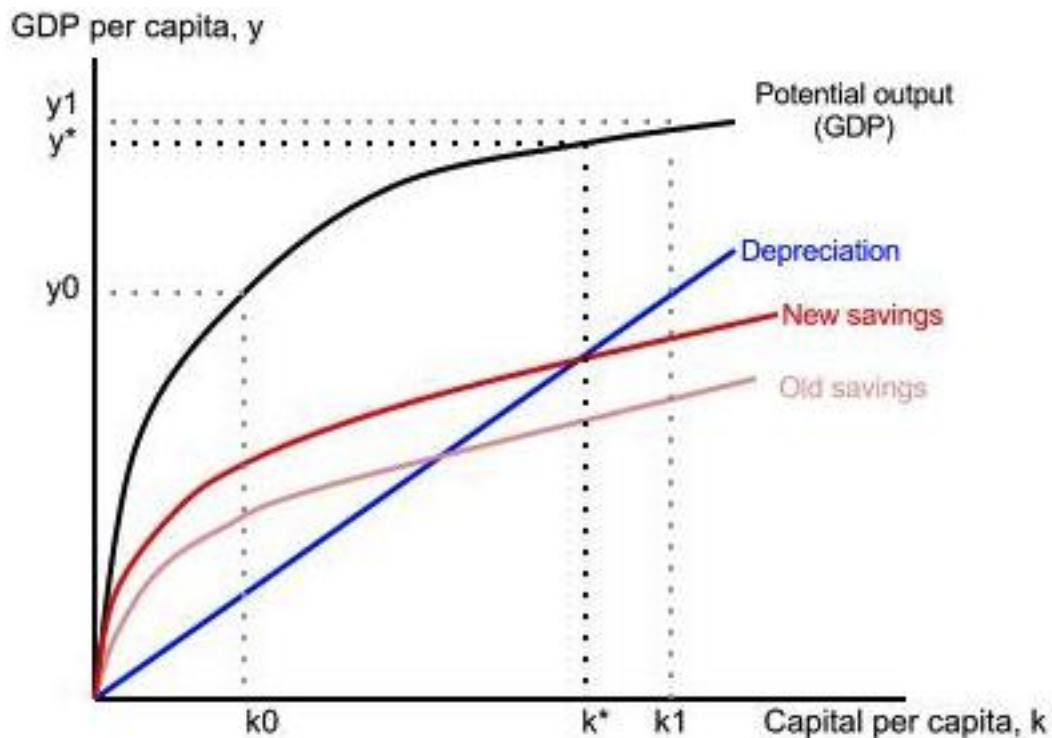
Capital and labor will work together to create a level of GDP per capita, called the steady state. At the steady state, there is no economic growth; it is only a stable standard of living for the country.

Figure 2: The simple Solow model



Here, you can see how savings and depreciation create GDP per capita. When savings equal the depreciation rate (the blue and red intersection), the economy is at a steady state where GDP per capita, y^* , and capital per capita, k^* , is neither rising nor falling. There is no economic growth. If the capital stock is at k_0 , there are more investments than what is being depreciated and the economy will grow towards k^* . At k_1 , investments fail to replace all capital that is being depreciated, and GDP per capita will be lower next year. This way the capital per capita always moves towards k^* , the steady state.

Figure 3: The simple Solow model with increased savings

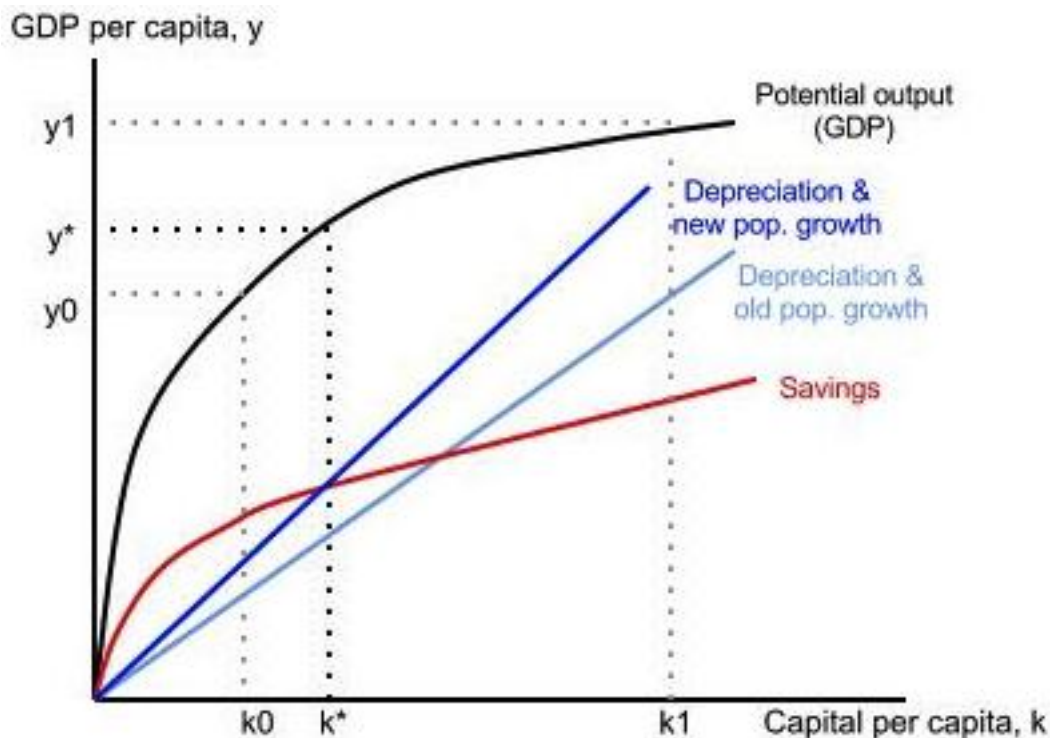


What happens if there is an increase in savings? Savings will now equal depreciation at a higher steady state, where there is a larger GDP per capita, y^* , at more capital per capita, k^* . The standards of living are higher than in the previous example, and the country is wealthier, i.e. a higher steady state.

As shown, a country's standard of living is measure in GDP per capita and capital per capita. If GDP per capita is to remain unchanged in an economy, output must grow at the same rate as population. The only difference from the previous model is that savings not only need to make up for depreciation of capital, but also for increased population that demands a share of GDP.²⁷

²⁷ Burda and Wyplosz, Macroeconomics, 2001, p. 56.

Figure 4: The simple Solow model with population growth



What happens if there is an increase in population? The depreciation line now also includes population growth, which means that savings need to be even larger to support both the new population and depreciation. If savings do not change, the steady state moves to a lower point, where both capital and output per labor decrease, at y^* and k^* . This explains why countries with a rapid population growth and low savings tend to be poorer than countries with little population growth.

Is labor and capital enough to cause economic growth? The answer is no because of positive but diminishing marginal productivity.²⁸ This means that if a firm has capital and labor, increasing the number of workers will increase the output. If we continue to increase the number of workers over and over, output will increase, but at a decreasing rate. The last worker added will not add as much to output as the first one. You can see this from the shape of the potential output line, which starts off steep and grows flatter. Capital and labor only affect the standards of living in an economy, not the growth rate.

²⁸ Ibid., p. 48.

4.1.2 The Solow model augmented with technological progress and human capital

So far, capital (savings, investments, depreciation), labor and population growth have caused a change in the steady state level of GDP per capita. Different countries end up at different steady states, as pictured above. Because of diminishing marginal productivity, you cannot keep adding capital and labor to increase economic growth because, in the end, it will make no difference. The model needs something more to explain long-term growth; why some countries grow faster than others, and what can be done to increase growth in developing countries. Two factors can increase the growth rate; technological progress and human capital.

Technological progress: Solow added technological progress to the model in order to explain why labor and capital is more efficient in some countries. The term technological progress is slightly misleading as the term actually incorporates all “intangible aspects of human progress that allow both population and capital to increase their productivity”, which can vary from country to country.²⁹

Technological progress causes economic growth without an increase in capital or labor because it makes the existing capital and labor more productive. Better machines and increased knowledge among workers increase output, as we have witnessed ever since industrialization. How is technological progress measured in the Solow model? The problem is, no one knows. Solow simply decided that new technology will increase output by π , but he failed to explain what exactly π is and where it comes from.³⁰ Fortunately, there were other economists who solved this problem.

Human capital was added to the model, not by Solow himself but by Mankiw, Romer and Weil.³¹ They thought that human capital could explain the origin of technological progress because an educated and healthy labor force will be more productive.³² Therefore, human capital, like education and healthcare, will have a positive effect on economic growth.³³ The model assumes that population growth is constant, so all change in productivity of labor is caused by human capital.

²⁹ Carlin and Soskice, *Macroeconomics: imperfections, institutions, and policies*, 2006, p. 481.

³⁰ Ibid., 2006, p. 483.

³¹ Mankiw et al, “A Contribution to the Empirics of Economic Growth”, 1992.

³² Ray, *Development economics*, 1998, p. 100.

³³ Carlin and Soskice, p. 501.

Human capital is accumulated just like physical capital.³⁴ Households, firms and the government “save” human capital by investing in education instead of in physical capital. The only difference is that they *choose* to do so; it doesn’t just happen like technological progress or population growth.

One part of output is invested in human capital and the rest in physical capital. The growth rate of human capital is the same as the growth rate of physical capital (the growth rates are shown in Appendix 1). These growth rates have the same effect on output as technological progress has, i.e. they change the rate that the economy grows.

4.2. Why use the Solow model?

The Solow model has received both praise and critique ever since the 1960’s. One of its limitations is that it fails to include entrepreneurship as a source of growth, and the strength of institutions. The model does not explain how or why technological progress occurs, which, as we know, led to Mankiw, Romer and Weil adding human capital to the equation.³⁵

The model has also had various empirical results performed, some of which support the model and some that do not. Still, it counts as the most important contribution to the neoclassical theory of growth and is the most widely used model when it comes to long-run economic growth.³⁶

³⁴ Ibid., p. 503.

³⁵ Mankiw et al, 1992.

³⁶ Todaro & Smith, 2006, p. 122.

5. Method and data

5.1 Method

This thesis will be implemented empirically using an econometric model, and therefore it has a quantitative approach.

Econometrics is a method that analyses statistical data in order to find links between factors, also called variables. The first step is to formulate a function that forms the basis for the research. The following function describes the relationship that is to be analyzed, i.e. how economic growth, to the left, is affected by the factors to the right. The object for research, in this case economic growth, is also called the dependent variable, and the factors of growth are called independent variables. A more detailed version of this function can be found in Appendix 2.

$$\text{Economic growth} = \text{Investments} + \text{Savings} + \frac{\text{GDP}}{\text{capita}} + \text{Pop growth} + \text{Healthcare} + \text{Education}$$

The next step is to find data for all the factors in the function. Since this thesis is based on the Solow model, all the factors represented in the Solow model should be included. Data for all variables was collected from the National Bureau of Statistics of China³⁷. This includes data for all factors, for the years 2003 and 2010 were chosen, and for some variables 1997-2003 and 2004-2010 (see section 5.3). The data that was chosen had information on all 31 regions in China.

When all this data is collected and compiled, it is analyzed using computer software that generates a result, which is further analyzed and discussed by the researcher. The software used is called R Commander but there are many others that can be used.

There are three different versions of the econometric model for the years 2003 and 2010 that will be compared to each other. The first model includes all 31 regions. In the second model, the five poorest regions have been omitted and in the third one the five richest regions have been omitted. The reason for using these three models is to see whether or not there are any differences in the factors affecting growth in poor and rich regions.

³⁷ National Bureau of Statistics of China. *National Bureau of Statistics of China, Annual Data*, 2012.

When using econometrics, it is important to have as many observations as possible (in this case, one region is one observation), otherwise the result is not trustworthy as it may be due to chance. Before deciding on these models, there were several attempts made with omitting both more and fewer regions. When omitting fewer than five, there were no visible differences in the result between the models. When omitting more than five, the result was not significant as there were not enough observations. Therefore, omitting five regions gave the clearest result.

The richest and poorest regions were found by calculating the average GDP per capita in each region for the years 1997-2003 and 2004-2010 respectively. A complete list of average GDP per capita for the time spans mentioned can be found in Appendix 3

In Model 2 (see section 6.3) the five poorest regions omitted are Guizhou, Gansu, Guangxi, Yunnan and Shaanxi for 1997-2003 and Guizhou, Gansu, Yunnan, Tibet and Guangxi for 2004-2010. In Model 3 (see section 6.4) the five richest regions omitted are Shanghai, Beijing, Tianjin, Zhejiang and Jiangsu for both 1997-2003 and 2004-2010.

5.2 Reliability and validity

The fact that econometric analyses are completely based on secondary data is both positive and negative in terms of reliability. When relying on someone else to collect the data there is a risk that the data is not correctly compiled, as might be the case with the National Bureau of Statistics. This lowers the reliability. But, when one and the same institution collects the data and it is available to everyone, the research becomes very reproducible. Reliability can also be an issue when not having enough observations, just like qualitative studies that only include a couple of interviewees, as generalizability will suffer. The number of observations in this thesis is hard to modify as China only has 31 regions, which I have also deemed as enough.

Validity is hard to estimate as the National Bureau of Statistics does not reveal its' sources. Validity is high as long as the researcher chooses appropriate data for the research. If data is not correctly collected, validity will be lower. Validity can be an issue when variables change fast over time, as in the case of population growth that does not include the floating population. As the data from the National Bureau of Statistics is the only one available, research on China will have to be made with this problem in mind.

When using economic data there are always outside factors that might change the result, such as irregular inflation rates and economic recessions. China has had high inflation rates and also been through two recessions with only ten years apart, which does affect quantitative research. The longer the time span included, the more generalizable is the result. But, the longer the time span the bigger is also the risk of including data from a recession, which might not be representable. The two variables measuring growth in this thesis, economic growth and population growth, have the time span of 1997-2003 and 2004-2010. In 1997, there was a recession in Asia, which might affect the result, but the option of including fewer years seemed like a bigger risk in terms of generalizability.

5.3 Variables

Below is the dependent variable, the object for research, along with the independent variables, the factors of growth.

Dependent variable

Economic growth is represented by the average nominal growth in Gross Regional Product per capita, i.e. GDP per capita for each region, divided by population in that same region. For the year 2003, average growth is calculated 1997-2003, and for 2010 it is calculated 2004-2010. The reason for using an average of seven years is to even out irregular occurrences that may affect growth for only one or two years.

Independent variables

Investments are represented by investment stocks in fixed assets divided by GDP in each region. This includes domestic investments, e.g. state-owned, collective owned and private, as well as funds from Hong Kong, Macao and Taiwan and foreign funded investments. Investments should have a positive impact on growth according to the Solow model.

Savings is household saving stocks divided by GDP in each region. Savings are expected to have a positive impact on economic growth according to the Solow model as increased savings give more capital and a higher steady state.

GDP per capita is the level of GDP in each region in 1997 and 2004 respectively, i.e. the initial years of the periods researched. This variable is included in the research in order to describe

capital formation, or the current standard of living in each region, where a high GDP per capita indicates a high standard of living. GDP per capita should have a positive impact on growth as a wealthy region has a history of economic growth, which enables future savings and investments.

Population growth is the average growth in population, measured in percent, in each region, in 1997-2003 and 2004-2010. In the Solow model, economic growth is measured in GDP per capita. A large population means that GDP will have to be shared by many people. Therefore this variable is expected to have a negative impact on growth.

Healthcare is represented by the number of persons employed in healthcare institutions and includes medical technical personnel, doctors, physicians and nurses. This number is divided by population in each region. The reason for choosing medical personnel as a measurement of healthcare is availability of data. The variable could have a positive impact on economic growth as health raises human capital and increases productivity. It could also have a negative impact on economic growth because a healthy population will live longer and want a higher share of the GDP. Or, the two effects will cancel out and there will be no measurable impact.

Education is measured by educational funds, i.e. governmental appropriation, funds from social organizations, donations, fund-raising and tuition fees, divided by GDP in each region. The reason for choosing educational funds as a measurement of education as opposed to for example literacy rate, is availability of data. Education is expected to have a positive impact on growth, as more educational funds should increase human capital and make workers more productive.

Below is a summary of the variables and the units in which they are measured.

Table 1: Summary of variables³⁸

Variable	Unit measured in	Expected outcome
Economic growth	Average $\frac{GDP}{pop} = \frac{100 \text{ million } \overline{\text{元}}}{10.000 \text{ pers}}$	
Investments	$\frac{Investments}{GDP} = \frac{100 \text{ million } \overline{\text{元}}}{100 \text{ million } \overline{\text{元}}}$	+
Savings	$\frac{Savings}{GDP} = \frac{100 \text{ million } \overline{\text{元}}}{100 \text{ million } \overline{\text{元}}}$	+
GDP/capita	$\frac{GDP}{capita} = \frac{100 \text{ million } \overline{\text{元}}}{10.000 \text{ pers}}$	+
Pop, growth	Average % growth	-
Healthcare	$\frac{Medical \text{ pers}}{population} = \frac{10.000 \text{ pers}}{10.000 \text{ pers}}$	+ or -
Education	$\frac{Edu.funds}{GDP} = \frac{100 \text{ million } \overline{\text{元}}}{100 \text{ million } \overline{\text{元}}}$	+

5.4 The variables in China

5.4.1 Dependent variable

There are several problems when it comes to estimating China's GDP. The first problem arises because China is a transitional economy. Since there have been so many new economic activities in a rather short time span, some things are being left out and the figures might be underestimated. Another problem is that data is often distorted to come across as better than it actually is, which causes it to be overestimated. This happens because local officials exaggerate the data to meet the expectations of their superiors.³⁹ It has also been difficult for other researchers to examine the sources that the National Bureau of Statistics use to collect data as they have refused to explain the sources and their methods of collecting it.⁴⁰

The problem with inaccurate data was most severe during the period of central planning because, for many years, data was not centrally collected, especially during the Cultural Revolution.⁴¹ The

³⁸ 1 $\overline{\text{元}}$ is approximately 1 SEK

³⁹ Ibid.

⁴⁰ Ding and Knight, 2012, p. 6-7.

⁴¹ Ibid.

problem was partly resolved in the late 1990's when the government took action against false reports and collection methods were somewhat more reliable.⁴²

In 2006, statistics for GDP from 1993-2004 were revised in order to correct for previous mistakes. This led to the average GDP growth rate being raised from 9,4% to 9,9%.⁴³ The insecurity of accuracy could be a problem when performing research that relies on statistical data, but for those who want to do research on China, this is the only data available.

5.4.2 Independent variables

Investments: In the last decades, China's investments in private and public assets as share of GDP have been extremely large, some years around 40%.⁴⁴ This is more than any other country has had for an ongoing period of time, only comparable to the high investment rates in the Soviet Union under central planning. What is interesting is that other economies have had high investment rates under central planning, but most investments decreased as market economy is introduced. In China, the investment rates have remained high.

Foreign Direct Investments are also a part of investments and make up 4% of China's GDP, which makes China the largest recipient of FDI in the developing world.⁴⁵ One problem with FDI is that some Chinese actors, like provincial authorities, have helped conduct round trip investments. Round trip investments takes place when a Chinese company sets up a company abroad, to which they sell an asset. Then the Chinese company buys that same asset back for the same price, which inflates the FDI figures and makes investments look larger.

Savings: Not only does China invest a lot, Chinese people also save a large amount of their income. In 1990 the average household saved 15% of their income, in 2009 that figure was 29%.⁴⁶ The reason for high savings rates is that China lacks a welfare system that provides for retirement, healthcare, education etc., since the people's communes were disbanded. Today, everything has to be saved up for. Ever since the one-child policy was implemented, household savings have become more important as old people can no longer count on being provided for by their children

⁴² Naughton, p. 141.

⁴³ Ding and Knight, 2012, p. 7.

⁴⁴ Eklund, *Kina: den nygamla supermakten*, 2011, p. 74.

⁴⁵ Eklund, p. 112.

⁴⁶ Ibid., p. 47.

and grandchildren. Another reason for high household savings is that capital markets are insecure and saving in banks is considered a much more reliable option.⁴⁷ However, there are downsides to saving in banks as inflation rates have been irregular for the past decades and are sometimes higher than the banks' savings rates, which decreases the value of savings.⁴⁸

Population growth: China's population is over 1,3 billion, the largest of any country in the world. Studying China, it is hard to get a proper understanding of the population because population growth is very inconsistent. The Great Leap Forward led to an extreme famine where more than 40 million people died and another 40 million less children were born.⁴⁹ This put a dent to the soaring population growth. Population growth has also been affected by the one-child policy. From the year 1970 to 2000, around 200 million abortions were performed and 150 million people were sterilized. It is estimated that, without the policy, China would have an additional 200-300 million inhabitants.⁵⁰ Although the policy has been relaxed it still prevents children from being born.

Another issue that makes China's population hard to measure is the floating population. About 200 million people are estimated to live and work illegally outside of their registered area of residence. These people are not counted in the region where they currently live, but where they are registered, which makes statistical data on population per region misleading.⁵¹

Healthcare: During the period of central planning, rural healthcare was provided by the state and based in the people's communes, whereas urban residents always had to pay for healthcare themselves. When the communes were decollectivized, the collective welfare system was undermined leaving the majority of rural residents without healthcare.⁵² In 2005, a healthcare insurance was introduced which aims to include 90% of the rural population but only includes a few percent, and in 2009 the decision to start a healthcare reform was made. Still, there have been problems implementing these changes, mainly because of corruption as doctors benefit from prescribing expensive medication and working in a private practice, which continues to disfavor the poor rural population.⁵³

⁴⁷ Ibid.

⁴⁸ Wong, "Kinas nya medelklass", 2008, p. 15.

⁴⁹ Eklund, p. 50.

⁵⁰ Ibid., p. 229.

⁵¹ Keidel, *The Causes and Impacts of Chinese Regional Inequalities in Income and Well-Being*, 2007, p. 4.

⁵² Eklund, p. 226.

⁵³ Ibid., p. 227.

Once again the floating population poses a problem with availability of healthcare, as government-funded healthcare is only available in your registered area of residence. Private healthcare is much too expensive for most people and is rarely an option.⁵⁴ Those who have to pay for private healthcare often end up in poverty.⁵⁵

Education: Under the period of central planning, the government funded all rural education.⁵⁶ After the market system was introduced, the government has continued to subsidize education to some extent but the subsidies have decreased, making education rather expensive.⁵⁷ Despite high costs, there is still a great demand for higher education. This has a number of explanations, one being China's history where education had high status.⁵⁸

In the 1970's and 1980's, researchers found that education did not affect a person's income at all, the only factors that increased your salary was being a member of the CCP and being male.⁵⁹ In the 1990's this changed. Those who were more productive got a higher salary and uneducated workers ran a higher risk of being fired. On top of that, once China opened up to foreign investors the demand for educated Chinese workers with language skills grew rapidly amongst foreign companies and the demand for education increased.⁶⁰

There are great inequalities in education. Rural areas are left behind, just like when it comes to healthcare, and there have been a number of reforms that aim to supply everyone with 9 years of mandatory schooling. According to some, this has been partially successful, but once again the floating population is left behind so the result is still unclear.⁶¹

⁵⁴ Ibid.

⁵⁵ Bennich-Björkman, "Fattigdomsspiral kan brytas med fri sjukvård." 2012-03-19.

⁵⁶ Ding and Knight, 2012, p. 40.

⁵⁷ Ibid.

⁵⁸ Ibid., p. 125.

⁵⁹ Naughton, p. 193.

⁶⁰ Ibid., p. 195.

⁶¹ Ding and Knight, 2012, p. 40.

6. Empirical results

6.1 How to interpret the results

For both years, 2003 and 2010, each model is performed in five steps. The first step only includes two variables, investments and savings. In the next step GDP per capita has been added, then population growth, then healthcare and the last step includes all six variables. The reason for doing so is to see whether or not the impacts of the variables change depending on how many variables, and which, are included.

Each box has a number, an estimate, that describes the impact on economic growth. If the number is positive, the variable has a positive impact on growth, and vice versa if the number is negative.

In some cases, there are symbols below the number. These symbols indicate the level of significance, i.e. credibility of the result.

(***) means that the risk of the result occurring by chance is less than 0,1%.

(**) means that the risk of the result occurring by chance is less than 1%.

(*) means that the risk of the result occurring by chance is less than 5%.

(.) means that the risk of the result occurring by chance is less than 10%.

The econometric software, R Commander, gives the symbols and levels of risk.

The level of significance has nothing to do with the size of the impact on growth; they only tell us whether or not we can trust the result. No symbol means that the risk of the result occurring by chance is rather large.

At the bottom of each model is the percentage explained by the model, i.e. how many percent of growth can be explained by the variables included. When there are only a few variables added, the percentage is usually quite low, which means that the variables chosen are not enough to explain growth. A high percentage means that the variables chosen are able to explain economic growth.

More details on the result can be found in Appendix 4.

6.2 Model 1: All regions

Table 2: Model 1 (2003)

Variables included	2	3	4	5	6
Investm.	-0.024	0.062 (*)	0.083 (**)	0.066 (*)	0.072 (*)
Savings	0.046	-0.020	-0.012	-0.032 (.)	-0.030
GDP/c		0.110 (***)	0.125 (***)	0.107 (***)	0.106 (***)
Pop. growth			-1.002 (**)	-0.791 (*)	-0.758 (.)
Health.				5.861 (.)	6.154 (.)
Education					-0.00001
% explained	-3.42%	86.19%	89.02%	90.05%	89.72%

(2010)

2	3	4	5	6
-0.525 (**)	0.064	0.029	-0.015	0.011
-0.080	-0.105	-0.171	-0.289 (*)	-0.245 (*)
	0.176 (***)	0.135 (**)	0.114 (**)	0.063
		2.768	1.015	3.545
			50.786 (**)	38.643 (*)
				-0.0002 (*)
23.07%	65.77%	66.46%	74.73%	78.71%

2003

We can see that for 2003, the factors that affect economic growth are investments, the level of GDP per capita, population growth and healthcare, because they have a symbol indicating significance. Investments, the level of GDP per capita and healthcare have positive numbers, which means that if they increase, so will economic growth. Population growth has a negative estimate meaning that if population increases it will have a negative impact on growth. This is all according to theory. Savings only show a low degree of significance when five variables are included and education is not significant to growth at all in this model.

2010

In 2010, GDP per capita has the most significant impact on economic growth. Investments and savings are also significant to some extent but have a negative impact, which is unexpected, and are not significant throughout the model. The major difference compared to 2003 is that population growth is insignificant to growth and that education is significant.

Estimates

Let's look at the impact of GDP per capita on growth. In both 2003 and 2010, the estimated impact is around 0.1. This varies slightly depending on how many variables are included which is normal as long as they don't vary too much (see Multicollinearity on the next page). Because GDP per capita is measured in 10.000 元, 0.1 means that an increase in the level of GDP per capita by 10.000 元 will cause an increase in annual growth by 1000 元 per capita.

The impact from population growth is approximately -1 to -0,7 in 2003. Because population growth is measured in percent and population is measured in 10.000 元, an increase in population by 1% will cause economic growth to decrease by 10000 元 to 7000 元 per capita.

The estimate for healthcare varies the most in between 2003 and 2010. In 2003 it is around 6, which shows that if the ratio of healthcare workers as a share of population increases by one, economic growth increases by 60.000 元 per capita. In 2010, the estimate is very large, 50 and 38, which would make growth increase by 380.000 元 to 500.000 元. This result is extreme and will be discussed in section 7.

Percentage explained by model

If we look at the bottom row that indicates the percentage explained by the model, we can see quite large differences between 2003 and 2010. In the first column where only two variables are included in 2003, the percentage is -3.42%, which means that investments and savings alone cannot explain growth at all, and economic growth must be caused by something else.⁶² In 2010, on the other hand, investments and savings can explain 23.07% of economic growth that year, so those two variables explain growth to some extent. For every variable that is added to the model, the percentage changes.

As soon as GDP per capita is added and there are 3 or more variables included, the percentage explained is very high for both years, around 65-86%. This means that the variables chosen are able to explain 86% of economic growth in 2003 and 65% in 2010. The remaining percentage points are due to some factors that are not included in this research.

⁶² Some readers might ask how this number can be negative. This has to do with how the percentage is computed which is way beyond the scope of this thesis. Please see Studenmund, 2011, for more on econometrics and how to interpret the results.

When population and healthcare are added, the model can explain an even larger percent of economic growth, although it is not a big increase. When education is added to the model the percentage *decreases* a little bit in 2003, from 90.05% to 89.72%, which means that education doesn't explain growth at all. In fact, it weakens the result. When all six variables are included, the percentage explained is bigger in 2003 than in 2010, and so in 2010 there are more or larger factors missing in the model than in 2003.

Multicollinearity

Multicollinearity occurs when two or more variables are related to each other and therefore makes it difficult to estimate the impact on growth. You can discover multicollinearity by looking at different parts of the results. First, if the estimate changes when variables are added, there might be a case of multicollinearity. For example, when healthcare is added, the estimates for savings and population growth change. The estimate for savings becomes twice as large and is also significant. The estimate for population growth decreases and becomes less significant. One possible explanation is that healthcare is related to population growth because good healthcare affects life expectancy. The relation to savings could be that household savings are used to fund healthcare. There are also signs of multicollinearity between education and healthcare and education and savings. The estimate for healthcare greatly decreases when education is included, and savings lose its' significance in 2003. Again, education is funded by household savings, which could explain the relation. Healthcare and education are thus also related to each other through being funded by savings, which explains the variables' multicollinearity.

6.3 Model 2: The five poorest regions omitted

Table 3: Model 2 (2003)

Variables included	2	3	4	5	6
Investm.	-0.029	0.0512 (.)	0.069 (*)	0.057 (.)	0.069 (*)
Savings	0.042	-0.033 (.)	-0.024	-0.042 (.)	-0.040 (.)
GDP/c		0.105 (***)	0.118 (***)	0.106 (***)	0.103 (***)
Pop. growth			-0.845 (*)	-0.697 (.)	-0.640
Health.				4.660	5.570
Education					-0.00002
% explained	-4.88%	85.64%	87.84%	88.38%	88.11%

(2010)

2	3	4	5	6
-0.448 (*)	0.092	0.089	0.044	0.055
-0.035	-0.096	-0.254 (.)	-0.395 (**)	-0.300 (*)
	0.169 (***)	0.095 (*)	0.089 (*)	0.029
		5.997 (*)	3.925	6.157 (*)
			49.318 (*)	42.538 (*)
				-0.0003 (.)
18.53%	59.96%	66.1%	73.29%	76.87%

In this model the five poorest regions for each year have been omitted in order to see if different factors impact economic growth in the richer parts of China. The largest difference from model 1 is that population growth is significant in both 2003 and 2010 whereas healthcare is only significant in 2010. Savings are more significant in both years compared to Model 1, and are still negative to growth. If the stock of household savings in 2010 increases by 100 million 元, GDP will decrease by around 200-300 元 per capita.

Another difference is that investments are slightly less significant in 2010, which means that investments are less important to growth in the richer parts of China. Healthcare still has large estimates and is positive.

Again, the percentage explained by the model is bigger in 2003 (88.11%) than in 2010 (76.87%) when all six variables are included. This shows that even when the five poorest regions are omitted, there are still more factors of growth missing in 2010 than in 2003.

6.4 Model 3: The five richest regions omitted

Table 4: Model 3 (2003)

Variables included	2	3	4	5	6
Investm.	-0.033	0.053 (*)	0.083 (***)	0.074 (***)	0.072 (**)
Savings	-0.015	-0.027 (.)	-0.021 (.)	-0.027 (*)	-0.027 (*)
GDP/c		0.112 (***)	0.139 (***)	0.130 (***)	0.132 (***)
Pop. growth			-0.879 (***)	-0.787 (**)	-0.814 (**)
Health.				2.857	2.809
Education					0.00006
% explained	-2.76%	71.96%	83.63%	84.23%	83.5%

(2010)

2	3	4	5	6
-0.208	0.042	0.039	-0.009	0.009
-0.301 (.)	-0.184	-0.196	-0.227 (.)	-0.260 (*)
	0.184 (**)	0.176 (**)	0.136 (*)	0.021
		0.627	0.146	3.509
			36.614 (.)	24.60
				-0.0002 (*)
12.82%	42.75%	40.26%	45.56%	56.72%

In the last model, the five richest regions have been omitted. In 2003, investments show a higher degree of significance and so does population growth. In 2010, both investments and population growth are completely insignificant to growth and healthcare is much less significant. Savings are more significant in 2003 compared to Model 2, but less significant in 2010.

The percentage explained by the model is smaller in both 2003 and 2010 than in previous models, and is especially small in 2010 with only 56.72%. There are more factors of growth missing from the model in the poorer regions in 2010 compared to rich regions.

7. Discussion

7.1 Factors included in the research

Investments and savings

Investments and savings are an important part of the Solow model because they determine the level of steady state output, i.e. how much capital is available per capita. China has had huge investments and savings rates, and therefore these variables were expected to be positive and significant to growth.

Investments are generally more significant to growth in 2003 than in 2010, which could mean that investments are losing some of its impact on growth. Investments show the highest level of significance in model 3 for the year 2003, meaning that investments are more important to growth in poor regions than rich. It could be that investments are larger in poor regions and have a more significant impact on growth, or that there are other factors that affect growth more in rich regions.

However, it is hard to say whether investments cause growth or growth cause investments. Large investments yield a higher level of GDP per capita and a higher steady state, according to theory, and combined with human capital it can yield growth. But a high level of GDP per capita can also be caused by other factors, such as savings or human capital. The GDP may in turn be used for investments. The results do show that there is a correlation between investments and growth. The fact that investments are significant to growth is not only according to theory but also to previous research (see section 3.). Both Ding and Knight,⁶³ Ek,⁶⁴ and Lundblad and Rosenqvist,⁶⁵ Hoeffler⁶⁶ and Wixe⁶⁷ has come to the same conclusion, which proves that investments are not only significant to growth in China but in other parts of the world as well.

Savings show some degree of significance in all models for both years but is consistently negative. The negative estimates are contrary to the Solow model. One explanation could be that savings are measured in household savings/GDP, and if GDP grows faster than the savings rate, then the savings/GDP ratio will decrease and it will be negatively correlated to growth. This correlation

⁶³ Ding and Knight, 2008.

⁶⁴ Ek, 2007.

⁶⁵ Lundblad and Rosenqvist, 2012.

⁶⁶ Hoeffler, 2002.

⁶⁷ Wixe, 2009.

will come across as having a negative impact on economic growth when savings might actually be increasing. GDP in China has been growing fast but unless savings grow at the same rate, the ratio will become smaller. Another explanation is that China has had large inflation rates, sometimes larger than the banks' savings rates.⁶⁸ Saving your money in a bank could therefore be negative to the household's income and therefore also to growth. If a large part of the household income is put into savings, that also means that less money is being consumed. Little consumption is negative to growth, which can also explain the negative estimate of savings.

None of the literature reviewed has included savings as a separate variable; there is only one joint variable for capital accumulation (savings and investments). Therefore it is not possible to compare this result to others.

GDP per capita and population growth

These two variables are also a part of the simple Solow model. GDP per capita indicates capital accumulation and population growth is an important factor of growth, as growth is measured in terms of per capita.

The results for GDP per capita and population growth don't vary so much in between rich and poor regions. GDP per capita is consistently significant for both years in all regions. The estimates in 2003 are about 0.1 in all models but vary more in between models in 2010. Thus, the estimated impact is more consistent in size in 2003 than in 2010. The high significance of GDP per capita could explain why the significance of investments was smaller in 2010. The level of GDP per capita is the result of capital accumulation in the past, whereas investments are present capital accumulation. China has had long-term growth since the late 1970's so it is obvious that present growth is a result of past decisions of investments, resulting in a high GDP per capita, rather than today's decisions. GDP per capita is included as a variable in some of the previous research, for example in Ding and Knight⁶⁹ and Lundblad and Rosenqvist.⁷⁰ However, both have come to the conclusion that investments are much more important to growth than GDP per capita.

Population growth is more significant in model 3 than in previous models, showing that population growth has a clear negative impact on growth in poor regions. This is expected, as the

⁶⁸ Wong, 2008, p. 15.

⁶⁹ Ding and Knight, 2008.

⁷⁰ Lundblad and Rosenqvist, 2012.

one-child policy has had a smaller effect in rural areas that tend to be poor, and so rural families have more children. There is also a big difference in the impact of population growth in 2003 and 2010. In 2003, population growth is significant and negative, just like the Solow model says, but in 2010 it is only somewhat significant in Model 2. China's birthrate has experienced a strong decline ever since the one-child policy was implemented, and population growth is not as detrimental to growth as it has been in the past. There has been a clear decrease in the impact of population on growth in between 2003 and 2010, which the result shows. This could also explain why GDP per capita has a bigger estimate in 2010 than in 2003. Decreased population growth in 2010 means that fewer people need to share the income, and GDP per capita will be bigger. The fact that a smaller population has a positive impact on growth was also the conclusion reached by Ding and Knight⁷¹ and Hoeffler⁷².

Healthcare and education

Healthcare has the possibility of being negative to growth if it is counted as population growth and positive if it counts as increased human capital. However, it has been consistently positive.

Healthcare is significant in both years in Model 1, but in Model 2 and 3, it is only significant in 2010. The fact that the significance in 2003 is somewhat inconsistent can be explained by the fact that the positive and negative effects cancel each other out and that, only in 2010, health reforms started to come through and has had an effect on growth. It could also be that efficient health care is a result of economic growth and not a cause of growth, which might explain why it mainly displays significance 2010, after a long period of growth in China.

In model 3, healthcare shows the smallest degree of significance and has smallest estimates, and so healthcare has smaller impact in poor regions. Because the poor often live in rural areas where healthcare is not available or very expensive, it will not be a determinant of growth. In richer areas, usually urban areas, healthcare is much more available and so healthy workers will be able to contribute to economic growth.

Even though healthcare was expected to be positive to growth, the estimates are larger in 2010 than should be possible. The healthcare variable is measured in employed medical personnel/population, and the reason for the exaggerated result could once again be population growth. When population growth slows down, the variable representing healthcare will seem to

⁷¹ Ding and Knight, 2008.

⁷² Hoeffler, 2002.

get bigger if the number of employed personnel stays the same, as there are more healthcare workers per capita.

Education is only significant to growth in 2010. This is most likely due to the fact that education has not been widely available in China but indicates that something has changed in between 2003 and 2010. As mentioned, there have been a number of reforms in order to provide education and the restrictions towards the floating population have been eased. Despite doubts of the impact of these reforms, education might have become more available, or the quality has increased. What is also interesting is that when comparing Model 2 and 3, there is a higher degree of significance in poor regions, if only a small difference, indicating that improvements are greater in poor regions. In terms of previous research, the impact of human capital has had different results. Ding and Knight fail to see any impact in China, but Wang and Yao⁷³ and Li⁷⁴ both find that human capital has a positive impact on growth. When it comes to the impact of human capital in growth in other parts of the world, Lundblad and Rosenqvist⁷⁵ also cannot find a relation in developing countries, whereas both Hoeffler⁷⁶ and Wixe⁷⁷ have found a significant correlation between human capital and growth, on a global scale and in Sweden.

7.2. Factors missing from the research

The results show that the percentage explained by the model was generally higher in 2003 than in 2010 when all six variables were included in the models. The difference between poor and rich regions was rather small in 2003 but is noticeable in 2010. This implies that there are factors missing from the models that explain growth, and that there are more factors missing in 2010 than in 2003, and also more factors missing in poor regions than in rich regions.

The factors missing could be for example environmental problems, which are an increasing problem in China. One example is carbon and sulfur that pollute the air, lakes and forests.⁷⁸ Not enough water is being cleaned which causes water shortage and pollution of the ground destroys farmland, which is detrimental to farmers' income.⁷⁹ These problems are often a result of fast

⁷³ Wang and Yao, 2001.

⁷⁴ Li, 2002.

⁷⁵ Lundblad and Rosenqvist, 2012.

⁷⁶ Hoeffler, 2002.

⁷⁷ Wixe, 2009.

⁷⁸ Kjellgren, 2000, p. 107.

⁷⁹ Ibid.

economic growth, as the government puts growth before environment, and are more severe in poor regions. Other factors missing could be the lack of functioning institutions, such as corruption or inequality between men and women or urban and rural residents. It could also be material things like the high oil price that slows down industrialization. The fact that there are more factors missing in 2010 than in 2003 shows that factors of growth in China are changing, and what used to be significant to growth will not necessarily be so in ten years from now.

Including all of these factors has not been an option in this thesis, because of time restraint and availability of data. Measuring environmental damage and inequality can be very challenging; especially when data cannot always be trusted, so quantitative research may not yield valid results on these issues. If and when reliable data is available, some factors can be included in future research, but too many variables increases the risk of multicollinearity and the result will not be reliable.

If the welfare system changes, many of the variables included in this research will change. If the hukou system is relaxed, keeping track of population will be much easier and give clearer results in terms of population growth and GDP per capita. If even more welfare is provided by the state, there will be a big change to healthcare and education, and also household savings as people won't have to put all their savings to medicine and schooling. This, in addition to the fact that there hasn't been a lot of quantitative research done on economic growth in China, leaves a lot to be researched in the future.

8. Conclusion

Let's return to the five questions formulated at the beginning of this thesis.

- Can the Solow model be used to explain economic growth in China 2003-2010?

Yes, although not completely. Any theory or model is a simplified version of reality, and so is the Solow model. It assumes a closed economy and the model augmented with technological progress and human capital also assumes no population growth. This is obviously not the case with China, or any other country for that matter. Disregarding these issues, the empirical results follow the Solow model fairly well. Investments and GDP per capita have a positive impact on growth and population is negative to growth, just as the model claims.

- What factors are the main determinants of growth?

The main factors most significant to growth in China in 2003 and 2010 are the level of GDP per capita, investments, and population growth.

- Are the factors of growth the same in rich and poor regions?

Growth in both rich and poor regions is affected by investments, GDP per capita and population growth. In poor regions, both investments and population growth are more significant than in rich regions, whereas healthcare is more significant in rich regions.

- Are the factors of growth the same in 2003 and 2010?

No. GDP per capita is the only factor consistently affecting growth but the impact is slightly less significant in 2010. Investments and population growth also have a smaller impact in 2010 than 2003. Healthcare is more significant in 2010 and than 2003, and education is only significant in 2010.

- Are the results in line with previous research?

Yes, although previous research has had a wide range of results. One common denominator is that capital is significant to growth, whether in the form of investments or GDP per capita, and that population growth is negative to growth. This is in line with the results of this thesis.

9. Bibliography

Printed sources

Burda, Michael, and Charles Wyplosz. *Macroeconomics: a European text*. New York: Oxford University Press, 2001.

Bennich-Björkman, Li. "Fattigdomsspiral kan brytas med fri sjukvård." *Svenska Dagbladet*, 2012-03-19

Carlin, Wendy, and David Soskice. *Macroeconomics: imperfections, institutions, and policies*. Oxford: Oxford University Press, 2006.

Ding, Sai, and John Knight. *Can the Augmented Solow Model Explain China's Economic Growth? A Cross-Country Panel Data Analysis*. Discussion Paper, Department of Economics, Oxford: University of Oxford, 2008.

—. *China's Remarkable Economic Growth*. Oxford: Oxford University Press, 2012.

Ek, Anna. *Utländska direktinvesteringars påverkan på ekonomisk tillväxt: En studie av Kina*. Bachelor Thesis, Jönköping: Jönköping University, 2007.

Eklund, Klas. *Kina: den nygamla supermakten*. Stockholm: Studieförbundet Näringsliv and samhälle, 2011.

Han, Dongping. "The Hukou System and China's Rural Development." *The Journal of Developing Areas*, 1999: 355-378.

Hoeffler, Anke E. "The augmented Solow model and the African growth debate." *Oxford Bulletin of Economics and Statistics*, 2002: 135-158.

Keidel, Albert. *The Causes and Impacts of Chinese Regional Inequalities in Income and Well-Being*. Carnegie Endowment for International Peace, 2007.

Kjellgren, Björn. *Kinakunskap*. Lund: Studentlitteratur AB, 2000.

Lundblad, Therése, and Johan Rosenqvist. *Utvecklingsländers ekonomiska tillväxt*. Bachelor Thesis, Huddinge: Södertörn University, 2012.

Li, Haizheng. *Economic transition and returns to education in China*. Atlanta, GA: School of Economics, Georgia Institute of Technology, 2002.

Loong-yu, Au. *Women migrant workers under the Chinese social apartheid*. Bangkok: Committee for Asian Women, 2007.

Macleod, Calum. "China reviews "apartheid" for 900m peasants." *The Independent*, 2001-06-10.

Mankiw, Gregory N., David Romer, and David N. Weil. "A Contribution to the Empirics of Economic Growth." *The Quarterly Journal of Economics*, 1992: 407-437.

Naughton, Barry. *The Chinese economy: transitions and growth*. Massachusetts: MIT Press, 2007.

Ray, Debraj. *Development economics*. Princeton, N.J.: Princeton University Press, 1998.

Studenmund, A.H. *Using Econometrics: A Practical Guide*. Boston: Pearson Education, 2011.

The World Bank. *China 2030, Building a Modern, Harmonious, and Creative High-Income Society*. Washington DC: The World Bank, 2012.

Todaro, Michael P., and Stephen C. Smith. *Economic development*. Harlow: Pearson/Addison Wesley, 2006.

Wang, Yan, and Yudong Yao. *Sources of China's Economic Growth, 1952-99: Incorporating Human Capital Accumulation*. Discussion Paper, Washington DC: The World Bank, 2001.

Wixe, Sofia. *The Effect of Globalization on Swedish Growth – A study of the years 1980 to 2050*. Bachelor Thesis, Linköping: Linköping University, 2009.

Wong, Ola. "Kinas nya medelklass." *Kinarapport*, 2008: 14-16.

Electronic sources

CIA - The World Factbook. *East and Southeast China*. 2012-05-03.

<https://www.cia.gov/library/publications/the-world-factbook/geos/ch.html> (accessed 2012-05-18).

National Bureau of Statistics of China. *National Bureau of Statistics of China, Annual Data*. 2012.

<http://www.stats.gov.cn/english/statisticaldata/yearlydata/> (accessed 2012-04-20).

Wikipedia. *China Provinces*. 2010-03-29.

http://commons.wikimedia.org/wiki/File:China_provinces.png (accessed 2012-05-20).

10. Appendix

Appendix 1: The Solow model

The simple Solow model

- The model assumes positive but diminishing marginal productivity of capital and labor separately.⁸⁰
- The model also assumes constant returns to both factors jointly.⁸¹
- Output can be produced using any combination of labor and capital.
- Savings equal investments,⁸² $S = I$
- Savings, investments and population growth are exogenous.

The production function is linearly homogenous and uses only capital (K) and labor (L). The plus signs underneath mean that output increases whenever capital or labor increases.⁸³

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

+ +

The same production function using output per labor (y) as a product of capital per labor (k).

$$y = f(k)$$

Capital formation including depreciation (δ) and the share of production that is being saved, (s).⁸⁴

$$\Delta k = s \cdot y - \delta \cdot k$$

This functions shows that the change in capital, on the left hand side, equals savings and depreciation of capital. Lower case letters mean that the factors are measured per capita.

Capital formation including population growth (n).

$$\Delta k = s \cdot y - (\delta + n) \cdot k$$

The Solow model augmented with technological progress

- Technological change is exogenous

Production function, including technological progress (A).⁸⁵ Even if capital and labor remain unchanged, output will increase if there is an improvement in technology.

$$Y = f(A, K, L)$$

which gives the capital formation function

$$\Delta k = s \cdot y - (\delta + a + n) \cdot k$$

⁸⁰ Burda and Wyplosz, 2001, p. 48.

⁸¹ Ibid., p. 49.

⁸² Ibid., p. 50.

⁸³ Ibid., p. 47.

⁸⁴ Δ = change over time, s = savings per labor

⁸⁵ Ibid., p. 58.

When introducing technological change, we now use efficiency units of capital and labor, as the existing capital and labor is used more efficiently.

$$\hat{y} = \frac{Y}{AL}$$

where \hat{y} denotes the amount of output produced by each efficient unit of labor.

$$\hat{k} = \frac{K}{AL}$$

where \hat{k} denotes the amount of capital available to each efficient unit of labor. This gives the capital formation function

$$\Delta \hat{k} = s \cdot \hat{y} - (\delta \cdot \hat{k} + n \cdot \hat{k} + \pi \cdot \hat{k})$$

where π is the effect of technological progress on existing labor, that, in the end, will cause an increase in output.

The Solow model augmented with human capital

- Technological progress and human capital are endogenous.

The production function including human capital is linearly homogenous with constant returns to scale and positive but diminishing marginal productivity.

$$y = k^\alpha \cdot h^{1-\alpha}$$

where h denotes human capital, α is the share of output from physical capital and $1 - \alpha$ is the share of output from human capital.

Part of output that is saved $k(t + 1) - k(t) = s \cdot y(t)$

Part of output that is consumed $h(t + 1) - h(t) = q \cdot y(t)$

where t denotes this time period, $t + 1$ is the next time period, s the propensity to save in physical capital, q is the propensity to invest in human capital.

All variables, y , k and h , grow at the same rate. The growth rates are calculated as follows

$$\frac{k(t + 1) - k(t)}{k(t)} = s \cdot r^{1-\alpha}$$

for physical capital, and

$$\frac{h(t + 1) - h(t)}{h(t)} = q \cdot r^{1-\alpha}$$

for human capital.⁸⁶

The two growth rates are the same in the long run, and therefore $s \cdot r^{1-\alpha} = q \cdot r^{1-\alpha}$, or $r = \frac{q}{s}$

⁸⁶ Ray, 1998, p. 102.

Appendix 2: Linear function

$$\Delta \frac{GRP}{capita_i} = \beta_1 + \beta_2 Investments_i + \beta_3 Savings_i + \beta_4 \frac{GRP}{capita_i} + \beta_5 \Delta Pop_i + \beta_6 Health_i + \beta_7 Edu + \epsilon$$

Appendix 3: Average GDP per capita

Region	Average GDP per capita 1997-2003, 10000元
Guizhou	0,272163557
Gansu	0,402020582
Guangxi	0,460903119
Yunnan	0,471510418
Shaanxi	0,479220719
Tibet	0,479352677
Ningxia	0,50212535
Sichuan	0,506067926
Jiangxi	0,509302124
Anhui	0,516321664
Qinghai	0,539028614
Shanxi	0,55003934
Henan	0,557020109
Hunan	0,564786672
Chongqing	0,581677304
Inner Mongolia	0,627669492
Hainan	0,666815807
Jilin	0,712773422
Hubei	0,749655829
Xinjiang	0,7498055
Hebei	0,785362664
Heilongjiang	0,886455724
Shandong	0,992563179
Liaoning	1,110281819
Fujian	1,174209531
Guangdong	1,213460916
Jiangsu	1,224940177
Zhejiang	1,378195699
Tianjin	1,734052369
Beijing	1,92132932
Shanghai	2,865303266

Region	Average GDP per capita 2004-2010, 10000元
Guizhou	0,827551408
Gansu	1,072112683
Yunnan	1,081107965
Tibet	1,201867244
Guangxi	1,27039279
Anhui	1,287071464
Sichuan	1,355246612
Jiangxi	1,375068523
Qinghai	1,524001548
Hainan	1,544370587
Hunan	1,552738183
Ningxia	1,614496017
Henan	1,625095778
Shaanxi	1,650600487
Xinjiang	1,716633915
Shanxi	1,751454722
Hubei	1,753516338
Chongqing	1,759695418
Heilongjiang	1,919736384
Hebei	1,992542551
Jilin	2,013403232
Fujian	2,648160273
Liaoning	2,743326763
Inner Mongolia	2,801417946
Shandong	2,818200684
Guangdong	3,19192625
Jiangsu	3,482139435
Zhejiang	3,610556916
Tianjin	4,915387681
Beijing	5,605872761
Shanghai	5,88924081

Appendix 4: Model 1-3, for 2003 and 2010

At the top in each box is the estimate, then the level of significance in brackets and standard error at the bottom in italics.

Model 1: 2003

	1 variable	2 variables	3 variables	4 variables	5 variables	6 variables
β_1	0.07900 (*) <i>0.03278</i>	0.04884 <i>0.04474</i>	-0.011388 <i>0.016946</i>	-0.027898 (.) <i>0.016203</i>	-0.02106 <i>0.01583</i>	-0.02082 <i>0.01610</i>
Inv/GDP 2003	-0.01156 <i>0.07035</i>	-0.02397 <i>0.07148</i>	0.061763 (*) 0.026882	0.083305 (**) 0.025156	0.06571 (*) 0.02564	0.07245 (*) 0.02992
Sav/GDP 2003		0.04574 <i>0.04617</i>	-0.019744 <i>0.017554</i>	-0.011663 <i>0.015912</i>	-0.03231 (.) 0.01858	-0.03004 <i>0.01952</i>
GDP/capita 1997			0.109585 (***) 0.008108	0.124589 (***) 0.008975	0.10727 (***) 0.01243	0.1058 (***) 0.01304
Pop growth 1997-2003				-1.002038 (**) 0.355160	-0.79122 (*) 0.35550	-0.7578 (.) 0.3686
Health/capita 2003					5.86099 (.) 3.05242	6.154 (.) 3.167
Edu/GDP 2003						-0.00001074 <i>0.00002345</i>
R ²	0.0009305	0.03477	0.8757	0.9048	0.9171	0.9178
Adjusted R ²	-0.03352	-0.03418	0.8619	0.8902	0.9005	0.8972

Model 1: 2010

	1 variable	2 variables	3 variables	4 variables	5 variables	6 variables
β_1	0.6752 (***) <i>0.1058</i>	0.75129 (***) <i>0.19278</i>	0.13183 <i>0.16497</i>	0.23153 <i>0.18181</i>	0.06674 <i>0.16662</i>	0.2421885 <i>0.1697743</i>
Inv/GDP 2010	-0.4960 (**) 0.1491	-0.52461 (**) 0.16273	0.06406 <i>0.14637</i>	0.02947 <i>0.14752</i>	-0.01547 <i>0.12888</i>	0.0109093 <i>0.1188219</i>
Sav/GDP 2010		-0.08037 <i>0.16921</i>	-0.10475 <i>0.11294</i>	-0.17127 <i>0.12387</i>	-0.28886 (*) 0.11408	-0.2452034 (*) 0.1063154
GDP/capita 2004			0.17580 (***) 0.02933	0.13503 (**) 0.04372	0.11381 (**) 0.03857	0.0627373 <i>0.0413926</i>
Pop growth 2004-2010				2.76778 <i>2.21913</i>	1.01450 <i>2.00847</i>	3.5452133 <i>2.1280605</i>
Health/capita 2010					50.78576 (**) 16.47176	38.6431363 (*) 15.9568457
Edu/GDP 2010						-0.0002007 (*) 0.0000843
R ²	0.2762	0.2819	0.6919	0.7093	0.7894	0.8297
Adjusted R ²	0.2512	0.2307	0.6577	0.6646	0.7473	0.7871

Model 2: 2003

	1 variable	2 variables	3 variables	4 variables	5 variables	6 variables
β_1	0.08963 (*) 0.03289	0.06213 0.04555	0.008099 0.017436	-0.008431 0.017670	-0.00380 0.01759	-0.003786 0.01779
Inv/GDP 2003	-0.01822 0.07042	-0.02869 0.07176	0.051179 (.) 0.027362	0.069825 (*) 0.026527	0.05659 (.) 0.02760	0.06946 (*) 0.03291
Sav/GDP 2003		0.04160 0.04742	-0.033082 (.) 0.018603	-0.024342 0.017560	-0.04183 (.) 0.02122	-0.04006 (.) 0.02160
GDP/capita 1997			0.104731 (***) 0.008667	0.118048 (***) 0.009960	0.10572 (***) 0.01311	0.1033 (***) 0.01365
Pop growth 1997-2003				-0.845379 (*) 0.378709	-0.69722 (.) 0.38503	-0.6402 0.3971
Health/capita 2003					4.65988 3.32099	5.57 3.581
Edu/GDP 2003						-0.00002047 0.00002773
R ²	0.002781	0.03507	0.8736	0.8979	0.907	0.9096
Adjusted R ²	-0.03877	-0.04884	0.8564	0.8784	0.8838	0.8811

Model 2: 2010

	1 variable	2 variables	3 variables	4 variables	5 variables	6 variables
β_1	0.6575 (***) 0.1073	0.69055 (**) 0.20077	0.12595 0.18072	0.28216 0.18043	0.11833 0.17229	0.3070241 0.1854360
Inv/GDP 2010	-0.4350 (**) 0.1541	-0.44756 (*) 0.16979	0.09228 0.16098	0.08893 0.14814	0.04379 0.13266	0.0546817 0.1235543
Sav/GDP 2010		-0.03502 0.17854	-0.09591 0.12575	-0.25389 (.) 0.13566	-0.39460 (**) 0.13219	-0.3000651 (*) 0.1315692
GDP/capita 2004			0.16873 (***) 0.03388	0.09480 (*) 0.04549	0.08885 (*) 0.04044	0.0288279 0.0479051
Pop growth 2004-2010				5.99679 (*) 2.68708	3.92481 2.51675	6.1565491 (*) 2.5882853
Health/capita 2010					49.31751 (*) 19.11907	42.5375223 (*) 18.1027211
Edu/GDP 2010						-0.0003450 (.) 0.0001704
R ²	0.2492	0.2505	0.6477	0.7152	0.7863	0.8242
Adjusted R ²	0.2179	0.1853	0.5996	0.661	0.7329	0.7687

Model 3: 2003

	1 variable	2 variables	3 variables	4 variables	5 variables	6 variables
β_1	0.07089 (***) <i>0.01523</i>	0.08161 (**) <i>0.02537</i>	-0.005516 <i>0.017251</i>	-0.03116 (*) <i>0.01460</i>	-0.03015 (*) <i>0.01435</i>	-0.03318 (.) <i>0.01730</i>
Inv/GDP 2003	-0.03405 <i>0.03280</i>	-0.03292 <i>0.03337</i>	0.052959 (*) 0.020552	0.08267 (***) 0.01730	0.07391 (***) 0.01820	0.07191 (**) 0.01957
Sav/GDP 2003		-0.01466 <i>0.02752</i>	-0.027236 (.) 0.014463	-0.02077 (.) 0.01116	-0.02681 (*) 0.01185	-0.02702 (*) 0.01214
GDP/capita 1997			0.112116 (***) 0.014207	0.13934 (***) 0.01274	0.12975 (***) 0.01440	0.1324 (***) 0.01677
Pop growth 1997-2003				-0.87888 (***) 0.21512	-0.78710 (**) 0.22196	-0.8138 (**) 0.2409
Health/capita 2003					2.85728 <i>2.13023</i>	2.809 <i>2.184</i>
Edu/GDP 2003						0.00005905 <i>0.00001782</i>
R ²	0.04297	0.05464	0.7532	0.8625	0.8738	0.8746
Adjusted R ²	0.003095	-0.02756	0.7196	0.8363	0.8423	0.835

Model 3: 2010

	1 variable	2 variables	3 variables	4 variables	5 variables	6 variables
β_1	0.4121 (**) <i>0.1127</i>	0.6379 (***) <i>0.1538</i>	0.18805 <i>0.17627</i>	0.20466 <i>0.18916</i>	0.081400 <i>0.193888</i>	0.3906 (.) <i>0.2132</i>
Inv/GDP 2010	-0.1784 <i>0.1514</i>	-0.2075 <i>0.1432</i>	0.04231 <i>0.13512</i>	0.03928 <i>0.13843</i>	-0.008795 <i>0.134986</i>	0.008567 <i>0.1206</i>
Sav/GDP 2010		-0.3006 (.) 0.1483	-0.18382 <i>0.12444</i>	-0.19597 <i>0.13400</i>	-0.226671 (.) 0.129118	-0.2599 (*) 0.1159
GDP/capita 2004			0.18436 (**) 0.05108	0.17557 (**) 0.06052	0.135992 (*) 0.062058	0.02098 <i>0.07220</i>
Pop growth 2004-2010				0.62664 <i>2.18580</i>	0.146369 <i>2.104571</i>	3.509 <i>2.315</i>
Health/capita 2010					36.613627 (.) 20.977509	24.6 <i>19.3</i>
Edu/GDP 2010						-0.0002314 (*) 0.00009327
R ²	0.05466	0.1979	0.4962	0.4982	0.5645	0.671
Adjusted R ²	0.01527	0.1282	0.4275	0.4026	0.4556	0.5672