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The sustainability of China's growth under extractive institutions

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Abstract

This thesis investigates whether or not the Chinese growth is sustainable in the longer term. The two major economies China and India share several common features in terms of e.g. growth and size, as well as fundamental differences regarding factors such as institutions and politics. There is a possibility that India, a democratic country, possibly, in the longer time horizon will overtake China as the major future economic power of the world, due to the advantage of India's, in relative terms, stronger and more well-established institutions, a more politically stable and innovation-friendly atmosphere etc. In order to analyze the sustainability of China's growth, a multisectoral Schumpeterian growth model with technology transfers is applied to empirical data for the two countries, where India acts as a frame of reference. The hypothesis is that China's growth will not be sustainable in the longer term, due to its extractive institutions. Furthermore, the thesis also analyzes whether there are any tendencies for India to outgrow China.

The theoretical simulations show tendencies for China to slightly fall behind the technological frontier and the simulations of the levels of steady state for China and India, indicate that there seem to be a tendency for India to catch up with China around 1990. The following conclusion can thus be made: if China does not transform its institutions and, at the same time, the present Indian development continues, there is a possibility that China is not able to sustain its growth acceleration and for India to continue to grow and eventually overtake China's position as the major future economic power.

Keywords: *economic growth, institutions, openness, China, India, Schumpeter*

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1. Introduction

Empirical evidence shows that growth accelerations among countries are common, but that many of these accelerations eventually fade out, and that the real challenge lies in how to sustain the growth. (Rodrik, 2003) Within the area of economic growth, it is argued that inclusive institutions, through the creation of creative destruction, will facilitate economies to manage to sustain their growth accelerations.[1] Furthermore, since the well-known work of Daron Acemoglu, it is believed that institutions – through e.g. the freedom of thought, learning-by-doing and free market entry – foster creativity, innovations and, thus, economic growth.

In this context, China is an interesting example since its economy, during the past decades of growth characterized by "catching up", has achieved phenomenal growth rates under extractive institutions. Parallels can be drawn to the development of the former Soviet Union that during the 1950-60s experienced increases in its per capita growth under extractive institutions. This growth was made possible because the country had to catch up with the rest of the world, something which could be realized in the presence of the extractive institutions, since the process of creative destruction is not a necessity during such a period of growth. (Acemoglu, Robinson, 2013, p. 440) However, there is a risk for the Chinese growth to enter a period of lower growth – or perhaps even stagnation – and the country may even get stuck in the middle-income trap, should the Chinese institutions not be able to transform and develop into more inclusive institutions. Since it is believed that stable, inclusive institutions will generate innovations and creative destruction in the longer term, it is possible that India will overtake China in terms of economic growth in the longer run, due to India's institutional advantage. In the early 1980s, the top political leadership in India undertook important attitudinal changes towards more market-oriented and private-sector-friendly policies that in retrospect seem to have been highly important for the development of India. (Rodrik, p.15)

In a country with extractive institutions, it is possible that the level of creativity and innovations is lower than in countries with inclusive institutions, since such a country is often characterized by more political planning. In the extreme case, it is possible that virtually everything in the economy is predetermined by the party or the dictator. Under such circumstances, the well-functioning institutions will probably not facilitate creative destruction as proposed by

[1] See e.g. Rodrik, (2003), *Growth strategies*

Schumpeter, since such a country is lacking a culture and mentality that inspires and gives rise to creative and free thinking, innovations and freedom of choice.

The question of interest in this thesis is whether or not the Chinese growth is sustainable in the longer term. The two major economies China and India share several common features in terms of e.g. growth and size, as well as fundamental differences regarding factors such as institutions and politics. There is a possibility that the democratic country India will, in the longer run, overtake China as the major future economic power of the world, due to the advantage of its relatively stronger and more well-established institutions, more politically stable and innovation-friendly atmosphere etc. In order to analyze the sustainability of China's growth, a multisectoral Schumpeterian growth model with technology transfers is applied to empirical data for the two countries, where India acts as a frame of reference. The hypothesis is that China's growth is not sustainable in the longer term, because its extractive institutions are unable to sustain the growth acceleration. The thesis also analyzes if there are any tendencies for India to outgrow China. Economic growth is a long-term phenomenon and, hence, when analyzing requires relatively long time-series or many countries to get as many observations as possible in order to be able to draw certain conclusions. This analysis uses all available data from 1960 up until now, and as the analysis concentrates on two countries only, the theoretical part of the thesis is of highest importance.

The thesis is organized as follows. Section 2 reviews previous research within economic growth and institutions. The theory is presented in Section 3, where the theoretical specification also is introduced. Section 4 introduces the methodology and the empirical specification. Section 5 presents the data and variables in the thesis. Section 6 presents the results and lastly, section 7 concludes the thesis.

2. Previous research

In his analysis of economic growth performance across countries of the world during the second half of the 20th century, Dani Rodrik concluded that growth accelerations are common, but that many of these accelerations eventually fade out and that the real challenge for economies lies in how to sustain the ignited growth process. Rodrik identified 64 episodes of growth transitions where he defined a growth acceleration as an increase of 2.5 per cent or more of a country's growth in GDP per capita that is sustained for at least 10 years (Rodrik, 2003, p.14).

Hausmann et al. confirmed these findings and defined a growth acceleration as an increase in growth per capita of 2 percentage points or more that is sustained for at least eight years and, furthermore, that the post-acceleration growth rate must be at least 3.5 per cent per year. In their sample, consisting of data from 110 countries on economic growth from the Penn World Table ranging from the 1950s to the 1990s, Hausman et al. identify more than 80 rapid growth accelerations that are sustained for at least eight years. (Hausmann et al., 2005, p. 305)

Rodrik highlights the important fact that the ignitions of growth are often the results of rather unconventional methods and reforms. During the past decades, China has performed remarkably well economically – and especially since the booming period in the second half of the 1970s (Rodrik, p.5) – and the country's performance relies on quite unconventional and non-standard reforms, such as e.g. the dual-track reform in the agricultural sector and the unusual system of Township and Village Enterprises (TVEs) when it comes to property rights (Rodrik, p. 8). Qian (2003) also highlights China's remarkable growth performance, even though the country has not developed conventional institutions such as e.g. liberalization, private property rights and the rule of law. According to Qian, China's significant growth development can be explained by the transformation process of imperfect institutions – called "transitional institutions" – where several institutional changes of firms, markets and the Chinese government were undertaken (Qian, p. abstract). Rodrik concludes that these unconventional institutions have performed well in China, since they did manage to produce conventional results such as property rights, market-oriented incentives and macroeconomic stability (Rodrik, p. 9).

In the past decades, China has managed to show exceptional growth rates in the presence of extractive institutions. The democratic India, also exhibiting high rates of growth, chose another path of organizing its institutions. Rodrik and Subramanian highlight that, since the early 1980s, the economic growth of India increased significantly, and explain this by an attitudinal shift among the politicians to a more pro-business approach, which favored the already existing businesses and producers in India rather than consumers or new entrants. India's pro-market orientation, with e.g. trade liberalization, took place later in the 1990s. (Rodrik, Subramanian, 2004, p.4) In spite of the fact that, during the past decades, India has shown a remarkable economic development, the authors emphasize that the country is still far behind China, especially in terms of levels of income. However, India has managed to create solid democratic institutions and e.g. developed a successful information technology sector, and it may well be the case that India will replace China as the future major economic power of the world. (Rodrik, Subramanian, 2004, p. 3)

China's rates of economic growth have undoubtedly been remarkable the past decades and Qian finds it unlikely that China's growth should end soon (Qian, p. 2). However, as Rodrik mentions, the real challenge in economic growth lies in how to manage to sustain the growth. According to Rodrik, the key to prosperity is, in the longer term, to "develop institutions that maintain productive dynamism and generate resilience to external shocks" (Rodrik, p. 18). Rodrik states that many of the past growth collapses of developing countries were related to an inability to adjust to external shocks and volatilities and that the internal weak institutions of conflict management rather magnified the external shocks. (Rodrik, p. 18) In contrast to Qian, Rodrik underlines that continued economic growth of China cannot be guaranteed and that the development of stronger institutions is required throughout the economy, from political governance to the financial market. (Rodrik, p. 19) Thus, institutions seem to constitute a crucial part of the development of economies.

The importance of governance and institutions for long-term growth and prosperity has, since many years, been well-known in economic research. In a cross-country analysis covering 47 countries, Kormendi and Meguire analyzed a measure of civil liberties and concluded that this variable had a marginal effect on economic growth and a dramatic effect on investment (Kormendi, Meguire, 1985, p. 157). In the following decades, the importance of institutions for growth were further investigated – e.g. Knack and Keefer (1995, p.18) concluded that through the protection of property rights such institutions are fundamental for economic growth and investment, and Hall and Jones (1999, p.114) highlight that long-run economic growth is determined by institutions and government policies that shape the economic environment where firms and individuals operate, and e.g. create and transfer ideas.

The creation and exchange of ideas is crucial for economic development and growth. Bjørnskov and Foss (2007) investigate differences in the level of entrepreneurship across countries by looking at differences in institutional design and economic policy. The authors capture the differences in economic policy and institutions by the concept of economic freedom and find e.g. that the size of government (i.e. the extent of government intervention), the overall financial environment, and the quality of the monetary policy strongly determine entrepreneurship (Bjørnskov, Foss, p.324).

Acemoglu and Robinson argue that growth requires creative destruction and will thus not be sustainable under extractive political institutions. During the past decades, China has managed to show phenomenal growth rates under these extractive institutions because the country, in terms of economic growth and development, had a lot of catching up to do – a sort of growth that in turn is facilitated under extractive institutions. However, as in all similar cases, this growth cannot sustain if the Chinese institutions are not able to transform themselves into more inclusive versions. (Acemoglu, Robinson, 2013, p. 441) Furthermore, the authors emphasize that some increases and improvements have been noted in China regarding technology and innovations, but the Chinese growth is still based on investments and the adoption of the existing technologies of the world, and, thus not based on creative destruction. (Acemoglu, Robinson, p. 439) Aghion et al. argue that democracy facilitates creative destruction and hence encourages innovations, since successful innovators will not be expropriated by the use of e.g. political pressure in more democratic economies (Aghion et al., 2013, p. 25) In their models, Aghion et al. measure democracy as the freedom of innovators to enter the market. (Aghion et al., 2013, p. 26) Aghion et al. (2007) investigate the relationship between democracy and economic growth using disaggregated data and conclude that democratic institutions and political rights may have different effects on different sectors of an economy and, furthermore, they conclude that these factors enhance growth of more advanced sectors, i.e. sectors that are closer to the technological frontier. Additionally, Aghion et al. conclude that more advanced countries benefit more from democratic institutions, thus indicating that the demand for democracy should increase as the level of income per capita increases. (Aghion et al. 2007, p.4)

Another important factor in the determination of economic growth is the role of trade openness. The effect of trade openness on economic growth has been highly debated among researchers. Ramanayake and Lee (2015) highlight that several studies have found positive correlations between openness to trade and economic growth (Frankel, Romer (1999); Rodriguez, Rodrik (2001)) whereas others come to the conclusion that openness to trade is not a strong predictor for growth – e.g. Vamvakidis looks at historical data from 1870 and finds no evidence for a positive effect of openness before 1970, suggesting that the positive correlation between trade openness and growth is only a recent phenomenon (Vamvakidis, 2002, p. 57). Despite this, in general, there seems to be consensus among researchers that openness to trade does have a positive impact on economic growth.

This study builds on and further extends the research regarding the relationship between long-term economic growth and institutions and aims at investigating whether, in the longer term, the Chinese growth phenomenon is economically stable or not. This question is highly important since China's growth process has achieved worldwide attention and the country influences and operates in other developing countries, not the least in Sub-Saharan Africa, even though e.g. the political climate and leadership of the country is highly questioned internationally.

Whereas numerous earlier studies have focused on increases in productivity and output per worker to explain forces of economic growth, the novel component in this analysis is to formalize the thought that institutions – through e.g. the freedom of thought, learning-by-doing and free market entry – foster creativity, innovations, and, thus economic growth. Furthermore, this will be incorporated into a multisectoral Schumpeterian growth model with technology transfers, that particularly investigates the two major economies China and India. By measuring the countries' costs of research and development, estimated by their levels of openness to trade, democracy and legal systems, their probabilities to innovate, and, thus grow, can be simulated. Based on empirical data from 1960 to 2016, this analysis is able to investigate the important role of the cost of research and development and how this factor affects economic growth. This study expects that the Chinese growth will eventually slow down – if the country is unable to transform its institutions to more inclusive institutions – and that the economy may get stuck in the middle-income trap, and, thus experience troubles in entering the group of high-income countries in the longer term. Since it is believed that good, stable institutions will generate creativity, innovations and creative destruction in the longer term, this study emphasizes the institutional advantage of India, and potential tendencies for India to overtake China in terms of growth will therefore be analyzed.

3. Theory

The following section presents the economic theory that forms the foundation of the hypothesis and analysis of the thesis. The theoretical model is explained in detail and the specific theoretical specification of the analysis is presented.

In order to capture the importance of institutions and innovations for economic growth, a Schumpeterian growth model is applied. Economic growth in Schumpeterian models – that constitute a part of the endogenous growth theory – is determined by innovations, and especially quality-improving innovations and the process of creative destruction, in which old products become obsolete and are being replaced by new innovations. (Aghion, Howitt, 2009, p. 69)

The model is based on a multisectoral Schumpeter model that has been extended to also account for technology transfers across countries. This extension should be able to capture the development paths of China and India during the past decades, since both countries have taken advantage of and incorporated the existing technology of the world into their own countries. Schumpeter models with technology transfer emphasize the process of innovation because this process transfers technology between countries. Furthermore, if a country is unable to innovate – due to e.g. too little investments in research – it will stagnate in its growth process, while the rest of the world continues to grow and develop (Aghion, Howitt, p. 152).

Furthermore, generally, this model emphasizes the process of technology transfer and explains why some high- and middle-income countries belong to the convergence club and share a common long-term growth rate, while other poorer countries exhibit significantly lower growth rates in the longer term and are excluded from the convergence club. The crucial factor for growth and convergence in the model is whether a country's research sector is profitable enough in order for the country to innovate at a positive rate.

3.1 Theoretical specification

In the Schumpeter model with technology transfers, there is one final good produced according to the following production function[2]:

$$Y_t = L^{1-\alpha} \int_0^1 A_{it}^{1-\alpha} \; x_{it}^{\alpha} \, di \qquad (1)$$

where $0 < \alpha < 1$, Y_t is total production in the economy, A_{it} is a productivity parameter, x_{it} is the input of intermediate product *i* and the labour force *L* has been normalized to 1. Furthermore, in the model, time is discrete and every individual lives for one period and has linear preferences in consumption.

The market for the final good is characterized by perfect competition, i.e. the price of each intermediate good will equal its marginal cost of production:

$$P_{it} = \alpha A_{it}^{1-\alpha} \, x_{it}^{1-\alpha} \qquad (2)$$

Monopolists use final goods as inputs in the production of the intermediate goods, which are produced one for one. In order to maximize profits, the monopolist maximizes the following profit function with respect to x_{it}:

$$\prod_{it} = p_{it} x_{it} - x_{it} = \alpha A_{it}^{1-\alpha} \, x_{it}^{1-\alpha} - x_{it} \qquad (3)$$

In equilibrium, the quantity and profit ends up as follows:

$$x_{it} = \alpha^{\frac{2}{1-\alpha}} A_{it} \qquad (3)$$

$$\prod_{it} = \pi A_{it}^{*} \qquad (4)$$

where $\pi = (1-\alpha)\alpha^{\frac{1+\alpha}{1-\alpha}}$ is a constant.

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[2] The following part is based on ”A Model of Club Convergence” by Aghion and Howitt (2009) p. 152-158, unless otherwise stated.

In the model, growth is dependent on μ, the probability of success for potential innovators in each sector of the economy, which in turn is a function of the innovators' productivity-adjusted expenditure $n = R_{it}/A^*_{it}$, where R_{it} is the expenditure of research and development and A^*_{it} is the target level of productivity. In order to maximize the expected profit, the innovator maximizes the following function with respect to μ:

$$\mu\prod_{it} - R_{it} = [\mu\pi - \tilde{n}(\mu)]\, A_{it} \qquad (5)$$

where $\tilde{n}(\mu) = {}^{\eta\mu + \psi\mu^2}/_2$ is the innovators productivity-adjusted research and development cost. The productivity-adjusted research and development cost is thus dependent on η, which is the cost of research and development, and ψ, which is a strictly positive parameter. Furthermore, in order for the equilibrium innovation probability to be less than one, it is assumed that $\eta + \psi > \pi$.

In contrast to other Schumpeter growth models, it may in this version be optimal for some countries not to undertake any research at all if the costs of research and development exceed the profits. However, if $\eta < \pi$, the payoff to an innovation exceeds its costs and is sufficiently large for producers to innovate. Hence, the first-order condition for equation (5) with respect to $\tilde{n}(\mu)$ is:

$$\tilde{n}'(\mu) = \pi \qquad (6)$$

with the solution:

$$\mu = \frac{\pi-\eta}{\psi} > 0 \qquad (7)$$

Equation (7), the probability of success in research, is of highest importance in this specific analysis since the growth in the economy is dependent on this probability. The probability depends on π, which are profits in research, ψ, which is a strictly positive parameter and η, which is the cost of research. The parameter η can be interpreted as a measure of a country's cost of undertaking research and be estimated with data on e.g. a country's level of openness to trade, democracy or protection of property rights. A more detailed analysis of η is presented later on.

In order to measure a country's distance to the technological frontier, a ratio of the country's average productivity parameter and the global productivity parameter can be calculated according to:

$$a_t = \frac{A_t}{\bar{A}_t} \tag{8}$$

By using μ, the probability of success for potential innovators, the following equation measures the distance to the world's leading technology:

$$a_t = \mu + \frac{1-\mu}{1+g} a_{t-1} \tag{9}$$

where g is the growth in the technological frontier of the world. It should be highlighted that if g increases, a country's distance a to the technological frontier will decrease. Furthermore, equation (9) has the following stable steady state:

$$a^* = \frac{(1+g)\mu}{g+\mu} \tag{10}$$

which also is the country's proximity to the frontier in the long term. Furthermore, $\partial a^*/\partial \mu > 0$ which means that a country with a higher probability of innovation will be situated closer to the technological frontier of the world. Moreover, $\partial a^*/\partial g < 0$ which indicates that the steady state-level of a will decrease in g.

The model predicts that countries that innovate (whose $\mu > 0$) with $\pi > \eta$ – i.e. when the rewards to innovations are larger than the costs of research and development – in the long run will grow at the same rate, namely the global rate of technology. Innovating countries will thus converge to the same growth rate because of the transfer of technology. Furthermore, a country initially further behind the global frontier will have larger average size of its innovations:

$$\bar{\gamma} - 1 = \frac{\bar{A}_t}{A_{t-1}} - 1 = \frac{(1+g)}{a_{t-1}} - 1 \tag{11}$$

The growth rate of an innovating economy will thus – as in many Schumpeterian growth models – be the frequency of innovations times the size of innovations:

$$g_t = \mu(\bar{\gamma} - 1) \tag{12}$$

This indicates that the further behind the global technological frontier a country is situated, the higher will its growth rate be. The model predicts that, eventually, a country will get so far behind the frontier that its growth rate will be equally large as the growth rate of the frontier, at a point in which the gap between them eventually will stop increasing. This fact puts a limit on how far a country can fall behind the technological frontier.

The relationship between a and g in this model requires further attention. A high value of a indicates that the country is closer to the technological frontier. Because a depends inversely on g, a high value of a will in turn imply that the country grows at a slower rate since the country's innovations are of smaller average size because the economy is moving away from the period characterized by "catching-up"-growth and it is thus more difficult to innovate, which indicates that the country will grow at a slower rate. This pattern can thus explain why many developing countries may experience significantly high growth rates even though they are far behind the technological frontier of the world. This rapid growth and "advantage of backwardness" is possible since the country can adopt the existing technology of the world (Aghion, Howitt, p. 151).

Furthermore, countries with $\pi \leq \eta$ will stagnate in growth in the longer term, since these countries are not innovating (i.e. their $\mu = 0$ which in turn means that their equilibrium proximity to the global technological frontier is zero) indicating that they will not catch up to the technological frontier of the world and will thus not grow. Such countries are not fully able to take advantage of the technology transfer between countries and this is a rather common situation for countries with e.g. poorly developed macroeconomic conditions, legal environments and educational systems.

According to theory, inclusive institutions and protection of property rights should have a positive effect on economic growth and investments (Knack, Keefer, p.18). Even though the effect of trade openness on economic growth is debated, there seem to be consensus among researchers that openness to trade does have a positive impact on economic growth.

Both μ, the probability of successful innovations, and π, rewards to innovations, are expected to have positive effects on growth. On the other hand, ψ, the positive parameter, and η, the cost of research, are expected to have negative effects on innovations and thus on economic growth.

Due to the inverse relationship between *a* and *g,* high values of *a* implies that the country is closer to the technological frontier of the world and are thus growing at a slower rate, since the average size of innovations will now be smaller because it is more difficult to innovate the more developed an economy is.

4. Method

The methodology of the thesis is based on the multisectoral Schumpeter growth model that allows for technology transfer which was presented in the theoretical part. This model enables the estimation of countries' growth paths, and, specifically, their respective levels of steady state and distances to the technological frontier of the world, i.e. the US. The following section presents and explains the methodical part of the thesis and the extension of the multisectoral Schumpeter model with technology transfers.

In order to estimate the economic developments of China and India, μ from equation (7) of the Schumpeter model, that measure the countries' respective probabilities of success in the innovating sector of the economy, is first of all measured as follows[3]:

$$\mu = \frac{\pi - \eta}{\psi} > 0$$

[3] The estimations and simulations were performed in Microsoft Excel.

where it is assumed that both π, the profits in research, and ψ, a strictly positive parameter, are equal in both China and India.

In order to get as accurate a measure as possible, the original Schumpeter model with technology transfer is now extended and the parameter η, that measures the cost of research and development, is instead measured as a function of different variables. The variable *openness to trade* captures the countries' openness and trade position to the rest of the world. The variable *polity*, that measures the countries' levels of democracy is able to capture the political situation, the freedom of thought and opinion etc. and will here act as a measure of the institutions in China and India. Furthermore, the variable *legal systems and property rights* measures the legal quality in the countries.

The variable *legal systems and property rights* only includes data for China exclusively from 1985 to 2016. Therefore, the sample is divided into two, where the first version ranges over the whole time period from 1960 to 2016 and excludes the variable that measures the legal systems in the countries, whereas the other version includes this variable but ranges from 1985 to 2016 instead.

The parameter η is therefore estimated as follows for the first time period ranging from 1960 to 2016:

$$\eta = openness^{\beta} + polity^{\gamma} \tag{13}$$

where $\beta < 0$ and $\gamma < 0$. For the second version of the estimation covering the period 1985-2016, the variable "legal system and property rights" is included in the cost function η that takes the following form:

$$\eta = openness^{\beta} + polity^{\gamma} + legal\, systems\, and\, property\, rights^{\rho} \tag{14}$$

Where $\rho < 0$. Since it is assumed that increases in the variables, e.g. a more democratic or open society, will, in the longer term, decrease the cost of research and development, the η-function will thus be a function that is increasing at a decreasing rate ($\eta' > 0$ and $\eta'' < 0$). Institutional variables, such as measures of democracy, are slowly changing variables and e.g. a slow strengthening of democracy in a country will slowly decrease the cost of research and development over time.

η, the cost of research, may be expected to be higher in China than in India, at least in the longer term. If η e.g. is only measured as a country's openness to trade, it is possible that, initially, the level of η in China will be lower than the level in India, since China did open up its country for trade earlier than India did. However it is possible that the cost of research and development in India, with its democracy and institutions – such as e.g. freedom of thought and opinion – will be lower in the longer term. This will in turn imply higher probabilities for innovations and thus higher growth rates. Therefore, it is reasonable to expect higher rates of economic growth for India in the longer term, and that the country will, eventually, overtake China in terms of growth. In order to measure the cost of research and development as accurately as possible, the parameter η was therefore measured as a function of the above mentioned variables.

The probability of successful innovations, μ, is then calculated based on the rewards to innovations π (where the parameter α as usual equals 1/3), η which is the costs of engaging in research and the strictly positive parameter ψ.

When China's and India's respective probabilities of success in their innovating sectors is calculated, equation (9), that measures the countries' distances to the world's leading technology is estimated according to:

$$a_t = \mu + \frac{1-\mu}{1+g} a_{t-1} \tag{15}$$

Finally, based on equation (9), the countries' levels of steady state are calculated and simulated according to the following formula:

$$a^* = \frac{(1+g)\mu}{g+\mu} \tag{16}$$

Equation (10), the countries' levels of steady state, is estimated and simulated over the time period from 1960 to 2016, and from 1985 to 2016, respectively. In the equation, the technological frontier of the world is represented by growth in the GDP of the US, since the growth in GDP will equal the growth in technology in Schumpeter models.

5. Data

The following section describes the data used in the analysis, which consists of various variables for China and India and the GDP of the US during the time period 1960-2016.

In order to estimate η, measures of the countries' degree of openness, democracy and protection of property rights is included in the analysis. To measure the degree of openness in the countries, data on *trade openness,* measured in percentages as a country's sum of exports and imports of both goods and services as share of GDP, is collected from the World Bank.

The measure "polity" from the Polity IV Project at the Centre for Systemic Peace is used in the analysis. This measure includes various measures for institutionalized democracy and autocracy and is constructed as a numerical scale ranging from +10 (strongly democratic) to -10 (strongly autocratic) by subtracting the countries' autocracy values from the democracy values. This process facilitates the comparison between countries, but, in this analysis, in order to avoid negative variables, the measure is recoded and the scale instead ranges from 0 to 20.[4]

When measuring the legal systems in the countries, the variable *legal systems and property rights* from the Fraser Institute is used. The variable is conducted as an index that measure various factors such as the protection of property rights, judicial independence and impartial courts. Since data on this variable is available every fifth year, only, a linear interpolation is applied. This variable is subject to measurement problems, since data for China is only available from 1985 to 2016. In order to overcome this problem, the sample is divided into two, where the first version ranges over the whole time period from 1960 to 2016 and excludes the variable that measures the legal systems in the countries, whereas the other version includes this variable but ranges from 1985 to 2016 instead.

Data on the variable *economic growth* is collected from the World Bank, where data of the countries' annual GDP per capita is used.

In equation (8), the growth rate in the technological frontier of the world is captured in the variable *g*. For this variable, the annual growth in GDP for the US is used since the US is

[4] See Appendix for the transformation of the variable.

considered to be in the front of the world's technological development. In Schumpeterian growth models, economic growth will grow at the same rate as the growth in technology.

6. Results

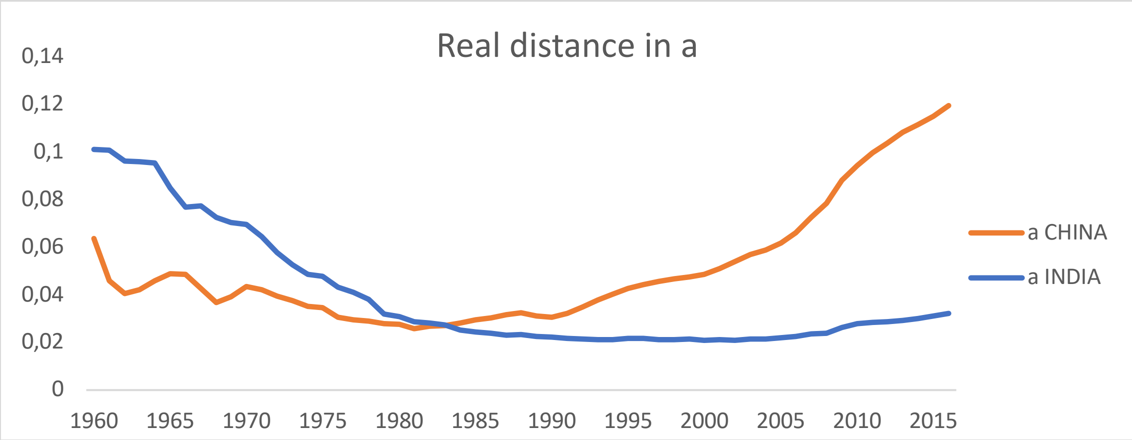
The following section presents the results from the simulations of the economic developments of China and India based on the theory of the multisectoral Schumpeter model with technology transfer.

This section consists of different parts. First of all, based on empirical data, the actual development of the technological levels of China and India is presented and discussed. Then the development of the important cost function of research is presented as well as the different simulations of the theoretical model. The purpose of the simulations of the model is an attempt to explain the actual development of the technological levels of China and India, theoretically. Thereafter, in order to analyze the long term equilibrium growth rates, the levels of the countries' steady states are simulated and compared. Lastly, the section ends with a simulation of the future development paths of China and India, in the investigation whether China will stagnate in growth or not.

6.1 Real distance to the technological frontier

The following figure illustrates the observed annual development of China's and India's distance to the technological frontier.

Figure 1: Real distance to the technological frontier



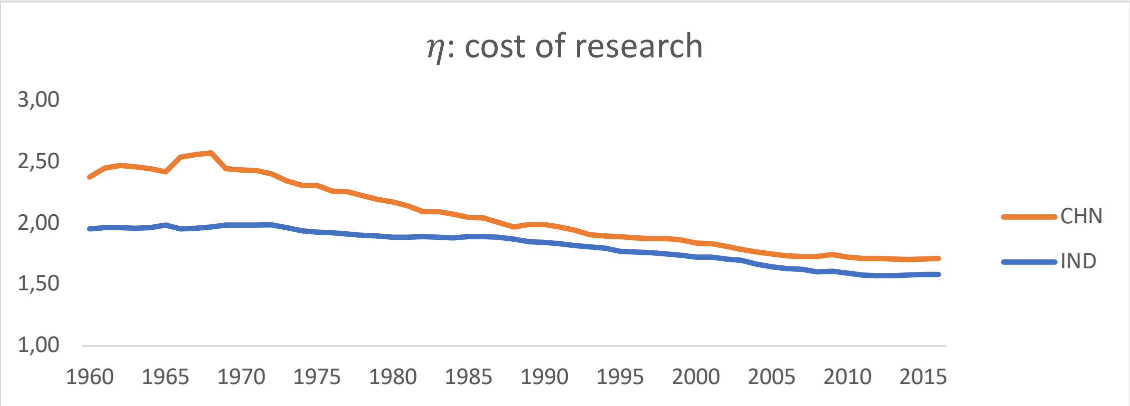
The distance is measured by equation (8) where the ratio of the countries' GDP:s relative to the GDP of the US is calculated. It is worth noticing that the ratio for China was lower than that of India in the early 1960's and was decreasing until the mid 1980's and has ever since then been constantly increasing. In this model, a high value of *a* indicates that the country is closer to the technological frontier. Because *a* depends inversely on *g,* a high value of *a* indicates that the country grows at a slower rate since the country's innovations are of smaller average size. This is because the country is moving away from the period characterized by "catching-up"-growth, and it is therefore more difficult to innovate, which, thus, in turn implies that the economy will grow at a slower rate.

From *Figure 1*, it can be seen that both China and India experienced decreasing levels of *a,* indicating that the countries fell behind the technological frontier, until the early 1980's , when China experienced rapid increases in *a,* whereas India's level of *a* increased at a more modest rate. The increases in *a* after the early 1980's indicate that both countries grew closer to the technological frontier, even though China's development has been more rapid than that of India. This particular pattern of the development of India's *a* is highly interesting. Although India's level of *a* is lower than China's, there is a tendency for the curve to slowly increase from the early 2000's and onwards. Exactly this pattern is particularly interesting in this analysis, because – apart from investigating the sustainability of China's growth – it also analyzes if any tendencies can be seen for India to, possibly, in the longer time horizon overtake China in terms of economic growth due to its relatively stronger and more well-established institutions, more innovation-friendly atmosphere etc. Institutional changes are slow in nature and do usually not affect economic growth immediately, but rather in a slowly and more positive way in the longer term by constantly rising growth at a slow rate. It is in particular this slowly but constantly increasing growth that is often associated with sustainable economic growth and development.

6.2 Development of the cost functions

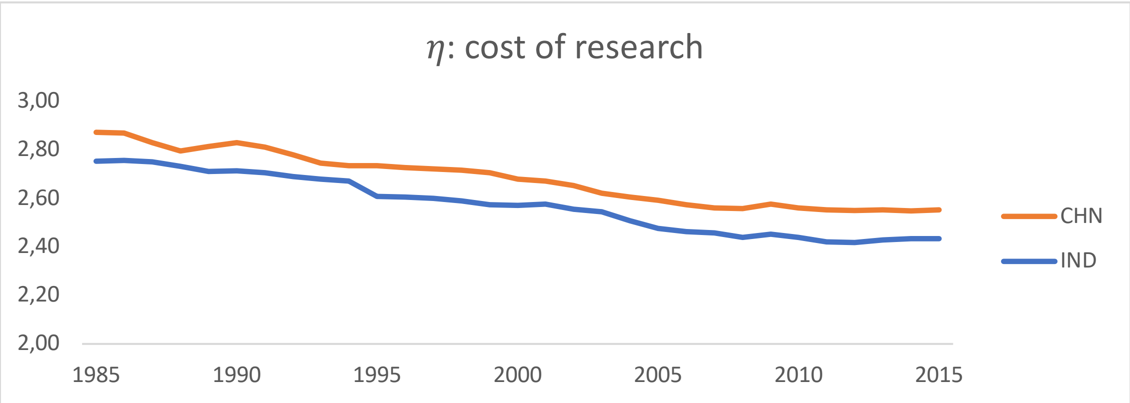
The following two graphs illustrate the annual developments in the different cost functions of research for China and India. The first graph illustrates the development of the simple cost function including the variables *openness* and *polity* during the time period 1960 to 2016. The second graph shows the cost function for the time period 1985 to 2016 were the additional variable *legal systems and property rights* also has been included.

Figure 2a: Cost of research and development 1960-2016



$\psi = 3;\ \beta = -0.1;\ \gamma = -0.2$

Figure 2b: Cost of research and development 1985-2016



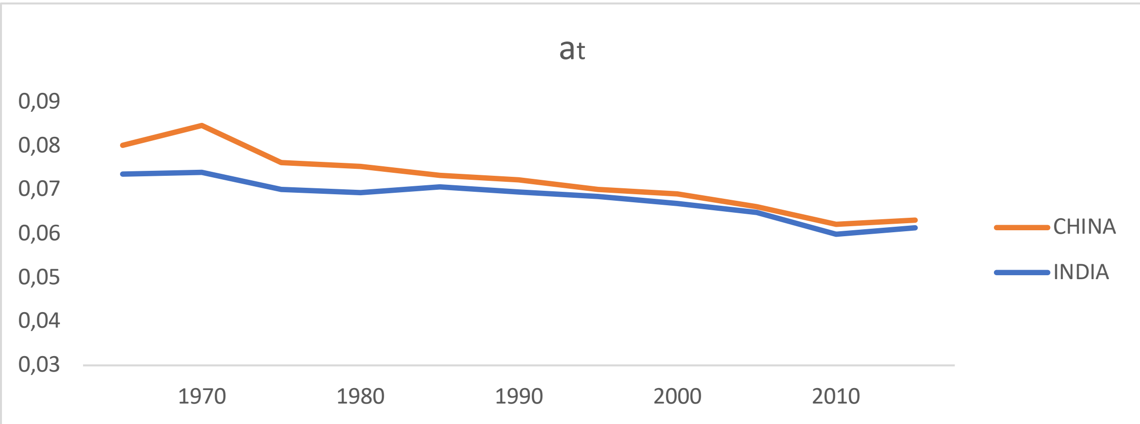
$\psi = 5;\ \beta = -0.1;\ \gamma = -0.2;\ \rho = -0.1$

From *Figure 2a* and *Figure 2b,* it can be noted that the cost function is lower for both countries in *Figure 2a* with the simple cost function. In both versions, the cost function in India is always lower than the Chinese function. In *Figure 2a,* the gap between the two cost functions is rather wide in the beginning and increases in the late 1960s until it decreases and narrows in the late 1980s. It can also be noted that the cost function in China has been decreasing since the 1970s – at the same time as China launched its unconventional reforms and the economic growth of the country picked up.

6.3 Simulations

The following section presents the different theoretical simulations in the level of technology for China and India, as well as their calculated levels of steady state in technology.

Figure 3: at *(openness* and *polity)*



$\psi = 3$; $\beta = -0.1$; $\gamma = -0.2$

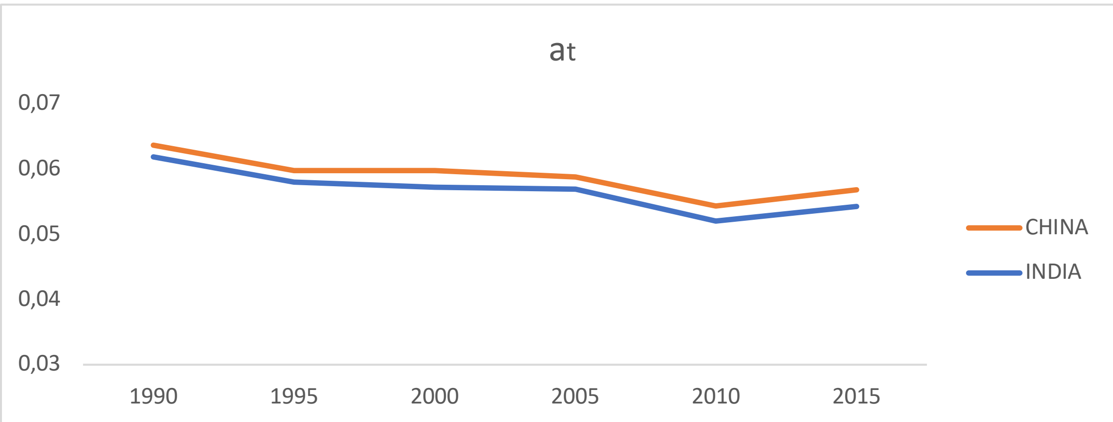
Figure 3 shows the simulation of equation (15), i.e. the countries' distances to the technological frontier of the world, during the time period from 1960 to 2016 where the cost of research includes the variables *openness* and *polity*. In order to avoid yearly fluctuations and shocks, the observations are divided into averages of five year periods.

In general, the two curves are more or less following the same pattern of development, where the level of China always is above the level of India. It can be seen that the distance between the two curves are larger in the beginning of the period. However, around the late 1980s and early 90s, the gap between the two curves seem to narrow since China's curve is decreasing and the curve of India increases slightly in the 1980s, indicating that the growth position of India is improving. Although, thereafter, *a* is slightly decreasing for both countries, the timing of this development in India is interesting. A strengthened growth position in the 1980s is in accordance with the findings of Rodrik and Subramanian, since the attitudinal changes among the Indian politicians to a more pro-business approach took place in the early 1980s and this may possibly have affected the economy in a slow and more positive way.

China undertook the unconventional reforms and the growth picked up significantly in the late 1970s. When looking at *Figure 3,* the level of *a* decreased during this period of time, which contradicts the increased growth. However, when this development is compared to the actual development in *a* in *Figure 1,* it can be noted that the increase in *a* of China did not actually pick up until the second half of the 1980s.

According to theory, if *g* increases, a country's "proximity" *a* to the technological frontier will decrease. As can be seen from *Figure 3,* the development of the technological levels in both countries started at a relatively high level in the 1960s – which is approximately in accordance with the observed levels of *a* in *Figure 1* – after which it has, however, been slightly decreasing during the time period. This may be explained by the fact that the growth in the US increased significantly in the 1970s. However, from *Figure 3,* it can be noted that the level of *a* in China is decreasing since the mid 1970s, indicating that the country is falling further behind the technological frontier.

Figure 4: at (all variables)



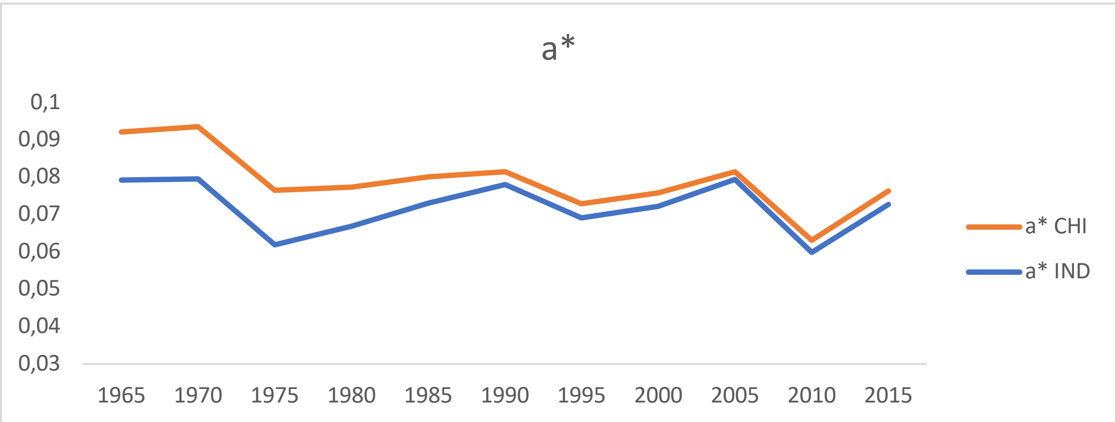
$\psi = 5;\ \beta = -0.1;\ \gamma = -0.2;\ \rho = -0.1$

Figure 4 illustrates the simulation of *a* where all three variables have been included in the parameter η, the cost of research and development. Again, the two curves are more or less following the same pattern of development, where the level of China always is above the level of India. With this cost function of research, the gap between the two curves seem to be rather constant throughout the time period. In contrast to *Figure 3,* where only *openness to trade* and *polity* were included in the variable for cost of research, the curves of the development of technology in *Figure 4* are more smooth. Worth mentioning is that *Figure 3* illustrates the development of the steady state-levels during the time period of 1985-2016.

Although a more thorough specification of the cost function should give the most accurate measure, the simulation in *Figure 3* seems to correspond somewhat better to the observed levels of *a* in *Figure 1* than the simulation in *Figure 4.* In *Figure 3,* the initial level of *a* for China is slightly higher than the actual value in *Figure 1,* whereas the level for India is too low in both simulations – especially in *Figure 4* – indicating that the simulation in *Figure 3* with the simple cost function, illustrates the most accurate simulation. Furthermore, the gap between the two curves is somewhat larger in *Figure 3,* which appears to be more realistic since research costs are quite country-specific. It is, however, important to keep in mind that this time period is rather short when it comes to evaluating economic growth. However, none of the two simulations are able to fully explain the rapid increase in China's technological level in the early 1990s, indicating that there seem to be other factors omitted from the cost functions in the models that contribute to the development.

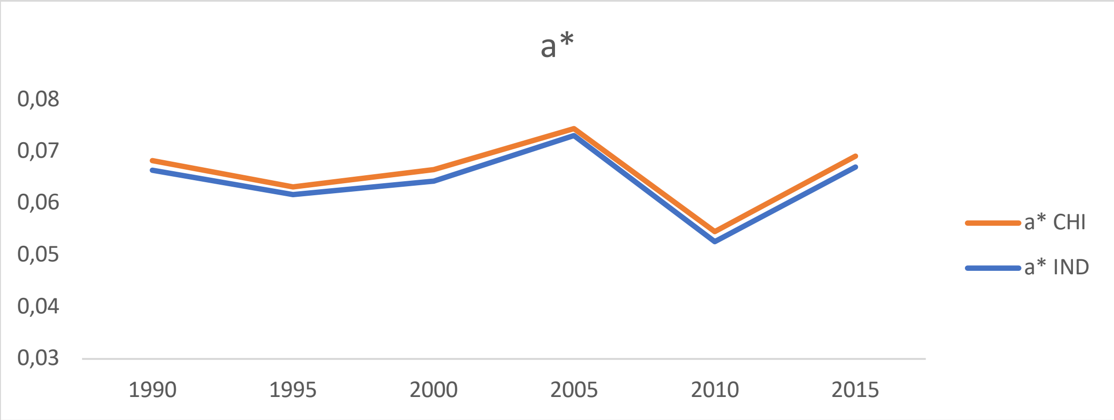
In order to analyze the levels of steady state for China and India, equation (16) was simulated twice with the different cost functions of research.

Figure 5: a* (*openness* and *polity*)



$\psi = 3; \beta = -0.1; \gamma = -0.2$

Figure 6: a* (all variables)



$\psi = 5;\ \beta = -0.1;\ \gamma = -0.2;\ \rho = -0.1$

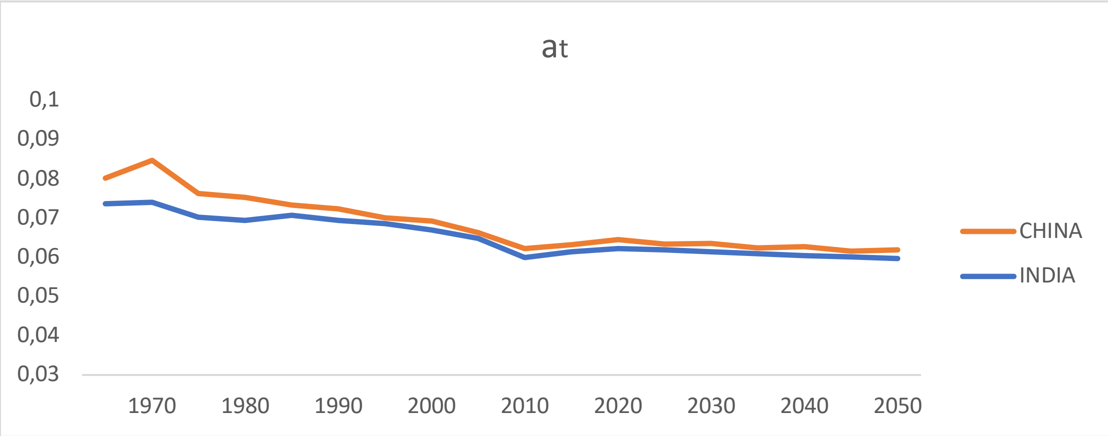
From *Figure 5* and *Figure 6,* it can again be seen that the simulation in *Figure 5* with the simple cost function, is the most appropriate one, since it captures the initial levels of *a* most accurately and seems to be more realistic because of the gap between the curves. This indicates that the two variables *openness to trade* and *polity* seem to be rather important for the cost function.

When analyzing *Figure 5,* the gap in *a* between China and India narrows considerably in the early 1990s and the gap continues to be rather small throughout the simulation. Again, the timing of this development is interesting since, according to Rodrik and Subramanian, the attitudinal changes among the Indian politicians towards a more pro-business approach took place in the late 1980s. China's economic boom started in the late 1970s and from *Figure 5* a slight increase in the level of steady state for China can be noted from this period, but this increase is not continuous throughout the entire time period. This may indicate that the increase in the Chinese growth was not fully sustainable, possibly because of the extractive institutions. When looking at the levels of steady state, there seem to be a tendency for India to catch up with China around 1990, since India's level of steady state in technology is increasing to the levels of China. This tendency points to the fact that if this Indian development would continue and China would not transform its institutions, there is a possibility that India would continue to grow and eventually overtake China's position.

6.4 Future simulation

Lastly, in order to analyze the future development paths of China and India and to investigate if there are any tendencies for China either to stagnate in growth or not, equation (15) is simulated for the time period up until 2050.

Figure 7: at, future simulation (*openness* and *polity)*



$\psi = 3;\ \beta = -0.1;\ \gamma = -0.2$

In the simulation, the simple cost function has been used with the same values of the parameters as before. In this predictive analysis, the US is assumed to grow at the average rate of the country's growth during 1960 to 2016. Based on the empirical data and growth developments of the variables, there seems to be a tendency for the gap between China and India to narrow even more, indicating that further on China will fall behind the technological frontier whereas India will be catching up more and more with China. The changes, though, are rather small. However, it is important to keep in mind that this predictive analysis, as usual, is rather uncertain since it is based on empirical data on e.g. the cost function of research which affects the probability of success in research, which in turn determines growth. The probability of success in research is thus rather difficult to determine.

7. Conclusion

This thesis analyzes whether, in the longer term, the Chinese growth is sustainable or not. The two major economies China and India share several common features in terms of e.g. growth and size, as well as fundamental differences regarding factors such as institutions and politics. Possibly, the democratic India may in the longer run overtake China as the major future economic power of the world due, e.g. to its relatively stronger institutions. In the analysis of the sustainability of China's growth, a multisectoral Schumpeterian growth model with technology transfers is applied to empirical data, where India acts as a frame of reference. The hypothesis is that China's growth is not sustainable in the longer term, because its extractive institutions are not able to sustain the growth acceleration. Furthermore, the thesis also investigates if there are any tendencies for India to outgrow China.

Rodrik highlighted that, in the future, China may stagnate in its growth process should its extractive institutions not be able to transform into more inclusive institutions. The theoretical simulations of the countries' distances to the technological frontier indicate that there are tendencies for China to slightly fall behind the technological frontier – e.g. *Figure 3* points to the fact that the level of a in China has been decreasing since the mid 1970s. Furthermore, the simulations of the levels of steady state in technology for China and India indicate that there seem to be a tendency for India to catch up with China around 1990, since India's level of steady state is increasing and on its way to converging to the levels of China. Thus, the following conclusion can be made: if China does not transform its institutions and, at the same time, the present Indian development continues, there is a possibility that China will be unable to sustain its growth acceleration and India will continue to grow and eventually overtake China's position as the major future economic power. This conclusion is in accordance with the findings of Rodrik, namely, that continued economic growth of China cannot be guaranteed if the country is unable to transform its institutions.

The extended Schumpeter model in this analysis builds upon the specification of the cost function of research. The cost function is rather problematic to estimate since it is dependent on various variables in the economy. Since there are no general rules regarding which variables to include in the cost function, and, furthermore, the problem with lack of empirical data for China, the estimation of the cost function is difficult. This analysis is not able to fully explain the actual developments of the countries, indicating that there are possibly other factors omitted from the cost functions in the models that contribute to the development. Additionally, economic growth and the development of institutions are long-term phenomena and, therefore, further research on this topic is encouraged when longer time series are available.

Further research regarding the developments of China and India, in particular will be highly interesting, due to the fact that these two countries have chosen very different paths in terms of e.g. political and institutional structure. For policy implications it will be interesting as well as important to follow the developments of these two large economies, since these two transitional economies most certainly will constitute role models for other developing countries which are full of hope for higher economic growth achievement in the future.

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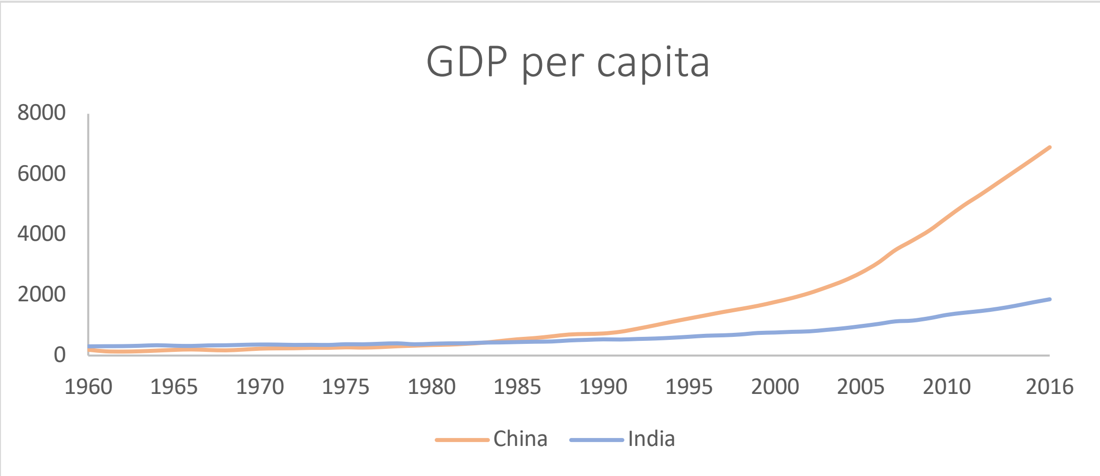
World Bank National Accounts Data, "GDP per capita", "Trade (% of GDP)"
(2017-04-10)

Appendix

A1. *Figure 8.* Development of GDP per capita in China and India 1960-2016



Source: World Bank national accounts data

A2. List of variables

Variable	Unit	Description	Source
GDP per capita	USD, constant 2010	Annual GDP per capita	World Bank national accounts data
Trade (% of GDP)	Per cent	The sum of exports and imports of goods and services measured as a share of gross domestic product	World Bank national accounts data
GDP growth (annual %) for the US	Per cent	Weighted average of the sum of gross value added by all resident producers plus any product taxes and minus any subsidies not included in the value of the products.	World Bank national accounts data
Polity	Numerical scale ranging from +10 (strongly democratic) to -	AUTOC score subtracted from the DEMOC score	Center for Systemic Peace, Polity IV Annual Time-Series 1800-2016

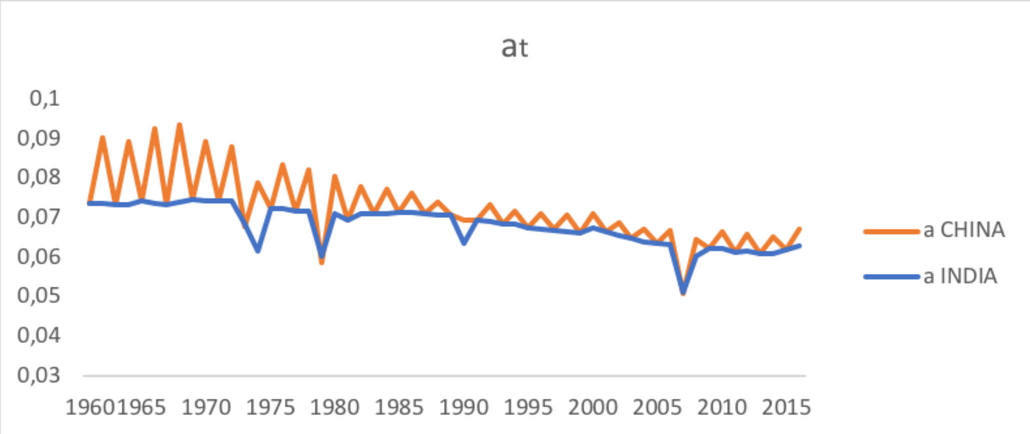
	10 (strongly autocratic)		
Legal systems & property rights	Numerical scale ranging from 10 to 10.	Index of the components: judicial independence, impartial courts, protection of property rights, military interference in rule of law and politics, integrity of the legal system, legal enforcement of contracts, regulatory costs of the sale of real property, reliability of police, business costs of crime	Economic Freedom, The Fraser Institute

A3. Transformation of *Polity*

Polity score	New score	Polity score	New score
-10	0	1	11
-9	1	2	12
-8	2	3	13
-7	3	4	14
-6	4	5	15
-5	5	6	16
-4	6	7	17
-3	7	8	18
-2	8	9	19
-1	9	10	20
0	10		

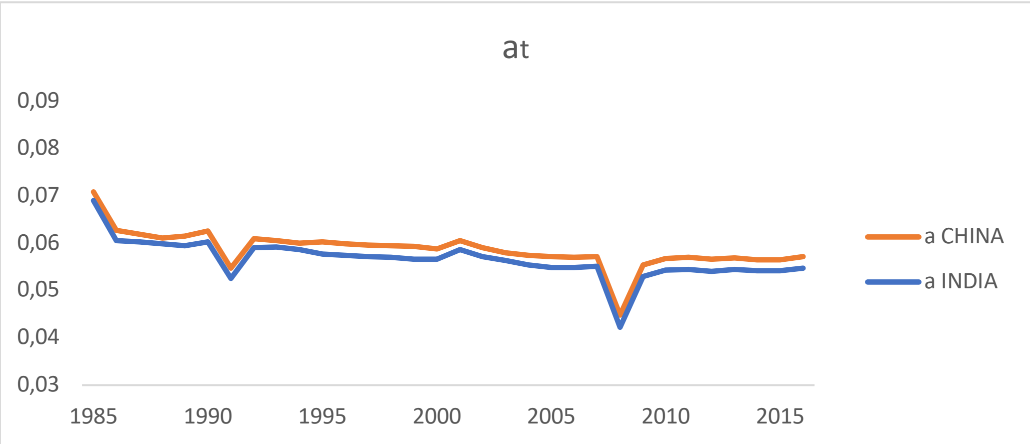
A4. Simulations

Figure 9: at, *openness* and *polity,* annual simulation



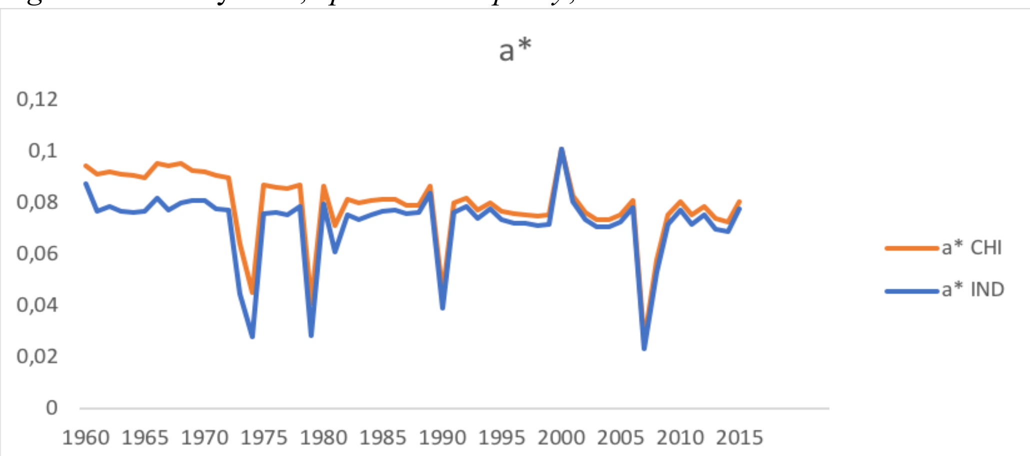
$\psi = 3; \beta = -0.1; \gamma = -0.2$

Figure 10: at, all variables, annual simulation 1985-2016



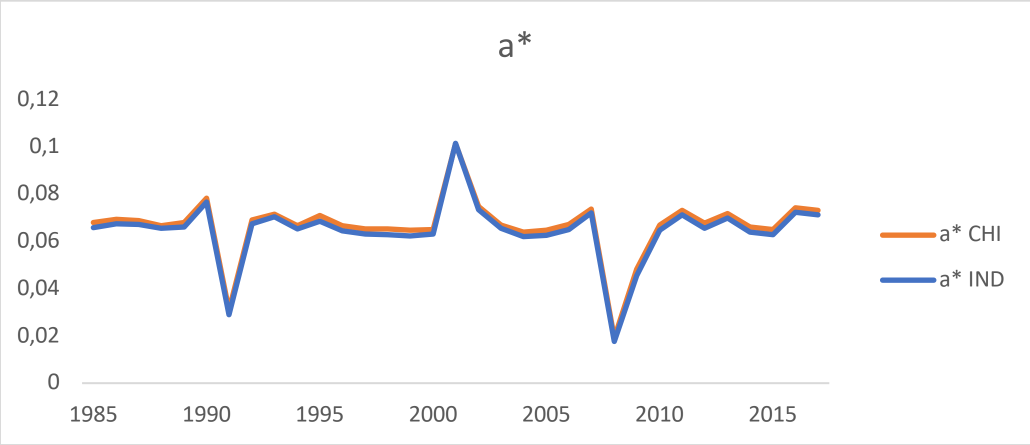
$\psi = 5; \beta = -0.1; \gamma = -0.2; \rho = -0.1$

Figure 11: Steady state, *openness* and *polity*, annual simulation



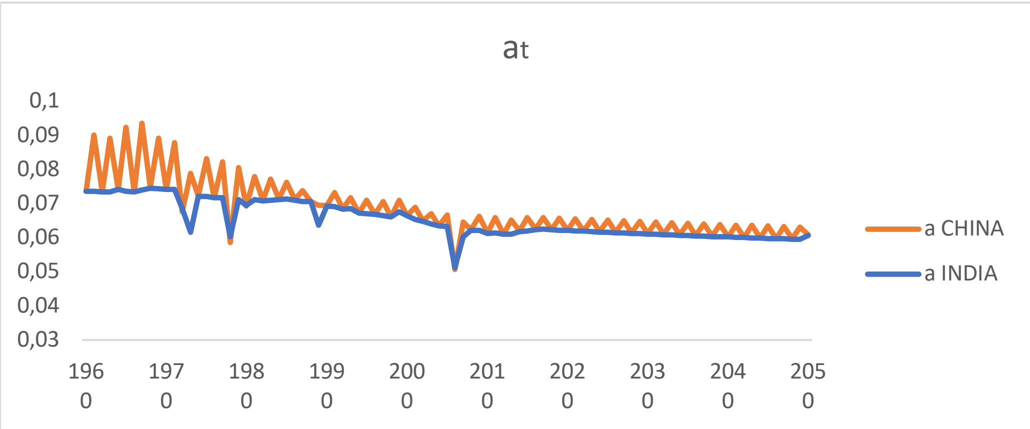
$\psi = 3; \beta = -0.1; \gamma = -0.2$

Figure 12: Steady state, all variables, annual simulation



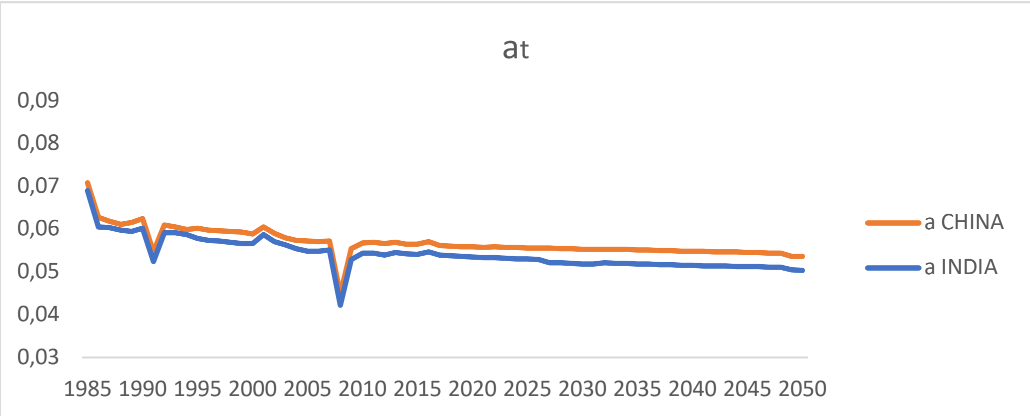
$\psi = 5;\ \beta = -0.1;\ \gamma = -0.2;\ \rho = -0.1$

Figure 13: at, annual future simulation, (*openness* and *polity)*



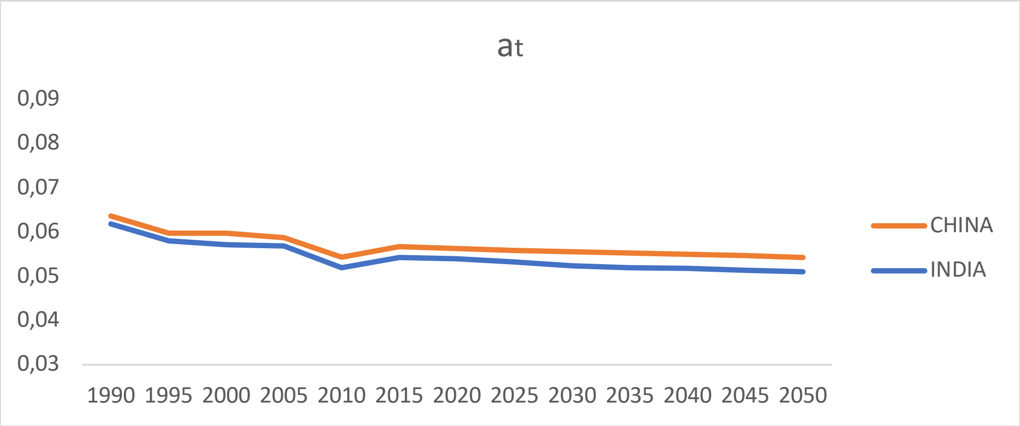
$\psi = 3;\ \beta = -0.1;\ \gamma = -0.2$

Figure 14: at, annual future simulation, all variables



$\psi = 5;\ \beta = -0.1;\ \gamma = -0.2;\ \rho = -0.1$

Figure 15: at, future simulation, 5 year averages all variables



$\psi = 5$; $\beta = -0.1$; $\gamma = -0.2$; $\rho = -0.1$