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Determinants of economic growth in Southeast Asia a comparative analysis

Diploma thesis

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Declaration of Authorship

1. Hereby I declare that I have compiled this master thesis independently, using only the listed literature and sources.
2. I declare that the thesis has not been used for obtaining another title.
3. I agree on making this thesis accessible for study and research purposes.

Prague, April 22, 2015

Signature

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Abstract

This thesis is focused on estimation of key drivers of economic growth in 8 countries in Southeast Asia region. Econometric approaches as Ordinary least squares and dynamic panel estimation are employed in order to find which variables are statistically significant for economic growth and in what direction of contribution. After the estimation itself predictions for GDP growth are provided based on the results from estimation of specified model. All in all, we concluded that variables like life expectancy, log of initial level of GDP, inflation are generally common positive statistically significant contributors. The evidence also indicates that human capital is a complicated determinant of economic growth.

JEL Classification	F11, O40, O43, C51, C53
Keywords	economic growth, panel estimation, Southeast Asia, determinants of growth, growth forecasting, analysis

Abstrakt

Tato práce je zaměřena na odhad klíčových zdrojů ekonomického růstu 8 zemí Jihovýchodní Asie. Ekonometrické přístupy jako Metoda nejmenších čtverců a odhad panelových dat jsou použity k nalezení toho, které proměnné jsou statisticky signifikantní pro ekonomický růst a v jakém směru. Po samotném odhadu jsou uvedeny predikce růstu HDP na základě výsledků odhadování specifického modelu. Celkově vzato, jsme dospěli k závěru, že proměnné, jako je odhadovaný věk dožití, logaritmus počáteční úrovně HDP, inflace jsou obecně pozitivně statisticky významné. Důkazy také dokládají, že rozvoj lidského kapitálu je komplikovaným determinantem ekonomického růstu.

Klasifikace JEL	F11, O40, O43, C51, C53
Klíčová slova	ekonomický růst, odhad panelových dat, Jihovýchodní Asie, determinanty růstu, odhadování růstu, analýza

Contents

List of Tables vii

List of Figures ix

Acronyms x

1. INTRODUCTION 1

2. LITERATURE REVIEW 3

2.1. Theoretical background of growth theories 3

2.1.1. Solow-Swan model of economic growth 3

2.1.2. Ramsey-Cass-Koopmans model 9

2.1.3. Research and development model 14

2.2. Economic growth and its factors in applied studies 24

3. OBJECTIVES 31

4. DATA AND METHODOLOGY 32

4.1. Data set description 32

4.2. Employed methodology 37

5. RESULTS OF ECONOMIC GROWTH ESTIMATION 41

5.1. Ordinary least squares estimation 41

5.1.1. Vietnam 43

5.1.2. Cambodia 45

5.1.3. Myanmar 46

5.1.4. Philippines 48

5.1.5. Thailand 49

5.1.6. Indonesia 51

5.1.7. Lao 52

5.1.8. Malaysia . . . 53
5.2. Dynamic panel data estimation . . . 54
5.2.1. Economic verification . . . 58
5.2.2. Statistical and econometric verification . . . 60

6. EVALUATION AND FORECASTING OF ECONOMIC GROWTH 62
6.1. Fitted values evaluation and forecasts for 2014 and 2015 . . . 62

7. DISCUSSION 67

8. CONCLUSION 70

Bibliography 73

A. Appendix A 77

B. Content of Enclosed CD 85

List of Tables

5.1. Autocorrelation results based on Durbin-Watson test 43
5.2. Homoscedasticity results using Breusch-Pagan test 43
5.3. Correlation matrix within the variables in the panel data 56

6.1. Results from fitted values evaluation and forecasts for 2014 and 2015 66

List of Figures

2.1. The graphical representation of Solow-Swan model equilibrium, borrowed from Romer (2006) 7
2.2. Balance growth path borrowed from Romer (2006) 8
2.3. Dynamics of consumption borrowed from Romer (2006) 13
2.4. Phase diagram of Ramsey model Romer (2006) 14
2.5. Phase diagram change in growth of knowledge with respect to growth of technology Romer (2006) 17
2.6. Phase diagram change in growth of knowledge with respect to growth of technology Romer (2006) 19
2.7. Phase diagram change in growth of knowledge with respect to growth of technology Romer (2006) 20
2.8. Phase diagram including capital in RD model Romer (2006) 22

4.1. Relationship between life expectancy and GDP, whole world borrowed from GapMinder (2015) 36

5.1. Distribution of residuals from panel data estimation 61

6.1. Fitted values for Malaysia 63
6.2. Fitted values for Indonesia 64
6.3. Fitted values for Thailand 65
6.4. Fitted values for Philippines 66

A.1. GDP per capita y/y growth 77
A.2. Relationship between fertility rate vis-à-vis secondary education . . 78
A.3. Relationship between GDP growth and life expectancy 78
A.4. Relationship between GDP growth and log GDP 79
A.5. Relationship between GDP growth and secondary education 79
A.6. Relationship between GDP growth and rule-of-law 80

A.7. Relationship between GDP growth and terms of trade 80
A.8. Relationship between GDP growth and democracy index 81
A.9. Relationship between GDP growth and government expenditure . . 81
A.10. Relationship between GDP growth and inflation 82
A.11. Relationship between GDP growth and investments 82
A.12. Relationship between GDP growth and patents 83
A.13. Development of GDP per capita in time 84

Acronyms

B-P Breusch-Pagan test of heteroscedasticity

D-W Durbin-Watson test for autocorrelation

GDP Gross domestic product

M-Z regression Mincer-Zarnowitz regression

OECD Organisation for Economic Cooperation and Development

RD Research and development

Chapter 1

INTRODUCTION

The growth theory within economy and the main drivers of economic growth are very common questions on minds of many economists and researchers. In this thesis the correlation between economic growth and various variables will be tested by using advanced econometric approaches such as panel data estimation or slightly less advanced such as Ordinary Least Squares approach. Chosen area of research are the rapidly developing Southeast Asia countries, namely countries Thailand, Vietnam, Cambodia, Lao, Myanmar, Malaysia, Philippines and Indonesia. The time focus of our research lays within the years 1993-2013. This thesis was written in order to uncover the main drivers of economic growth in Southeast Asia region as the standalone countries have been so far overlooked in academic literature. They were part of bigger picture; estimation rather than standalone. This area seems to be very interesting as it is full of contrasts, from countries like Lao and Myanmar on one hand to countries like Malaysia or Thailand so-called Tiger Cub economies. The whole area experienced rapid economic growth in recent decades and it is quite rational to be curious what stood behind this fast development. Also it seems to be interesting to find out whether this rapid growth could be maintained even in the years to come.

Regarding the literature review of papers or books focused on similar topic, for example Barro (1996) explored the key economic growth drivers all over the world and many other examples can be found in economics textbook e.g. Barro and i Martin (2004) or Doppelhofer et al. (2000). More space will be devoted to the literature review on forthcoming pages. The crucial for us is to find out what are the determinants of economic growth in Southeast Asia. At the beginning we established several hypotheses. First hypothesis tested in this thesis would be:

- Despite approximately 20 years of time lag between estimation performed in this thesis and Barro´s or Sala-i-Martin´s results we do not suppose that our estimation of coefficients will be statistically significantly different from their estimates.

However, Barro estimated all data at once using panel data approach, but in this thesis we intend to perform single regression on particular state as well, in order to explore whether panel data approach is capable to catch all the statistically unobservable differences in particular economies. Which brings us to second hypothesis of this thesis:

- Employing single regression estimation on particular states will yield more precise results (in terms of R^2) than estimation via panel data. Which means that the differences within the countries that are subject of research are so significant that panel data yields less precise results. The reason for such hypothesis is the fact that we truly believe that underlying dynamics in particular economies vary significantly. Varying in terms of political establishment, structure of the economy etc.

Furthermore not to perform only estimation but provide also some forward looking implication of research of this thesis, economic growth will be forecasted using estimated coefficients. Firstly within the time frame, followed by the evaluation of the fitted values. Afterward if predictions prove them self to be useful, the forecasts for future will be performed. In order to test whether this estimation is any useful for predicting the future growth rates of particular countries, forecast within the time frame will be performed. Afterward the forecast values will be put under Mincer-Zarnowitz test Mincer and Zarnowitz (1969). Mincer-Zarnowitz test enables us to tell whether the predictions are statistically different or indifferent from the real values. With this topic come the third hypothesis:

- Fitted values using estimated coefficients will be in reasonable boundaries therefore it would be feasible and reasonable to perform forward looking values based on estimated coefficients.

Chapter 2
LITERATURE REVIEW

2.1. Theoretical background of growth theories

In this chapter several growth theories will be provided, as estimating the econometric model without any theoretical background would be just a guessing not the correct approach to econometric modeling. We will show how crucial is the development of technology for economic growth, at first the technology growth will be assumed exogenous but third model presented in this thesis works with technology growth as an endogenous variable. All in all, the purpose of this sub-chapter is to provide the reader the assumed essential growth drivers in academic theory.

2.1.1. Solow-Swan model of economic growth

The very first evidence of complex economic growth theory could be tracked back to Solow and Swan when in 1956 Solow simultaneously with Swan published the very famous A Contribution to the Theory of Economic Growth Solow (1956). In his paper Solow described how economic growth in economy is dependent on several variables, which will be explained later. Firstly we need to focus our attention on the simplified assumptions of Solow-Swan model. The derivation of the model is borrowed from Romer (2006).

Assumptions of the model regarding households:

- Households are the owners of all input and assets in the economy thus their decisions have impact on outcome of the economy
- What households save (their savings = income - consumption) is equal to the level of investments

The Solow-Swan model has also several assumptions regarding firms in the economy:

- Firms hire workers (L_t) and capital (K_t) in order to produce good or outcome (Y_t). The final product of firms is created via so called production function (F(.))
- Firms have further opportunity to access the technology (A_t) which increases the production thru increase of effectiveness

Now when the assumptions have been cleared let´s focus on structure of the model. As the Solow-Swan model works with so called intensive forms of variables i.e. variables are derived per worker and as well are the savings derived as a proportion of the output. From very basic economic equation:

$$C_t + S_t = Y_t$$

We could explore after the division of above mentioned equation by Y_t the saving rate (s_t) in Solow-Swan model is within the interval of (0,1), simultaneously the propensity to consume (c_t) is equal 1-s_t. The growth rates of labor force which is hired by the firms grows on endogenously given rate of n and the knowledge (or technological progress) increases on the exogenous rate of g.

As was mentioned above the Solow-Swan model employes so called production function which can be mathematically described as follows:

$$Y_t = F(K_t, A_t L_t)$$

where:

- K_t is the level of capital within the economy at time t
- L_t is the number of workers and time they work
- A_t represents the effectiveness/technology

The production function has several important attributes. Firstly the constant return to scale are assumed:

$$F(cK, cAL) = cF(K, AL) \text{ for any } c \geq 0$$

Secondly, the production function could be rewritten in so called intensive form. If we assume $k = \frac{K}{AL}$ (unit of capital reallocated to effective worker) and $y = \frac{Y}{AL}$ and lastly $f(k) = F(k, 1)$ we can finally derive that:

$$y = \frac{Y}{AL} = \frac{F(K,AL)}{AL} = F(\frac{K}{AL},1) = F(k,1) = f(k)$$

Which basically implies that outcome per effective worker is a function of capital allocation to the particular worker. The production function also features the so called positive but diminishing returns to inputs, which in mathematical way means set of two next equations:

$$\frac{\delta F}{\delta K} > 0, \frac{\delta F}{\delta L} > 0$$

The first derivative condition satisfies that the production function is increasing in capital and labor, which meas any additional unit of capital or labor would be transmitted into higher output. The diminishing returns are satisfied when following in-equation holds (basically the condition of concavity of the production function):

$$\frac{\delta^2 F}{\delta^2 K} < 0, \frac{\delta^2 F}{\delta^2 L} < 0$$

Last feature of Solow-Swan production function are so called INADA[1] conditions:

$$\lim_{K\to 0+} \frac{\delta F}{\delta K} = \lim_{L\to 0+} \frac{\delta F}{\delta L} = \lim_{k\to 0+} f^{\acute{}}(k) = \infty$$

Which satisfies that in the near of 0 the production function rapidly increases as the level of capital per effective worker increases.

$$\lim_{K\to \infty} \frac{\delta F}{\delta K} = \lim_{L\to \infty} \frac{\delta F}{\delta L} = \lim_{k\to \infty} f^{\acute{}}(k) = 0$$

This equation describes that after certain level of capital any increase would have no impact on the final output per effective worker. And finally last INADA conditions states that:

$$F(K,0) = F(0,L) = f(0) = 0$$

Which can be translated that no output can be reached without capital or labor and that the production function passes thru (0,0) point on standard X,Y axis.

In order to find the optimal level of capital per effective worker we have to accept several assumptions. Firstly, we assume that labor and technology develop exponentially according to exogenously given growth rates, n for labor and g for technology, i.e.:

[1]INADA conditions are named after Japanese economist Ken-Ichi Inada

$$L(t) = L(0) * e^{nt}$$

$$A(t) = A(0) * e^{gt}$$

Further assumption in way to find the optimum in Solow-Swan model must be made regarding the development of capital within the economy. As proposed above, the final outcome is divided into consumption and savings. Savings are in the model immediately transmitted into investments. Final assumption regarding the capital development is that capital depreciate over time at rate δ. In equation the development of capital is represented as follows:

$$K^{'}(t) = I(t) - \delta K(t) = sY(t) - \delta K(t)$$

where:

- $K^{'}(t)$ represents the change (the first derivation) of capital stock at time t
- $I(t)$ stands for investments made in time t, using the above mentioned identity we can derive that $I(t) = sY(t)$
- and $\delta K(t)$ is how much of capital is depreciated at time t

Equation of development of capital can be further rewritten into intensive form (variables per effective worker) as follows:

$$k^{'}(t) = sf(k(t)) - \delta k(t)$$

The final derivation of equilibrium equation goes according to the following pattern. Knowing the rules for derivations we finally arrive at:

$$k^{'}(t) = \left(\frac{K(t)}{A(t)L(t)}\right)^{'} = \frac{K^{'}(t)}{A(t)L(t)} - \frac{K(t)}{(A(t)L(t))^2} * \left[A(t)^{'}L(t) + A(t)L^{'}(t)\right]$$

$$= sf(k(t)) - (n + g + \delta)k(t)$$

The above derived equation is the most famous from Solow-Swan model. The equation describes that in order to achieve optimum level of capital i.e. $k^{\acute{}}(t) = 0$, the change of capital allocated to effective worker is equal to new allocation of capital to effective worker ($sf(k(t))$) decreased by the outflow of capital caused by growth of labor force, depreciated capital and increase in technology ($(n+g+\delta)k(t)$). Should we intend to present above mentioned equation in graphical way it is depicted in figure 2.1. From the graph the k^*represents precisely the optimum level of capital employed in the economy, or the point where $sf(k(t)) = (n+g+\delta)k(t)$.

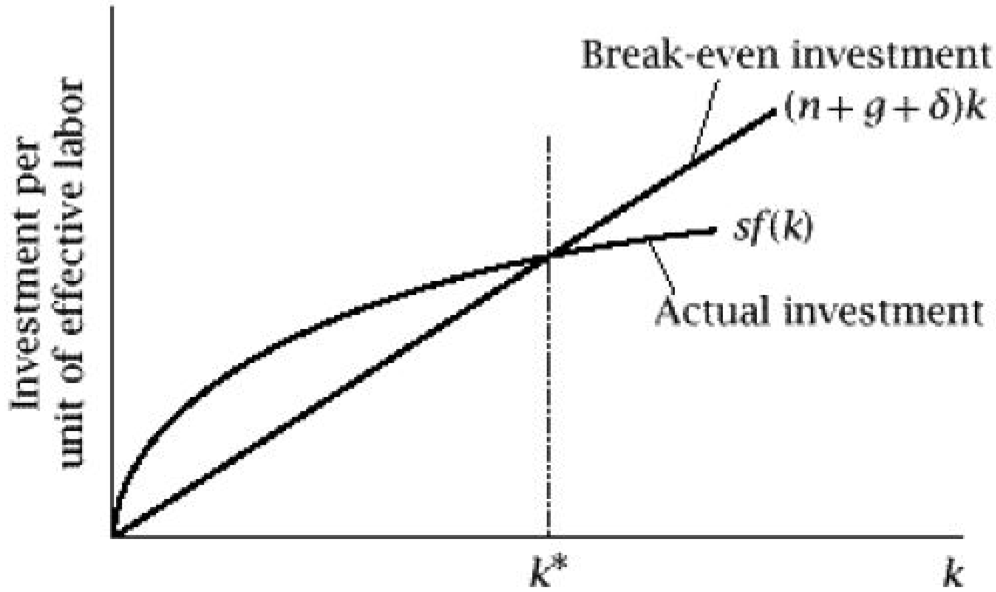

Figure 2.1.: The graphical representation of Solow-Swan model equilibrium, borrowed from Romer (2006)

Furthermore we can observe the dynamics of the model, when the level of capital is lower than k^* (on the left side of equilibrium) the economy would smoothly end up in k^*, as the excessive savings would increase the level of capital to the point where eventually the level of capital would be equal to $(n+g+\delta)k(t)$. Similarly for the points on the right side of the optimum. The development of change in capital per effective worker is usually called growth path. The graph bellow representing this balanced growth path summarizes what has been written above. When economy operates under optimal level of capital per effective worker (i.e. on the left side of k^*) capital stock would increase until convergence to k^*. For the points on the right side of k^* the situation would be precisely opposite, meaning change in capital per effective worker would be negative until reaching the optimal level of k^*.

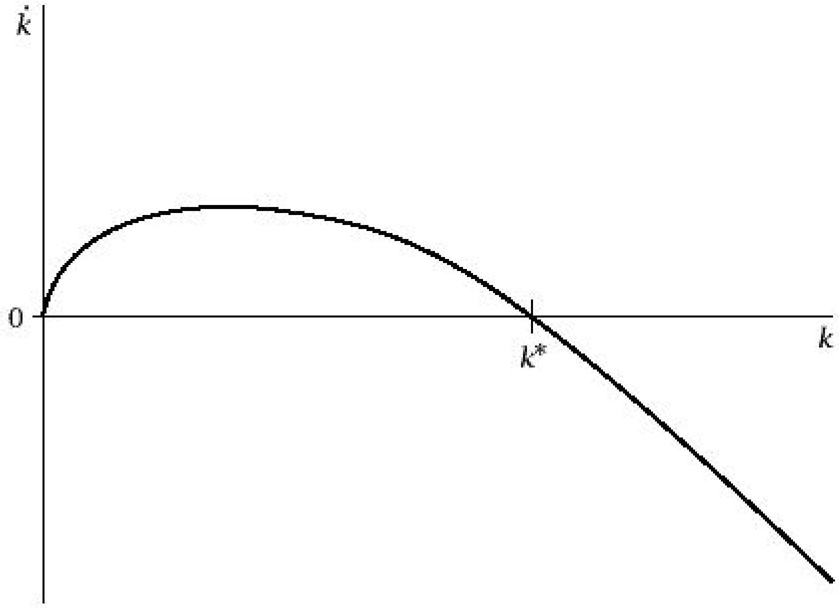

Figure 2.2.: Balance growth path borrowed from Romer (2006)

When speaking of Solow-Swan model the very last thing must be mentioned, the so called Golden rule. The golden rule basically says at what point the consumption is at its maximum and where the savings are optimal. The derivation of Golden rule is intuitive. Basically we want to explore at what point the line represented by $(n+g+\delta)k(t)$ is tangent to production function $f(k)$. Using first derivation we would arrive at:

$$f^{'}(k) = n+g+\delta$$

All in all, the Solow-Swan model however does not take into account the institutional framework or institutions at all. For example taxation is completely excluded. But even though there are some white spots in the model according to Romer (2006) the Solow-Swan model can explain economic differences between various countries via different level of effectiveness of labor which in the model is represented by variable A. In addition, Solow-Swan model contributes to clarification of converge story in economic theory. Frankly speaking convergence theory assumes that poor countries starting with lower levels of economic indicators (in Solow-Swan model meaning lower levels of capitals and effectiveness per effective worker) will grow faster than the rich countries and eventually would catch up with the rich ones which is economically reasonable assumption. The theory whether the convergence story truly holds was tested in e.g. Baumol (1986). Baumol examined wide data range between years 1870 until 1979 within 16 developed countries. Very briefly to explain, Baumol estimated following model:

$$ln\left[\left(\frac{Y}{N}\right)_{i,1979}\right] - ln\left[\left(\frac{Y}{N}\right)_{i,1870}\right] = \alpha + \beta ln\left[\left(\frac{Y}{N}\right)_{i,1870}\right] + \varepsilon_i$$

Where $\frac{Y}{N}$ is income per person (correlating to y in Solow-Swan), i is particular index for every country. Now if any convergence holds we would suppose that β is equal to -1, which means the larger economic growth within 1870 until 1979 the lower initial value of income per person. The results Baumol arrived at suggest that the convergence story truly holds:

$$ln\left[\left(\frac{Y}{N}\right)_{i,1979}\right] - ln\left[\left(\frac{Y}{N}\right)_{i,1870}\right] = 8.5 - 0.995 ln\left[\left(\frac{Y}{N}\right)_{i,1870}\right] + \varepsilon_i$$

With significantly high value of R^2 being equal to 0.87. The results suggest that the convergence theory drawn in Solow-Swan model truly exists within the economies.

In order to summarize Solow-Swan model we need to bear in mind several facts. Firstly, despite its simplicity Solow-Swan set the path for many growth theories onward and actually interprets economic growth using real data in accurate manners. The wide range of usage of Solow-Swan model is not only limited to pure economic growth but to questions connected as well, i.e. the convergence theory and its estimation by Baumol (1986). However, there are some blank spots in the model as the institutional framework (now considered very significant part of economic growth) or the question of corruption are completely excluded from the model or any micro-economic decision making of households.[2]

2.1.2. Ramsey-Cass-Koopmans model

Despite Solow-Swan model proved itself to be convenient and simple tool for explaining the theory for economic growth, there is lack of any micro-economic roots. The model describes well economic growth but completely excludes the decision making process of households. In this part the so called Ramsey-Cass-Koopmans will be presented. This particular model employes the decision making process of households. The model was not invented at once, but the development took almost 40 years. First one who set the academic ground for further development of the model was Ramsey (1928) and further developed later by Cass (1965) and Koopmans (1965). The

[2] To be honest there are some interesting extensions to Solow-Swan model presented in Romer (2006) i.g. including pollution etc.

model was built on large extent to Solow-Swan model. When focusing on the model assumption regarding the firms Romer (2006) suggests following summary:

- Large amount of firms producing according to production function $Y = F(K, AL)$ which shares the same assumptions as in Solow-Swan model (is increasing in both K and AL, concave) and satisfies INADA conditions.
- As in Solow-Swan firms hire labor and take exogenously given level of technology (A) that grows by the rate of g.
- Firms are maximizing profits and owned by households therefore all the profit goes to households.

Following the pattern several assumptions are made regarding economic behavior of households as well:

- Firstly there is a large number of identical households within the economy.
- Each member of household supplies only one unit of labor at any time
- Initial capital equipment of households is equal to $\frac{K(0)}{H}$ where K(0) is total amount of capital at the start and H represents the number of households within the economy.
- The split of income is possible only between consumption and savings.

Finally bringing some micro-economic theory, the households have utility function which is represented by following equation:

$$U = \int_{t=0}^{\infty} e^{-\rho t} u(C(t)) \frac{L(t)}{H} dt$$

In the formula where C(t) stands for consumption, L(t) is total amount of labor, H represents the total number of households and ρ is so called discount rate, therefore $e^{-\rho t}$ represents the discount rate of households to postpone the consumption to the future.

Regarding the utility function $u(C(t))$ that is purely drive by consumption. The mathematical representation of utility function takes following shape:

$$u(C(t)) = \frac{C(t)^{1-\theta}}{1-\theta} \text{ where } \theta > 0 \text{ and } \rho - n - (1-\theta)g > 0$$

The utility function with this equation is usually called constant relative risk aversion utility function. The reason for the name comes from the fact that coefficient of relative risk aversion defined as $Cu^{''}(C)/u^{'}(C)$[3] for this utility function is completely

[3] $u^{''}$ stands for second derivation of utility function and $u^{'}$ represents the first derivation

independent from C and equal to θ. θ in the utility function represents the willingness of households in postponing the consumption between today and the future, in case of θ being close to zero households are almost indifferent in time preference of consumption, i.e. the consumption today brings almost same utility as consuming in the future.

As was already mentioned earlier basic concepts of micro-economic theory are incorporated into the Ramsey-Cass-Koopmans model and we will focus on these in following paragraphs. Firstly, starting with the firms, they are proposed to hire labor (households) in order to produce and maximize profits. Firms have to however, set the wage paid to workers in manners that is micro-economically rational and maximizing the profits. In order to derive proper wages paid we firstly need to focus on derivation of real interest rate. As the depreciation of assets is not considered in the model we can clearly suppose that:

$$r(t) = f^{'}(k(t))$$

In other words real interest rate within the economy is equal to marginal product of capital employed in the production. On the other hand the marginal product of labor must be equal to:

$$\frac{\delta F(K,AL)}{\delta L} = A\left[f(k) - kf^{'}(k)\right]$$

Therefore following the same rational as in derivation of real interest rate the optimal wages per effective worker (w(t) paid at time t must be equal to:

$$w(t) = f(k(t)) - k(t)f^{'}(k(t))$$

The problem of optimization from firms point-of-view is solved, however, the households have their own decision making regarding the optimal amount of consumption spent now and in the future. First of all we need to define so called budget constraint (set of all possible combination which are feasible for households) which in Ramsey model takes following shape:

$$\int_{t=0}^{\infty} e^{-R(t)} u(C(t)) \frac{L(t)}{H} dt \leq \frac{K(0)}{H} + \int_{t=0}^{\infty} e^{-R(t)} W(t) \frac{L(t)}{H} dt$$

Where the left hand side of in-equation represents the discounted value of consumption that has to be less or equal to initial wealth of particular households and discounted value of future wages received for supplied labor. Sometimes rearranged in-equation is provided:

$$0 \leq \frac{K(0)}{H} + \int_{t=0}^{\infty} e^{-R(t)} W(t) \frac{L(t)}{H} dt - \int_{t=0}^{\infty} e^{-R(t)} u(C(t)) \frac{L(t)}{H} dt$$

Which is usually further developed into the form known as ”No Ponzi game” restriction. However, the meaning remains the same as in above mention in-equation, i.e. households cannot indebt themselves higher than their initial set up of capital and discounted value of income from work

Now having set the utility function and budget constraint we can move forward to solving the utility maximization problem of the households. The whole derivation can be found e.g. in Romer (2006) we will present only the final steps. Households face the problem of maximizing the utility via consumptions while facing the budget constraint. The problem could be solved via Lagrangian. Let us define:

$$L = B \int_{t=0}^{\infty} e^{\beta(t)} \frac{c(t)^{1-\theta}}{1-\theta} dt + \lambda \left[k(0) + \int_{t=0}^{\infty} e^{-R(t)} e^{(n+g)t} w(t) dt - \int_{t=0}^{\infty} e^{-R(t)} e^{(n+g)t} c(t) dt \right]$$

where $B = A(0)^{1-\theta} \frac{L(0)}{H}$ and $\beta = \rho - n - (1-\theta)g$. Again step-by-step solution can be found in Romer (2006) and the final solution takes following shape:

$$\frac{\mathring{c}(t)}{c(t)} = \frac{r(t) - \rho - \theta g}{\theta}$$

This equation (called Euler equation) finally describes the optimal behavior of households under budget constraint with above proposed utility function. Basically the equation describes that in optimum the change of consumption to consumption itself must be equal to real interest rate lowered by discount rate from utility function and further minus growth rate of technology multiplied by time preference of household consumption over the time preference itself. The graph of above mention solution is represented in following manner, the level of capital does not influence the development of consumption:

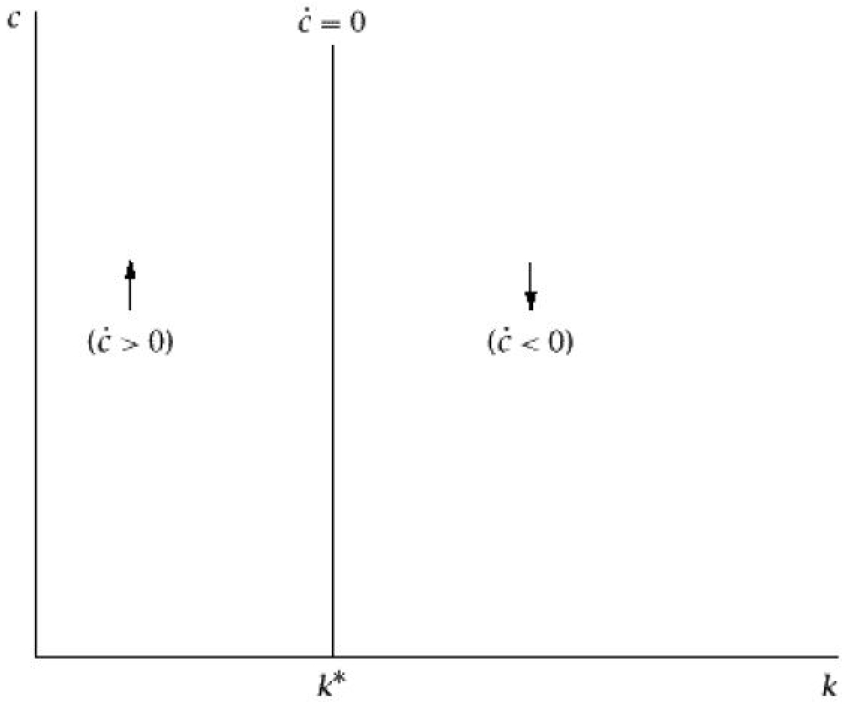

Figure 2.3.: Dynamics of consumption borrowed from Romer (2006)

The problem of households decision making process was solved. However, one could ask what would be the optimal level of capital invested in the economy as described in Solow-Swan model. Fortunately in the Ramsey-Cass-Koopmans model the equation describing the capital development is borrowed from Solow-Swan model, which means:

$$k^{\acute{}} = f(k(t)) - c(t) - (n+g)k(t)$$

Which again explains that the change in capital within the economy is equal to the portion of income that is saved minus break-even capital portion. Finally combining the above mentioned equation with the solution the households´ optimization problem we arrive at famous phase diagram:

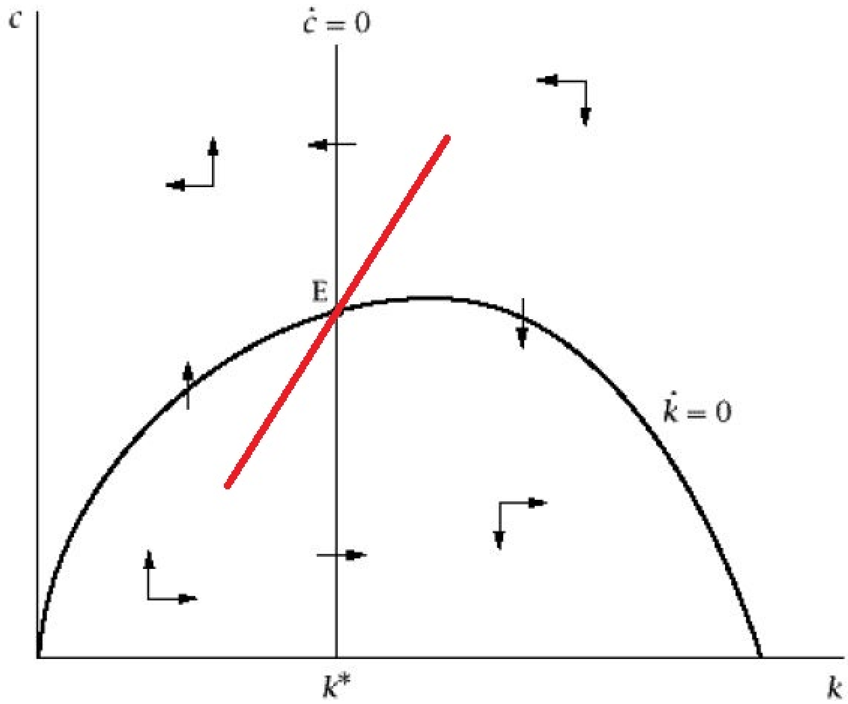

Figure 2.4.: Phase diagram of Ramsey model Romer (2006)

In graph the red line represents the saddle path on which the economy would converge into its equilibrium. The arrows stands for directions the economy would develop if the initial values would be in the particular areas. We can clearly observe that the equilibrium (E) can be reached only the particular areas where change in consumption is lower than zero and change of capital is greater zero and vice versa.

All in all, unlike in Sollow model here we have basic micro-economic concept of decision making process of households. Unfortunately these micro-economic assumptions are hard to test under common statistical approach as the utility function of households is complicated to estimate. On the other hand in Ramsey model we can develop the presence of government sector which was not possible under Sollow.

2.1.3. Research and development model

So far two mainstream models have been provided, both of them arriving at the same driver of economic growth, i.e. increase in technology or knowledge. However, none of these two models tried to answer how the technology increase is derived, they assumed that technology growth or increase is given rather exogenously. In order to clarify how the technology develops the so called research and development (usually abbreviated to RD) model will be provided in this part. To some extent the model explanation is derived and borrowed from Romer (2006).

Starting with the assumption part as in previous cases we need to draw several key stones. Firstly, compared to previous cases now beside the household, firm and potential government we need to add another sector where the technology and including knowledge increase is made. One could guess that this sector bears a name research and development. With some acceptable simplification we can imagine that this sector contains both privately and publicly employed scientists. Secondly, the production function of economy outcome is expected to be Cobb-Douglas production function, which is common for all three models provided in this thesis. Thirdly, in RD model the technology development is derived from Cobb-Douglas function as well. And last but not least the proportion of savings and labor employed in research and development sector are taken as given, therefore exogenous and expected to be constant.

Now starting with the mathematical derivation of the model. As in previous cases we employ four variables: labor (L), capital stock (K), technology (A) and final output (Y). As proposed earlier there are two sectors (for simplification now excluding the government sector). The first sector is where the final product is created, therefore called production sector. The second sector provides technological progress that drives increase of production in the production sector. As in previous cases we work with intensive forms of all variables, therefore we can call them labor,capital etc. per effective worker. Now as we have two sectors that consume the labor, capital we need to divide these variables. We simply use the notation for a_L is a fraction of labor employed in RD sector, therefore $1-a_L$ is the fraction used in production sector. Similarly for the capital stock. As proposed earlier the final production is Cobb-Douglas based production function, therefore:

$$Y(t) = [(1-a_L)*K_t]^{\alpha}\,[A_t(1-a_L)*L_t]^{1-\alpha}\; 0 < \alpha < 1$$

It is worth to point out that the production function proves itself with constant return to scale, i.e. after multiplication of inputs by some constant the final output changes perfectly accordingly to the constant.

As far as production of new knowledge is concerned, we suppose as previously mentioned the Cobb-Douglas production function:

$$\mathring{A}(t) = B\,[a_L*K_t]^{\beta}\,[a_L L_t]^{\gamma} A_t^{\theta}\; 0 < B\; 0 \leq \beta\; 0 \leq \gamma$$

The B variable is so called shift parameter. In nutshell, the above mentioned equation describes that change in knowledge and therefore technology is directly related to amount of labor and capital allocated into the RD sector and to some extent to the technology/knowledge so far developed (noted as A_t). Unlikely the production function the technology-development function does not bear constant return to scale. Which seems to be quite reasonable assumption, if we realize that the technology development cannot be simply increased by forcing more people to work in RD sector. Regarding the so far discovered technology in the equation (A_t), the parameter θ stands for the effect of existing technology on new discoveries.

Following the idea of Solow model we further suppose that the change in capital is directly equal to the portion of final output that is not consumed but saved. In order to put it in equation manner:

$$\mathring{K}_t = sY_t$$

Where again the s stands for marginal propensity to save and is equal to 1-c. Simply what is not consumed from the the output is saved. Regarding the population growth we simply assume, that population develops exponentially with exogenously given growth rate, which means:

$$\mathring{L}_t = nL_t$$

The primary assumptions are set, now as far as the further derivation of the model is concerned for simplification we assume firstly that there is no capital present within the economy. Given this simplification the production functions logically shrinks into to form of:

$$Y_t = A_t(1-a_L)L_t$$

Consequently for the technology/knowledge equation shrinks as well accordingly:

$$\mathring{A}(t) = B\,[a_L L_t]^{\gamma} A_t^{\theta}$$

Based on simplified form of production function we can easily show that the output per worker is proportional to A_t. When we want to explore the growth rate of technology (noted as g_a) we simply divide the equation by A_t. Which leads us to the form of:

$$g_a(t) = \frac{\mathring{A}_t}{A_t} = Ba_L^{\gamma} L(t)^{\gamma} A(t)^{\theta-1}$$

After taking logarithms, differentiating and using $\mathring{L_t} = nL_t$ we arrive at:

$$\frac{\mathring{g_A}(t)}{g_{A(t)}} = \gamma n + (\theta - 1)g_A(t)$$

After multiplying by $g_A(t)$ we finally get the formula describing the growth of technology as follows:

$$\mathring{g_A}(t) = \gamma n g_A(t) + (\theta - 1)g_A^2(t)$$

Now we need to distinguish between three logical cases in respect with θ. Firstly we need to consider θ being smaller than 1, equal to 1 or bigger than 1.

For the case θ being smaller than 1, we employ graphical representation to clarify it. For smaller values of $g_A(t)$ the function is positive and increasing which seems to be rational as with low initial value of growth in technology the change in growth is positive and increasing. And for large values of $g_A(t)$ the change is negative which can be uphold rationally as well, as with large amount of technology and knowledge there is the risk that some of it will be forget.

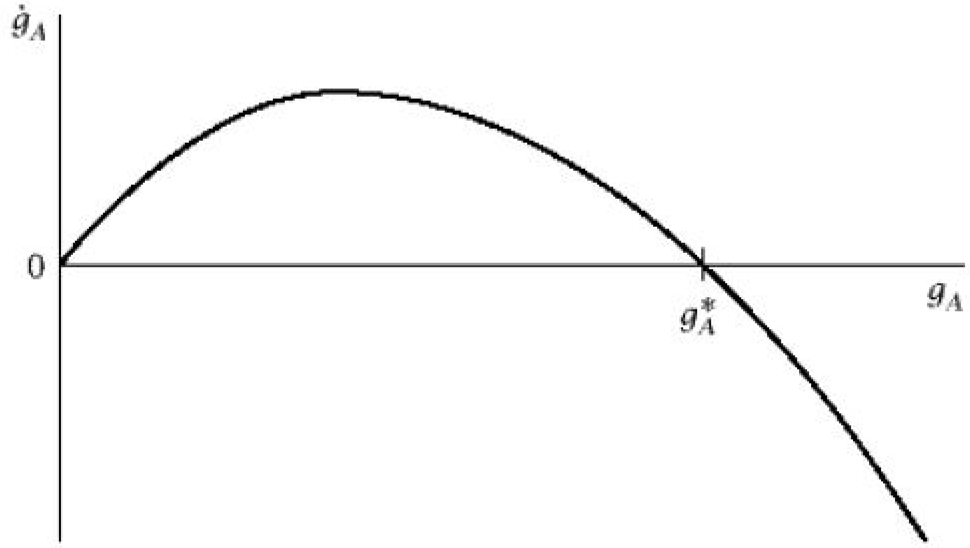

Figure 2.5.: Phase diagram change in growth of knowledge with respect to growth of technology Romer (2006)

Let´s mark the point where the $\mathring{g}_A(t)$ is equal to zero, or in other words the equilibrium, with g_A^*. Now for mathematical derivation we simply use the derived version of change in technology and set it to zero, which results in:

$$0 = \gamma n g_A(t) + (\theta - 1)g_A^2(t)$$

$$0 = \gamma n(t) + (\theta - 1) g_A(t)$$

Substituting the $g_A(t)$ with $g_A^*(t)$ we finally yield the result of optimal technology growth as follows:

$$g_A^*(t) = \frac{\gamma}{1-\theta} n$$

The above mentioned equation provides us with the information that regardless of initial setup in the economy, the economy would converge to the optimum. And moreover if the economy is on the right or left hand side of the optimum it would converge to the g_A^*. It is also worth to mention that unlike the two previous models presented in this thesis RD model finally perceives the growth in technology to be endogenous, not given exogenously but created within the economy. However, there are some pitfalls in the equation as well. For example we can observe that growth in technology/knowledge (and therefore growth of final output as well) is directly correlated with population growth denoted as n. This correlation seems to be more likely a condition for growth rather than rule. For growth in technology and economy you certainly need population. But does the population growth implies directly growth in technology? We could definitely think of several examples of developing countries that have significant population growth but lack on the technology growth side.

Secondly, focusing on the case when θ is greater than 1. In this particular situation the change in technology/knowledge growth diverges with higher values of technology growth. For better clarification we employ graphical representation of the case. Basically newly produced knowledge develops more new knowledge.

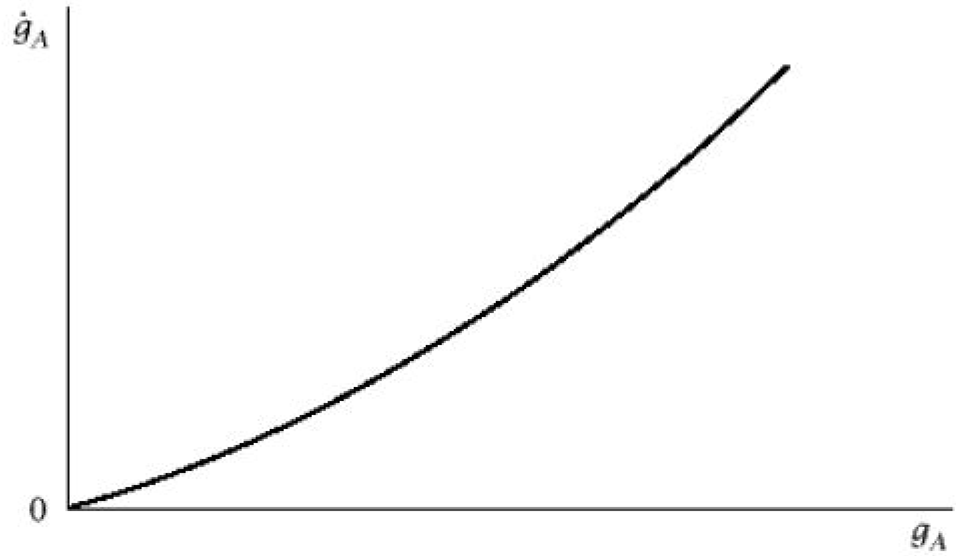

Figure 2.6.: Phase diagram change in growth of knowledge with respect to growth of technology Romer (2006)

Again it is easy to spot that the $\mathring{g}_A(t)$ increasing in $g_A(t)$ as proposed above. This situation is rather academical than from real economy as with any additional amount in technology growth produces more knowledge.

Last case remaining to be explained is the case where θ exactly equal to 1. Frankly speaking it is the situation where growth in technology/knowledge is exactly enough for generating new knowledge. Recalling the equation describing general behavior of growth in $\mathring{g_A}(t) = \gamma n g_A(t) + (\theta - 1)g_A^2(t)$ for this case the equation shrinks to the following form:

$$\mathring{g_A}(t) = \gamma n g_A(t)$$

Which implies that if the population growth is positive, the growth in knowledge is satisfied and vice versa. As far as graphical representation goes, we can imagine this particular situation as follows:

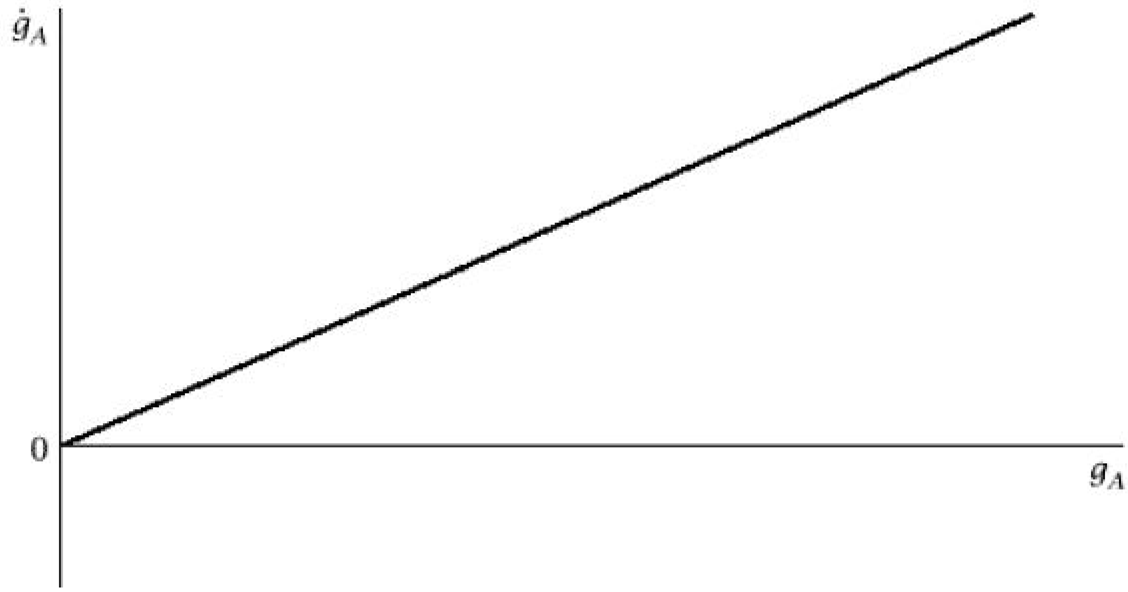

Figure 2.7.: Phase diagram change in growth of knowledge with respect to growth of technology Romer (2006)

All of three above presented cases have completely different impact on the change in technology or knowledge within the economy. It has been already shown that only reasonable situation is the case when θ is smaller than one.

What has been so far clarified in RD model was rather a simplification excluding the importance of capital within the economy. On next pages we are going to include capital and show how the implication for growth theory differs from simplified version of RD model.

Adding capital into the model has one significant impact on overall assumptions of the RD model. With capital included we have now two sets of variables that are endogenously created A for technology and K for capital. A being endogenous was shown earlier and for K being endogenous variable we just need to realize how the capital is created. Taking into account equation regarding the capital change:

$$\mathring{K}_t = sY_t$$

We can clearly conclude that the amount of capital flowing into the economy runs according to the value of s which is endogenously given. Now with help of lastly mentioned equation we can further rewrite the equation describing the development of capital as follows:

$$\mathring{K}_t = sY_t = s(1-a_k)^{\alpha}(1-a_L)^{1-\alpha}K^{\alpha}(t)A^{1-\alpha}(t)L^{1-\alpha}(t)$$

After dividing left and right hand side of equation by K(t) in order to get an intensive form and furthermore knowing that $c_k = s(1-a_k)^{\alpha}(1-a_L)^{1-\alpha}$ [4]

we arrive at following result:

$$g_k(t) = \frac{\mathring{K}(t)}{K(t)} = c_k \left[\frac{A(t)L(t)}{K(t)}\right]^{1-\alpha}$$

Taking logarithms of both sides of equation and making first derivation with respect to time:

$$\frac{\mathring{g}_k(t)}{g_k(t)} = (1-\alpha)(g_A(t)+n-g_k(t))$$

We can clearly assume that $g_k(t)$ is positive if $(g(t)+n-g_k(t)$ is positive and vice versa. Knowing this we can derive the graphical representation of the equation in the following manner. Furthermore, we can observe that when the economy is on the left hand side of the locus (points where $\mathring{g}_A = 0$) naturally the economy slide according to the arrow in the graph.

Similar procedure is employed for derivation growth rate of capital. Because the procedure is rather mathematical exercise, we provide only the final form of equation. The equation describing the growth of knowledge in RD model is as follows:

$$\frac{\mathring{g}_A(t)}{g_A(t)} = \beta(g_K(t)+\gamma n+(\theta-1)g_A(t))$$

From the graph (Figure 2.8) the capital E represents the equilibrium growth rates for capital accumulation and knowledge. The arrows represents directions that economy would follow if being outside the equilibrium. Moreover it is quite simple to derive the equilibrium as a function of other variables, knowing that E is an intersection of two locus curves, one for capital and the other for knowledge. Combining the two locus equation we finally arrive at the optimal level of knowledge growth as follows:

$$g_A^* = \frac{\beta+\gamma}{1-(\theta+\beta)}n$$

For the optimal level of capital accumulation growth we simply employ the locus curve equation and we yield:

[4]It is easy to prove that this equation holds knowing that consumption of capital is equal to portion of output from Cobb-Douglas production function multiplied by marginal propensity to save. Basically the current equation is just a special case of general macro-economic identity K=S=s*Y

$$g_K^* = g_A^* + n$$

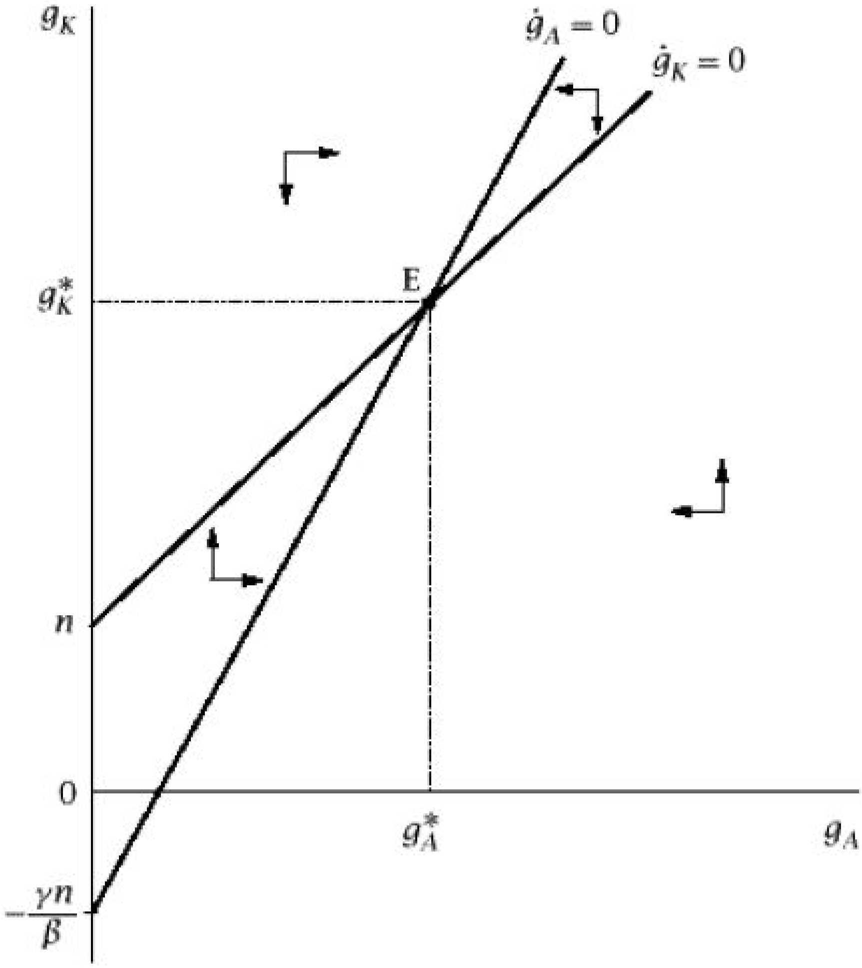

Figure 2.8.: Phase diagram including capital in RD model Romer (2006)

So far we provided theoretical framework for RD model. We heavily employed new term in growth theory that has been somewhat different from previously provided models. However, what we can imagine under the term knowledge under RD model, Romer (2006) suggests thinking of knowledge rather in wide range, from highly abstract terms (e.g. new discovery in quantum physics) to applied knowledge regarding regular every-day life. It is important to point out that knowledge under theoretic concept in RD model bears two attributes. Firstly knowledge is nonrivaly. Which means consumption of knowledge by one person does not exclude the consumption for someone other. In order to provide example if we provide the RD model brief introduction in this thesis it does not exclude someone else to use it his or her thesis as well. Secondly, knowledge proves itself with excludability from consumption. This second attribute is tightly connected with private rights and rather belong to institutional economic field. To clarify the excludability term, let us provide the example of patents where illegal knowledge of someone´s knowledge or discovery is punishable according to law.

But does RD model provide any policy recommendation regarding the research and development area of economy? Firstly, we need to divide between two main sources of new knowledge the basic scientific research and private driven research. The basic scientific research is rather providing new knowledge for free of charge, we can think of it as the universities. Because of releasing the knowledge usually at zero charge, we should consider this sub-sector as a provider of positive externality.[5] Because of this positive-externality attribute and almost zero income from knowledge providing the basic scientific research should be subsidized by the governing authority. However, aside from the basic research in the economy we can find also private research. In this sub-sector the new knowledge are produce intentionally in order to increase profits, market share etc.

Regarding the testing whether the RD theory is really applicable to real economy, we want to provide results from Kremer (1993). In his paper author examined the importance of technological development since 1 million B.C. until 1993. The paper is based on assumptions that technological growth is endogenous and correlated with population growth. However, the relation between technology and population growth is rather an implication than equivalence, as has been shown earlier. Based on the Kremer´s findings the previously one way implication was confirmed and moreover based on the results he could not reject following hypothesis. The hypothesis consisted of following: several areas separated by natural causes from each other, starting with same technology would end up in different state of technology according to the size of population inhabiting the particular area. Based on common sense, this seems to be pretty logical, but importance of Kremer´s findings is that particular hypothesis was not rejected on the date over more than million of years.

In order to wrap up this section let´s repeat what are the main economic growth drivers based on mainstream economics. All authors presented in this chapter perceived the technological growth as the main driver of economic growth. Some authors assumed the growth in technology to be exogenously given (for simplification). However, in RD model the technology growth was assumed to be endogenous, i.e. created within the economy. Moreover according to findings from Kremer (1993) we

[5]Positive externality means that economic activity of given subject has positive outcome or impact on other participants in economy.

can clearly suppose furthermore that population growth is essential for technological progress in economy. Many of these findings we be further employed in slightly updated model from Barro (1996).

It was a purpose to show main econometric models, which are three basic one regarding the topic of economic development. In this paper we proposed a model, which borrowed the importance of investments from Solow-Swan model, then we used patents related to Research and development model. Unfortunately, we were not able to use Ramsey-Cass-Koopmans model as this model is based on microeconomic assumptions that we could not find data for.

2.2. Economic growth and its factors in applied studies

There have been published many works regarding the various estimations of what stands behind the growth and even the question itself is part of many debates not only in economics, but politics, policy and other fields as well. In this part we will focus mainly on papers from Barro (1996), Doppelhofer et al. (2000), Kaldor (1963) and others. Interesting fact is that these works often come up with different or even controversial drivers of economic development. One of the first modern researchers was Kaldor (1963) who introduced a number of stylized facts in the process of economic growth:

- Per capita output grows over time, and its growth rate does not tend to diminish.
- The rate of return to capital is nearly constant.
- The shares of labor and physical capital in national income are nearly constant.
- Physical capital per worker grows over time.
- The ratio of physical capital to output is nearly constant.
- The growth rate of output per worker differs substantially across countries.

These statements later seemed to be true for many countries in the world, even though he derived it from U.S. and U.K. data. During the time working papers on this topic have developed due to better and easier obtaining of data. Most studies uses various econometric analysis for data processing, e.g. Islam (1995) enhances the benefits of using panel data in growth studies by claiming that the biggest advantage of using panel data is the fact that this approach should capture the particular differences within the economies. However, using panel data might end up in slightly different estimates than obtained from simple OLS.[6] Regarding the high number of various studies connected with economic growth it was necessary to focus on broadly respected authors within the academic society, mainly Barro and Sala-i-Martin.

In his paper Barro (1996) proposed using estimation of economic growth all at once, which means using panel data approach on roughly 100 countries from 1960-1990. However, due to some breaks in the data the whole data set was pooled into three periods 1965-1975, 1975-1985 and the rest of 1985-1990. Based on the presented results several interesting conclusions have been drawn which are perfectly in line with assumptions and implications used in this thesis. Firstly, economic growth is negatively correlated with the initial level of GDP, which basically means the higher level of GDP country has the lower economic growth (on terms of year-on-year growth of GDP) we can expect. This result is basically in line with common economic theory saying that rich countries tend to have lower GDP growth and on the other hand poor countries in terms of GDP tend to experience rapid growth of GDP. Secondly, regarding the initial level of human capital which is approximated by the share of secondary schooling and life expectancy, as proposed earlier common sense would suggest the positive correlation between human capital represented by these two variables and GDP growth. However, in this thesis we rather than common sense decisions care more about decisions based on statistical tests and relations. But, even positive statistical relationships was proved in case of human capital and economic growth.

When we focus on the variable share of government expenditure to GDP we can conclude that commonly assumed relationship holds even within statistical boundaries, Barro (1996) showed that increase in government spending per GDP indeed has negative impact on the GDP as we proposed in the earlier stages of this thesis. The rational behind is that government expenditures need to be funded via bond issuance or increasing taxes (therefore shift from household consumption to tax expenditures).

Economic growth relationship to the fertility rate has been proven negative, however here we would like to point out that despite Barro´s findings there is another paper focusing on the correlation between population growth (including fertility rate) that arrives on the different conclusions. Three years prior to Barro (1996) Kremer (1993) found out that population growth is a necessary condition for economic growth.

[6]This statement will be further proved in our model.

Regarding the rule-of-law based on the Barro´s findings it can be concluded that basically the better institutional framework in the country the better/higher economic growth is. This conclusion is perfectly in line with institutional economic stream within the economic theory. When we focus on the terms of trade variable Barro found out that indeed there is a positive relationship with economic growth but we have to bear in mind that the variable terms of trade was defined in precisely opposite way than we employ in this thesis, therefore we expect the estimated coefficient will be negative.

Growth economists have faced the problem, which drivers of growth are regarded to be robust or to be generally true in every case. According to Doppelhofer et al. (2000) this problem exists because economic growth theory is not explicit about what variables matter for growth. For example there are some socioeconomic variables that contribute to growth such as attitudes toward work, which is hard to be quantified. Next variables that influence the overall economic growth are weather, level of competitiveness within the economy, impact of taxation on decision-making of households, imperfections of the market (wage and price rigidities). Diversity of possible regressors is one of the main struggles faced by researches intending to explain empirical evidence on economic development. In many papers economists and other researchers tend to include dozens of variables and after calculations they just interpret the significant ones as the drivers of economic growth. The fixed variables in their research are the initial level of income per capita, the life expectancy and primary school enrollment in 1960. Talking about robust variables we have to point out results of Barro and i Martin (2004). Their empirical results suggest that there are several variables robustly correlated with growth. First one is dummy for East Asian countries, which is positively related to growth. Others are the primary schooling enrollment rate in 1960, the average price of investment goods between 1960 and 1964, the initial level of per capita GDP and life expectancy. Also robustly correlated, but in a negative way appears to be the share of government consumption related to GDP. In addition to other variables terms of trade seem to be insignificant to growth, which might be surprising result. When we look at nonlinear relationships they found out that even though it is believed that inflation has a negative impact on growth, but only for very high levels of inflation. Moreover, according to them the reasonable prediction that lower initial level of GDP means higher growth in conditional and it is true only if the other explanatory variables are held constant. For someone might seem interesting their finding that democracy is not crucial for growth. Democratization appears to promote growth for countries that are not very democratic, but to harm growth for countries that have already achieved a substantial amount of democracy.

The problem occurs when authors arrives with completely contrary result. As a example we provide one variable and it is education or human development in general. On one hand, it sounds reasonable that economy or state with higher level of human capital or education can reach higher growth, because education seems to be a catalyst for more developed economy. On the other hand, studies of authors came on with diverse results. Costantini and Monni (2008) in their article Environment, human development and economic growth found out that the role of education as initial human capital establishment has the same role as the initial level of GDP where countries with higher school enrollment rates are those with lower growth rates. However, they point out that increase in human development is necessary to provide a sustainable path for the country. Bassanini et al. (2001) agree with this recommendation when they assume that investment in human capital could have a long-term effect on growth rates,because highly skilled workforce means faster rate of technological process. We already found out from Rommer´s model that research and development are one of key factors of economic development. In addition to this, we can assume that this conclusion is more relevant for already developed countries, because higher education level in developing countries does not mean so far higher skilled workforce because of still very important primary sector and not developed the third sector. Some authors like Suri et al. (2011) suggest that here is a two-way relationship between economic development and human capital. They claim changes in human capital are important and significant factors of the growth rate and also social expenditure ratios and income distribution in economic growth to human capital relationship are significant. Barro (2001) discovered in his panel analysis of 100 countries that growth is positively correlated to average years of schooling of males at the secondary and higher levels. Surprisingly, growth is insignificantly correlated to male schooling at the primary level. Regarding women education, he found out growth is correlated with primary education in a indirect way through lowering fertility rate and the secondary and higher level of female schooling is insignificantly related to growth. Probably the most skeptical author regarding the role of education and human capital in general, seem to be Sala-i-Martin in the article written by Snowdon et al. (2006) where he summarizes his findings on the topic human capital and economic growth. After completing many empirical studies Sala-i-Martin declares he does not find a strong relationship between most measures of human capital and growth. After fifteen years of studies he found out very few measures of human development are positively correlated with growth. On the contrary with

Barro´s results Barro (2001), Sala-i-Martin claims the only measure of that seems to be positively correlated with growth is primary schooling and that secondary and university schooling is insignificant. All these results forced him to say that regarding economic growth, results of human capital measures seem to be disappointing. We should take into consideration his words that while World bank and other institutions spent lots of funds on building schools and highlighting investment in human capital, it does not seem to have a positive effect on economic growth. In their joint research book Barro and i Martin (2004) they claim only primary male education matters and total and female primary education turned out not to be significantly correlated with growth. In addition to these results, study of Hafner and Mayer-Foulkes (2013) showed a causal long-term relationship between high income, high human development and low fertility. In this survey they compare advanced and developing economies. Their recommendation is that only higher human development and a healthy population may conduct to lower fertility rate and it is a solution for approaching developing economies to advanced ones.[7]

Other confusing factor seems to be financial development. The question is whether better financial development causes higher growth, or vice versa. The study of Rousseau and Wachtel (2011) detected that financial factors are no longer important for economic growth. Their role is to be a reminder that the connection between finance and growth is more complex than the simple relationships suggest. Hassan et al. (2011) used for this topic panel data analysis. They found out that a low initial level of GDP is linked with a higher growth rate, so there is a strong relationship between financial development and growth. Nevertheless, Saharan Africa and East Asia and Pacific countries have causality that runs from growth to finance, which means underdeveloped financial systems do not lead to growth. According to these authors the key for these parts of the world is to improve financial systems and international trade, which might stimulate economic growth. In summary, while financial development may be necessary, it is not sufficient to reach a stable economic growth rate in developing countries.

Other variables such as government fiscal policies and trade are also essential determinants of growth. Although trade might contribute to growth in more complicated pattern, for example Harrison (1996) concluded there exists an issue of causality. More open trade policies forgo higher growth rates, but also higher growth rates might lead to more open trade regimes. Bassanini et al. (2001) also showed the

[7] Hafner and Mayer-Foulkes (2013) are convinced that human capital returns are linked to technological change, which in long-term might by a contributor to economic development.

importance of financial markets, trade openness, macroeconomic environment and research and development activities in their regression analysis of OECD countries. They also claim that many of the policy influences drive not only in direct way on growth but also indirectly via the mobilization of resources for fixed investment. It is worth noting that based on their results RD actions provided by business sector seem to have higher social returns and there is no clear relationship between non-business RD activities (e.g. energy, defense or university research) and growth, but they might create basic knowledge with possible technology spillovers in the long-term.

Some authors have searched for determinants of growth somewhere else. Sachs (2005) claims that geography is very important factor of economic growth and that landlocked countries have a disadvantage because of their position and higher transport costs. He also considered that cultural and religious differences have an impact on growth. This is the complete opposite of Sala-i-Martin´s findings in Snowdon et al. (2006).

Last but not least to mention Barro and Sala-i Martin (1997) came up with interesting model mixture of endogenous growth model and convergence story borrowed from Solow (1956). Basically the implication drawn are as follows:

- Main long run growth driver of global economy is the technological progress in the developed or leading countries.
- This technological progress is copied in less developed countries afterward. Which has economic rational behind as the copying is less cost requiring than funding the innovation process
- The second bullet point implies that the countries that exploit copying will grow faster (they experienced lower costs)
- However there are limitations, as the number of innovations that has not yet been copied goes down, substantially the costs of copying increase therefore the growth decreases.
- All in all, every country will eventually grow at the rate of innovation in the leading places Barro and Sala-i Martin (1997)

It was a difficult task to found complex studies regarding determinants of economic growth just in Southeast Asian countries.[8] Although we have found some studies from this region, most of them were analysis of just one factor on economic growth,

[8]Most of the studies focused on countries within the whole world, or only developed countries, which could easily provide trustful data or just single state analysis from Southeast Asia

e.g. FDI in one country, like Malaysia or Indonesia (for more information see Tambunan (2005), Athukorala and Waglé (2011) or Vu et al. (2008). That is definitely not sufficient for our analysis, because we believe this topic is much more complex.

All in all, we do not suspect any major deviation from conclusion proposed above. However, we are curious about the outcome of the variables where has not been general academic agreement on implication to economic growth yet. Furthermore, due to some different source of data (rule-of-law might be the example) we might arrive on slightly different implications of estimated coefficients. Also it is difficult to predict results on those determinants where authors have different opinions.

Chapter 3
OBJECTIVES

The aim of this thesis is to answer what are the main determinants of economic growth in Southeast Asia, particularly in Vietnam, Cambodia, Lao, Thailand, Myanmar, Malaysia, Philippines and Indonesia through comparative analysis within these countries. As recorded in literature overview, many scientific papers and studies have been carried out to analyze and find out what factors are crucial and inevitable for economic development. This part of the world is still regarded as a developing world, in spite that there are countries, which have been indicated as the East Asian Miracle. There are still huge differences between countries. Economists, politicians, researchers and many others have been always trying to detect what stands behind the growth in each particular country and also what could be the possible future development in this area. To be able to fulfill the main goal we established several auxiliary objectives:

- to outline the development of growth theories
- to find out the main determinant of economic growth in the scientific literature
- to provide OLS model and panel data approach for 21 years from 1993 to 2013 for determination of significant variables for economic growth
- to find out whether our results and proposed hypotheses correspond to relevant authors or there is a structural shift in mentioned economies
- to provide forecasts of GDP growth per capita y/y within our model and outside the model for predictions
- to evaluate our predictions by using Mincer-Zarnowitz regression whether our model is unbiased

Chapter 4
DATA AND METHODOLOGY

4.1. Data set description

In this sub-section the basic description of employed data set will be provided. For the purpose of estimation we firstly needed to gather various variables for examined countries: Vietnam, Cambodia, Lao, Thailand, Myanmar, Malaysia, Philippines and Indonesia. We intentionally did not include countries such as Brunei and Singapore due to the fact that these countries are very specific outliers in terms of economic development. Brunei´s economy is based on oil production and export, Singapore is already developed country unlike the previously mentioned 8 countries and it is regarded as a city state unlike the rest. Regarding the time frame of observation, the data were collected within the period of 1993-2013 yielding 21 years of observation. As far as the variables go, we employed some of Barro (1996) suggestions and add some variables that in our humble opinion and based on the presented theory could have significant impact on economic growth. All in all, we collected data for:

- Annual GDP growth per capita, which stands for the variable to be explained based on the following variables. In the model it is represented by variable y. The annual growth rates are computed from the level of GDP per capita in current USD borrowed from IMF database for the particular time period IMF (2014). In the model the variable log GDP is provided as well due to strong academic recommendation based on literature review. For the graphical representation please see A Figure A.1. The graph perfectly describes the decline in GDP growth per capita in 1997 - 1999 in all tested countries, which is usually referred as an Asian financial crisis. The deepest decline was recorded in Indonesia, Thailand and Malaysia and on the other hand the least effected country was Vietnam. The second most severe decrease was visible in connection to the global financial crisis in 2009. These results and drops can be also seen in A Figure A.13 where we can see that Malaysia was the mostly hit country in terms of Asian financial crisis and the global financial crisis.

- Secondary education borrowed from World bank database - World development indicators as the most of the variables WorldBank (2014). Based on the Barro (1996) suggestion we suppose that higher enrollment rate into secondary education would result in positive contribution to economic growth. However, we applied the whole secondary education i.e. also female students, unlike some previous models including Barro (1996) or Doppelhofer et al. (2000). For the purpose of estimation we employed percentage share with secondary education on total population in the country which is often used as a proxy for human capital (see Barro (1996)). In the model represented by variable SE.
- Life expectancy (LE in the model), we suppose that this variable will be positively correlated with economic growth, i.e. the higher life expectancy the higher economic growth. The data are borrowed from WorldBank (2014). Moreover, we can view the life expectancy as a proxy for human capital as proposed in Barro (1996). Rationally we would assume that the direction between life expectancy and economic growth goes other way around, i.e. higher economic growth means higher life expectancy. However, there are works which strongly disapproves with this direction of causality and reverses it in the way the higher life expectancy is transmitted into higher economic growth. For the whole research regarding this topic please see Odrakiewicz (2012). For the simple XY scatter plot of life expectancy and economic growth please see A.3 in A.
- Fertility rate, as proposed in theory part in order for the country to have significant economic growth the population growth must be ensured. However, we suppose that somehow slight correlation with life expectancy may arise. The fertility rate is represented by FR variable in the model bellow and is expressed as the total lifetime live births for the woman over her expected lifetime WorldBank (2014).
- Share of government expenditures on GDP (variable GE in the model bellow), from short-term point of view, government may boost economic growth via fiscal stimulation of the economy, commonly assumed by Keynesians. However, in the long-term perspective several difficulties may arise for the state from having significantly high expenditures to GDP ratio, e.g. rising cost of funding the debt or even bankruptcy. But in our case, we recorded mostly very moderate

expenditures-to-GDP ratio only occasionally above 30% IMF (2014).

- Rule-of-law (variable RL), we decided to incorporate this variable into the model as a proxy to quality of institutional framework in the particular countries. The data came from World bank database of Worldwide Governance indicators WorldBank (2015). Again it is commonly assumed that better the institutional framework (rule-of-law, better enforcement of property rights, corruption free justice system etc.) should be positively correlated with economic growth. But on the other hand we might suppose that there is not immediate transmission to economic growth, i.e. improved institutional framework implies higher growth but in years to come.

- Terms of trade (variable TT) in our model represents the imports less the exports in the particular country expressed in % of year 2005 DataMarket (2014). The reasoning for including this variable into the model is as follows. Generally speaking openness of economy is assumed to be positive contributor to economic growth. Moreover given the examples in Southeast Asia we could claim that in initial stages of rapid growth the economy records significantly higher exports than imports.

- Democracy index (variable DI) is included in the model as we suppose that in given geographical area the more democratic the country is, the higher growth we can expect. Speaking honestly one could think of several examples less democratic countries, that experienced massive growth of economy in recent decades. For example Brunei might be the case and based on this specific attribute we decided not to include it in the model (as was proposed earlier Brunei´s economy is heavily dependent on oil exports and less democratic than the rest of the particular area). As a benchmark the proxy computed by Polity IV Project was employed Marshall (2014). The variable ranges from -10 to -6 meaning complete autocracy, followed by -5 to 0 representing closed anocracy, open anocracy is captured on the scale in the range 1-5, democracy 6-9 and finally the notch 10 meaning full democracy. The greatest progress in this field occurred in Indonesia, which turned from -7 to 8 value. The most stable state showed up to be Vietnam with fixed value -7. One could found interesting the case of Thailand. This state started in 1993 with 9 value, then there was recorded a significant slump in 2006 to -5 and ended in 2013 with 7. This evidence corresponds with the political crisis in Thailand which started in 2006.

- Inflation (represented by the variable INF in the model bellow) is another variable included in the model WorldBank (2014). Usually Central banks worldwide tend to have moderate inflation connected to economic growth. However, there is no clear statistical evidence based on Barro (1996) findings between the level of inflation and economic growth. Speaking frankly we could expect that hyperinflation would harm the economy in the same manner as deflation, but the relationship of moderate inflation and growth is rather unclear in academic works.

- Based on theory presented in the theoretical framework part, where the importance of technological growth was the main driver of economic growth we decided to incorporate the proxy for technological growth. Based on the overview of literature regarding the technology progress proxy we decided to employ: "Patent activity is frequently used as a proxy for technological innovation" Fleur Watson and Hascic (2009). Or for example Jalles (2010) suggests using number of new patents as a proxy for technological development. For the data we chose database of World Intellectual Property Organization as our source WIPO (2015). In the model bellow represented by the variable PAT. One could think of another proxy for technological growth and it is the share of research and development expenditures per GDP. This proxy might seem to be more sophisticated than our employed number of patent applications by residents, but the particular data regarding our chosen countries are really hard to collect.
- Investment variable represents the share of investments on the GDP in particular (variable INV in the model bellow) IMF (2014).[1] Again commonly assumed, the investments should have positive impact on overall economic growth in the country. Connecting the investment variable with the theoretical background presented in the previous chapters the investments truly positively contributes to economic growth, however we must take into account that there is certain level of equilibrium in the economy. If the investments are too high the economy should according to Sollow model naturally converge to its optimum via decreasing level of investments and increasing the level of consumption. Including variable investments to GDP basically follows conclusions proposed by Solow (1956) presented in the part 2 of this thesis.
- Last but not least employed variable is the infant mortality (IM variable) UnitedNations (2014), where generally the negative correlation is expected with economic growth, the lower infant mortality the higher growth. However, we suspects that some kind of correlation with the fertility rate or life expectancy

[1] In case of Lao we had to use only FDI as a percentage of GDP, which is a suitable approximation.

may arise during the estimation procedure. All these suspected correlations will be subject to testing a priori the estimation itself as proposed in methodology part.

It is quite interesting to focus on the relationship between life expectancy and GDP in broader terms, comparing it to the rest of the world. Bellow we provided graph created using GapMinder (2015) which depicts the relationship between life expectancy and GDP as of 2013. Unfortunately, here we cannot provide the development in time as the site www.gapminder.com enables. However when you run the graph for last two centuries you may observe that until some particular level of life expectancy (around 65-70 years) the effect on GDP is negligible but after this particular point both variables turn to grow simultaneously.

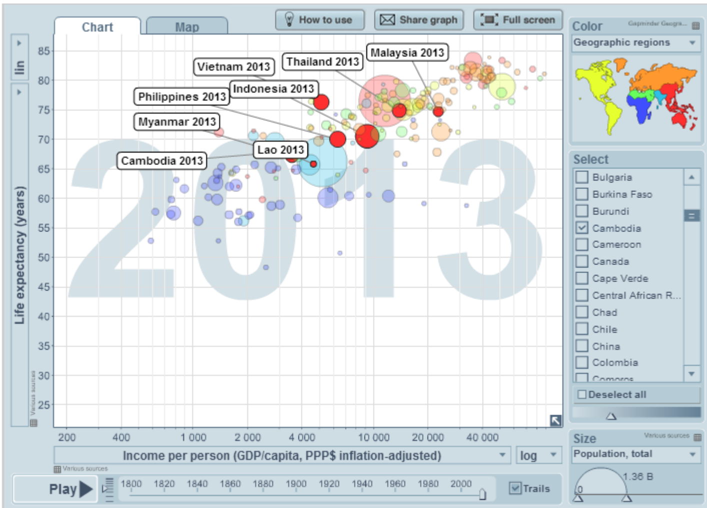

Figure 4.1.: Relationship between life expectancy and GDP, whole world borrowed from GapMinder (2015)

Generally speaking, all in all in this thesis following model will be estimated:

$$y = \alpha + \beta_1 SE + \beta_2 LE + \beta_3 FR + \beta_4 GE + \beta_5 RL + \beta_6 TT + \beta_7 DI + \beta_8 INF + \beta_9 PAT + \beta_{10} INV + \beta_{11} MOR + \beta_{12} Log(GDP)$$

However, this suggestion of shape of the model to be estimated is prior to any correlation analysis of the variables. As proposed earlier we suspects some of the above mentioned variables to be correlated between each other. More details on the correlation analysis of the variables will be provided in the result part of this thesis.

It is important to point out that not all the values for the particular variable have been gathered due to some gap places in the data sources. With missing observation there are basically two ways to deal with this problem. Firstly, we might accept the fact that values are unavailable and leave it that way. Or secondly, compute the missing values based on some statistically relationship within the variable. However, in this thesis we decided to follow the first approach rather than artificially impute missing values which might drive the results into biased conclusions.

4.2. Employed methodology

Following the brief description of data set, in this subsection we will provide introduction to methodology employed in estimation of key economic drivers in Southeast Asia countries. As one could guess when estimating the key economic drivers across the countries for certain time period we needed to employ advanced approach of panel data estimation. On forthcoming pages we will also explain briefly the panel data estimation. For the source of methodology we decided for Baltagi (2008). As we intend to only briefly introduce the methodology, we would suggest for more interested readers to see Baltagi (2008) for more information not only for panel data estimation, but rather the whole econometrics.

As has already been mentioned in introduction part, we intend to perform simple Ordinary Least Squares (OLS) estimation on particular states. We truly believe that there might be some statistically unrecordable significant differences within the states. Which bringing back the second hypothesis of this work would suggest, that simple OLS would yield higher R^2 than estimation via panel data approach. We will not present the deep analysis on how OLS work, but rather in nutshell information, for more information we would again suggest visiting Baltagi (2008)Starting with the simple OLS estimation assumption:

- The model is supposed to be linear i.e. $y = X\beta + \varepsilon$ in matrix notation where X is the matrix of explanatory variables, β is the vector of coefficients and ε is called residuum.
- Furthermore we suppose that the $E(\varepsilon) = 0$ which could be explained that the model is not shifted up or down
- Regarding the data matrix X, it is supposed to have full rank. Otherwise the computation procedure would be more difficult as the multicolinearity arises.
- For the residuals we suppose homoscedastic behavior, which means the variance (σ^2) is same for every residual.

- Last but no least the normality of residuals assumption. When this assumptions is fulfilled then the OLS estimation equals to Maximum likelihood estimation, i.e. OLS is the "best" estimation not only in the class of linear models but also in the non-linear class.

Regarding the logical background of OLS estimation, as already the name suggests the main idea is to minimize the sum of squares. Which means finding the best argument that would yield in the lowest sum of squared residuals. In equation way:

$$\beta^{OLS} = arg.min \sum (y - X\beta)^2$$

Finally arriving to formal form of OLS estimation:

$$\hat{\beta}^{OLS} = (X^T X)^{-1} X^T y$$

Where X is the matrix of explanatory variables, X^T is the transposed matrix of X and $(X^T X)^{-1}$ represents the inverse matrix of cross product.

Even though, OLS seems to be easy to apply, there are some pitfalls. First of all attention to the fulfillment of assumptions must be paid. Very important is to check whether there is any evidence of multicolinearity within the data set. As proposed above multicolinearity arises when matrix X does not have full rank, therefore $(X^T X)^{-1}$ is hard to compute and usually results in distorted results of β estimation. In order to address this problem we will employ colinearity matrix. Regarding the normality of residuals, the residuals will be tested using normality test.

First of all we need to start our methodology introduction with so called error components model. The regression equation for panel data bears some interesting features which differs it from ordinary cross-sectional or time series estimation. The general panel data equation has following shape:

$$y_{it} = \alpha + X_{it}^{\prime} \beta + u_{it}$$

Where the left hand side of the equation is the variable to be explained, in our case economic growth, α is just a constant, $X_{it}^{\prime}$ is the matrix of variables that will help us to explain economic growth and finally arriving to u_{it} which are the disturbances. In order to differentiate between various countries and years of observation we employ the donation of i and t, where i stands for particular country and t for the year the observation has been recorded.

Furthermore we assume that the disturbances are made of two components:

$$u_{it} = \mu_i + v_{it}$$

where μ_i stands for the cross-sectional specific component. We can reasonably assume that some differences within the countries cannot be explained by the model so it is quite rational to assume that μ_i captures this difference within countries and the v_{it} is the random error which ideally is normally distributed. Now, there are two approaches how to handle the estimation. First we assume that μ_i is fixed, not random. As the attribute suggests this approach is called the Fixed effect model.

In order to put it in equation we arrive at:

$$y_{it} = \alpha + X_{it}^{'}\beta + \sum \mu_i D_i + v_{it}$$

In the above mentioned equation the D_i is the dummy variable for the i-th country, i.e. for i-th country the variable is 1 in all other cases equal to zero. As proposed earlier the component v_{it} is supposed to be independently identically distributed with zero mean and variance equal to σ^2. Given the assumptions on the model applying simple Ordinary least squares (usually abbreviated to OLS)[2] yields theoretically very good fit to the data, i.e. the OLS with given model is best linear unbiased estimator, or BLUE. Best in meaning having the lowest variance of the estimate, linear is pretty clear and unbiased means the estimate is not skewed in any direction.

So far fixed effect estimation panel data proved itself to be handy tool for panel data analysis. In our case of estimation it seems to be reasonably assumed that the fixed effect is present within the economies of Southeast Asia.

The second approach how to handle panel data estimation is the so called random effect. As the name already suggests, unlike in previous fixed effect estimation, the disturbances μ_i are assumed to be randomly distributed. It is important to point out that in equation of disturbances:

$$u_{it} = \mu_i + v_{it}$$

Both components μ_i and v_{it} are assumed to be randomly distributed with zero mean and particular variances of $\sigma_\mu^2$and σ_v^2 respectively and independent to each other. The random effect procedure is more employed in cases when we assume some degree of randomness within the data, i.e. withdrawing observations from large sample randomly. However, one should ask how to properly (based on statistical evidence) differentiate between fixed effect and random effect? Usually first test to explore which

[2]For more information regarding the OLS estimation and its assumptions we suggest looking into Baltagi (2008)

approach to employ is the Hausman´s test. In nutshell Hausman test allows us to select proper approach to model the data based on efficiency. Under null hypothesis the test assumes that random effect estimation is consistent and efficient and fixed effect is assumed to be consistent as well however inefficient. Under alternative hypothesis the random effect is inconsistent and the fixed effect on the other hand is consistent.

So far two main approaches and particular test have been presented. However, due to complexity of our data set and based on recommendation from Barro (1996) or alsoBarro and i Martin (2004) the approach employed in this thesis is dynamic panel data models. The dynamic panel data model assumes the presence of lagged dependent variable on the right hand side of the equation, i.e.:

$$y_{it} = \delta y_{i,t-1} + x'_{it}\beta + \mu_i + \nu_{it}$$

For estimation of economic growth it is reasonable to assume that economic growth would be somehow related to the previous values moreover current literature regarding the panel data estimation of economic growth also suggest employment of dynamic approach, please see Barro (1996) or Barro and i Martin (2004).

Lastly it is intended to provide the thesis with kind of forward looking statements regarding economic growth. Based on the estimated coefficients, firstly the forecast within the time frame will be performed and afterward evaluated with use of so called Mincer-Zarnowitz regression, for details please see Mincer and Zarnowitz (1969) . Mincer-Zarnowitz regression is handy tool to evaluate the accuracy of the forecasts vis-à-vis its true values. The evaluation follows simple regression given by following equation:

$$y_t = \beta_0 + \beta_1 \hat{y}_{t,t-i} + \varepsilon$$

Where y_t is the actual value of economic growth in time t, $\hat{y}_{t,t-i}$ represents forecast of economic growth for time t performed in t-i. In order to have accurate forecasts one would expect to β_0 being zero and β_1 being equal to one. And precisely that is why, the above mentioned coefficients are put under joint hypothesis.

Chapter 5

RESULTS OF ECONOMIC GROWTH ESTIMATION

5.1. Ordinary least squares estimation

Following the pattern proposed in the methodology part of this thesis, we will now present the results from OLS estimation. The OLS estimation basically ran on each state trying to estimate the coefficients in the manner to minimize the sum of squares residuals. In this section the results will be presented for each state individually as the regression was performed in the way of state by state approach. First of all it is important to stress out that not in every case we were able to gather all the data regarding the variables due to practically missing values in the data source. Furthermore during the estimation we found out that the correlation between economic growth and number of patents applied for is not clear. This relationship might be caused by the fact, that there is some time gap between application for the patent and some addition to economic growth i.e. for example patent applied for 2014 might have positive impact on economic growth in 2015 or longer or does not have to positively contribute to economic growth at all. In addition the variables infant mortality and fertility rate had to dropped out in order to improve the estimation (significant correlation with the variable life expectancy has been proved as suspected earlier in the data description part). In the case of Vietnam results the full reasoning of the estimated coefficients is provided, for the rest of the countries less comprehensive description is provided. This is due to the fact that the reasoning for the other states are very close to ones provided in Vietnam, so in order to save space it was not intended to repeat what was already written. Where necessary the results of adjusted model (model with lower number of variables) are provided. We decided to include adjusted model results when the original model did not describe the data in proper manner (i.e. large amount of insignificant coefficients or the p-value of F-test[1] was higher than 5%). Last but not least please bear in mind that R^2 presented bellow the equations represents adjusted R^2.[2] All statistical results in tables and figures are based on author´s own calculations and estimates if not stated otherwise. Then we need to find out autocorrelation of residuals. Based on the following table (Table 5.1.) using Durbin Watson statistics was proved that the residual component of the model is not correlated with their lagged values. This is true for countries with the best data sets with not many missing observations, which would disable to calculate D-W statistics. It means mainly Malaysia, Thailand and Vietnam where D-W statistics could be easily calculated with no changes in our model. When we focus on countries where we needed to made some minor changes in order to be able to calculate autocorrelation of residuals, we received suitable results in case of Myanmar and Indonesia. However, regarding Cambodia and Lao we found out slightly negative autocorrelation. For Philippines we do not mention D-W, because we would need to make more than minor changes from our model in order to obtain D-W statistics.

[1] F-test in this estimation process represents testing the joint hypothesis of all coefficients being equal to 0

[2] Adjusted R^2 is more reliable indicator of fitness of the model as it punishes for extra regressors compared to regular R^2.

Country	D-W test value
Vietnam	2.40
Cambodia[a]	N/A (2.77)
Myanmar[b]	N/A (2.20)
Philippines	N/A
Thailand	2.12
Indonesia[c]	N/A (2.48)
Lao[d]	N/A (2.80)
Malaysia	2.05

Table 5.1.: Autocorrelation results based on Durbin-Watson test

[a] In the brackets we provided D-W test statistics for adjusted model with removed variables generating the most missing values (variables SE and RL).
[b] In the brackets we provided D-W test statistics for adjusted model with removed variables generating the most missing values (variables GE, RL and TT).
[c] We need to made the necessary correction from our adjusted model and it means to remove variable patents, because there are few years in the middle of our data set with missing values.
[d] In the brackets we provided D-W test statistics for adjusted model with removed variables generating the most missing values (variables SE, RL and GE).

Afterward we tested the constant variance of random components - the presence of homoscedasticity. We came out with suitable results using B-P test when in all cases was p-value higher than our significance level.

Country	p-value, full model	p-value, adjusted model
Vietnam	0.80	
Cambodia	0.46	
Myanmar	0.97	0.87
Thailand	0.24	0.27
Philippines	0.60	0.50
Indonesia	0.19	0.82
Lao	0.40	0.35
Malaysia	0.97	0.87

Table 5.2.: Homoscedasticity results using Breusch-Pagan test

5.1.1. Vietnam

Firstly we started with estimation of economic data with Vietnam. The model proposed in methodology section of this thesis has been estimated on the gathered data.

In order to save space in this thesis only equation forms of the results will be provided as is quite common in the academic literature. The simple OLS regression yielded following results:

$$\begin{aligned}
\widehat{y} = & \underset{(5.9634)}{-68.5073} - \underset{(0.0054752)}{0.0598719}\,\mathrm{SE} + \underset{(0.090668)}{1.04932}\,\mathrm{LE} - \underset{(0.0029086)}{0.0142166}\,\mathrm{GE} \\
& + \underset{(0.088561)}{0.764305}\,\mathrm{RL} - \underset{(0.0026221)}{0.0248252}\,\mathrm{TT} + \underset{(0.00071064)}{0.00886808}\,\mathrm{INF} + \underset{(0.0022129)}{0.00855002}\,\mathrm{INV} \\
& - \underset{(7.7536e\text{–}005)}{0.000648680}\,\mathrm{PAT} - \underset{(0.079957)}{0.3255881}\mathrm{_Y}
\end{aligned}$$

$$T = 11 \quad \bar{R}^2 = 0.9913 \quad F(9,1) = 127.20 \quad \hat{\sigma} = 0.0075054$$

(standard errors in parentheses)

From the results provided in the table above we arrived at significantly high value of R^2 of 99% and adjusted R^2 at 99% , which generally speaking should be one of positive signs of the proper estimation. Furthermore, regarding the normality of the residuals with p-value 0.78, which means p > α on significance level of 5%, therefore we cannot reject null hypothesis and residuals have normal distribution.[3] Regarding the F-test we recorded p-value converging to 0, which indicates the rejection of null hypothesis all coefficients being equal to zero. In the light of the results it could be clearly concluded that economic growth Vietnam is heavily dependent on the following variables. Life expectancy is very significant positive contributor to economic growth, with p-value of 0.05 we even reject the null hypothesis of coefficient being zero. Regarding the terms of trade, we expected this variable to have negative coefficients (as is constructed as imports/export). It is important to point out that the terms of trade variable with its significance perfectly fits in the common economic theory i.e. if developing country intends to increase the economic growth, it must improve its openness. Interestingly it can be concluded that mild inflation can boost economic growth in certain way. The impact of some variables on the overall economic growth might be disputable. Based on the results presented above it implies that impact of secondary education and patents have negative impact despite the common economic knowledge. However, we address this dispute to rather shorter time frame of data than truly some negative impact on the economic growth. Moreover it was already found out that total share of secondary education might have negative impact on overall economic growth, for reasoning please see Barro (1996), Barro

[3]When the residuals are normally distributed the OLS estimation is equal to maximum likelihood approach, therefore in that case the OLS is the best unbiased estimator even within non-linear models.

and i Martin (2004) or Doppelhofer et al. (2000). When we focus on the rule-of-law variable, the negative coefficient actually does not mean that institutional framework has negative impact on the economic growth. But due to the insignificance of the variable it can be basically excluded from the model. Moreover the improvement of institution in the particular state is not matter of few years but rather a continuous change that takes time. Regarding the patent variable, it was concluded that despite the suggestions from academic literature the variable is insignificant. The reason for this insignificance might be coming from the fact that the patents are usually lagged behind economic growth, i.e. applying the patents in production takes time.

5.1.2. Cambodia

In the case of Cambodia we experienced some missing values in our variables, which put some obstacles to the estimation. Due to this missing values data we must carefully drew any conclusions from the results.But here are some common signs with Vietnam regarding the contribution and importance of the variables. We came out with very solid results with adjusted R^2 about 95%. Regarding normality of residuals we calculated p-value 0.65, which means residuals are normally distributed. F-test p-value came out on the level of 0.01 which leads us to rejection of null hypothesis of all coefficients being equal to 0.

$$\begin{aligned}\widehat{y} = & \underset{(1.3661)}{-6.74179} - \underset{(0.0078510)}{0.0290122}\,\mathrm{SE} + \underset{(0.024232)}{0.138496}\,\mathrm{LE} - \underset{(0.0048777)}{0.0279724}\,\mathrm{GE} \\ & + \underset{(0.24208)}{0.286273}\,\mathrm{RL} + \underset{(0.0042647)}{0.00610839}\,\mathrm{TT} + \underset{(0.0019246)}{0.00716101}\,\mathrm{INF} + \underset{(0.0040351)}{0.00375698}\,\mathrm{INV} \\ & - \underset{(0.31533)}{0.2271411}\_\mathrm{Y}\end{aligned}$$

$$T = 12 \quad \bar{R}^2 = 0.9497 \quad F(8,3) = 26.986 \quad \hat{\sigma} = 0.019181$$

(standard errors in parentheses)

As in case of Vietnam it was found out that life expectancy is the most significant driver of the overall economic growth followed by inflation. So to provide some kind of policy recommendation for Cambodian government we could clearly recommend in order to increase economic growth, focus on availability of medical treatments for citizens (therefore increase the life expectancy) and keep the inflation in the mild boundaries. Regarding the data set we can declare that Cambodian initial level of GDP per capita was the third lowest and still there is a huge potential for development, which was not exploited yet. Life expectancy displayed the lowest value in our first observation together with Lao, but the positive fact for Cambodia is that in 2013 was life expectancy almost 4 years higher than in Lao. The same positive results was proved in fertility rate and infant mortality rate. To sum up these findings proved variables correlated with the economic growth in direct or indirect way improved and it is just a matter of time when these improvements will be proved by economic development in this country. Regarding the secondary education importance, it was proven negative correlation with the overall economic growth, which is however, perfectly in line with findings suggested by Barro (1996),Barro and i Martin (2004) or Doppelhofer et al. (2000). Their findings suggest that attainment of females or both sexes education turned out not to be significantly correlated with the economic growth and male education level is the only one positive correlated with the growth rates. Their results proposed an idea as follows: Female education[4]seems to be important for other indicators of economic development mainly fertility rate, infant mortality rate and political freedom. The strongest relation is the negative correlation of female primary education and fertility rate.[5] It could be considered female education has an indirect impact on development through fertility rate, because when Barro (1996) removed fertility rate from his regression, the estimated coefficient for female schooling was positive but not significantly different from zero.

5.1.3. Myanmar

In case of Myanmar we had to face significant lack of the data. Due to its political environment (military junta is in charge) the availability of basic statistics is rather hard to access. The lack of data caused that none of the variables proved them-self significant from statistical point of view. Moreover, during the estimation it was found out that the full model did not fit the data properly and the adjusted one only purely with disputable effects on the economic growth. This fact might have several reasons, firstly as proposed above the government in Myanmar is the military junta, hence some statistics may be cheated in order to serve mainstream propaganda. Secondly, we cannot reconsiliate the data from Central bank of Myanmar to any reliable source.[6]

[4]And slightly also total education could turn out in the same results.

[5]For general relationship between fertility rate and secondary education in total panel data set please see A A.2

[6]Even the data provided on World bank sites are borrowed from Central bank of Myanmar and National statistical office, therefore the validity of the data might be disputed

$$\begin{aligned}\widehat{y} = &\underset{(41.434)}{-20.9749} - \underset{(0.092782)}{0.104181}\,\mathrm{SE} + \underset{(0.75339)}{0.439553}\,\mathrm{LE} - \underset{(0.11966)}{0.100077}\,\mathrm{GE} \\ &+ \underset{(1.3268)}{1.66108}\,\mathrm{RL} + \underset{(0.022855)}{0.00754248}\,\mathrm{TT} - \underset{(0.0059081)}{0.00512272}\,\mathrm{INF} - \underset{(0.19396)}{0.0519184}\,\mathrm{INV} \\ &+ \underset{(0.46317)}{0.4115131}\mathrm{\_Y}\end{aligned}$$

$$T = 10 \quad \bar{R}^2 = 0.2219 \quad F(8,1) = 1.3208 \quad \hat{\sigma} = 0.13526$$

(standard errors in parentheses)

Even though the adjusted R^2 reached the level of 22%, the regular R^2reached more than 91%, but as it was already mentioned before we could hardly proved significance from this full model. Moreover the F-test with p-value on the level of 0.06 suggested that some improvements in the model might be needed, therefore we step forward to estimation of adjusted version of the model. At least residuals in our full model are normally distributed with p-value 0.29.

$$\begin{aligned}\widehat{y} = &\underset{(18.761)}{-9.09589} - \underset{(0.059076)}{0.0775824}\,\mathrm{SE} + \underset{(0.35337)}{0.262712}\,\mathrm{LE} - \underset{(0.044967)}{0.142818}\,\mathrm{GE} \\ &+ \underset{(0.72613)}{2.10142}\,\mathrm{RL} - \underset{(0.0035361)}{0.00574923}\,\mathrm{INF} + \underset{(0.19528)}{0.3308521}\mathrm{\_Y}\end{aligned}$$

$$T = 10 \quad \bar{R}^2 = 0.5918 \quad F(6,3) = 9.1744 \quad \hat{\sigma} = 0.097970$$

(standard errors in parentheses)

We arrived at adjusted version of the model by removing variables with the highest p-value, therefore the most insignificant ones or the most rigid variables, which were indifferent during the time. This had to be done regarding higher adjusted R^2, which would not punish us for using irrelevant variables as in the full model. In case of Myanmar these variables were investments and terms of trade. After eliminating them we reached adjusted R^2 at the level of 59% and we also cannot reject null hypothesis about normality of residuals with p-value 0.35. We found out government expenditures are significant in a negative direction and rule-of-law is significant in a positive direction to the economic growth. These findings, even though might be irrational or not logical, are supported and described in Barro (1988) or Summers and Heston (1984). The reason behind this relationship is the fact that government expenditures are funded basically through two ways. First one by debt funding, meaning issuance of government debt or more commonly by taxation of citizens. And the taxation of citizens actually lowers the saving rate of households in the economy.[7] It has been already shown in the theoretical part the economy has some particular optimal level of saving rate and the taxation might shift the saving rate out of the equilibrium. Regarding the military junta in charge there has been recorded some melting down or rigid government structures during last couple of years AsianDevelopmentBank (2015). This fact can be proven by democracy index in our data set[8] where there was recorded a positive shift from -7 value to -3. This progress was firstly displayed in 2008 and then in 2011 with the new president.

5.1.4. Philippines

When focusing on Philippines results we can clearly conclude that arrived at very high value of R^2 but none of the variables proved statistically significant. Moreover F-test suggested that the null hypothesis of all coefficients being equal to zero cannot be rejected. On the other hand, residuals were normally distributed with p-value 0.85.

$$
\begin{aligned}
\widehat{y} = {} & \underset{(16.838)}{9.87913} + \underset{(0.026520)}{0.0145968}\,\mathrm{SE} - \underset{(0.59165)}{0.327010}\,\mathrm{LE} - \underset{(0.091632)}{0.232870}\,\mathrm{GE} \\
& + \underset{(0.77427)}{0.414606}\,\mathrm{RL} + \underset{(0.13330)}{0.0783636}\,\mathrm{TT} - \underset{(0.032580)}{0.0223847}\,\mathrm{INF} + \underset{(0.017641)}{0.0319263}\,\mathrm{INV} \\
& + \underset{(1.7419)}{1.043271}\mathrm{\_Y}
\end{aligned}
$$

$$T = 10 \quad \bar{R}^2 = 0.8334 \quad F(8,1) = 6.6282 \quad \hat{\sigma} = 0.051578$$

(standard errors in parentheses)

Therefore we decided to proceed with second regression with lower number of variables in order to improve the accuracy of the model.

[7] Households under taxation have lower amount of funds to save in order to pay the taxes.

[8] Democracy index is subjective variable provided by independent Polity project compared to data from national statistics, which means we can be more trustful in case of Myanmar.

$$\widehat{y} = \underset{(7.1363)}{44.1618} + \underset{(0.0095837)}{0.0383963}\,\mathrm{SE} - \underset{(0.12855)}{0.858295}\,\mathrm{LE} + \underset{(0.053420)}{0.215815}\,\mathrm{GE}$$
$$- \underset{(0.19388)}{1.43172}\,\mathrm{RL} - \underset{(0.0091115)}{0.00490781}\,\mathrm{INV} + \underset{(0.0015362)}{0.0108956}\,\mathrm{PAT} + \underset{(0.099142)}{0.5293041}\text{\_Y}$$

$$T = 10 \quad \bar{R}^2 = 0.9543 \quad F(7,2) = 27.827 \quad \hat{\sigma} = 0.027025$$
(standard errors in parentheses)

We decided to exclude the most stable variable democracy index, which is during the whole observed period constant. Together with the democracy index we removed terms of trade and inflation. After the elimination very solid result came out with adjusted R^2 of 95% and residuals were also normally distributed with p-value 0.58. Interestingly the life expectancy showed up to be negatively correlated with growth due to the fact that it was the most sluggish variable among all states. The other reason had been described by Barro (1996) and it is due to the fact that time series offers little variation in many of the variables. On one hand, GDP grew on double digit pace, but the life expectancy lagged very significantly behind increased by 4% between 1993 and 2013 (where e.g. Vietnam grew by 6% for the same variable and period). Just as in a case of Lao, secondary education seemed to be positively correlated with growth. Rule-of-law recorded negative correlation with economic growth because of the position of state on the negative scale of the rule-of-law index. Not surprisingly the initial level of GDP and the number of patent applications were positively correlated with economic development. Last but not least to be mentioned we arrived at significantly improved results of F-test with p-value lower than our internal benchmark of 5% significance level.

5.1.5. Thailand

Thailand holds a special place among the other countries in terms of share of investments to GDP. Between 40%-30% of the overall GDP was created through investments which might be tightly connected to the boom of tourism in the country in the last two-three decades in meaning investing into hotel complexes etc. Unfortunately like in the previous case the results came out with significantly high value of R^2 but none of them was statistically significant and moreover the F-test result with p-value of 0.4 suggests that the model does not accurately describe the data, but we cannot reject null hypothesis about normality of residuals with p-value 0.19. In order to improve the estimation we decided to drop some variables in order to find out what are the really significant drivers of economic growth in Thailand.

$$\begin{aligned}\widehat{y} = \underset{(64.131)}{23.5620} + \underset{(0.026759)}{0.0225520}\,\mathrm{SE} - \underset{(1.0231)}{0.438379}\,\mathrm{LE} - \underset{(0.091342)}{0.0873181}\,\mathrm{GE} \\ + \underset{(2.7298)}{1.89411}\,\mathrm{RL} - \underset{(0.022284)}{0.0439646}\,\mathrm{TT} - \underset{(0.024524)}{0.0424074}\,\mathrm{INF} - \underset{(0.025704)}{0.0312367}\,\mathrm{INV} \\ + \underset{(0.00029350)}{0.000590487}\,\mathrm{PAT} + \underset{(1.2037)}{1.690481}\_\mathrm{Y}\end{aligned}$$

$$T = 11 \quad \bar{R}^2 = 0.6775 \quad F(9,1) = 3.3345 \quad \hat{\sigma} = 0.073961$$

(standard errors in parentheses)

In the adjusted version of the model we included only some variables, the choice of variables was made based on experience from previous cases and our best guess. All in all, the variables included were life expectancy, initial level of GDP per capita, share of government expenditures on the GDP, inflation, investments and number of patent applications. It has been proven that investments and number of patent application are statistically significant and positive contributors to the overall economic growth. However, based on the estimation we found out that life expectancy is negatively correlated with the economic growth, but the variable is not significant on any level of significance threshold, so we can leave it. Last but not least we arrived at F-test p-value 0.01 which also indicates improvement from previous results[9] and in addition residuals were normally distributed in our adjusted model (p-value 0.77).

$$\begin{aligned}\widehat{y} = \underset{(4.4469)}{6.42964} - \underset{(0.084353)}{0.114404}\,\mathrm{LE} - \underset{(0.011335)}{0.00649474}\,\mathrm{GE} - \underset{(0.010581)}{0.0228727}\,\mathrm{INF} \\ + \underset{(0.0078028)}{0.0162777}\,\mathrm{INV} + \underset{(0.00019829)}{0.000621386}\,\mathrm{PAT} + \underset{(0.23877)}{0.1481891}\_\mathrm{Y}\end{aligned}$$

$$T = 18 \quad \bar{R}^2 = 0.5640 \quad F(6,11) = 4.6646 \quad \hat{\sigma} = 0.082201$$

(standard errors in parentheses)

[9] In the equation we provide only value of particular values of F test with particular degrees of freedom, for finding p-value any statistical software might be employed.

5.1.6. Indonesia

When we focus on the case of Indonesia we must firstly accept the fact that our proposed model do not describe the model in appropriate manners. The first regression arrived at adjusted R^2 on the level of almost 34% which basically implies using too many regressors in the estimation. Moreover F-test p-value was above our 5% threshold and p-value from test of normality of residuals was 0.08.

$$\begin{aligned}\widehat{y} = &\underset{(7.7053)}{-4.54346} - \underset{(0.029262)}{0.0467553}\,\mathrm{SE} + \underset{(0.13526)}{0.0224735}\,\mathrm{LE} + \underset{(0.022228)}{0.000653841}\,\mathrm{GE}\\ &+ \underset{(0.0072528)}{0.00258734}\,\mathrm{TT} - \underset{(0.013166)}{0.0133786}\,\mathrm{INF} - \underset{(0.026774)}{0.0372384}\,\mathrm{INV} + \underset{(0.00091069)}{0.00108253}\,\mathrm{PAT}\\ &+ \underset{(0.40247)}{0.9132671}\mathrm{\_Y}\end{aligned}$$

$$T = 14 \quad \bar{R}^2 = 0.3399 \quad F(8,5) = 1.8367 \quad \hat{\sigma} = 0.081879$$

(standard errors in parentheses)

Furthermore none of the variables was proved significant in above mentioned equation except the initial level of GDP, which was significant only on 10%, therefore we decided to explore whether there might be less complicated model that describes the data better. We decided to include only variables life expectancy, government expenditures, inflation, investments, patents and initial level of GDP.

$$\begin{aligned}\widehat{y} = &\underset{(2.8937)}{4.77592} - \underset{(0.048179)}{0.122339}\,\mathrm{LE} - \underset{(0.017989)}{0.00241926}\,\mathrm{GE} - \underset{(0.0023505)}{0.0133006}\,\mathrm{INF}\\ &- \underset{(0.0088431)}{0.0522603}\,\mathrm{INV} - \underset{(0.00057131)}{0.000166709}\,\mathrm{PAT} + \underset{(0.19828)}{0.7367021}\mathrm{\_Y}\end{aligned}$$

$$T = 17 \quad \bar{R}^2 = 0.8265 \quad F(6,10) = 13.703 \quad \hat{\sigma} = 0.087374$$

(standard errors in parentheses)

First of all, the adjusted version of the model yielded higher R^2 which is generally good sign. Focusing on p-value of F-test we recorded significant improvement as the p-value was converging to 0 and also residuals had normal distribution with p-value 0.31. Furthermore we arrived at the result that initial level of GDP positively and significantly contributes to economic growth. However, frankly speaking we also yielded results that might be rather disputable. For example the coefficients for the variables life expectancy and investments to GDP were estimated negative.which might be driven by the following fact. Despite was Southeast Asia the area of our research, there are still huge differences between the countries. In terms of GDP per capita we can include Indonesia to more developed country vis-à-vis Vietnam, Burma. So there is a chance that already the positive contribution of life expectancy was already exploited.[10]

5.1.7. Lao

In case of Lao we had to face missing observations, therefore estimation of general model was proved inappropriate as the variables were insignificant and overall adjusted R^2 arrived only at 32%. Moreover the results of F-test, testing the hypothesis of all coefficients being equal to zero yielded p-value of 0.22 which leads us to estimation of adjusted model like in case of Indonesia, even though residuals were normally distributed (p-value 0.47).

$$\begin{aligned}\widehat{\mathrm{y}} = \underset{(19.947)}{3.01640} + \underset{(0.026089)}{0.0434881}\,\mathrm{SE} - \underset{(0.47066)}{0.102354}\,\mathrm{LE} - \underset{(0.014856)}{0.0117217}\,\mathrm{GE} \\ + \underset{(0.0051834)}{0.00465515}\,\mathrm{TT} + \underset{(1.4855)}{0.219263}\,\mathrm{1\_Y} - \underset{(0.75117)}{0.0827283}\,\mathrm{RL} + \underset{(0.021529)}{0.0128131}\,\mathrm{INF} \\ + \underset{(0.027149)}{0.00778763}\,\mathrm{INV}\end{aligned}$$

$$T = 11 \quad \bar{R}^2 = 0.3115 \quad F(8,2) = 1.5655 \quad \hat{\sigma} = 0.064271$$

(standard errors in parentheses)

Bellow we present the results of adjusted model estimation, where we arrived at significantly higher value of adjusted R^2. Furthermore the initial level of GDP was concluded as a positive contributor to overall GDP growth as the Lao is in the lower half of GDP per capita, which is perfectly in line with the general assumption of convergence theory stating that countries with lower GDP per capita would experience rapid growth in terms of GDP per capita year to year growth. Interestingly the secondary education was found to be positively contributing to economic growth unlike in previous cases. And finally the p-value of F-test came out at 0.02 and p-value for testing normality of residuals at 0.91 which is positive outcome as well.

[10] This fact might be supported by commonly known case of Japan that in last two decades has experienced sluggish growth despite very high life expectancy. Therefore the conclusion might be that indeed life expectancy positively contributes to economic growth but only in initial stages of GDP.

$$\widehat{y} = \underset{(3.8844)}{11.8755} + \underset{(0.016528)}{0.0582869}\,\mathrm{SE} - \underset{(0.092394)}{0.291701}\,\mathrm{LE} - \underset{(0.0060906)}{0.00635154}\,\mathrm{GE}$$
$$+ \underset{(0.0024804)}{0.00551653}\,\mathrm{TT} + \underset{(0.25012)}{0.6601101}\_\mathrm{Y}$$
$$T = 12 \quad \bar{R}^2 = 0.7020 \quad F(5,6) = 6.1831 \quad \hat{\sigma} = 0.048624$$
(standard errors in parentheses)

5.1.8. Malaysia

Malaysia is somehow special within our data set and standing up among the rest of the countries as the Malaysia is included into Asian tigers countries. Therefore we must carefully draw any conclusions as the general model proposed is aimed mainly on developing countries. Bellow we present the results of general model estimated on the Malaysia´s data. The value of adjusted R^2 arrived at 93% and p-value for testing normality of residuals was 0.13, however the p-value of F-test is above the 5% threshold, therefore we decided to step further for the the adjusted model.

$$\widehat{y} = \underset{(37.720)}{-60.2764} + \underset{(0.0088204)}{0.00301845}\,\mathrm{SE} + \underset{(0.60335)}{0.857684}\,\mathrm{LE} - \underset{(0.019995)}{0.0367800}\,\mathrm{GE}$$
$$+ \underset{(0.36028)}{0.0299057}\,\mathrm{RL} + \underset{(0.049379)}{0.0378220}\,\mathrm{TT} + \underset{(0.045275)}{0.152501}\,\mathrm{DI} - \underset{(0.023416)}{0.0976268}\,\mathrm{INF}$$
$$+ \underset{(0.055580)}{0.0615536}\,\mathrm{INV} - \underset{(0.00022125)}{0.00135645}\,\mathrm{PAT} - \underset{(1.4962)}{0.7793731}\_\mathrm{Y}$$
$$T = 12 \quad \bar{R}^2 = 0.9329 \quad F(10,1) = 16.297 \quad \hat{\sigma} = 0.037784$$
(standard errors in parentheses)

Adjusted version of the model estimated included variables: secondary education, life expectancy, government expenditures ratio to GDP, terms of trade, log of GDP and investments. We arrived at improved value of F-test claiming that with this model we have to reject the H0 of all coefficients being equal to zero. While trying to find optimal set of variables yielding in the highest value of adjusted R^2 we arrived at such model, but these models did not reject the null hypothesis of F-test, therefore we do not present them here. Residuals of our adjusted model were still normally distributed with p-value 0.76. Regarding the significance and contribution to economic growth of particular coefficients, we can conclude that interestingly secondary education has proved positive impact, terms of trade is in line with previously drawn results. Interestingly the life expectancy is estimated to be negative contributor to growth. Which might be similar case as in Indonesia, i.e. the contribution of life expectancy to growth has been already exploited. Regarding the investments share on GDP variable, it was recorded that indeed negative relationship is between this variable and economic growth. It might seem disputable, but the reason for that is the fact that during last two decades the Malaysian investments to GDP ratio decreased from roughly 40% in 1993 to 26% in 2013. Which means that even though the GDP recorded significant increase during that period, the investments lagged behind in terms of growth, therefore its contribution to overall economic growth is negative. Last but not least is the initial level of GDP that was estimated with positive impact on economic growth. Which means in case of Malaysia we might expect continuing rapid growth but not as high as in the past in forthcoming future due to the fact that the current level of GDP still has not catch up with developed countries.

$$\widehat{\mathrm{y}} = \underset{(11.858)}{32.9271} + \underset{(1.4753)}{5.92049}\,\mathrm{Log\_Y\_} + \underset{(0.014152)}{0.0280226}\,\mathrm{SE} - \underset{(0.21085)}{0.644103}\,\mathrm{LE}$$
$$- \underset{(0.013815)}{0.00826619}\,\mathrm{GE} - \underset{(0.024596)}{0.0854396}\,\mathrm{TT} - \underset{(0.014800)}{0.0336254}\,\mathrm{INV}$$
$$T = 18 \quad \bar{R}^2 = 0.4803 \quad F(6,11) = 3.6180 \quad \hat{\sigma} = 0.090020$$

(standard errors in parentheses)

5.2. Dynamic panel data estimation

In this subsection panel data estimation results are provided bellow. Unlike in cases provided above it was intended to estimate all countries at once. As proposed in methodology part fixed effect approach was employed in order to capture the differences between particular economies. We decided to employ first lag of economic growth year to year (under auto-regression approach, i.e. AR(1)) which implies we do not have to worry about the unit root in the variable as the economic growth year to year is already differentiated. First of all, we calculated the correlation matrix to check multicolinearity between variables in our panel, as can be seen from the table below. We found a problem when the infant mortality rate was highly correlated with life expectancy with - 0.91 value and also with secondary education. Fertility rate was not highly correlated with life expectancy in this matrix like it was presented in OLS section, but the only logical result was to remove fertility rate from our panel, even though in this matrix arrived at only - 0.7 value.[11]

Regarding the question of autocorrelation of residuals, it is not possible to test it under using dynamic panel data approach as on the the right hand side of the equation we have already the lagged economic growth. However, if we ran Durbin-Watson test on simple fixed effect panel we arrived at value of 2.01 which indicates no autocorrelation. All in all, we do not have to consider the problem of autocorrelation under dynamic panel estimation, on the other hand using simple fixed effect yielded arrived at D-W test value of nearly 2 suggesting no presence of autocorrelation.

[11] If we considered only this result from correlation matrix we could include the fertility rate in our panel model. However, when we took into account results of correlation matrices of every single state when the fertility rate was in every case highly correlated with life expectancy we could not overlook this fact and we had to adjust our variables.

Correlation coefficients, using the observations 1:01–8:21
(missing values were skipped)
5% critical value (two-tailed) = 0.1515 for n = 168

y	Y	SE	LE	FR	
1.0000	−0.0193	0.0297	0.0859	−0.1542	y
	1.0000	0.4402	0.5734	−0.3801	Y
		1.0000	0.7218	−0.4466	SE
			1.0000	−0.7038	LE
				1.0000	FR

GE	RL	TT	DI	INF	
−0.1189	−0.2088	0.0479	−0.1287	−0.0974	y
0.5631	0.7316	−0.0977	0.4489	−0.2596	Y
0.5645	0.6019	−0.3165	0.4493	−0.3082	SE
0.7447	0.7254	−0.2704	0.3047	−0.3857	LE
−0.3206	−0.3315	−0.1261	−0.0954	0.1935	FR
1.0000	0.6458	0.0373	0.0557	−0.2754	GE
	1.0000	−0.1938	0.4944	−0.3376	RL
		1.0000	−0.3107	0.3483	TT
			1.0000	−0.3475	DI
				1.0000	INF

INV	IM	PAT	
0.0251	−0.0344	−0.0285	y
0.2497	−0.6427	0.8030	Y
0.2797	−0.8247	0.5746	SE
0.6389	−0.9113	0.6138	LE
−0.2860	0.6959	−0.5468	FR
0.4372	−0.6484	0.4736	GE
0.4849	−0.7658	0.6909	RL
−0.1253	0.2623	−0.1310	TT
0.0787	−0.5119	0.4633	DI
−0.2897	0.3950	−0.2499	INF
1.0000	−0.5346	0.2265	INV
	1.0000	−0.6389	IM
		1.0000	PAT

Table 5.3.: Correlation matrix within the variables in the panel data

The results obtained are broadly in line with results yielded while performing regression state by state.[12] Regarding the secondary education it could be concluded that unlike the results from Barro (1996) the insignificance of variable was found. But, we must point out that we employed total enrollment rate in secondary educa-

[12] In the evaluation of results we focused mainly on significant variables.

tion (due to data public-availability reasons) unlike Barro (1996) who focused only on male ratio.[13]The life expectancy that was estimated with mixed outcomes on economic growth while estimating state-by-state, here in panel data model was proved very significant with positive impact on growth, which is coming from the previously mentioned fact, that life expectancy can be seen as an proxy for human capital. Therefore the life expectancy acted as an tool for differentiating the level of human capital within particular countries. In case of government expenditures per GDP it was estimated that the overall impact on economic growth is rather negative and significant. This may be an indicator that the public sector does not function well, the level of taxation might be too high, the expenditure might refer to poor fiscal discipline threatening public finances. Furthermore, the reason for this relationship between government expenditures and economic growth might be coming from two facts. Firstly, countries are not investing into infrastructure that may help boosting growth (highways etc.) and secondly all countries mentioned in our research are dealing with the problem of corruption (for deeper research please see e.g. Bhargava and Bolongaita (2004)), which means that even though intention of the government might be clear but due to the corruption some part of the money allocated to the particular project might end up in someone´s pocket. Regarding the variables that were employed as proxies for quality of institutional framework we found out that rule-of-law has significant impact on economic growth on 10% significance level threshold. This might seem somehow in the contradiction with our previous argument regarding the government expenditures and corruption, but we can address this contradiction to the fact, that in our opinion the corruption is significantly present on the places where funds are distributed, but not in the other areas that enter the variable rule-of-law such as justice system, enforcement of property rights etc. On the other hand, it has been proved that democracy index is insignificant driver of economic growth. Terms of trade resulted in negative contribution as expected, however the overall impact is insignificant. The variables inflation and investment yielded positive estimated coefficients. However only inflation is significant on the 5% significance level, investments insignificant. Therefore the policy recommendation suggested in state-by-state estimation holds in the panel as well, just to recall that we suggested that the central banks or other monetary authorities should focus on stable and mild in-

[13]Regarding this topic we would like to point the research of Barro and Lee (1994) where comprehensive statistical analysis of schooling by gender is provided. „We also find that female educational attainment has a pronounced negative effect on fertility, whereas female and male attainment are each positively related to life expectancy and negatively related to infant mortality. Male attainment plays a positive role in primary-school enrollment ratios, and male and female attainment relate positively to enrollment at the secondary level´´ Barro and Lee (1994)

flation in order to support economic growth. When we focus on the variable number of patent applications we are in line with results from the state-by-state regressions and it is the fact that this variable does not immediately affect the growth but rather is lagged in meaning patents take time to be part in production process and therefore contribute to economic growth. We provided verification just for the variables, which are significant to the economic development.

Model : 1-step dynamic panel, using 70 observations
Included 7 cross-sectional units
Time-series length: minimum 9, maximum 11
H-matrix as per Ox/DPD
Dependent variable: Δy

	Coefficient	Std. Error	z	p-value
y(-1)	0.0383008	0.0479527	0.7987	0.4245
const	−0.0565727	0.0163586	−3.4583	0.0005
SE	−0.00411816	0.00396775	−1.0379	0.2993
LE	0.0316747	0.00934221	3.3905	0.0007
GE	−0.0105190	0.00447506	−2.3506	0.0187
RL	−0.214159	0.110427	−1.9394	0.0525
TT	−0.000956893	0.00233082	−0.4105	0.6814
DI	0.00473254	0.00352856	1.3412	0.1799
INF	0.00368532	0.00182869	2.0153	0.0439
INV	0.00125181	0.00247235	0.5063	0.6126
PAT	3.31647e–005	0.000131529	0.2521	0.8009
l_Y	0.446721	0.0594529	7.5139	0.0000

Sum squared resid 1.299153 S.E. of regression 0.150971

Number of instruments = 70
Test for AR(1) errors: $z = -1.246$ [0.2127]
Test for AR(2) errors: $z = -0.8500$ [0.3953]
Sargan test: $\chi^2(57) = 61.2896$ [0.3248]
Wald (joint) test: $\chi^2(0)$ = NA

5.2.1. Economic verification

In economic verification we consider especially the direction and intensity of the explanatory variables on the endogenous variables Cechura (2008). In our case we consider the direction and intensity of GDP per capita, secondary education, life expectancy, government expenditures, rule-of-law, terms of trade, democracy index, inflation, investments and patents on the growth of GDP per capita in Southeast Asia. Just to remind we incorporated logarithm only to the variable GDP, other variable remained unchanged. Our interpretation based on the estimation is as follows:

- In case of constant if all explanatory variables will be null the economic growth per capita would be equal to -0.06%. The direction of the variable might seem confusing, because one may expect in this part of the world increasing economic development. However, we have not consider this variable in our assumptions of the model.
- If life expectancy would increase about one unit (one year), the economic growth would increase about 0.03%, ceteris paribus. This result perfectly corresponds with its academic assumptions.
- If government expenditures would increase about one unit, which means that share of government expenditures related to GDP will increase by one percentage point, the economic growth would decrease about 0.01%. This result confirms its economic assumptions.
- If the variable rule-of-law increases about one unit on the scale, the economic growth will decrease about -0.22%, ceteris paribus. This result might seem irrational, but as it was already discussed, we need to look at it from the broader perspective. Most of the countries are in the negative part of the rule-of-law range, in fact Malaysia was the only one with positive sign in 2013. That reflects Malaysia has among other states the best system with less official corruption. So, at the first sight this result does not correspond with the theoretical assumptions. But this might be coming from the fact that if we perceive rule-of-law to be similar to democracy i.e. the higher rule-of-law means higher democracy.[14]Also it had been proved in Haggard et al. (2008) that in developing countries are formal institutions not so important and on the other hand, informal institutional arrangements play a significant part.
- If the inflation would increase about one unit, which means one percentage point, the economic growth would increase about 0.004%, ceteris paribus. This result is broadly in line with the common assumptions that mild inflation sup-

[14]We are fully aware that this relationship does not hold in worldwide comparison, e.g. Saudi Arabia records rule-of-law on the higher level then most of the countries in Southeast Asia. On the other hand, in democracy is on the lowest possible level Marshall (2014), WorldBank (2015). Therefore the relationship between rule-of-law and democracy can be disputed in this case.

ports the economic growth and of course high inflation or hyperinflation harms the growth. This assumptions are confirmed by the fact that having the mild inflation is the primary aim of many central banks including e.g. Czech national bank.

- If the level GDP per capita would increase about one unit (one current dollar), the economic growth would increase about 0.46%, ceteris paribus. We discussed earlier that when there is low initial level of GDP the country is growing faster. This result, however, corresponds with our assumptions, because these states mostly belong to the emerging economies and increasing their level of GDP is helpful to the economic development.[15]

5.2.2. Statistical and econometric verification

This part is focused to assess the statistical significance of the estimated parameters and of the entire model. We consider the compliance our estimated model with data set and statistical significance of the estimated parameters Cechura (2008). The criterion of significance: t>α. The parameter is statistically significant at the significance level α with np degrees of freedom.

We calculated statistical significance in Gretl and the results were:

- Parameters of GDP per capita, life expectancy (and constant) got *** stars in Gretl, which means a 99% confidence level
- Parameters of government expenditures, rule-of-law and the inflation got ** stars in Gretl, which indicates a 95% confidence level

Dynamic panel model was used, therefore there is no R^2 or Durbin-Watson statistics, because there is a lagged variable GDP growth. The standard error for the slope is not large relative to estimates which resulted in significant t-statistics.

When we focus on the test of normality of residuals (Figure 5.1), which indicates whether the proposed model is the best unbiased, we unfortunately had to reject the null hypothesis of residuals being normally distributed (p-value was recorded only at 0.0047), but we could conclude it is on the edge of the 5% significance level.

[15] For developed countries this explanation could not be applied, because as they are already developed their economic growth is rather slow, e.g. Japan.

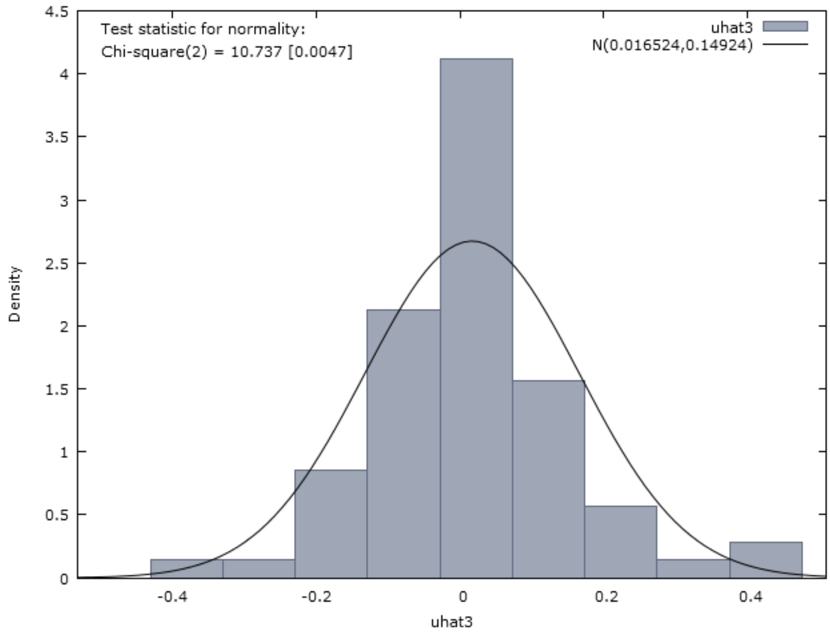

Figure 5.1.: Distribution of residuals from panel data estimation

Chapter 6

EVALUATION AND FORECASTING OF ECONOMIC GROWTH

6.1. Fitted values evaluation and forecasts for 2014 and 2015

In this part of the thesis we will focus on the ex post evaluation of fitted values based on results from state-by-state regressions. Predictions will be performed for each state, even though we will concentrate here and we will discuss in detail ex post predictions of economic growth in 2013 for Malaysia, Philippines, Thailand and Indonesia.[1] For forecasting as previously proposed we employed Gretl. The following chapter runs according the proposed pattern: firstly we show in the graph the fitted values and comment the fitness of prediction, then provide the results from Mincer-Zarnowitz regression[2] that allows us to say whether the fitted values are truly statistically insignificant from the actual values and last but not least we focus on the predictions for 2014 and 2015 using linear extrapolation on the data set. We performed all these above mentioned steps at once.

Firstly starting with Malaysia the OLS estimation yielded following results, which are for the convenience depicted in the graph (Figure 6.1). The shaded areas represents 95% confidence intervals (both upper and lower). From the graph it is clearly visible that our fitted values follow more or less the actual values of economic growth.

[1] One reason is that these states generate least missing values and secondly, their statistics seem to be the most reliable.

[2] In general we estimated $y_t = \beta_0 + \beta_1 \hat{y}_{t,t-i} + \varepsilon$ where y_t is equal to actual value of economic growth and $\hat{y}$ is the fitted value. Afterward the coefficients were put under F-test exploring whether β_0 is zero and β_1 is equal to one from statistical point of view.

It seems important to point out that our model is able to ex post predict some turbulent point in GDP growth such as Asian crises in late 90´s. However, ex post predictions are usually more easier to perform than ex ante. Which is caused that in financial world the events are not evenly distributed but rather having fat tails (the probability of extreme events i.e. Black Swans is higher in real life than in statistical theory). Not to perform only graphical representation as proposed earlier we employed Mincer-Zarnowitz regression in order to explore whether the fitted values obtained from estimated model are statistically indifferent from actual values. As proposed in methodology part Mincer-Zarnowitz regression is handy tool for evaluation of predictions/fitted values. Basically we ran regression where on the left we had actual values regressed on constant and the fitted value. Afterward the results were put under F-test where we could not reject the null hypothesis of β_0 being equal to 0 and β_1 being equal to 1 which means our fitted values are good enough for performing forward looking statements regarding GDP growth in Malaysia for next two years to come. We estimated that GDP in Malaysia will record flat development on year to year basis in 2014 and slight contraction in 2015 being equal to -1% year to year.

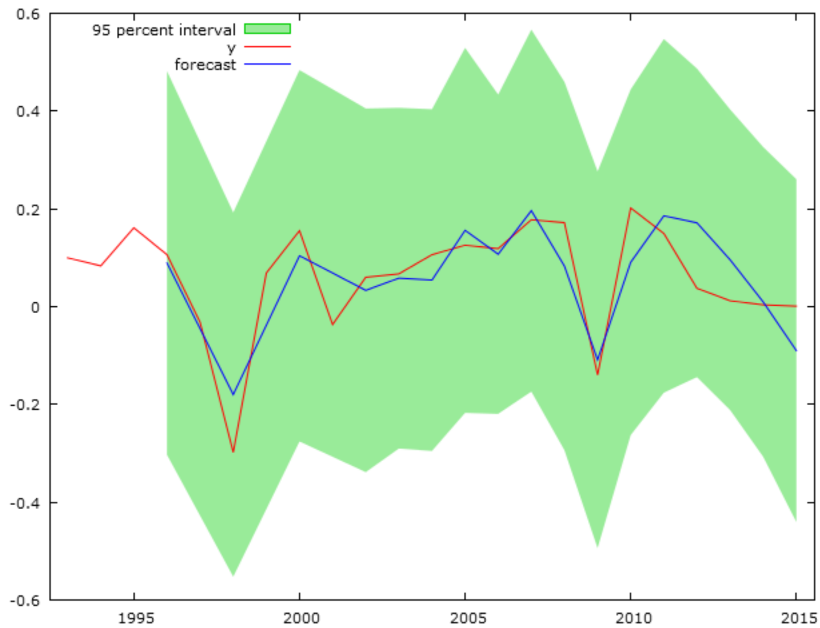

Figure 6.1.: Fitted values for Malaysia

In case of Indonesia the fitted values seem to fit the actual figures in quite good way, however there is one exception and it is the Asian crisis. However this is rather accountable for lack of data in the history rather than the model imperfections and moreover the drop in GDP was the most severe within the tested countries with decrease of 56% year to year. Excluding this imperfection we however agree that the fitted values are describing the actual development in GDP in proper manner. This statement was moreover supported by the results from Mincer-Zarnowitz regression. When we focus on the forecasts of GDP growth for 2014 and 2015 however we must admit that Indonesia will based on our internal model experience contraction of GDP in 2014 and 2015. For 2014 we estimated that the contraction amounted to -2% year to year and accelerated in 2015 to -5%.

Figure 6.2.: Fitted values for Indonesia

For Thailand we recorded fitted values that are depicted in graph bellow. Interestingly the model was able to "predict" the financial crisis in late 90´s as in case of Malaysia. From the graph moreover we can see that fitted values represented by blue line more or less follow the actual development of GDP, moreover the Mincer-Zarnowitz results suggests that indeed the fitted values fit the actual values properly. Regarding the forecasts for 2014 and 2015 we estimated that in case of Thailand the GDP growth should amount to 5% for 2014 and then slowed down to the value of 3% for 2015.

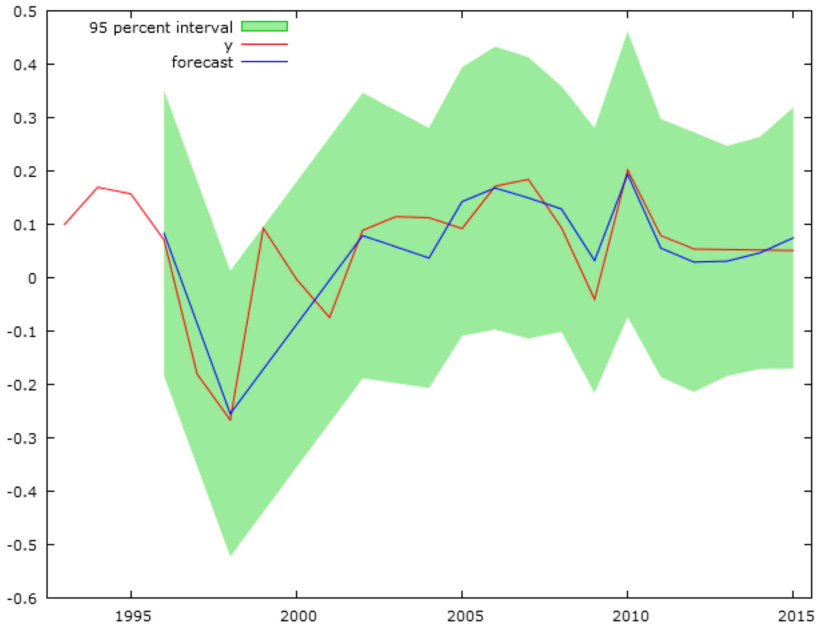

Figure 6.3.: Fitted values for Thailand

When we focus on the Philippines, we might conclude that as in case of Malaysia and Thailand our model was able to predict the financial crisis ex post. However, the model could not capture and predict the steep increase in GDP after the crisis took place. Excluding this element we can clearly see that the blue line of fitted values more or less follows the actual value. Moreover the result from Mincer-Zarnowitz regression suggests same conclusion as proposed above, i.e. the fitted values are statistically insignificant from the actual values. When we focus on the GDP growth predictions for 2014 and 2015 we must clearly admit that based on our model the Philippines will experience the most rapid growth within these four presented countries. For 2014 we estimated the GDP to grow by 5% in year to year comparison and even more for 2015 being equal to 7%.

Figure 6.4.: Fitted values for Philippines

In order to wrap this section up, let us provide the table bellow summarizing the results presented above. As already proposed at the beginning it was necessary to compute missing observations for 2014 and 2015 using a linear trend of these variables, as it seemed the most reasonable solution. However, this procedure was not calculated for all explanatory variables. There were few variables where we could not estimate its values using the linear trend, e.g. democracy index, which generated the stable trend. After putting our new data set to Gretl we received the following result:

Country	Mincer-Zarnowitz results	GDP 2014	GDP 2015
Malaysia	H0* not rejected	0%	-1%
Thailand	H0* not rejected	5%	3%
Indonesia	H0* not rejected	-2%	-5%
Philippines	H0* not rejected	5%	7%
*H0 of $\beta_0 = 0$ and $\beta_1 = 1$			

Table 6.1.: Results from fitted values evaluation and forecasts for 2014 and 2015

Chapter 7
DISCUSSION

After the comprehensive analysis performed in this thesis we can now compare our own results with those obtained from academic researches. The answer is, however, not that simple and we cannot just say our conclusion are fully supported from literature, or not.[1] When we think about Kaldor´s stylized facts about stable real rate of return Kaldor (1963), Barro and i Martin (2004) argue that this hypothesis should be replaced by a tendency for returns to fall over some range as an economy develops, which sounds more reasonable even in our case and data. Which is in line with common economic theory of diminishing returns, i.e. any additional unit of input will bring lower marginal product.

First of all when we consider robust (time invariant, stable) variables mentioned in Doppelhofer et al. (2000) or Barro and i Martin (2004) our findings fully support that initial level of GDP and life expectancy are positively correlated with growth and government expenditures are negatively related to economic development.

When we look at the initial level of GDP as a possible driver of growth, which was discussed in Barro and i Martin (2004) or Barro (1996) our empirical results suggest that the convergence story still holds in the case of Southeast Asian countries, because the initial level of GDP is still positive contributor to economic growth on our observed countries.[2] Even in OLS approach this variable is significant factor of growth. The common claim that richer countries have lower GDP growth and vice versa was also supported by our results. Countries like Malaysia, Thailand or Indonesia have already attained economic boom and their growth is not expected to

[1] We discussed and commented our results through the whole thesis, so here we just want to stress the most important findings.

[2] Unlike results from Barro (1996) who arrived on negative contribution due to estimating more 100 countries at once. As we chose only Southeast Asia countries we truly believe that our findings are in line with commonly assumed opinion, i.e. Southeast Asian countries are still not as developed as "rich" countries in terms of GDP, therefore initial level of GDP might be supporting growth

be double digit in next years, which was supported by our forecasts. In 2013, last year of our observations, Lao experienced the highest economic growth of 13%. On the other hand Myanmar seems not to be on the way of rapid economic growth lately, probably because of complicated political situation. We are confused about study of Rousseau and Wachtel (2011), which found out East Asia countries have causality that runs from growth to finance, which means underdeveloped financial systems do not lead to growth.[3]Of course there is a country like Myanmar that should improve financial system for fostering growth, but in general we found out the initial level of GDP is still important contributor.

We have to point out the role of education and human capital in economic development. In this part we have to agree from all mentioned authors with Snowdon et al. (2006), because our results showed up there is no significant correlation between total secondary schooling and growth. In OLS method we recorded positive correlation just in case of Lao and Philippines, but in panel model no correlation at all arose. We assume we could bring out different results using just male education or just primary level of education, which was suggested by Sala-i-Martin as the only relevant level, however regardless of our best effort we could not find any of these data in publicly available databases.[4] However, frankly speaking there are works that employ different concept of education role on the overall economic growth, for example Fagerberg et al. (2015) arrived at positive and significant role of education on growth. Which means that we cannot of course reject the generally assumed positive impact of education on economic growth in general, it depends on the concept the education is handled. When we consider life expectancy, which is about healthy population and life style as a part of proxy for the quality of human capital[5] we cannot say that human capital is not significant for growth anymore.

It is not generally surprising that inflation is positively correlated with growth. That means mild inflation is able to boost economic growth, which is in the fact perfectly in line with Barro and i Martin (2004). Even in OLS inflation was recorded positively correlated in Vietnam and Cambodia. In order to extend this conclusion we are, based on the results, able to say that one of central banks´ or other monetary

[3]Basically Rousseau and Wachtel (2011) concluded than in East Asia the direction of causality is different than in developed countries, where economic growth enhances financial system to develop. In case of East Asia countries this causality runs in different direction, i.e. developing of financial system supports economic growth. Which means developing of financial system is a condition for further economic growth.

[4]We had to face the fact that our variable total secondary education recorded the highest number of missing observations, which could influence the outcome.

[5]As it was declared by Barro (1996).

authorities´ target in Southeast Asia should be keeping the inflation within reasonable boundaries.

When we take into account that RD model from Romer (2006) as one of the most important models of economic growth, it is really a disappointment that number of patents was not correlated to growth in our panel model. Only in OLS patents were positively correlated in Thailand and Philippines, which are the countries with higher number of patents among others, like Lao or Cambodia. We found innovations very important driver of growth and we are really curious what would be the results if data for RD investments were provided for every country. We might predict positive correlation, but in this point it is just a speculation. Also we could improve our model by switching patents for trademarks applications which are recorded even in Lao or Myanmar, countries with no recorded patent applications. One may be curious why innovation are not concluded in many studies presented in literature review. The truth is data for these studies were collected several decades before where the statistics for some particular variables was not available or considerable at all. We assume in new researches there will be more place for innovation as a driver of economic development. Last but not least we should stress that democracy index is indeed insignificantly correlated with economic growth, which is perfectly in line of most of the authors regarding this topic as we presented earlier.

Chapter 8
CONCLUSION

The aim of this master thesis was to answer the question what are the main determinants of economic growth in Southeast Asia and subsequent prognosis for two years. In the first part, literature review, we clarified three basic models of economic growth out of which everyone has its specifics and is based on different determinants and furthermore provided the latest research effort carried out in the field of economic growth estimation. In this thesis we borrowed and adjusted model from Barro (1996). The proposed model applied its specification from Solow-Swan and Ramsey-Cass-Koopmans. In order to include the conclusion from RD model we incorporated the number of patents application into the model, as the proxy for technological growth. The estimation of key economic growth drivers ran in two levels. Firstly, we estimated the model state-by-state by simple Ordinary least square method then all at once using dynamic panel approach. The reason for this careful division is the fact that very commonly we were not able to completely fulfill the data regarding the particular country (due to lack of data or not existing data at all). So in order not to draw any conclusion based on biased results we decided rather to split the estimation into these two levels. Generally, in OLS state-by-state we basically found out that some of our findings were compliant with results from other authors some were not. In case of initial level of GDP and life expectancy variable we were perfectly compliant with conclusions suggested by Barro (1996) or Doppelhofer et al. (2000). The value of adjusted R^2 was recorded mostly significantly high. However, there is one problem that should be concerned and it is the rejection of null hypothesis of normality of residuals even it was on the edge. Therefore we might find other non-linear model describing the data more accurately.

When focusing on dynamic panel approach, i.e. estimating all the data at once, the conclusions were similar to ones drawn from state-by-state OLS approach. First of all it is worth to mention that GDP growth is tightly related to log(GDP) therefore the benefit of growing from lower base has not been fully exploited yet. As in OLS results it was found out that variable life expectancy is a significant positive driver of economic growth in this particular region. Furthermore the inflation positively contributed to the overall GDP growth, therefore the common aim of central banks worldwide (have mild inflation) seems to be reasonable even in these 8 countries of our research. On the other hand it was estimated that variable government expenditures is significantly negative, it means that the government expenditures are going into projects that not primary support GDP growth but rather to the field of army expenditures etc. Institutional framework represented by variable RL was on the edge of 5% significance level. Last but not least it is worth to mention that regarding the variable total secondary schooling our model proved insignificance of this variable. Reason for that might be coming from the fact that we employed (due to data availability reasons) total share of secondary schooling, not male only as performed in Barro (1996). However, we must admit that the first hypothesis of this thesis which was that despite of 20 years time lag the results obtained from our regression are not significantly different from Barro´s and Sala-i-Martin´s, was rejected. The reason of the rejection might be coming from using different data sources, we solely worked with publicly available information, on the other hand both of authors mentioned above used paid databases. For the second hypothesis it was concluded that indeed the simple OLS approach yielded more precise estimation of GDP growth equation in terms of adjusted R^2, therefore we could not reject the second null hypothesis. The reason for this might be coming from the fact that the underlying dynamics of the particular economies are so strong that from estimation point of view it is more accurate to estimate the models on state-by-state approach rather than all at once using panel.

Last part of this thesis focused on forecasting of GDP growth for years 2014 and 2015. The forecasts were based on the results obtained from OLS for countries Malaysia, Indonesia, Thailand and Philippines. We chose this set of 4 countries simply on the fact that these countries offered the most comprehensive data sets. Firstly, we performed the evaluation of fitted values vis-à-vis the actual values using Mincer-Zarnowitz approach. The results came out positive in meaning the fitted values were statistically indifferent from the actual values, therefore we could not reject the third and last hypothesis of this thesis regarding the accuracy of predictions. Therefore we proceeded to perform forecasts for 2014 and 2015. All in all, it was predicted that these countries will not experience such rapid growth as in last two decades, but around mid-single-digit growth.

Last but not least, for future enlargement of this thesis we would focus on obtaining as much possible data as employed Barro and Sala-i-Martin, it means not only publicly available but even some paid databases. Second enlargement might be included some other advanced econometric estimation procedure, which might include approaches as vector auto-regressive (usually abbreviated as VAR).

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Appendix A

Appendix A

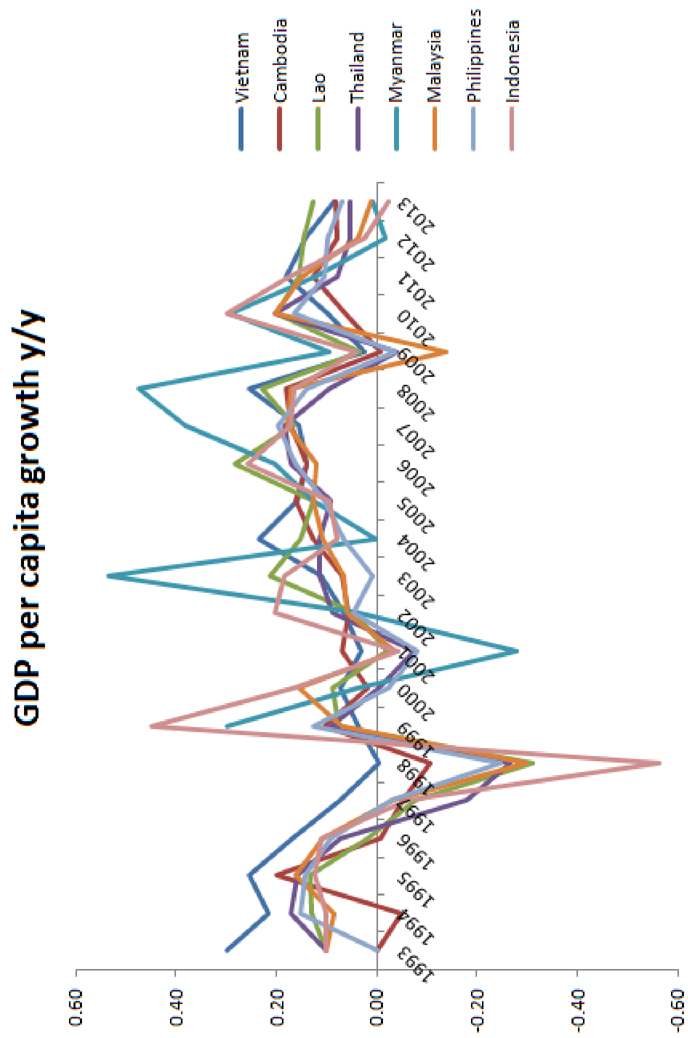

Figure A.1.: GDP per capita y/y growth

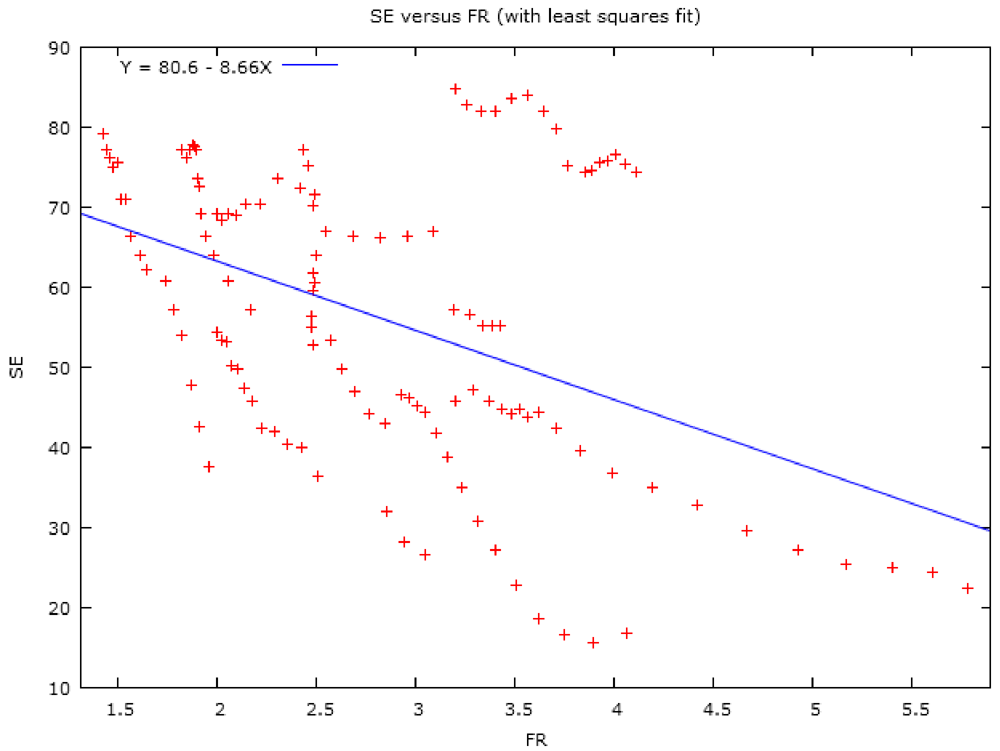

Figure A.2.: Relationship between fertility rate vis-à-vis secondary education

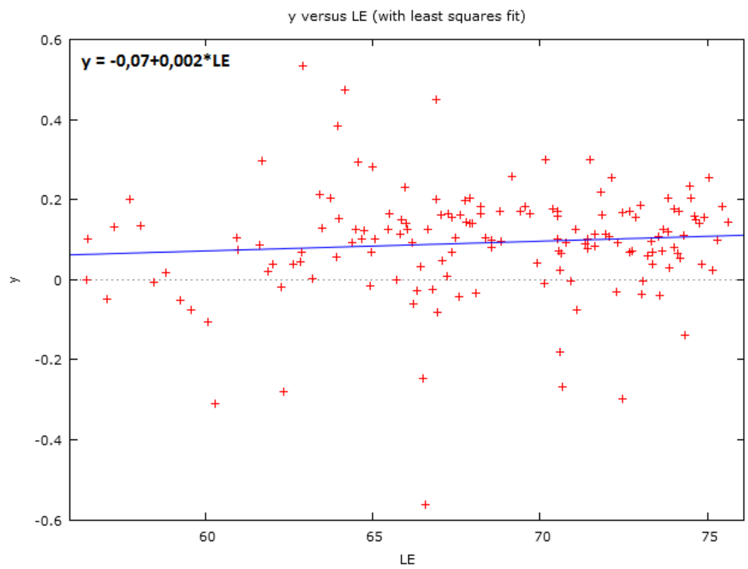

Figure A.3.: Relationship between GDP growth and life expectancy

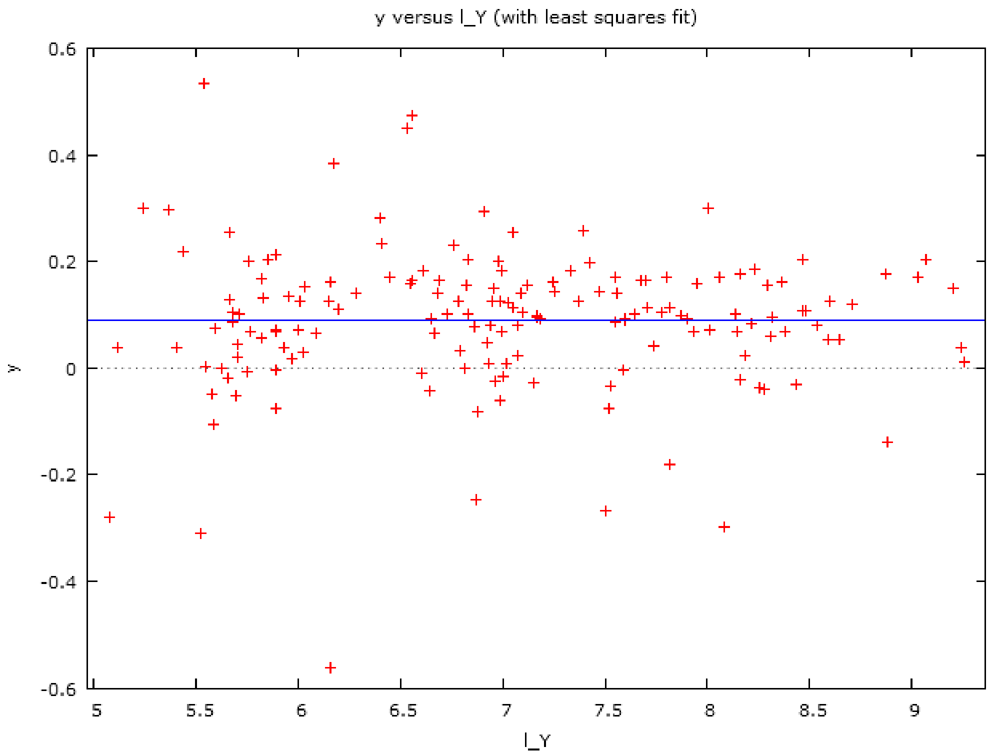

Figure A.4.: Relationship between GDP growth and log GDP

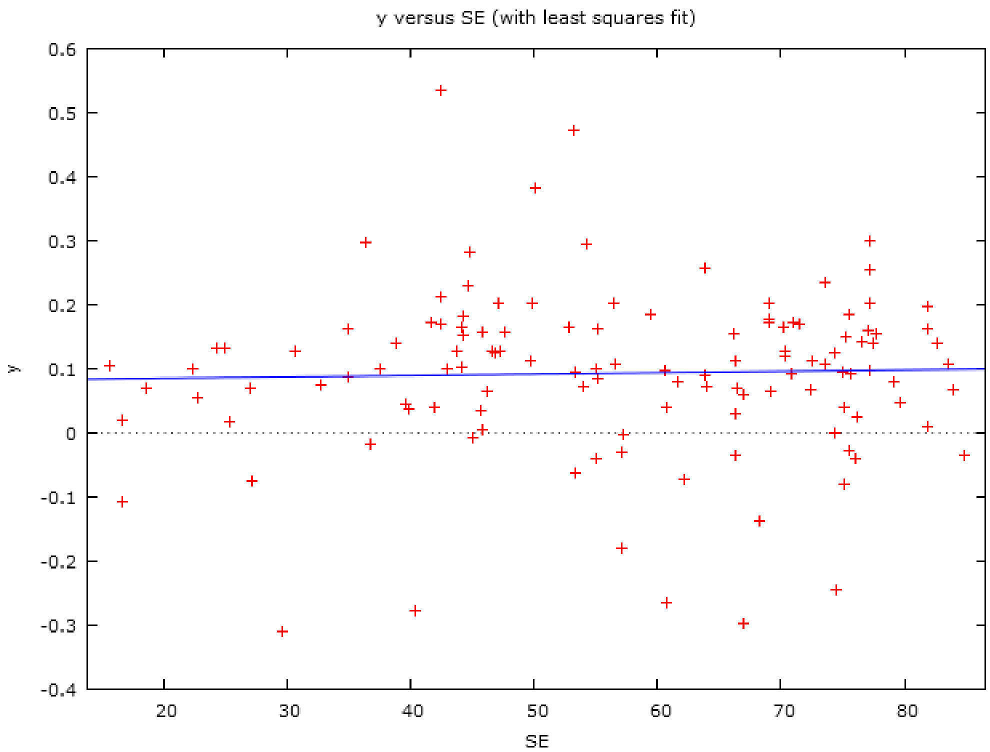

Figure A.5.: Relationship between GDP growth and secondary education

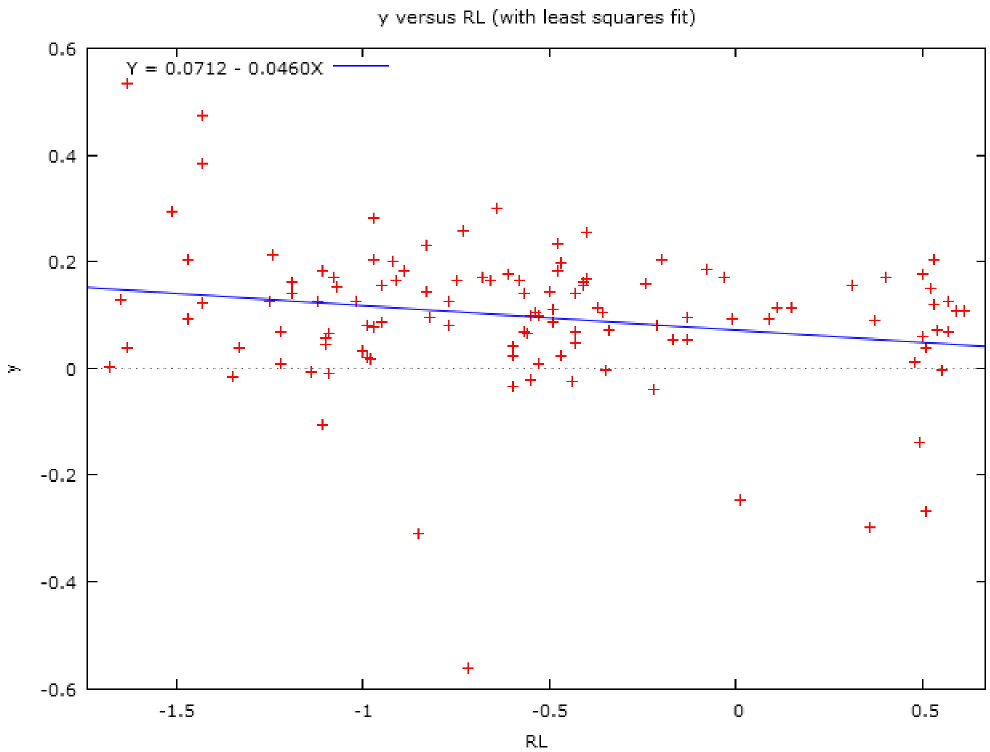

Figure A.6.: Relationship between GDP growth and rule-of-law

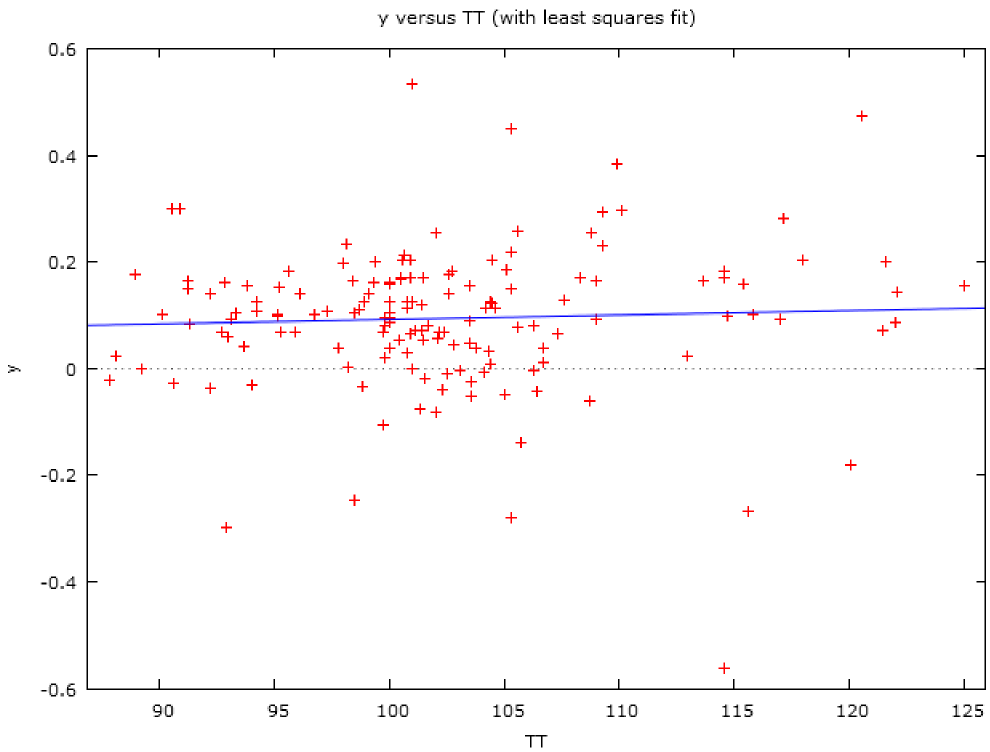

Figure A.7.: Relationship between GDP growth and terms of trade

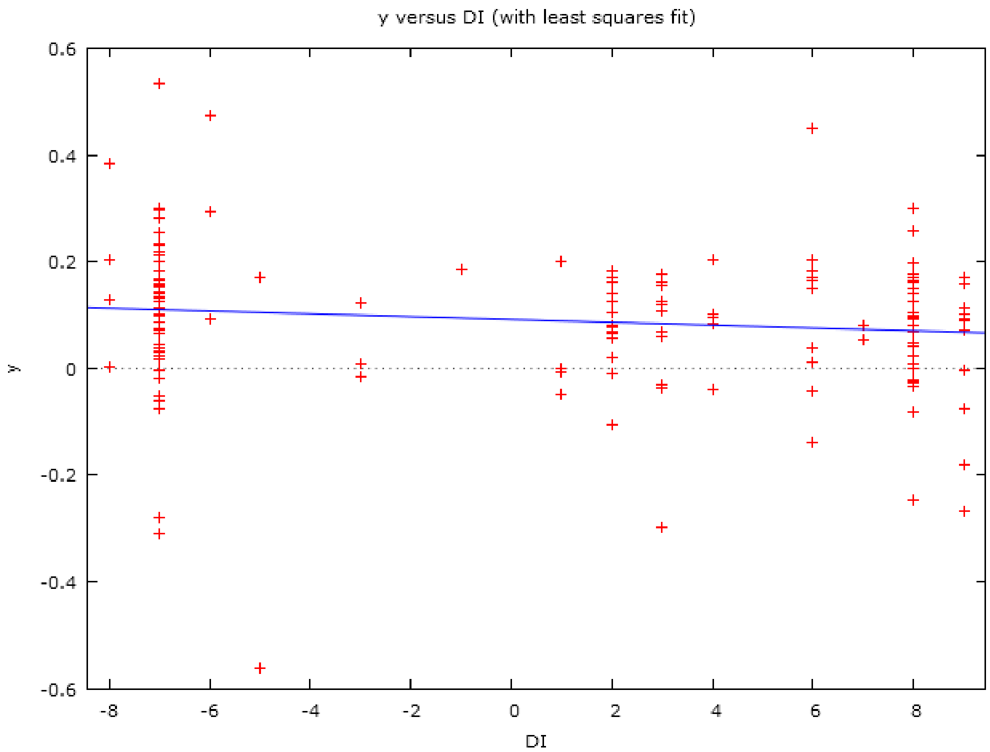

Figure A.8.: Relationship between GDP growth and democracy index

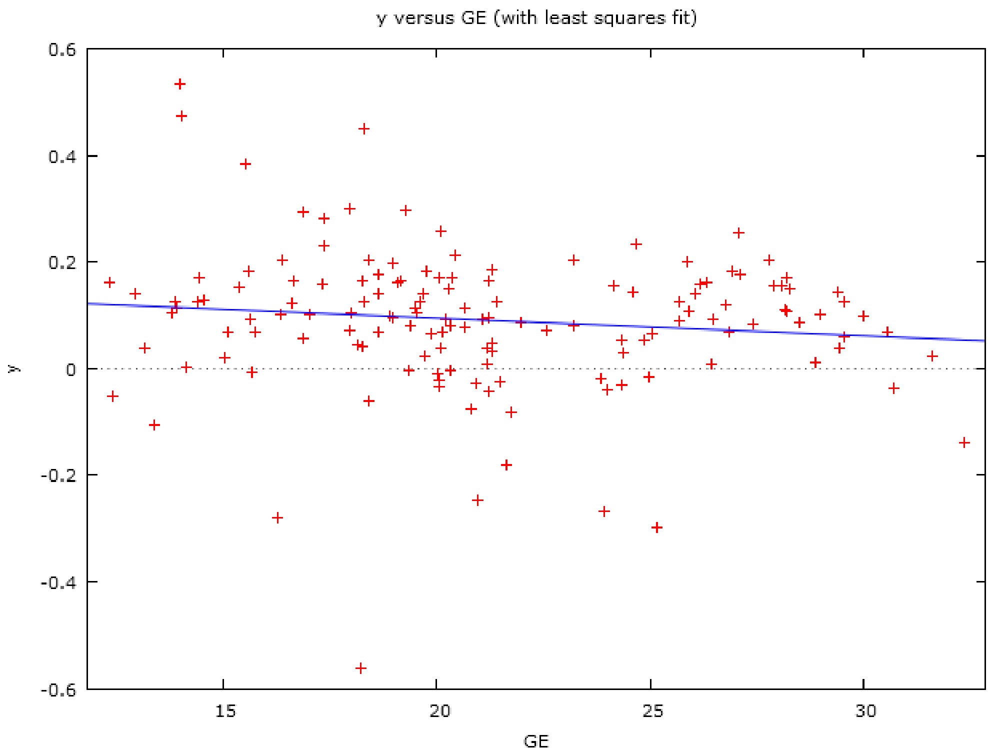

Figure A.9.: Relationship between GDP growth and government expenditure

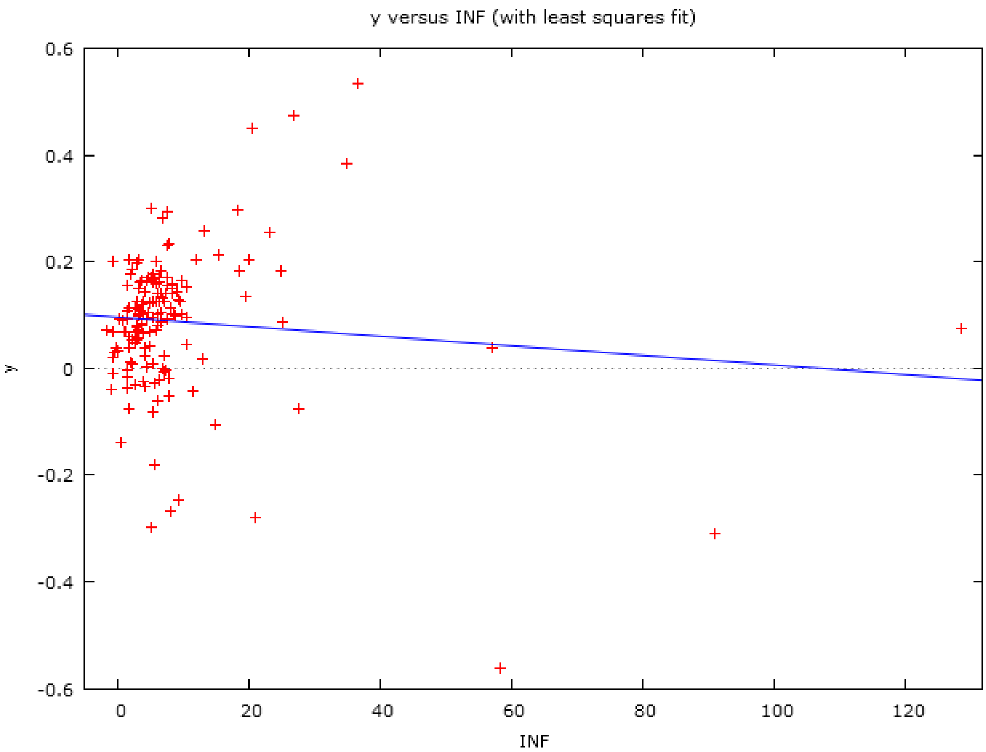

Figure A.10.: Relationship between GDP growth and inflation

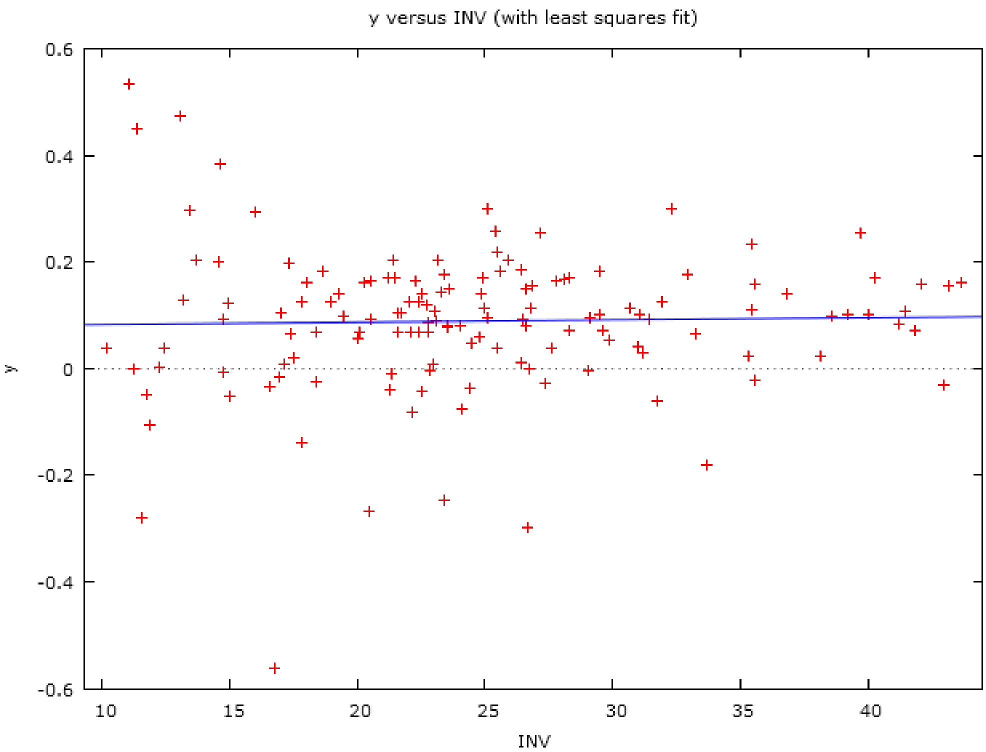

Figure A.11.: Relationship between GDP growth and investments

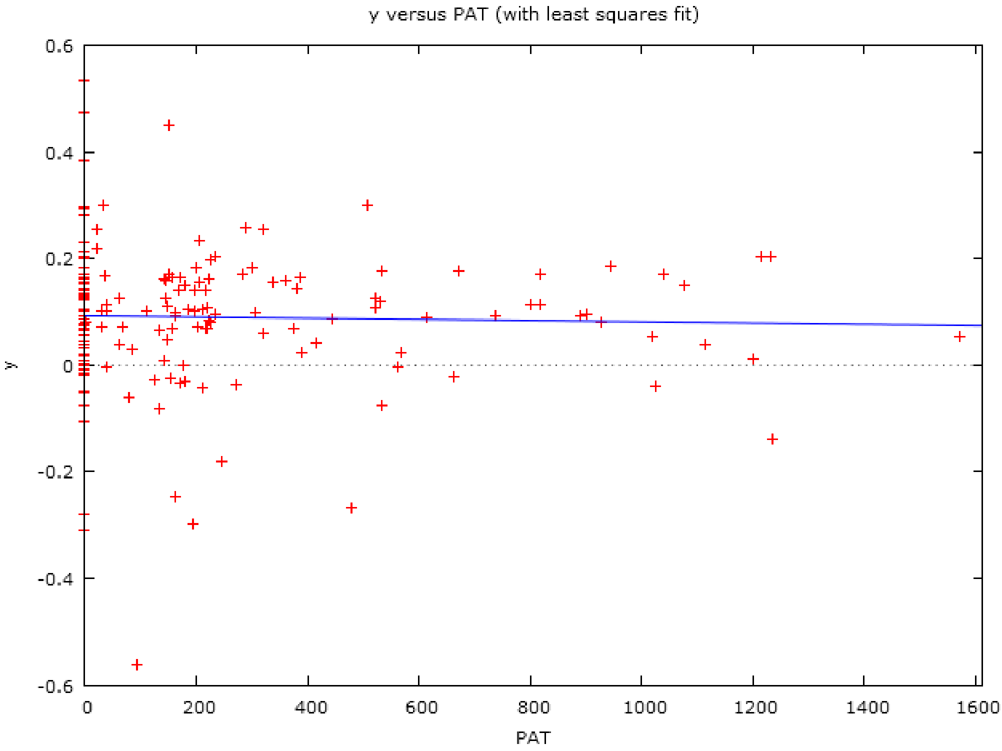

Figure A.12.: Relationship between GDP growth and patents

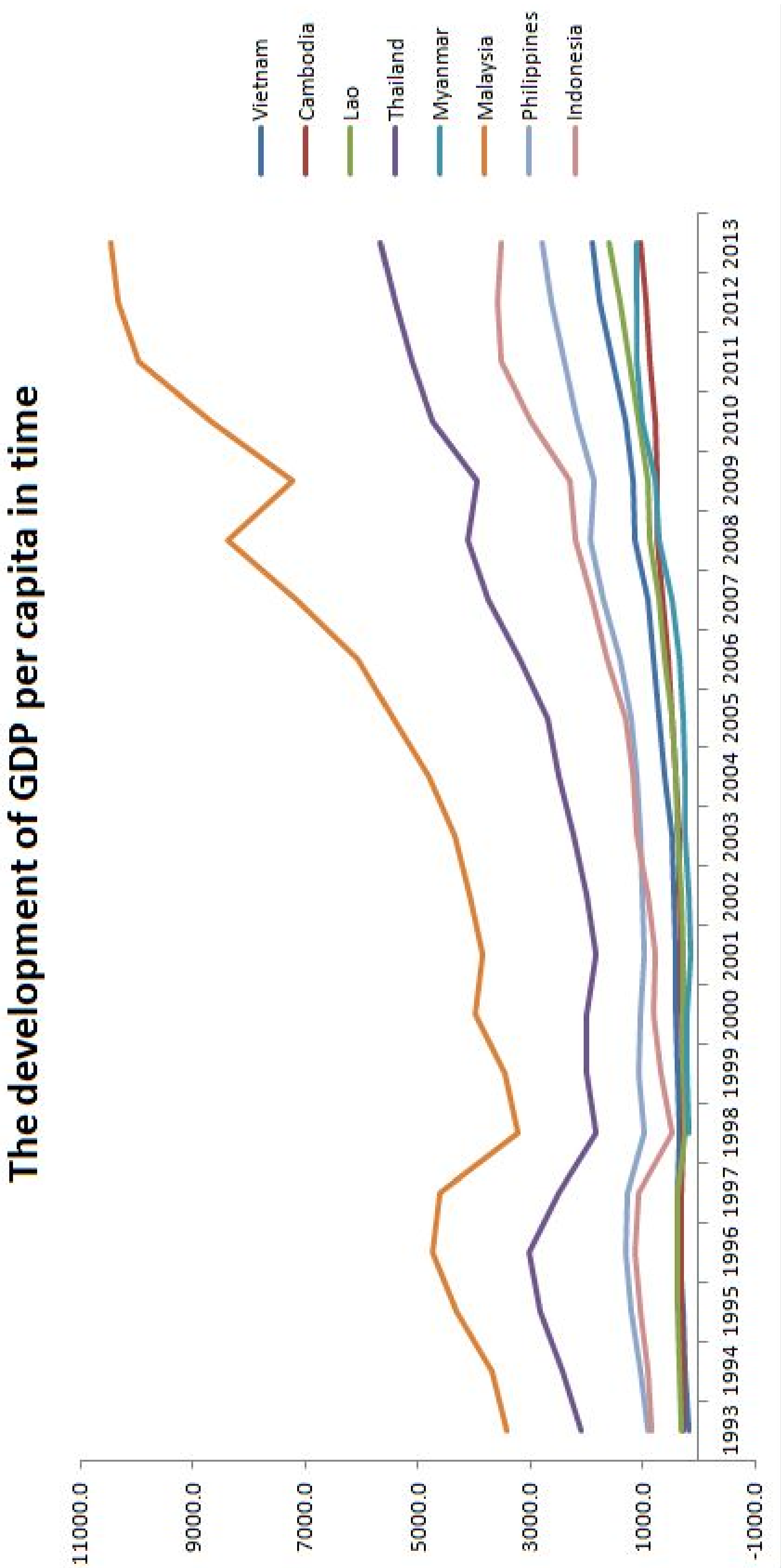

Figure A.13.: Development of GDP per capita in time

Appendix B
Content of Enclosed CD

Original data set in the file data_set.xls + master thesis