Doctoral (PhD) Dissertation

Financial Risk Evaluation Methods in the Economics of Education

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Financial Risk Evaluation Methods in the Economics of Education

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Nyilatkozat

Alulírott Vona Máté nyilatkozom, hogy

a) értekezésemet korábban más intézményben nem nyújtottam be és azt nem utasították el;
b) nem állok doktori fokozat visszavonására irányuló eljárás alatt, illetve 5 éven belül nem vontak vissza tőlem korábban odaítélt doktori fokozatot;
c) a disszertáció önálló munkám, az irodalmi hivatkozások egyértelműek és teljesek.

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Vona Máté

"*Economics has perhaps been somewhat 'underpowered' in terms of research that recognises how education can define major life outcomes – occupation, marriage/relationships and soon – but also can change you as a person – increasing your sense of self-esteem, self-awareness and consideration of the future. It changes key skills that are not often captured in standard models – education may make you more opinionated, more decisive. It may promote trust, civic engagement. You may also have the skills to avoid lifetime 'traps' –making you better at running your household budget, managing your time and your allocation of time to the benefit of others such as your children."*

Dickson – Harmon (2011:1121)

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Introduction

The main question of the thesis is the following: what is the role of risk in individual higher educational choice and what are its short-term macroeconomic implications? Namely, whether it can cause a macroeconomic crisis if individuals experience negative rate of return to education on a mass level? For the better understanding of this question, I devote Chapter 1 of the dissertation to the interpretation of risk, individual educational choice and macroeconomic implication. These are concepts that can have many interpretations. I will approach the topic of risk and education using the tools of economics. In Chapter 1.1 the main concepts and definitions of risk and its measurement will be described, risk being one of the main topics of financial economics. In this dissertation investment risk will be discussed. It is related to uncertainty of future returns, however, in case of risk, some knowledge on possible outcomes is assumed. The main economic example of risky investment is investment in financial assets. In Chapter 1.1 a short introduction to the Markowitz model will be given. The main idea of the Markowitz portfolio theory is that there are efficient baskets of financial investments, in other words portfolios that are favourable. It is assumed that decision-makers prefer more return over less return at given level of risk and less risk over more risk at given level of return. *Risk is basically an economic bad in that sense.*

After the introduction to the economic theory of risk, it will be applied for higher education in Chapter 1.2. In economics the social role of education is explained by numerous theories. Consumption theory suggests that education is similar to other consumption goods. Human capital theory proposes that people choose to invest in education to increase their future productivity and to earn a higher level of income. Sorting theories argue that education is a solution for labour market information asymmetry. People study to signal their productivity and the education system is a screening device. Human capital and sorting theories have received the most attention so risk will be discussed in these two cases. The discussion will be narrowed down to higher education because that is the market where the financial stakes are the highest for individuals and individual decision-making is easier to accept as an assumption. Result 1 of the thesis will concern the role of these theories in evaluating the risk in educational choice. It will be concluded that in the main characteristics there is no difference in the role of risk in educational choice depending on the theory we use for education, however, there are some differences that can be useful, so they should be kept in mind.

Chapter 1.3 focuses on social implications. Individuals win or lose compared to the expected return. At a macroeconomic level risk appears as the interaction of the markets. Macroeconomic theory suggests that there is a long run level of national output and it is expected to grow in time if certain conditions are met. If the output of the economy decreases and it is under the long run level, we talk about an economic crisis. If market risks add up[1] and underperformance is experienced, especially on a market that has a strong relation with the income of individuals; it can spread through the entire economy. This will decrease the aggregate demand, which as a result will lead to an economic crisis. In Chapter 1.3 the fundamental ways for funding higher education and the ideas behind an economic crisis caused by a setback at the higher education market will be discussed.

After the theoretical review in Chapter 1, in Chapter 2 an overview of the empirical literature of the topic will be provided. First of all, the kind of heterogeneity measured will be discussed, together with its measured determinants in the literature. Secondly, it will be discussed in great detail who have used the Markowitz theory for education programmes[2] and what results they have had. Result 2 of the thesis will be derived from some empirics from Education at a Glance 2014. That set of data indicates that student loan markets are evolving fairly slowly. Thirdly, it will be shown who suspects that education can create an economic crisis and what kind of empirical observations they found for their argument. All these topics will be dealt with in their respective subchapters.

In Chapter 3 data and methodology will be introduced for the empirical results of the thesis. My thesis contributes to the literature on Markowitz theory in the economics of education. A sample of the Hungarian student loan borrowers will be examined. This sample is especially interesting because student loan borrowers might be taking the highest risk compared to other ways of funding.

For the social implication study international data sources were used, including the World Bank and the Education at a Glance report of OECD.

Chapter 4 will include the analysis and the empirical results of my thesis. The first analysis concerns the role of risk in educational choices. In Chapter 4.1, I compare the measured risks and the returns with scatter-plots for my sample of 34 educational programmes of the Hungarian higher education system. Education programmes in this thesis are defined by a

[1]By the term risks adding up I mean a situation where the worst case scenarios play out for many of the market participants at the same time.

[2]I refer to formal education when ithas a certain duration and field of science; an education programme, for instance, a BSc in Engineering or an MSc in Health Science

certain level of education and a certain field of education. For instance, they include a Bachelor's in Engineering or a Master's in Social Sciences. Result 3 of the thesis will suggest that the empirical findings are similar to the findings of Palacious-Huerta (2003), Christiansen et al. (2007) and Glocker – Storck (2014). Some educational programmes seem to fit the efficient frontier while other can be found within the feasible set. A possible explanation for it is that sample members are not following the Markowitz-type of ordering. Sharpe-ratios offer some explanations to this phenomenon. These results are new because these relations were only shown for the most developed countries including the United States, Germany and Denmark and not especially for student loan borrowers. The Sharpe ratio findings are also new to the literature. These findings are summarized in Result 4.

Chapter 4.2 will consider short-term social implications of risk accumulation on the education market. First, I narrow down my analysis to such countries where the average individual financial commitment to studies is the highest. The United States will remain as the prime candidate for an education market induced crisis. With the help of graphs and tables, I compare the relative size of the education market of these countries to other markets that are very closely related to macroeconomic performance. Result 5 of my thesis will state that the education market and the student loan market in the USA are still too small for such a social impact to appear. However, these markets are too small, a future exponential growth might increase them. Result 6 of my thesis will argue that even in that case the fundamental features of education as a human capital investment limit the possibility for extreme market corrections.

My thesis will end with a conclusion highlighting my main results and the implications of them and will also outline future research possibilities.

1. Theoretical Review – Concepts and Definitions for Risk Analysis of Individual Higher Education Investment

The main question of the thesis is the following: *what is the role of risk in individual higher educational choice and what are its short-term macroeconomic implications? Namely, whether it can cause a macroeconomic crisis if individuals experience negative rate of return to education on a mass level?* Before analysing this topic some questions should be answered. What is risk and how can it be measured? What is individual educational choice in economic context? How can educational choices have macroeconomic implications? Fortunately there is a fairly rich literature on these topics. In this part of the thesis the main concepts and definitions will be given for the rest of the thesis based on the literature of the topic. It is not the goal of this chapter to give a full overview on these topics. For instance risk itself is such a complex question that a deep literature analysis of it would reach far beyond the limits of the thesis. The goal of this chapter is to highlight some of the main ideas of the related theoretical literature. This is useful for the further analysis because it will be built on the definitions and concepts in this chapter.

The chapter will be divided to three main subchapters based on the aforementioned questions and it will be closed with a summary. Chapter 1.1 will give a definition for risk based on the financial economics literature. The main model of the risky investments will be introduced in greater detail because in Chapter 4 this model will be used for analysis of educational choices. This is the so called Markowitz portfolio theory.

Chapter 1.2 will focus on the social role of education especially higher education. In economics there are different approaches to explain the social role of education. In my opinion they are complementary to each other, but in some cases they suggest different predictions. It will be discussed how it effects risk analysis.

If education is mainly human capital accumulation then mass education is strongly connected to economic growth. As it will be introduced in Chapter 1.3, besides the people who actually study, their households, companies and organizations and even the government is involved in funding the education system. This results in a complex system of funding. Through the tool of student loans the financial sector is involved. The recent global economic crisis gave an example on how the increased indebtedness of the households can cause macroeconomic turbulence. Chapter 1.3 will introduce the main elements of funding higher education.

1.1 Risk and the Markowitz Portfolio Theory

In this chapter economic concept of risk and the so called Markowitz theory will be introduced. The Markowitz theory describes investor behaviour on a market where different kinds of risky investments are available. Knight (1921:20-21) differentiated between risk and uncertainty. Both risk and uncertainty derive from limited knowledge about the future. In risk theory there is an information problem. The economic actors have limited information regarding future events. The future price of a financial asset is a random variable for them. *Risk is when investors have information on the distribution of the future asset price, but they do not know the exact value.* This means that they know all the possibilities and their probability. In that sense financial investment has more in common with betting on throwing a dice. If the dice is regular, then we know the possible outcomes and their probability and the possible payoffs in each case. The fundamental difference between gambling with the dice and financial investment is that for financial investment there are positive expected returns, whereas in casinos there are negative expected financial returns. *If we assume uncertainty, this means we assume investors have limited information even on the distribution of future prices. Not all possibilities and probabilities are known. In real life uncertainty is what describes financial investments better, but risk is the better assumption to work with.*

Since Markowitz (1951), financial mathematical textbooks usually introduce choice between risky investments with this model. The original analysis was designed for risky security investments like shares and bonds. In this dissertation, following a specific branch of the literature, it will be applied to education investment. Although it is a fundamental financial theory, a thorough derivation is necessary because if we apply a theory for a different phenomenon than it was originally intended to describe a deep understanding of the model is necessary. This introduction will mostly follow Merton (1972).

Markowitz measured risk with variance of the rate of return. In this case we understand risk as the possibility of alteration from the expected value. This is intuitive because the larger the variance the less precisely we can predict the future outcome; for this reason the investment is more risky. However, real life investors evaluate the differences from the expected return differently, based on the direction of the difference. If the return becomes larger than the predicted one this does not bother the investor, in fact it is welcomed; on the contrary, negative differences bother the investor more, because it is money lost. If the investor has scarce resources then loss of resources can make future investments impossible. For instance,

if a bank does not have enough reserves for an extreme scenario they can go bankrupt and lose the money of the owners and depositors.

Risk was very carefully analysed in a financial environment, and multiple sources of risk were differentiated. They are introduced based on Duffie – Singleton (2003) and Gourieroux – Jasiak (2010).

- Market risk: This is caused by unexpected price changes over time. It is experienced when the investor holds assets that have liquid markets. It can be underestimated in a market expansion period.
- Credit risk: This is caused by a default on a credit. If a bank or any other kind of investor lends money through a financial product for a future stream of cash flows, there is always a possibility that the borrower will stop the repayment. This can be because the borrowing firm or institute goes bankrupt or a person has no income at the time of the repayment to pay back the credit. If the lender's business depends on the repayment then a default can create huge damage to the business.
- Liquidity risk: if an investor holds a financial asset in a portfolio it has value only when it can be sold. There is a risk in finding a counter party when the asset does not have a liquid market, which means there are a low number and low volume of trades on the market. In this case the investor has to wait long to find a counterparty for a transaction. If the investor is in great need of cash this is a risk.
- Operational risk and systematic risk: the first includes internal organization risks such as fraud or system failures, and the second is the risk of an economic meltdown or in other words a risk of a market crisis.

If these risk categories can be interpreted for education investment then we can apply the measures used in finance for them. Education will be discussed in great detail in the next chapter, however it can be stated in advance that education is considered an investment by the economists. In case of human capital investment market risk can be experienced because of the changing need for skills and knowledge on the labour market; moreover, this demand can be influenced by many other factors than the knowledge held by the individual. Credit risk can be an extreme case, when there is no demand for a certain skill at all. For example this would be almost the case for an oil engineer if the Earth ran out of oil. A liquidity risk occurs if there is a demand for a certain skill but it is not continuous or predictable. Actors and musicians can experience something like this. Operational risk is can be connected to workplace injuries or some other vis major cases. *For our purposes we will focus on market risk of educational investment. This risk exists because of the fluctuating nature of personal*

incomes. Given that the payoff of a human capital investment can be risky, a decision on obtaining a portfolio of skills and knowledge is a risky decision. Before discussing the issue in great detail the original model must be introduced.

1.1.1. Markowitz Portfolio Theory

The assumptions of the Markowitz portfolio theory are the following:

- There are many atomic financial investors. They cannot influence current or future prices with their investment choices. These mean prices are exogenous variables.
- There are many financial assets with known current prices and known future price distributions. All the investors have full information on these issues.
- There are no costs of trading, and no taxes.
- An investor can buy an arbitrary amount of any assets, even short selling is possible.[3]
- Investors follow Markowitz ordering, which means they prefer less risk for a given return and more return for a given risk. (Return is a normal economic good, risk is an economic bad)
- All the investors on the market are optimising for the same period of time and they measure risk with the variance in future possible rates of returns.

The Markowitz ordering fully informed[4] investor chooses a basket of investments, or in other words, a portfolio that has minimal risk on a given level of rate of return and has a maximum rate of return for the given level of risk.

For the evaluation of the risk-minimisation problem let us suppose that a collection of potential securities (indexed by i, running from 1 to n) is given. Let R_i denote the return in the next time period on security i, (i =1,…,n). In general, R_i is a random variable, although some securities may be essentially deterministic. A portfolio is a collection of real numbers w_i $(i=1,...,n)$ whose sum is 1. w_i shows what fraction of the unit capital is invested in the ith security. In other words, it is the ratio of the fund invested in the ith security. The *gain* (on a unit capital) one would obtain with the portfolio in the next time period is

[3] Short selling means that investors borrow and sell the asset in the present, and buy it back later and give it back to the owner. Short selling is a loan in the form of assets, not in money. The point of short selling can be that if an investor expects the price to decrease, then short selling makes it possible to earn money with the price drop. The short seller will sell the asset for the high current price and buy it back at the low future price and keep the difference as a payoff. Short selling can also be used as a hedging technique.

[4] From now on, he or she will be referred to as a rational investor.

$$R = \sum_{i=1}^{n} w_i R_i$$

The expected return associated with the portfolio is defined as the expected value of R:

$$\mathbb{E}(R) = \sum_{i=1}^{n} w_i \mathbb{E}(R_i) = \sum_{i=1}^{n} w_i r_i \text{ where } r_i = \mathbb{E}(R_i)\ (i = 1, \dots, n)$$

The risk of a portfolio in the Markowitz theory is measured by the variance (or standard deviation) of R which can easily be calculated using the properties of expected values:

$$\sigma^2 = varR = \mathbb{E}\big(R - \mathbb{E}(R)\big)^2 = \mathbb{E}\left(\sum_{i=1}^{n} w_i (R_i - \mathbb{E}(R_i))\right)^2 = \sum_{i=1}^{n}\sum_{j=1}^{n} w_i\, w_j\, \sigma_{ij}$$

where

$$\sigma_{ij} = \mathbb{E}\Big((R_i - \mathbb{E}(R_i))\big(R_j - \mathbb{E}(R_j)\big)\Big) = cov(R_i, R_j).$$

Let $C=(\sigma_{ij})$ denote the covariance matrix of the random vector $(R_1,\dots,R_n)$.

It is known that if we suppose that random variables $R_1,\dots,R_n$ are linearly independent (i.e. $\alpha_0 + \alpha_1 R_1 + \dots + \alpha_n R_n = 0$ holds only if all scalars are zero, namely $\alpha_i = 0$ (i =1,…,n)) then the covariance matrix is positive definite and its determinant is positive (hence it is invertible) (Prékopa, 1962). In the sequel we assume this linear independence. This assumption is not very restrictive, because in real life it would be very strange to find original stocks or bonds that have returns that can be derived as a linear combination of other stocks or bonds.

Rational investors are supposed to know the expected returns and the covariance matrix of the securities, i.e. the (column) vector **r** and the matrix **C**.

$$\mathbf{r} = (r_1, r_2, \dots, r_n)^{\intercal}; \mathbf{C} = \begin{bmatrix} \sigma_{11} & \cdots & \sigma_{1n} \\ \vdots & \ddots & \vdots \\ \sigma_{1n} & \cdots & \sigma_{nn} \end{bmatrix}$$

The investor uses this set of information to set up a portfolio in the present by taking w_i positions in the different securities. Introducing the notation $\mathrm{w} = (\mathrm{w}_1, \mathrm{w}_2, \dots, \mathrm{w}_n)^{\intercal}$ for the portfolio weights the total return and the risk (variance) of the portfolio can be obtained as.

$$R = \mathbf{w}^{\intercal}\mathbf{r}; \sigma^2 = varR = \mathbf{w}^{\intercal}\mathbf{C}\mathbf{w}$$

The investor wants to find the portfolio where w gives the reward R with minimal risk. To achieve this one has to solve the conditional extremum problem

$$\mathbf{w} \to \frac{\mathbf{1}}{\mathbf{2}}\sigma^2 \; is\; minimum \tag{1.1}$$

subject to the constraints

$$R = \boldsymbol{w}^{\intercal}\boldsymbol{r}, 1 = \boldsymbol{w}^{\intercal}\mathbf{1} \tag{1.1a}$$

where $1 = (1, \dots, 1)^{\intercal}$.

The first constraint refers to the level of return. *R* is usually assumed to be a positive number, because a rational investor would not invest in a portfolio with a negative return. The second constraint means that the investor must spend the whole budget on financial investments.

The Lagrange function for this problem is

$$L(\mathbf{w}, \lambda_1, \lambda_2) = \frac{\mathbf{1}}{\mathbf{2}}\mathbf{w}^{\intercal}\mathbf{C}\mathbf{w} + \lambda_1(R - \mathbf{w}^{\intercal}\mathbf{r}) + \lambda_2(1 - \mathbf{w}^{\intercal}\mathbf{1}) \tag{1.2}$$

From (1.2) we derive the first order conditions for the minimum. They are

$$\frac{\partial L}{\partial \mathbf{w}} = \mathbf{C}\mathbf{w} - \lambda_1\boldsymbol{r} - \lambda_2\mathbf{1} = \mathbf{0} \tag{1.2a}$$

$$\frac{\partial L}{\partial \lambda_1} = R - \mathbf{w}^{\intercal}\mathbf{r} = 0 \tag{1.2b}$$

$$\frac{\partial L}{\partial \lambda_2} = 1 - \mathbf{w}^{\intercal}\mathbf{1} = 0 \tag{1.2c}$$

Equation (1.2*a*) is a (column) vector equation (the partial derivative with respect to **w** means a column vector whose coordinates are the partial derivatives with respect to w_i).

To solve the (1.2*a*), (1.2*b*), (1.2*c*) system of equations first we find the Lagrange multipliers.

Multiplying equation (1.2*a*) by the inverse matrix $\mathbf{C}^{-1}$ we get

$$\mathbf{w} = \lambda_1\mathbf{C}^{-1}\mathbf{r} + \lambda_2\mathbf{C}^{-1}\mathbf{1} \tag{1.3}$$

Multiplying (1.3) by $\mathrm{r}^{\intercal}$ and $1^{\intercal}$ we get

$$\mathbf{r}^{\intercal}\mathbf{w} = \lambda_1\mathbf{r}^{\intercal}\mathbf{C}^{-1}\mathbf{r} + \lambda_2\mathbf{r}^{\intercal}\mathbf{C}^{-1}\mathbf{1} \tag{1.3a}$$

$$\mathbf{1}^{\intercal}\mathbf{w} = \lambda_1\mathbf{1}^{\intercal}\mathbf{C}^{-1}\mathbf{r} + \lambda_2\mathbf{1}^{\intercal}\mathbf{C}^{-1}\mathbf{1} \tag{1.3b}$$

Using the rules of transposition from (1.2b), (1.2c) we get a state where $\mathrm{R} = \mathrm{r}^{\intercal}\mathrm{w} = \mathrm{w}^{\intercal}\mathrm{r}, 1 = 1^{\intercal}\mathrm{w} = \mathrm{w}^{\intercal}1$.With the notations

$$\begin{aligned} \mathbf{r}^{\intercal}\mathbf{C}^{-1}\mathbf{1} &= A \\ \mathbf{r}^{\intercal}\mathbf{C}^{-1}\mathbf{r} &= B \\ \mathbf{1}^{\intercal}\mathbf{C}^{-1}\mathbf{1} &= C \end{aligned} \tag{1.4}$$

we can rewrite the system (1.3a), (1.3b) in the form

$$B\lambda_1 + A\lambda_2 = R \tag{1.5a}$$

$$A\lambda_1 + C\lambda_2 = 1 \tag{1.5b}$$

since by the symmetry of the covariance matrix its inverse is also symmetric, thus we have $\mathrm{r}^{\intercal}\mathrm{C}^{-1}1 = \mathrm{A} = \mathrm{A}^{\intercal} = 1^{\intercal}\mathrm{C}^{-1}\mathrm{r}$. The determinant ($\mathrm{D} = \mathrm{BC} - \mathrm{A}^2$) of this system is positive (this follows from the properties of the covariance matrix; the details can be found in Merton (1972)), hence it has a unique solution

$$\lambda_1 = \frac{CR - A}{D}, \qquad \lambda_2 = \frac{B - AR}{D} \tag{1.5}$$

With these values of the Lagrange multipliers the optimal portfolio - the solution to our minimum problem - can be obtained from (1.3). In the sequel **w** represents the optimal portfolio weights. Multiplying (1.2a) with $\mathbf{w}^\intercal$ we get

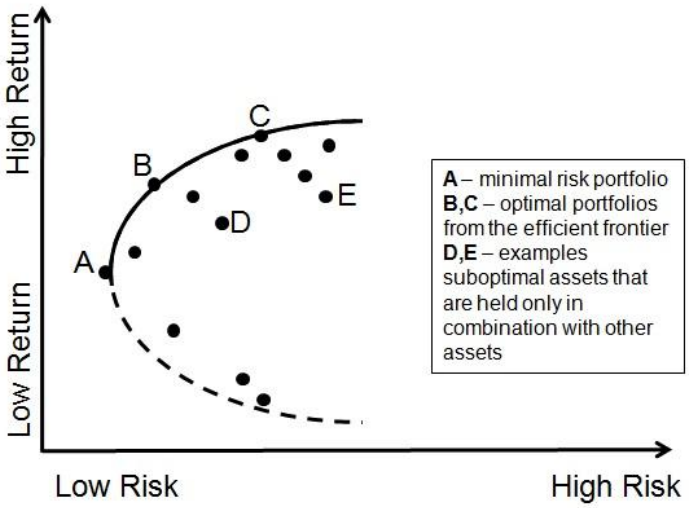
$$\mathbf{w}^\intercal\mathbf{C}\mathbf{w} - \lambda_1\mathbf{w}^\intercal\mathbf{r} - \lambda_2\mathbf{w}^\intercal\mathbf{1} = \mathbf{0}$$

and using (1.5) and (1.2b), (1.2c) with the notes made after (1.3b) with respect to *R* and the portfolio weights, we get

$$\sigma^2 = \frac{(CR-A)}{D}R + \frac{B-AR}{D} = \frac{B}{D} - \frac{2A}{D}R + \frac{C}{D}R^2 \tag{1.6}$$

Equation (1.6) describes a parabolic function in the *varR-R* space, and a hyperbolic function in the more common standard deviation *σ-R* space. Part of this curve is the efficient portfolio curve. *A portfolio of investments is efficient if it offers the least risk for a given level of return or the most return on a given level of risk. A set of portfolios fulfils these two requirements at the same time. This set is called the efficient frontier. The efficient frontier is part of a parabola in a mean-variance space, but it is more common to graph it in the mean-standard deviation space, where the frontier is a hyperbola (Merton 1972).* It is illustrated in Figure 1.

Figure 1: Illustration of the Markowitz portfolio theory



Source: Author

Figure 1 shows the image of the efficient frontier in the mean-variance space. The continuous part of the line represents the efficient portfolios. Portfolios outside the line cannot be realized and portfolios within the line are not mean-variance optimal. The non-optimal part of the frontier offers minimum variance for a given level of return, but not the maximum return for the given level of risk. This graph will be frequently in Chapter 2 and Chapter 4 to draw conclusions.

1.1.2. The Sharpe Ratio

One more financial term has to be discussed: the Sharpe-ratio. The Sharpe-ratio was named after William F. Sharpe, who introduced the measure in his seminal paper Sharpe (1966). Sharpe (1994) summarized some experiences with the ratio as well as defining it once again. Sharpe (1994) clearly distinguishes the *ex ante* and the *ex post* Sharpe ratio as two different variables. With certain assumptions the latter can be used to approximate the former. The Sharpe ratio is strongly connected to the Markowitz theory as it uses two momentum of return.

The *ex ante* Sharpe-ratio is the difference between the expected return of an asset r_i and a benchmark asset r_b divided by the standard deviation of the difference (σ_d where $d= R_i-R_b$, the difference between the two returns). The benchmark asset can be anything, but usually it is the risk free rate. In this case the difference is called the risk premium of the asset; moreover, the standard deviation of the difference equals the standard deviation of the risky asset.

$$S_{EA} = \frac{r_i - r_b}{\sigma_d} \tag{1.7}$$

The Sharpe-ratio has a special role in the above mentioned Markowitz model. Merton (1972) shows that if there is a unique riskless asset among the investment possibilities, then the efficient portfolios will lie on a line in standard deviation-expected return space[5], and they can be set up by mixing a special portfolio of risky assets and the riskless asset. The line is called the credit market line, and the special portfolio is the so-called market portfolio, and can be described by the intersection of the efficient portfolio frontier and the credit market line. The slope of the credit market line is the Sharpe-ratio of the market portfolio if the benchmark asset is the risk free rate.

Investment strategy can be based on the Sharpe-ratio. The point of taking the difference in the numerator is that a zero-investment strategy is assumed. This means that to buy an asset the investor loans or shorts an asset as well. The expected return of such an investment is the difference between the cost and the return. The expected return is then compared to the risk of such an investment. With this in mind, an investment with a large Sharpe-ratio would be advised for a long position, while an asset with a low Sharpe-ratio would be advised for a short position. However, as Sharpe (1994) points out, it is not very wise to base decisions on such a simple measure; other momentums should be taken into account. If the assumption of no-arbitrage stands then all the assets should have the same Sharpe-ratio, otherwise there

[5] Actually it is an absolute value curve (V-shaped), but one of the branches is inefficient, because it does not offer maximum return for the given level of risk

would be opportunities for risk arbitrage. In fact, in an intuitive way the Capital Asset Pricing model can be derived from this theory, and it is a cornerstone model of finance, but a derivation is dismissed, because at this point it might seem that we have moved away from the questions of education. However, this is not the case. In Chapter 2 it will be argued that there are barriers to investment, like minorities and disadvantages, and, moreover, that it is time consuming. In Chapter 2 it will be also argued that the state is deeply involved in education markets and might have many distortions. It all points to the inefficiency of the education market as an investment market. This means that if there are risk arbitrage opportunities then those might remain for a long time. In an efficient market price changes would make an arbitrage opportunity vanish immediately, because infinitely many investors with infinite investment resources would try to exploit it. However, if education offers a high return for risk the adaptation would take a long time. In fact, Palacious-Huerta (2003) point out that human capital investment seems to offer significantly larger Sharpe-ratios than capital markets. It will be discussed in Chapter 2.

The *ex post* Sharpe-ratio is the statistical measurement of the historical experiences for the variables. This is expressed in Equation 1.8, where $d_t=r_{it}-r_{bt}$ and it is the difference in the experienced return at time period *t*.

$$S_{EP} = \frac{\sqrt{T-1}\sum_t (r_{it}-r_{bt})}{T\sqrt{\sum_t (d_t-\bar{d})}} \quad (1.8)$$

The *ex post* Sharpe-ratio is a good approximation if we assume that the past is a good example of the future in the sense that it develops from the same distribution as the future data will be.

In conclusion of this subchapter: Risk was defined as market risk for the thesis. It derives from the possible deterrence from the expected return to an investment. Variance was used for measuring it and the Markowitz model was introduced for understanding investor choice on a risky market. The conclusion was that investors choose from efficient portfolios, if they follow Markowitz ordering. These efficient portfolios must fit to a specific equation and it has a simple graphical interpretation. It will be used to understand educational choices where we assume different educational programmes are portfolios of human capital investment. First education theory must be introduced.

1.2. Education theory – Social role of education in economics of education

Education will be approached as an investment that has its costs and returns. It must be made clear right at the beginning, that not even I believe that education is purely an investment. Polónyi (2011), in a summary paper, states that education research in economics is part of

"economic imperialism", which refers to the phenomenon that economics, with its methodological tools, discusses topics that traditionally belonged to other realms of science. Education as the field of research is discussed in several other sciences such as sociology or psychology. As Lazear (2000) express it: the point is that economists approach things with certain tools, and this is what separates them from other social scientists, not necessarily the topic of the research. The approach includes the following assumptions:

1. *Actors in economic models use constrained maximization to make decisions.*
2. *There is an equilibrium of the market, and unless some external change occurs, the system will be in equilibrium.*
3. *Efficiency is a central question in equilibrium evaluation. An efficient equilibrium occurs when no player can be better off without someone else being worse off who cannot be compensated.*

Basically, these are the tools that will be used throughout the thesis. Human capital theory is one of Lazear's (2000) prime examples of a field in which economic theory has achieved great success. Neither this nor any of the results of this dissertation suggest that a student of the education system, a state legislator or a company in the region of the higher education institution[6] should, in fact, be a conditionally maximizing "*homo oeconomicus*". This is a general assumption, and does not necessarily have to be true. Friedman's (2008:154) *Methodology of Positive Economics* is an important reference in which he explains, through physical and social science examples, that a hypothesis should be judged not by the reality of its assumptions but the explanatory power of the relatively simple model. If we want to calculate when a heavy ball dropped out of a window will reach the ground, we should use an equation deriving from a model in which a vacuum is assumed. It will provide us a fairly accurate calculation even if the ball is in fact not falling in a vacuum. However, if we want to apply the same theory to a feather it will lead us to a wrong calculation. In Chapter 3 it will be discussed how the assumptions of the aforementioned Markowitz model translates to the higher education market.

This must be emphasised, because not even I think that, for instance, students are atomic decision-makers maximising one or two factors, although this is the assumption throughout the paper. Decisions on what an individual will study, how long he/she will study, and how he or she will use the knowledge acquired is the outcome of complex social interactions. This has

[6] Higher education institutions will be referred to as colleges or universities; however, they are two types of higher education institutions. There are even differences among countries in the actual type of institutions they refer to. So, henceforth, when the terms 'college' or 'university' are used they should be understood as an average institute in the higher education system.

interesting social and psychological aspects. In this dissertation a simplification will be used for the sake of modelling and the complexity of the actual decision-making process will not be considered. Only monetary gains and costs will be considered, although education has other returns than wage advantage; these, however, are beyond our current measurement purposes.

Even though education was simplified to monetary evaluation of costs and benefits there are still some questions that should be addressed. It must be explained how education will result in future benefits. Two set of theories offer explanation. Human capital theory relates education to productivity enhancement while sorting theories suggest that education has information value on the labour market. First the theories will be discussed in respective subchapters then the risk literature will be overviewed. In this subchapter human capital and investment in human capital will be defined for the thesis. The idea behind the rate or return to education will be introduced and some alternatives for the social role of education will be presented.

1.2.1. Definition of Human Capital

One of the fundamental questions of economics is why some countries, regions, cities, and individuals prosper and others do not. What kind of income participants earn is a characteristic feature of any economic system. This subchapter will be a short summary on microeconomic studies on individuals' investment in education. Why do some individuals choose to study more than others? What consequences does this have for the individuals? What is the relationship between education and earnings, and how can it be explained?

Adam Smith is a popular point of reference for the origins of involving education in economic conversation. Adam Smith introduced the idea that the labour force should be considered as a capital asset and it is a part of the production process. That idea underpinned the classic approach, which includes the number of employees in production functions (Varga 1998). However, the homogenous labour approach tends to be an oversimplification. It certainly is when we consider complex, creative industries where the role of human labour is not based on the physical attributes of the employees. In these cases the productivity of the employees can differ significantly.

For a long time people did not felt it right to consider labour as a type of asset, because they felt it is somewhat degrading for people; however, it is necessary to enter it as an input when we try to construct an accurate production function (Varga 1998). This is why the amount of labour consumed is represented in a usual economic production function, and generally

symbolized by the letter L. As Schultz (1961) suggested, it is not necessary to consider an individual's contribution to the production as a unit. This would be like only counting the number of different machines when we try to count the capital consumed in production.

Measuring human capital considers the difference among individuals based on their productivity. The source of the differences in productivity is the different investment individuals make in their own human capital. Based on Becker (1964), human capital is usually defined as the individual's knowledge, skills, information and health. As Wright – McMahon (2011) mentions, psychologists, for example, define it differently. Throughout this paper human capital will be understood as human features that influence productivity. One can invest in human capital by consuming productivity enhancing products and services. For example, a chef buying and studying a cookbook can raise productivity, or attending a language school and studying a foreign language raises productivity if one works in a job where the use of foreign language has positive benefits. Schultz (1961) points out five typical productivity enhancing activities:

- Health care expansions;
- On-the-job training;
- Formal general education;
- Adult education outside of the firm;
- Migration.

Different approaches to human capital than the above mentioned microeconomic-econometric approach can be found. As Wright et al (2014) points out, strategic management and human resource management both approach human capital from different directions, and offer some newer systems for human characteristics to determine human capital. These studies are very important for managers when they want to enhance the productivity of their employees and subordinates. However, an anecdote cited by Wright et al (2014) is very fitting:

"The Jain version of the blind men and the elephant tells the story of six blind men who are asked by a king to describe the elephant. Each man feels a different part and describes the elephant in terms of something he can explain (e.g., the one feeling the tail says it is like a rope, the one feeling the ear describes it as like a hand fan, the one who feels the tusk likens it to a pipe). Many use the story to illustrate that no one's subjective experience completely describes a phenomenon. Like the blind men and the elephant, since the economist Becker (1964) proposed "human capital theory," the study of human capital has emerged across a

variety of disciplines. Within the management discipline, both the strategy and human resources management (HRM) fields have devoted considerable attention to the concept of human capital, yet these two areas seem to have emerged along separate, but somewhat parallel, paths." Wright et al (2014:353-354)

This is the reason why more detailed discussion of different human capital definitions will not be presented, but the Schultz-Backer type of approach will be accepted.

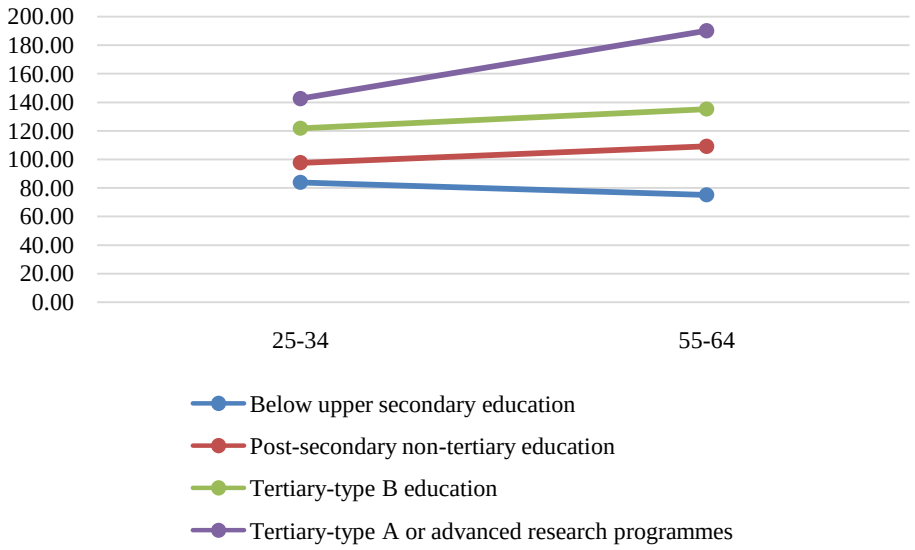
1.2.2. Rate of Return to Education

In traditional economic fashion the human capital increasing effect of education will be reflected in different wages. This leads us to one of the focal points of interest: different earnings functions for different educational attainments. Figure 2 is simple but well represents the core problem. It shows the relative earnings of employees by educational attainment and age group based on data from 2012. The data is the average of the 34 OECD countries.[7] Average income for a given age-education attainment cohort is given in percentage of the secondary educated group of each age group. Those who finish education before upper secondary education and are in the 25-34 age group earn approximately 84% of those who finish after upper secondary education in the same age group. Those who have degree from a tertiary type-A or advanced research program and are from the same age group have a 42% wage advantage. The income advantage of the more educated seems to increase over time as gaps are wider for elder cohorts.[8] This suggests that there must be some kind of long run relationship between educational attainment and productivity. The task was to find a way to quantify it.

[7] There will be a detailed introduction to the database in Chapter 3.1.3.

[8] Varga (1998) emphasises that the cross-sectional nature of the data is important, because those who belong to different age groups were involved in different educational experiences. Nowadays elementary education is not the same as the elementary education of the 1980's or 1950's.

Figure 2: Relative earnings of employees, by educational attainment and age group (2012), Adults with income from employment in OECD countries; upper secondary education = 100



Source: Based on OECD (2014a:141)

Various classical authors have made calculations and contributions to human capital measurement. William Petty, Von Thünen, Farr, Marshall, Giffen, and Engel contributed to the determination of investment in human capital, but creating a coherent theoretical system for human capital occurred in the 1960's. Three authors are usually referred to for human capital theory: Schultz, Becker and Mincer (Varga 1998). Schultz and Becker were awarded a Noble prize for their contribution to economic science in the field of economic development and human capital, among other topics[9].

Becker (1964) approaches the questions of human capital in a formal way. He compares on-the-job training, and the general training provided by the company. Becker (1964) considers schools as producers specialized in general training. One chooses or even pays to participate in formal education because it has a positive private return to it in the future. The student compares the productivity enhancement effects on future earnings and the costs of schooling such as tuition fees, price of textbooks, dorm rental, etc... The opportunity cost of education is the unearned wage during the time spent studying. When Becker mathematically formalizes his theory he uses the tools of standard investment theory, which is why the internal rate of

[9] In 1979 it was awarded to Theodore Schultz together with Arthur Lewis, for "their pioneering research into economic development research with particular consideration of the problems of developing countries", and in 1992 to Gary Becker "for having extended the domain of microeconomic analysis to a wide range of human behaviour and interaction, including nonmarket behaviour".

return has an accentuated role in his work. Calculating the rate of return could be approached by a comparison of the life-long earnings function of those who have a higher education degree and those who have only completed secondary education. Those who have only completed secondary education have a positive income in the earlier stage of their lives; the difference between the two curves at this stage is the opportunity cost of education. This should be extracted with the direct costs. The benefit is the difference between the two curves for the time when the earnings are higher for those who have higher education. *The rate of return to schooling is the rate of return that makes the present value of costs and returns equal (Psacharopoulos 1995).*

First we have to calculate the net present value of the investment in education. Equation 1.9 is based on the rate of return calculation presented in Blöndal et al (2002); here we use the notation but a net present value measure is presented

$$NPV_j = \sum_{t=a+l+1}^{n}(1+\delta)^{-(t-a)}B^j(t) - \sum_{t=a}^{a+l}(1+\delta)^{-(t-a)}C^j(t) \quad (1.9)$$

Where:

$$C^j(t) = \left[1-\tau(w^{j-1}(t))\right]\left[1-\gamma^{j-1}(t)\right]w^{j-1}(t)(1+g)^{t-a} + \varphi^j(t)(1+g)^{t-a} - S(t)B^j(t)$$

$$= \left[1-\tau(w^j(t))\right]\left[1-\gamma^j(t)\right]w^j(t)(1+g)^{t-a} -$$

$$-\left[1-\tau(w^{j-1}(t))\right]\left[1-\gamma^{j-1}(t)\right]w^{j-1}(t)(1+g)^{t-a} - R(t)$$

The variables in Equation 1.8 are:

δ – Alternate cost of education (can be the rate of return to a lower level of education)

t – The age of the individual when starting level *j* education, that takes l years to finish

$C^j(t)$ – Net cost of *j* level education

$B^j(t)$ – Net income advantage of the degree holder with *j* education over *j-1* education[10]

$w^j(t)$ – Net annual earning with *j* level of education

$\tau(w^j(t))$ – Tax rate with *j* level of education

g – Rate of economic growth

$S(t)$ – Money transfer after education

$R(t)$ – The student loan repayment

$\gamma^j(t)$ – Unemployment rate in the given cohort (*j* education, *t* age)

$\varphi^j(t)$ – Cost of j education

[10] j minus one education, one level lower education.

a – Typical age for starting education j

l – Standard length of education j

n – Expected year of retirement

The internal rate of return of such an equation is called the rate of return to education. As it can easily be seen this requires a huge amount of data. A large panel of data is needed for a long period of time and for different levels of education to take into account the foregone earnings. The foregone earnings are the earnings that would have been earned without obtaining a given level of education. The usual benchmark is the average earnings with secondary education. This kind of calculation is costly but more meaningful when it is calculated for a large proportion of the population. For example, what are the rates of return in the Hungarian education system? It becomes more difficult when we want to calculate what kind of return people should expect, if they had completed, for instance, their MSc degree in a 6 semester economics programme in 2007. It is also important to take from Equation 1.9 the fact that the rate of return is sensitive to how the costs are dispersed over time. Another methodology of calculating the rate of return is based on the Mincer income equation. It will be considered in Chapter 3 of thesis since it is more of a methodological question. *According to financial theory an individual would invest when the rate of return is greater than the expected return, because this will also represent positive net present value.*[11]

The relationship between education and earnings is so strong that rate of return studies have found positive returns to education for generally all levels of schooling, but the rate of return does not necessary grow with the level of schooling. To demonstrate this let us consider three studies involving three different countries. Psacharopoulos (1995) introduced the calculation of the rate of return to education in the case of Venezuela. In that country elementary studies have the highest rate of return with 25-30%, whereas secondary and higher education have between a 10 and 15% rate of return, according to the calculation method. On the contrary, in Australia the bachelor degree has the highest expected rate of return for those who were 15-17 years old at the time of measurement, but all the rates of return were somewhere between 10% and 20%. It is also important to mention that in both these examples the rate of return is heavily dependent on such indices as nationality or sex. Varga (1995) measured the highest rate of return to university studies as 13.4%, while a secondary school certificate has an 8.2% rate of return and vocational training has the lowest with 4.8%. Not surprisingly, Hungary witnessed a huge educational expansion after the mid 90's.

[11] This is true only when an investment has negative cash flow in the beginning, then strictly positive cash flows, and there are no changes in sign.

As Weiss (2015) summarises in his paper recalling Becker's work, his books on human capital have a citation index over 2000, and the number is still exponentially growing. The term human capital has become part of the technical vocabulary of economics. Some of the best known economists of the 20th century added to the field of human capital and Weiss (2015) mentions a few of them, including Mincer, Ben Porath, Rosen, Heckman, Lucas, and Barro. Human capital theory and research into it is the part of mainstream economics.

The reason it has remained a much debated topic is that although both microeconomic relationships and macroeconomic relationships are fairly easy to show, this does not necessarily mean there is a causal connection. Ideas on causality should come from theory. This is the most difficult part. Internal productivity is something that cannot be measured directly, especially not when the individual is not even employed. Because of this, the individual's productivity before, during and after the education process is not known, which means that there are many ways to explain the connections between a higher level of education and better economic endowment even if we remain strictly within economic theory. First the idea of risky human capital investment will be discussed then alternative theories will be evaluated, because they are essential to the robustness of the results of the thesis.

1.2.3. Risky Human Capital Investment

The main problem of the dissertation is related to the topic of how risk can be measured in human capital investment. Risk in individual education investment was studied as early as the 1970's (for instance: Levhari-Weiss 1974, Hamilton 1987, Judd 1998, Putvaara 2003). The theories are usually the outcome of a two-round Fisherian dynamic optimization problem. *Risk appears as a random variable multiplying the outcome of human capital accumulation. This is basically an exogenous variance in human capital returns.* It will be shown that neither the theory nor the empirical evidence has answered every risk related questions yet. The main contribution of the paper will add results to this field of literature. However, first both theoretical and empirical results must be discussed in more detail.

In the seminal paper by Levhari – Weiss (1974) the Fisherian tradition was followed by analysing the effect of risk on human capital investment in a two-period model. This framework caught on in the literature and was developed further by Eaton – Rosen (1980) and Hamilton (1987). They analysed the influence of income tax, tax on interest income, and transfer incomes on human capital investment. Hamilton (1987) expended the Eaton – Rosen model with interest income taxation in such a way that it did not affect the conclusions derived from the original model. For this reason the basic model of risky human capital

investment is referred to as the Eaton – Rosen – Hamilton model (T. Kiss 2010). In order to clearly define assumptions, variables and relations we introduce the maximization problem of the ERH model without discussing the derivation of the solution in great detail, which can be found in the original paper. The model will be introduced based on Hamilton (1987).

The model describes a two period economy with atomic actors. Initially equal participants decide on education investment and consumption in the first period. Education is chosen by allocating time. The actors do not spend anything but time on studies, so the cost of education is fore-gone earnings. The money that was not spent on consumption is saved. In the second period the actor consumes all earnings and savings with its return. The state is also an actor, who collects labour income tax and interest income tax and also provides social transfers. The state can manipulate the choices of the other actors with these tools. The model will be introduced in a simplified form with no interest rate tax. It is based on Hamilton (1987).

The list of variables in the model is the following:

L_i – labour supply in the *i*th period; this is a measure for time (can be chosen by the individual);

H – human capital investment the first period, $H \in [0,1]$ (can be chosen by the individual) =>$\mathrm{L}_1 = 1 - \mathrm{H}$ is the labour supply in the first period (time not spent with studies);

ε – random variable with $E(\varepsilon) = 1$;

w_i – wage in the *i*th time period; $w_1$is known with certainty and $w_2(H, \varepsilon)$ is the function of H investment and ε random variable.

C_i – consumption in the *i*th period; the price of consumption is assumed to be 1

S– saving in the first period;

r– interest rate; known with certainty

B– lump sum transfer, such as scholarships, grants or other support;

t_w – wage tax;

ρ – discount factor between the two periods;

$U^i(C_i, L_i)$ – utility function in the *i*th period; this is assumed to be strictly concave

Y_2 – capital in the second period, $Y_2 = S(1 + r) + B;$

$V^2(\cdot)$ – indirect utility function in the *2*nd period; this is the function of the price of work and consumption and the budget.

$\overline{\mathrm{G}}$ – the targeted balance of the income sheet of the state.

The wage of individuals in the second period is the function of first period of human capital investment and the value of a random variable, so it is $w_2[\varepsilon, H]$, but w_1 is an exogenuous

constant. It is assumed that there are no possibilities to hedge against the risk. Individuals solve the problem (Equation 1.10) in the first period.

$$\mathrm{C}_2, \mathrm{L}_2 \rightarrow \mathrm{U}^2(\mathrm{C}_2, \mathrm{L}_2) \text{ is maximum} \qquad (1.10)$$

subject to the constraint:

$$C_2 = (1 - \mathrm{t_w}) w_2(H, \varepsilon) \mathrm{L}_2 + \mathrm{S}(1 + \mathrm{r}) + \mathrm{B} \qquad (1.10a)$$

Equation 1.10*a* refers to the fact that the individual consumes all resources available. The three parts of the sum are the net income from labour activity, savings and its interest and the lump sum transfer amount. The consumption derives from labour supply, so individuals will choose the labour supply that maximizes consumption. The maximization problem in the first round

$$H, S \rightarrow \{\mathrm{U}^1(\mathrm{C}_1) + \rho \mathbb{E}(\mathrm{V}^2((1 - \mathrm{t_w}) \mathrm{w}_2(\mathrm{H}, \varepsilon), \mathrm{Y}_2))\} \text{ is maximum} \qquad (1.11)$$

subject to the constraints:

$$C_1 = (1 - t_w) w_1 (1 - H) - S + B \qquad (1.11a)$$

$$\mathrm{Y}_2 = S(1 + r) + B \qquad (1.11b)$$

where $\mathbb{E}(\mathrm{V}^2((1 - \mathrm{t_w}) \mathrm{w}_2(\mathrm{H}, \varepsilon), \mathrm{Y}_2))$ is the expected indirect utility given H, which determines the w_2 and Y_2.

In Equation 1.11*b* the constraint refers to the fact that the first period consumption is the leftover from earnings and transfers after savings and taxation. Human capital investment decreases first period earnings because the investor's time was partially inactive. If the individual decides to invest in human capital and cannot work full-time, she has to give up $1 - H$ portion of her income. With the aid of the features of the indirect utility function and Roy's identity[12], Hamilton shows that individuals' human capital investment is influenced by the wage tax. The higher the wage tax is the lower level of human capital investment will be chosen.

Hamilton (1987) compares the individual maximization problem to the problem of the state. The state wants to maximize the utility of the population by choosing the right level of income tax, lump sum tax and human capital investment. Putting the last variable in the decision range of the state might appear strange, but the purpose is to compare whether there

[12] Roy's identity states that the individual consumer's marshallian demand function is equal to the ratio of partial derviatives of the indirect utility function. (Wainwright 2004:8)

is underinvestment if human capital decisions are made by individuals. In real life in public education there is a minimum school leaving age, so the state sometimes has greater influence on human capital investment than just a simple incentive. With Equation 1.11, 1.11a and 1.11b we arrive at the conditional maximization of the state:

$$\mathrm{t_w; B; H} \rightarrow \left\{\mathrm{U}^1\left((1-t_w)w_1(1-H)-S+B\right)+\rho\mathbb{E}(\mathrm{V}^2((1-\mathrm{t_w})\mathrm{w_2(H,\varepsilon)}, S(1+r)+B))\right\} \text{ is maximum} \quad (1.12)$$

subject to the constraint

$$\mathrm{t_w}\left(\mathrm{w_1}(1-\mathrm{H})+\frac{\mathbb{E}(\mathrm{w_2 L_2})}{1+\mathrm{r}}\right)-\mathrm{B}\left(1+\frac{1}{1+\mathrm{r}}\right)=\overline{\mathrm{G}} \quad (1.12a)$$

Equation 1.12*a* refers to the assumption that the state must hold a balance target $\overline{\mathrm{G}}$. Income can come from two periods. Fore-gone earnings in period 1 are a cost for the government, because it will cause fore-gone taxation.

As Hamilton (1987) solves problem in Equation 1.12 he states that from the point of view of the government it does not matter how the savings are affected by the taxation and transfer payments. After making natural assumptions on the sign of the derivatives he derives two important results of the literature. The first is that if wages are insecure, labour supply is a non-decreasing function of wages, and a decreasing function of lump sum transfers and taxation then in the framework of the model the optimal income taxation is positive. When Hamilton (1987) enters the taxation of interest it will have a positive value as well. Another statement is if $\mathrm{w_2[H;\varepsilon]} = \mathrm{f[H]g[\varepsilon]}$, so *in the individual optimum there is sub-optimal investment in human capital because of risk. This is a very important message, because it means risk can deter human capital investment, so the state must step in with regulation, taxation and transfer support*.

There is a debate in the literature about whether education should be approached as a risky investment or as an insurance against labour market risk (Anderberg – Andersson 2003). The core concept of the debate is that those who have more education tend to perform better in the most important labour statistics. This is hard to argue with, although if it is insurance then it requires a very large amount of investment. Those who participate in full time education programmes usually miss years from the labour market. Even if we accept the insurance hypothesis, this insurance does not give full protection, and its payoff is not automated. As Avery-Turner (2012) pointed out, although higher education graduates have better career expectations there are large differences in the private rate of return to education experienced

by the individuals. Cunera et al (2004) finds that 30% of the graduates would have changed their education if they had been aware of their life-long earnings. The private risk of education has an important role in the public financing of education. Hillman (2014) published a study dealing with the fact that students with low-incomes and from minority backgrounds have a disproportionally high chance of defaulting on their student loan. Depending on education's risk-increasing or decreasing nature, different policy advice can be given (Anderberg – Andersson 2003, Jacobs et al 2009, Anderberg 2009), but this has been criticised by da Costa – Maestri (2007). In Chapter 2 more empirical evidence on educational risk will be introduced, such as Carniero et al (2003) and Chen (2008). The previous discussion is expended with some results in Chapter 4.

1.2.4. Introduction to Alternative Theories of Education Especially with Respect to the Role of Risk

Features of human capital theory will be used in Chapter 4 to derive some results. For this reason alternative theories should be discussed. It might be necessary because even mainstream economics have some complementary theories to human capital theory. In fact there can be many more explanations for the connection between higher life-long earnings and educational achievements then human capital theory. For example *education can be consumption.* It is easy to believe that those who like learning new things, and who are not afraid of testing themselves, and are willing to take responsibility can be successful at the workplace and in school. So people with high productivity may likely prefer schooling as consumption at a younger age than those who are not productive. However the theories that received the most attention were sorting theories.

Sorting is a family of theoretical and empirical models, and the common element is that education has information value in asymmetric information environment. The models assume information asymmetry on the labour market. This means productivity cannot be measured by future employers. It is a realistic assumption, because if scientists have difficulty measuring it, it must be equally difficult for companies. If heterogeneity of productivity is added as an assumption, something which was already involved and accepted in human capital theory, the labour market can be an ideal example of the analysis of markets with information asymmetry. In fact this theory arises unrelated to the subject of education.

The seminal paper by Akerlof (1970) suggested the examination of markets where the sellers of products have an information advantage over buyers with regard to the quality of the product. The buyers only have information on the distribution of the quality of products

brought to the market. However, they cannot distinguish between a good quality and bad quality product. He introduced the concept with the famous example of used cars. It is the market for lemons (i.e. poor quality cars). In Akerlof's model the information asymmetry led to the total disappearance of the market. The buyer would evaluate good cars higher than their owners, but if they could not distinguish between good and bad quality, they would only be willing to pay the price of an average quality car. Consumption would become a lottery for them. In Akerlof's model, sellers would not sell undervalued cars. So they would only bring lemons to the market, which would drive away the customers. Consequently the market would become crowded out by lemons. This is a suboptimal equilibrium, because in the absence of information asymmetry the good quality cars would have changed hands, and buyers and sellers would be better off.

One possible solution to the problem of information asymmetry is signalling. Signalling is an activity for sellers with costs negatively correlated to the quality of the sellers' product. Spence (1973) explained it through the example of the job market. Spence argues that the cost of education is a decreasing function of the individuals' predetermined productivity. Consequently the decision on investment in education is a game. It has separating equilibrium when people with lower productivity decide to stay away from school, but people with higher productivity rather invest in schooling. The different behaviour of the two groups makes it possible for the employer to distinguish between more productive and less productive employees and on a competitive job market, this will lead to wage differentiation.

The signalling model has a wide range of applicability, but it has also made a great impact on education theory. The signalling model offers an investment explanation for schooling without assuming human capital enhancement. This has made a profound impact on the literature, and even though it was stated that the human capital enhancement effect of education can be inserted into the models, it became associated with a rejection of human capital enhancement. Many emphasise the feature of the basic models, i.e. that education has no growth effect. This is unfortunate, because for instance, as early as Stiglitz (1975), it was shown that with some easy modification, models can have a growth effect. If signalling is used for job-matching it can increase the output of society. Job-matching refers to the possibility that individuals have a different productivity in every different job they take. Matching those who have high productivity in one type of job to that exact job has an effect on others as well. So even if education is a signal it can have a positive external effect.

Besides signalling, another family of theories is the screening hypothesis. The idea of education as filter or screen was used first by Arrow (1979). He introduced a model where

two types of job exist. Everyone has the same productivity in a type one job, but the marginal product of labour is heterogeneous in a type two job. So the company is interested in sorting out those who are more productive in the type two jobs, and assign the less productive to the type one jobs. Screening is done by education, and the company gives incentives to the people to be screened by offering a job menu. People can choose from requirement-payoff combinations. Those who would be better off in type two jobs even if they satisfy the employer requirements will have higher education attainments. It is also a crucial feature of the screening model that the cost of education has a negative relationship with productivity in type two jobs.

This kind of screening can have a job-matching effect. It raises the total product if the more able people are assigned to the type two jobs. This is usually overlooked. Education has only an informational value in screening theory, but this information is used to enhance production so this will lead to a positive social return, not only a private return.

Whereas human capital theory is the most popular, all the three concepts might be equally true. Any *sorting theory can be expended to include human capital accumulation*. Riley (1979) had giving an example. Even Arrow (1979) states before introducing labour market screening theory that he does not believe in that the only purpose of schooling is screening. In case of consumption theory Elster (1997) reacts to Becker (1996) by suggesting a clever example. If human capital investment is a pure investment then it is giving up something in the present to gain an advantage in the future. However, if education is consumption and human capital accumulation in the same time, then it is like gaining advantage now to have even more advantage in the future. *This states that education can have immediate benefits and future benefits as well*, whereas other types of investment have immediate costs and only future benefits.

Risk can be introduced to sorting theories. Risk can be connected to:

- the knowledge on productivity;
- the test of the productivity;
- the future value of the information.

For sorting theories to work the requirement is that one party should be better informed then the other. The better informed must not necessary be fully informed. Levin (2001) provides example on markets where the seller has partial information on the product quality. It can be specified for job market. If the worker has better information for estimating his or her productivity they can make signalling decisions based on that. However eventually after job

market employment people can experience that the *ex ante* estimation turn out to be wrong. That is a risk, because worker would have been better off without signalling.

The test of productivity itself can be a risk factor. If for example the probability of the test success is a positive function of productivity the test results can serve as a signal. Feltovich et al (2001) use similar risky signalling devices. If the costs are upfront but education as a test results in an unfortunate dropout[13], then it is a risk. Dilme – Li (2014) also presents theoretical work using signalling context to evaluate the role of dropout. They analyze the effects of exogenous dropout on endogenous dropout. They argue that some of the collage dropouts only attend college to mix with those who actually wanted to finish, but for some unfortunate reason they drop out. So the early year dropouts are a mix of more able and less able, although later dropouts are mostly more able. They also offer their model with human capital expansion.

In consideration of the risk of the future value of the information it is worth to consider some recent studies. Some of the more recent papers on the topic of job market signalling and screening are good illustrations of how sophisticated the field has become. Zheng (2013) examines the extensive growth in US higher education, which this paper will also consider in Chapter 4. He assumes a dynamic technological change that results in growing importance of skilled labour. However, companies can only observe signals. In his model agents have financial barriers to signal, but economic growth makes higher education more accessible. This will lead to better signals and increase the wage gap between university and high school graduates. He finds that 15% of the gap can be explained by the signalling effect. Regev (2012) introduces an interesting idea where it is not the costs of education which differ for the more able and the less able, but what kind of return they can expect on their education investment. It is a mixed human capital-signalling model, where education increases productivity, but the human capital accumulation depends on its initial value, and information asymmetry exists as well. Regev (2012) argues that his theoretical results fits very well with the above mentioned mechanics on the higher education market, such as increasing participation, increasing tuition fees, and an increasing wage gap.

[13] By unfortunate an exogenous effect is meant. For instance someone who is perfectly capable of finishing education drops out, because an injury that does not affect long term productivity.

Even the Spence (1963) study discusses the conditions for a cost structure of signalling that results in a separating equilibrium. Information is useless when it is not separating groups. If everyone has a degree, it will have no effect in a signalling environment.[14]

All three risk factors points to a same conclusion. Risk is eventually appearing in these models in the fluctuating nature of future income. This is fundamentally the same as how it appeared in human capital theory. However in case of human capital theory education produces some additional productivity no matter of the credentials. This suggests that even an unfinished education program can have long run effect. In case of signalling dropout usually means large decrease in the value of education and even successful finish can have minimal value if too many people have equivalent education signals.

For the sake of simplicity education will be considered as human capital investment but where it is necessary there will be reference to the alternative theories.

1.3. Short Term Macroeconomic Implications – Risk of an Economic Crisis Caused By Student Loan Debt

Macroeconomics deals with the economy as a whole. Education has different ties to macroeconomics. A simple consequence of the idea of human capital theory is economic growth fuelled by human capital accumulation. If education increases productivity then where and when people are more educated the total output should be higher. One very popular idea is to include human capital in growth models. One very famous example is the Mankiw-Romer-Weil model that augmented the cornerstone Solow model with human capital. Human capital is represented in econometric models often by education proxy variables. Since the growth theory was augmented with human capital education became a regular topic in economic growth literature. This extremely rich literature offer at least three approach for the explanation of the relationship between education and macroeconomic performance. The first suggests that human capital has exogenous effect. Some countries have more educated population for some reason not explained by the model and consequently the human capital level is higher so as the economic output. Some theory suggests that human capital is an endogenous variable. Lucas (1988) is one of the famous examples. According to Lucas (1988) human capital spills over. So a high level of human capital will lead to even more human capital. The third approach suggests that both high level of human capital and high level of output is the result of institutional settings that favours economic growth. Summarising the seminal work of North and Thomas, Acemoglu et al. (2014) point out that a higher level of

[14] Unless the type of the degree matters.

human capital in more developed countries is not a cause but a consequence (together with other better economic conditions). The level of human capital is endogenously determined. As Acemouglu et al (2014:876) states, citing North: "*The thrust of their argument is that although rich countries clearly have greater levels of total factor productivity (TFP); more educated employees (human capital); and more machines, tools, and factories (physical capital); this is not an explanation of the sources of differences in prosperity. Rather, it just redescribes what it means to be prosperous."*

They also find in their research on economic history, that the level of human capital is more likely to be a side-effect or a proxy of better institutions, which fits their previous researches. They use cross-country analysis. Their results are disputed by such names as Gleaser, who argues that human capital is more complementary to the effect of institutions than a consequence of it.

Without further analysis of this exciting field of literature it can be concluded that the long term effect of education on economic growth is fairly complex even if it is assumed to be human capital accumulation. The picture is even more colourful if we consider the earlier mentioned alternative theories. However the questions are numerous they approach education as some sort of process that has long term effect and it takes long time to create these effects. A more concrete example: an education reform is not expected to have nearly as rapid effect on the economy as a change in the Federal Reserve interest rates. Accumulating skills and knowledge is a very time consuming activity. Can the education choices have short-term effects on the whole economy? Davies-Harrigan (2012), McCluskey (2013) and Stiglitz (2013) argue they can have that, for instance they can cause a crisis.

The idea spans from that the educational choices have financial consequences. The education funding system ties education to the financial market, such as the housing market is tied to the financial market. Housing market fluctuation shook the financial system in 2008. However before the evaluation of the possibility of a macro level crisis caused by the education market the education funding system must be introduced. In this chapter the participants of systems will be grouped, the main tools of funding will be introduced and finally the crisis theory will be described.

1.3.1. Participants of Funding Higher Education

The classification will be made based on the close review of the topic in Johnstone (2004)[15]. One of the fundamental issues in economics is the participation of the government in any

[15] A great literature review can also be found in Semjén (2013)

market. The government is so involved with the education market that it is the main financer. The OECD average of public financing of pre-tertiary education is 91.4% and for EU 21 countries it is 93%. Among OECD countries private financing only exceeds 20% in Chile[16] (OECD, 2014a). For tertiary education the picture is more mixed, but state funding is very important even at this market. So for higher education financing the argument is reversed compared to other cases. It is usually argued in the literature to include other participants in the funding system besides the government. Involving households and companies in education funding is usually referred to as cost-sharing. Following Johnstone (2004), the participants of cost-sharing are introduced.

The first is the government. Government involvement is usually called public financing. The government uses the tax-system to collect the necessary funding. The state can be the owner of the education institutions. The direct price of education is the tuition fee, but there can be other expenditures collected by the institutions, for example, the service fee for the dormitory. The other method of funding is through tax-payer's money. There can be a direct education tax[17], such as a health care contribution or a pension contribution. The advantage of direct taxation is that it makes financing education more transparent, but it has the disadvantage of being very unpopular. Health care or pension contributions are related to a future possibility, although education is something that happened in the past. Someone who is not planning to participate in education in the future would not vote for an education tax[18]. If education is financed indirectly from the tax income of the state, for example, some portion of the collected income tax or value added tax can be spent on education. This has the advantage that the individuals do not know how much they have spent on education and it gives a flexible source of financing. The government has several options for spending money on education. It can finance the other participants of cost sharing, although not necessarily the higher education institutions (Johnstone 2004). It is a rich field of the literature what justifies the involvement of the government in the education market, but it will be not discussed here.

The second participant of cost-sharing is the group of parents and other relatives. If we approach it on economic terms they participate in financing, because they are the closest to

[16] Pre-Tertiary education is compulsory, so almost the whole of society is connected to the schooling system. Another argument for state intervention includes equal opportunity and fairness. This can be achieved by standardizing pre-tertiary education to some extent. One way to do this is for the state to organize and run the education system, and collect the necessary funding through the tax-system.

[17]Taxes may be direct or indirect, but this refers to the method of collection. Here the term refers more to whether the tax-payer knows what the tax money will be used for or not.

[18]This relates to the free rider effect. If education has an external effect and is a common good and is financed commonly, then the free riding of individual will not change the effect he is receiving.

the spill-over effect. Of course, there are emotional, cultural and psychological elements involved. Parents' contribution to education financing is very difficult to measure, because one of the main contributions they can make is to provide housing or food for the student in the family. The problem is not only with the measurement; it is almost impossible to decide whether they would save these expenses if the student exited the education system. The family can receive direct support for education from the state, or receive a tax-allowance. (Johnstone 2004)

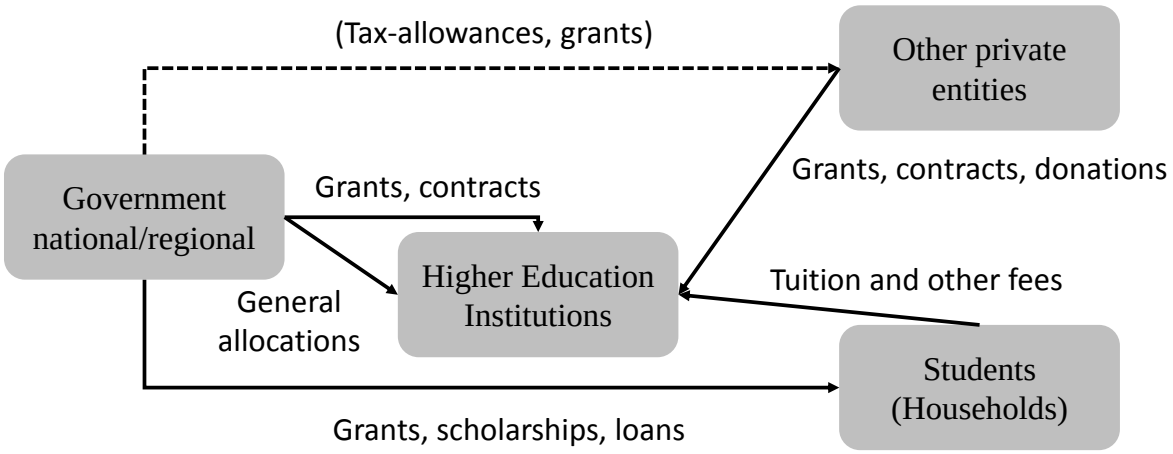
The third participants are the students themselves. They usually pay tuition fees and must find a way to fund their living costs during the education process. They can receive direct or indirect support from all the other participants. The parents' and the students' investment in education is measured together as household investment in education. (Johnstone 2004)

The fourth group of participants are the individual or institutional donors. Companies can make educational contracts with institutions or individuals. A company is better off with more educated labour. It should be mentioned that on a pure competitive labour market companies would not spend on education. If a company funds the productivity enhancement of its worker it will not increase its profits, because the marginal product must be paid out as wage. The educated labour can decide to change company and consequently take away the human capital. A new company will have all the fruits of the original investment. Of course in real life the labour market is not perfect. Education can have a positive return for the company. Companies organize on-the-job trainings and some support higher education institutions. There are non-profit institutions, wealthy alumni or other entities that support education. Together with profit oriented firms they are usually listed as other private entities (Johnstone 2004).

1.3.2. Tools of Higher Education Funding

After introducing the groups participating in the higher education market their relationship to the funding of higher education must be expressed. Halász (2012) introduces an extended version of a model from Lepori et al (2007). The model is shown in Figure 3.

Figure 3: Funding Channels of Higher Education



Source: Halász (2012:23)

Some minor modifications are suggested here. Students should be extended to households and loans should be included in the main tools of government financial aid to students and households. The connecting line is dashed because it was introduced into the original model by Halász (2012), but has every right to be involved in the model, as it is a growing element in higher education financing. Describing Figure 3 will provide us the necessary definition for the rest of the dissertation.

In the centre of the model are Higher Education Institutions. Higher Education Institutions provide tertiary education and do research. They can be private or owned by the state. In both cases they can receive large amounts of government support. One channel is general allocation. There can be several methods of allocation. Lepori et al (2007) mention three typical methods: a) negotiated allocation based on historical criteria b) negotiated allocation based on input or performance indicators c) formula-based allocation. There is no one superior type of the methods mentioned above. There are even variations to the model based on what kind of data is used for the mathematical formulas, input data or output data of education. In some countries allocation decisions are made by local government, while in some countries they are centralized. There are variations based on the autonomy of the Higher Education Institutions. Highly autonomous institutions have free discretion to use the support they receive as they wish. In a centralized system, they have strict budget restrictions on their expenses. Aghion et al. (2007) offers an argument that highly autonomous systems are more productive in higher education. On the other hand, giving more autonomy to institutions can increase competition, which can decrease equal opportunity and fairness. Higher education

policy has a very rich literature because there is no equilibrium policy setting which unarguably trumps all other possible policy choices.

The other possible channel is grants and contracts. A grant is money, a product or service received without the necessity of repayment. In case of contracts something must be delivered. In higher education financing the two types of higher education activity – education and research – are considered separately. Grants and contracts are tools of financing research. However, for education material development, or infrastructural repairs and renewals or upgrades or education advisory activities these tools can offer possible solutions.

General allocation and grants and contracts are the direct channels between Higher Education Institutions and the government. There are indirect channels in which money can flow to Higher Education Institutions through students and through private entities. To understand the logic behind indirect financing the market dynamic has to be clearly understood. In a purely competitive higher education environment the investment in higher education would be lower than the social optimum (Varga 1998), but Higher Education Institutions would serve students' needs the most efficiently[19], even at the cost that those who cannot pay the fees cannot participate in education. In a purely state financed education system the main goal of institutions is to serve education policy, to fit to formulas and to develop the strength to conduct negotiations. If the higher education policy is good the outcome more or less fits the needs of the students, but this is rarely the case. So policymakers tend to create some kind of balance in terms of the positive effects of competition and the positive effects of state intervention. One possible solution is to introduce tuition fees but add government support to the payment. Higher Education Institutions have to compete to fulfil student needs and to fulfil policymaker requirements as well.

There is more than one tool for financing student decisions. Grants are usually awarded based on economic need. This serves equal opportunity in that it helps those who otherwise cannot afford higher education. Scholarships are in some way similar to grants, because they are not repaid, but they are usually awarded based on some kind of achievement. Highly talented students can earn these scholarships by past scholarly or athletic achievements, and usually they have to make some kind of commitment for the future. This has the purpose of providing an incentive to maximize effort, and to show the policymaker who deserves support the most.

In this thesis student loans are added to the support tools. Student loans as a form of financial aid appeared around the 1950's and have become fairly popular over the last half century as it

[19]This only stands if all the assumptions of competitive markets stand (Semjén 2012)

will be shown in Chapter 2. Although student lending is done through the financial markets it was included in governments' financial aid tools for a reason. First of all, a government can be the lender. If the government does not lend then it has to give some kind of guarantee. It can guarantee repayment if the loan defaults or if a mediator institution is involved in the lending process it can guarantee that the lending institution will not default. Both accept a financial commitment from tax-payers' money so this constitutes government financial aid. There are two types of student lending: mortgage-type lending and income-contingent lending (Berlinger 2002). The two types differ in their repayment structure. Mortgage-type lending has a simple annuity-like repayment structure. The maturity of repayment is set at the beginning and unless the interest rate changes, the monthly repayment will not change. An income-contingent repayment sets the ratio of the repayment to the income[20] of the borrower at a given level. This means that if there are fluctuations in the income of the borrower a default remains unlikely. If the ratio is set at 8%, then if the income is low, the maturity of the loan repayment will be longer, but the borrower most likely will not default. It is assumed that the borrower decreases her other expenditure by the same ratio as the decrease in her income. The downside of this scheme is that the term of repayment is uncertain (for more details see, for example: Garcia-Penalosa – Walde 2000; Berlinger 2002; Chapman 2006; Del Ray – Racionario 2010).

It has to be noted that unlike grants and scholarships, student loans do not decrease the amount of tuition or other costs that have to be paid. *They change the dispersion of payment over time. A future increase is taken for the present decrease in payment. If we analyse these tools from the point of view of risk, grants and scholarships decrease the present costs, so the private rate of return increases no matter whether the future income is lower or higher. On the other hand, a future default caused by low income and high repayment obligations can be much more devastating than a simple low return on investment, or not investing at all. Student lending has become a very popular method of financing. Many countries have introduced their own system.* This is why student lending will be the main topic of the dissertation. Chapter 2 will give an analysis of the topic with an in depth introduction to the current trends in international student lending. Chapter 4 will discuss it on an individual level.

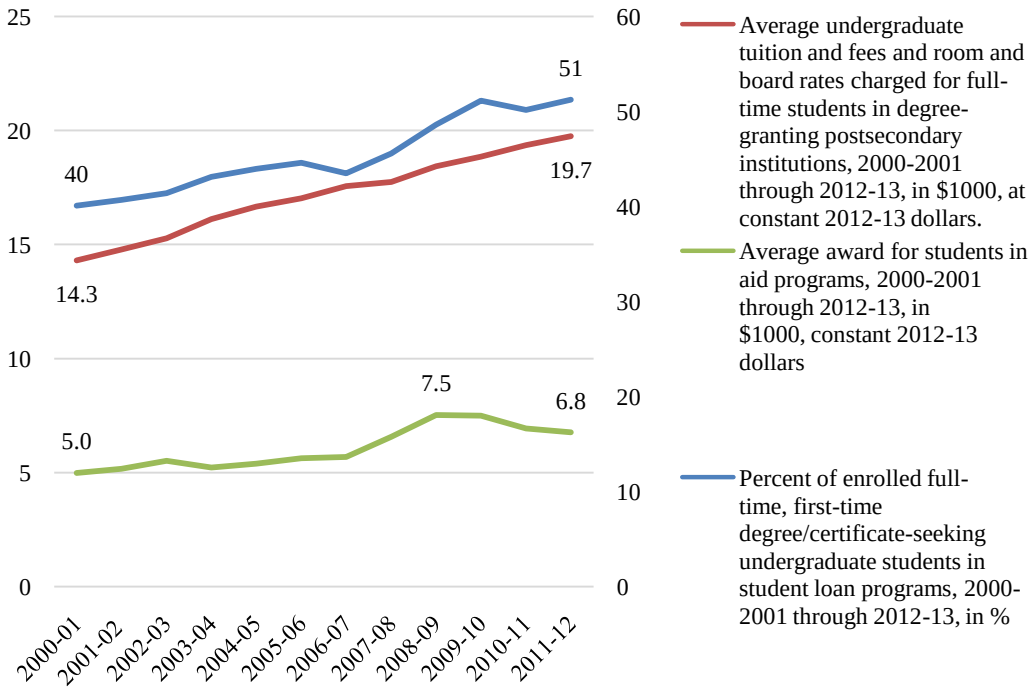
1.3.3. The Concept of a Macroeconomic Crisis Created by a Student Loan Market Crisis

The 2007-2008 financial crises had been one of the hottest topics of economics in the past decade. Neither the financial crisis itself nor the general theory is the topic of the dissertation,

[20] In Chapter 3.2.3 this will be termed the repayment burden.

but it has to be mentioned to understand the argument behind the macroeconomic concerns about the student debt market. Pre-2008 there was a real-estate bubble. Some factors behind the bubble were an overall positive outlook on the future of the US economy, growing real-estate prices, low-interest rates, and financial innovations in risk management. Low interest-rate lending fuelled the bubble, and the level of sub-prime loans rose in the repackaged derivatives. When the housing market bubble burst it affected the financial market where financial institutions built enormous positions in mortgage-backed assets. In 2008 the US state let the largest firm, namely Lehman Brothers, go bankrupt, which caused a domino-effect and triggered a financial crisis that spread globally (Király et al 2008). After a euphoric period resulting in a crisis, there is always caution and sobering reflection. On the contrary the education market has not suffered any setback related to the crisis. Figure 4 shows some key higher education statistics for the US, which was the epicentre of the financial crisis. Whereas other markets suffered through a huge fluctuation in the average tuition fee level and the overall debt level showed a steady rise. Even in constant dollar prices the average yearly cost has risen by 5 000 dollars, which represents 37.8% growth. There was a 10 percentage-point growth in the share of students with student loans, the awarded amount increased by 36% during the period, and at some point the growth was 50%.

Figure 4: Growth of tuition fees and the student loan market from the academic years 2000-01 through 2011-2012 in the United States



Source: Based on the data of Kena et al (2014) and NCES (2015) Table 330.10 and 331.20.

Many authors both from a journalistic and from an academic background claimed that student loan debt will be the next bubble and cause a crisis. The argument was presented in the press by writers such as Davies-Harrigan (2012), McCluskey (2013) and also in the Hungarian press (PSZO, 2012)[21]. The argument is that the US government keeps the student loan interest levels low, their availability is open, tuition fees are raising and there is an overinvestment in education (Stiglitz, 2013). There are several ideas about how a crisis happens. My opinion is that models can be grouped along two dimensions. The first dimension is exogenous and endogenous models. Exogenous models include models where the cause of the crisis is an exogenous event, just like a stone dropped in water, creating waves of effects. Other types of models keep the cycles endogenous. In these models there is no long term equilibrium that is always affected by some exogenous event, but it is the nature of financial markets that there are always boom-bust cycles. The other dimension can be the efficiency of the market. On an efficient market all information is contained in the price of the assets and there are no overvalued or undervalued assets, neither for the short-term, nor for the long term. Some explain crises by irrationality. During a euphoric period speculative rushes drive prices far from the fundamentals, and the moment at which the long-term correction back to the fundamental value[22] appears is the time of the crisis. It is accepted in modern financial theory that a value of a share is the present value of the income it offers. The problem is that a share does not contain the amount that the issuer owes to the buyer, as a bond does. The share represents ownership rights. In the valuation of shares the growth potential of the dividend plays a major role. Brealy-Myers (2005) showed through a textbook example how a minor revaluation of the growth expectation can have a drastic effect on the present value of the share. *An exogenous shock to the growth expectation can cause fluctuations in the price of the asset. In this thesis this approach will be followed. If there is an irrational growth expectation for future incomes than an overinvestment in education is possible.*

[21]This is not only an overseas phenomenon. The recent global economic crisis had a severe impact on the Hungarian economy that led to years of stagnation. This was one of the reasons behind the government's need to intervene in the status quo of the Hungarian higher education system. Most students recently starting in such fields as economics or law must pay a full cost contribution. To aid this change in the costs of education a new student lending vehicle was introduced (Balogh et al, 2012), called Diákhitel 2.

[22] Fundamental value is usually the present value of the asset's future income.

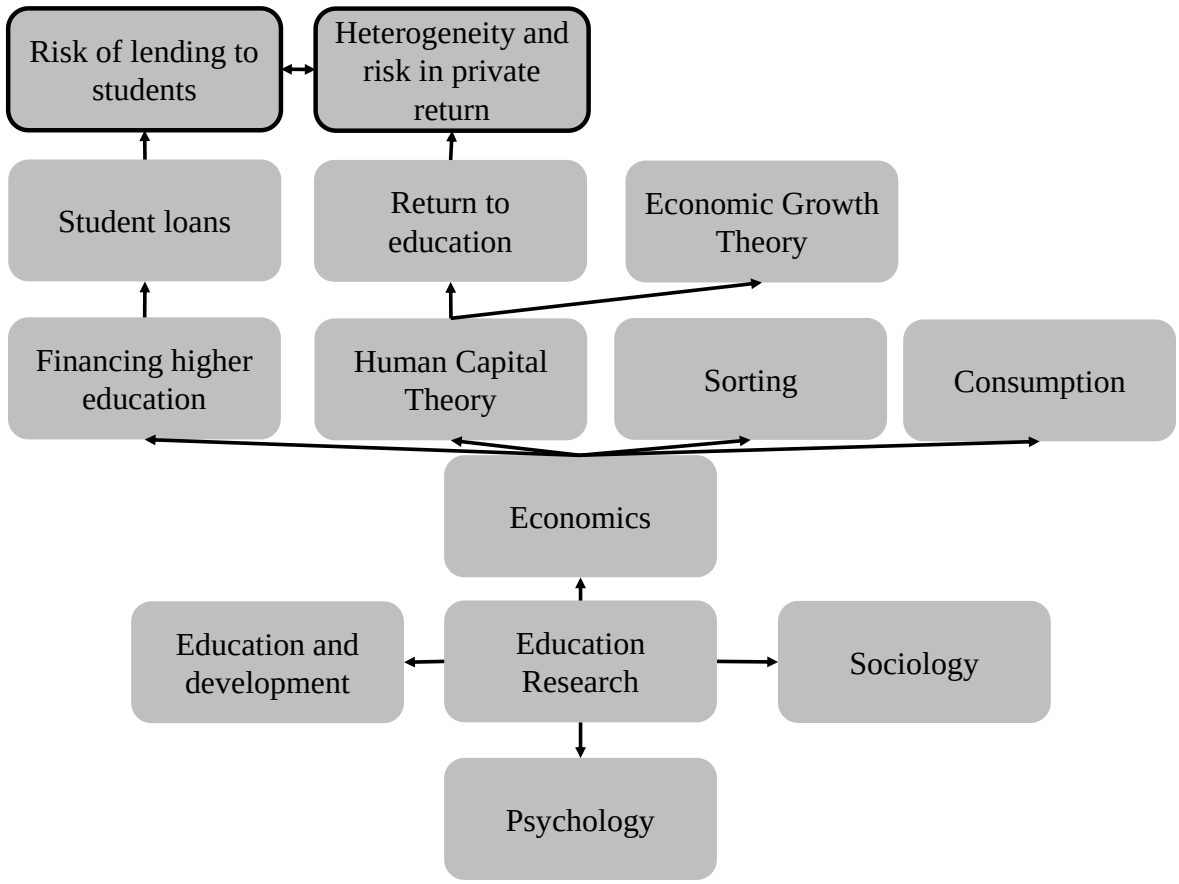
1.4. Summary

This chapter collected the most important concepts and definitions for the evaluation of the main question of the thesis. Throughout the introduction, the most popular lines of literature in economics and especially the economics of education were mentioned. The thesis attempts to fill in gaps in this literature. The literature on risk of individual educational choices is less rich than the literature of rate of returns to education. A standard approach for the question is to analyse it using the Markowitz approach and in fact the empirical literature does that. This will be introduced in the following chapter. The macroeconomic implications of individual risk-taking are important as well. While the long-term effect of education on economic growth is a rich field of literature, the short-term effect of it is less explored. Davies-Harrigan (2012), McCluskey (2013) and Stiglitz (2013) argued that over-expenditure in education can lead to macroeconomic crisis. The empirical evidence that might point to such a conclusion will be shown in the following chapter. However, it must be stated that later chapters of the thesis will deny that such a phenomenon will ever occur.

The summary of the chapter will position the thesis in the fields of economics based on the concepts shown earlier. Result 1 of the thesis will be given based on the literature review in this chapter and hypotheses will be phrased for the following chapters based on the literature.

Figure 5 is a simplified tree of education research. The fields mentioned in this chapter are presented, recognising that there are many other equally important fields of research. This dissertation contributes to the field of economics of education. As part of this, a human capital and education financing approach will be taken. Both fields offer interesting research for higher education. Student loans have a growing importance in funding higher education. Student loans represent a cost-sharing tool. The point is to postpone private costs to a time when the individual will have already started to earn the benefits of the human capital investment. This introduces a new kind of risk to human capital investment. If it does not earn the expected benefit, then the student loan borrower might default and this can have drastic effects on future possibilities, both for the borrower and the lender.

Figure 5: Illustration of the scientific tree of education research (bold brackets signal the place of the dissertation)



Source: Based on the literature review in Chapter 1

Chapter 1.4.3 will summarise the scientific questions of the hypotheses that the later chapters will examine. Chapter 2 and 4 will answer those hypotheses. Risks and returns will be compared and the results will be integrated into the literature.

1.4.1. Result 1 of the Thesis Based on the Theoretical Literature Review

Risk of individual educational choice is examined mainly as a risky human capital investment. To the best of my knowledge, a thorough comparison of education theories has not been completed yet. Two main sets of theories consider education as an investment. Human capital theory suggests that it is an investment in skills and knowledge and sorting theories suggest it is an investment in information on productivity. Table 1.1 compares the two sets of theories based on different risk-related points of view.

Table 1: Comparison of investment theories of economics of education from the point of view of risk

Theories	**Human Capital**	**Sorting**
Investment creates	Skills and knowledge	Observable information
Method of creation	Learning	Testing
Costs	Direct and indirect cost (Tuition fee, Fore-gone earnings, living cost etc...)	Direct and indirect cost (Tuition fee, Fore-gone earnings, living cost etc...)
Return	Wage advantage over less educated people	Wage advantage over less educated people
Sources of risk	Unable to acquire the skills and knowledge offered (drop-out from the education institution)	Failure at the test (drop-out from the education institution)
	Unpredictable labour market demand for those skills and knowledge that the individual acquired (different income than the expected income)	Unpredictable labour market demand for those skills and knowledge that the individual signalled or was screened for (different income than the expected income)
		Cost did not separate the labour supply (no income advantage)
	Limited information on own skills and knowledge (different from expected income)	Limited information on own skills and knowledge (different from expected income)

Source: Based on literature review in Chapter 1.1 and Chapter 1.2.

Table 1.1 summarises the main similarities and differences. Both theories can offer some explanation for the phenomenon of dropping out. However, it should be mentioned that theories can offer an explanation for a situation where dropping out was not a risk but a rational choice that has been made prior to the start of the programme. Human capital theory

does not suggest that someone has to finish an education program to accumulate skills and knowledge. In fact, it is a slow process. Someone might know in advance that an introduction to some profession is enough. Sorting theory suggests that observable information can be valuable for the labour market. Acceptance to an institution and obtaining a degree from the institution can be different sets of information evaluated separately by the market as Dilme-Li (2013) has shown.

While the causes of risk are different in the two models, the observable effects of it are similar. Drop-outs and future income is unpredictable. As Table 1.1 suggests, one of the main differences is that in some cases while skills might be valuable the information itself is not valuable. This is a different source of risk from what human capital offers. Result 1 of the thesis gives a summary of this finding.

Result 1

The literature review of the economics of education has showed that two investment-type sets of theories are offered. Risk has different sources in human capital and sorting models, but they have not been fully compared yet. The main result of my literature review is that in both theories risks can be summarized in the fluctuating nature of future income. However, in case of human capital theory education produces some additional productivity irrespective of the credentials. This suggests that even an unfinished education program can have a long run effect. In case of signalling a dropout from education usually means a large decrease in the return to education and even successful completion can have minimal value if too many people have equivalent education signals. This can happen because the cost structure of education does not result in a separating equilibrium. That is important because it has to be taken into consideration in Result 6.

1.4.2. Hypotheses

Risks of education investment were pointed out as the motivation for the dissertation. Chapter 1 placed this research in the context of education research. First of all, the economics approach was chosen from among the branches of sciences that conduct education research. Economics offers more than one explanation for educational choice. Human capital theory was chosen, however, it was shown that if we are analysing risk in educational choices the other mainstream theory, sorting, can also be used and it leads to the same results. People study for many reasons; human capital theory focuses on one set of them: accumulating skills and knowledge. In fact, the role of formal education in human capital investment and

especially education is at the centre of the dissertation. From the point of view of risk in education, higher education is very interesting. It is voluntary, expensive, and takes a lot of time to finish, and adults are making individual decisions on entering or leaving the education system.

Financing higher education is an essential topic for risk analysis. Education as human capital accumulation has not only private but public benefits as well. It has been shown that there are four participants who have an interest in individuals receiving more education. First of all, the individuals themselves, i.e. the students. Then there are the households, the family and relatives who support the students. Future employer companies and other private entities can have an interest in a better educated future labour supply. Last, but not least, there is the government, which should represent the interests of society and help in overcoming the inefficiencies of the education market, such as information asymmetries and a lack of financing for students. The state should promote equal opportunities and fairness. Higher education funding works in two ways; either it is higher education institutions which are supported, or private entities such as students, households or companies. In many cases the state finances higher education institutions, many of them are state property, and then the institutions offer tuition-free education. Individuals in a human capital model base their decisions on the costs and return of an additional year or level of education. Tuition fees or other financial costs, including living expenses, are not the only costs. Education is time consuming so the investor must take into consideration foregone earnings as the opportunity cost of education. Educational choice is risky even if it requires marginal direct costs to enter a programme because the future earnings advantage in many cases does not justify the effort that was made or the earnings that had been given up. In some countries even the direct costs are fairly high because the state actively shares the costs of education with the private sector. If an education system is built on high tuition fees, then there is a system to support the investors. Frequently used types of student aid include grants, scholarships and loans. Student loans are special in the sense that they do not decrease the risk of taking an education program, but only help to spread the cost between different time periods. Student lending is also special because it is different from other investment loans due to the fact that the object of the investment cannot be mortgaged and the usual student borrower has no other possessions to be mortgaged. The 2008 financial crisis pointed out that the financial system was still fragile, despite, or just because of, the great financial innovations taking place since the 1970's. Some - mainly in the United States - suspect that the expending tuition fee and

student loan market might be a factor in the next economic crisis. If we are studying risk in education investment this topic must be addressed.

Another line of literature focuses directly on the returns of education and questions the apparent heterogeneity in return. The higher education system offers very different opportunities based on gender, ethnicity, college choice, family back ground and social status. The topic of the rates of return to education is very well-researched but foreseeable and unforeseeable heterogeneity has a rich literature as well. As the education system is more open than ever, many people enter it in hope of a great career. The issue of risk and wage differences deserve as much attention as expected returns.

Both theoretical and empirical studies have been made on the risks of human capital investment. As an example of the complex issue in question, there is an ongoing argument in the literature as to whether education increases or decreases labour market risk. Should it be approached as a risky investment or an insurance against a larger risk? In the risk evaluation of education investment this question should be addressed.

This literature has led to two branches of human capital theory where risk has an essential role. One is financial, related to the tools of higher education financing. The other is more microeconomic and studies the role of risk in choosing among education levels, education programmes, and the role of individual features in this choice. These are the two topics the dissertation contributes to and the questions of the dissertation are derived from those fields.

Main question

What is the role of risk in individual higher educational choice and what are its short-term macroeconomic implications? Namely, whether it can cause a macroeconomic crisis if individuals experience negative rate of return to education on a mass level?

Sub-question 1

Do students follow Markowitz ordering behaviour in choosing the field of education they take part in if we apply the standard Markowitz theory of risky investments, where the risk is measured by the standard deviation of the rate of return to education investment; then do the risk-return combinations for different fields of education fit a so-called efficient frontier which is the section of a hyperbola with a positive slope in the risk-return space?

Sub-question 2

Are there any patterns in the evolution of student loan markets or the products available on student loan markets? Are there any markets where private commitment to student loan systems is extreme?

Sub-question 3

Can student loan markets experience exponential growth? Can the decreasing enthusiasm at the end of such growth cause the kind of financial turbulence typical of such markets as the equity market, mortgage loan market or foreign exchange market?

Based on the literature of these questions and the databases available for the research, the following hypotheses were tested.

Hypothesis 1

Student loan borrowers in Hungary who paid back their loans between 2008 and 2012 do not follow the Markowitz ordering investment behaviour towards education programmes of different levels and they tend to choose programmes that do not belong to an efficient frontier in a risk-return space, defined by measures that are tested in the branch of literature characterised by Palacious-Huerta (2003), Christiansen et al (2007) and Glocker – Storck (2014).

Hypothesis 1 will be answered in Chapter 4.1 and Result 3 and 4 will summarize it.

Hypothesis 2

High levels of education investment can be achieved without cost-sharing and a high level of private investment in education. Student loan schemes are introduced slowly and they appear in many models. There are outstanding countries in private investment and in the use of student lending.

The answer for Hypothesis 2 will be the result of the evaluation of the basic empirics and empirical literature of the field. It will be summarized in Result 2 in Chapter 2.

Hypothesis 3

Growth on the higher education market is an exponential growth process. Human capital investors overvalue the growth opportunities in their future income, so they pile up current debt at a level that they cannot finance from the earnings on their investment. When they

realise the true return on their human capital investment (their true earnings after graduation) they will find that they cannot pay back their student loan debt. This will happen on a mass level. The student loan default rate will be so high that it will affect the financial markets. This can cause financial crises at least on a national level, but a future global crisis is also possible.

Hypothesis 3 will be examined with macro level comparison in Chapter 4.2 and Result 5 and 6 will conclude the outcome.

In the rest of the dissertation a detailed examination of these hypotheses will be carried out. The process will lead to the phrasing of numerous results. First, the empirical literature will be reviewed then the data and methodology for my own empirical analysis will be introduced followed by the introduction of the results of my own research.

2. Review of the Empirical Literature

Chapter 1 of the thesis has derived the hypotheses from the theoretical literature of the field of education and risk. In this chapter the related empirical findings of the literature will be reviewed. In the previous chapter the unpredictability of the future income of the individual was defined as the main source of risk. It was argued that it can be explained by both human capital theory and sorting theories of education. The Markowitz portfolio theory was introduced as the framework for risky decision making. In the Markowitz theory variance of the future return is the measure of risk. It fits to the idea of the unpredictable future income. People have an income expectation for the future and the actual experience can be better or worse. One of the main arguments of the empirical literature is that expectations are based on a set of information available for the decision maker at the time of making the decision. This set includes demographic information like gender, socio-economic background, ethnics etc.... Estimations of risk can only be performed if these social variables are controlled. It will be discussed under the title heterogeneity in the rates of return to education.

One very important line of literature for my thesis uses the Markowitz portfolio theory to understand the choices of those who study different education programmes. These papers will be discussed in fairly detailed fashion because this thesis will use similar methodology to evaluate a sample of student loan borrowers. The introduction of this literature will be given in the second subchapter. It can be concluded that based on the general samples these authors used that it can be suspected that education decisions are not fitting to Markowitz ordering. That is not a problem, while education and financial investment is very different in many aspects. However if something like that can be shown for student loan borrowers that would suggest that risk accumulation can have a possibility. If risks accumulate on a market it can lead to a crisis. In fact this is what was introduced in the previous chapter. The third subchapter will consider the trends of the student loan markets in an international context and will conclude that student loan markets spread fairly slowly and their importance in funding education can be hard to anticipate because rather different models can be found.

This chapter will end with a summary. It will include Result 2 of the thesis derived from the empirical review.

2.1 Heterogeneity in the Rates of Return to Education

Rate of return calculation were introduced in Chapter 1 of the thesis. Usually a sample of observation is taken for rate of return calculations. For that sample there will be considerable

heterogeneity while people with the same education can have great and not so great careers. Some sources of this heterogeneity can be:

- the type of institution;
- gender;
- socio-economic background;
- ethnics.

These factors can cause heterogeneity in returns but are known before the educational choice, so they are not considered a risk factor. In the analysis they should be controlled if it is possible. Because they are not risk factors this chapter does not attempt to fully explore the vast literature of heterogeneities in education returns just gives some main ideas.

2.1.2. Heterogeneity in the Structure of the Higher Education System

To evaluate the type of institution some introduction to the higher education system must be given. It is a very important feature of the education system in most countries that elementary, and even some secondary education, is compulsory. This is one of the main differences of higher education compared to other levels. EURYDICE (2015) collected regulations on the start and finish of compulsory education from 42 countries and states. There are some countries where regulation differs within the country. For example in Northern Ireland compulsory education starts at the age of 4 whereas in the other parts of Great-Britain 5 is the starting age. In most countries schooling must be started at the age of 6 and cannot be finished earlier then the age of 16[23]. Usually this is the age when children finish ISCED level 2 education, or have just started ISCED level 3 education. The ISCED system will be introduced right next, but first it must be mentioned that in the OECD countries only 24 percent of the age cohort of 25-64 has a lower education attainment then ISCED level 3. Most people add upper secondary education to their studies whether it is obligatory or not. *On the other hand "only" 33% of the same age cohort has tertiary education, and in some countries this ratio is lower than 20%. This makes a post-secondary education choice much more interesting. After upper secondary education people are considered adults, so this is more their own decision than compulsory or even upper secondary education. So the decision is*

[23] Even with school leaving age there are some interesting examples. School leaving can depend on the time period an individual was born in, or the type of programme that was chosen. In some countries part time education after leaving the full time programme is compulsory, for instance in Belgium and Germany.

more similar to risky financial decisions in the case of a higher education choice. This is the main reason why the dissertation and education risk research focus on higher education.

The above mentioned categorization is a tool used by UNESCO that helps international comparison. Education systems within and among countries have a wide range of differences. In 1997 UNESCO issued a categorization in order to help policy makers and researchers make international comparisons, named the International Standard Classification of Education (ISCED). In some form or other these levels can be matched to various programmes that an education system offers. It also helps that, for instance, in the European Area a large-scale unification in higher education has occurred, called the Bologna-process. Some of its goals were to introduce a three cycled, credit-based, comparable education system to the members of the European Higher Education Area. The European University Association followed-up on this process by issuing a biannual study on the process, where they evaluated the progress that had been made. In the 2007 issue of the so called Trends series, Crosier et al (2007) stated that the adaptation of the three-cycle education is 82% completed[24].

The most recent issue of the international database that is used in this dissertation, Education at a Glance[25], uses the ISCED 1997 classification. The above mentioned three cycle system is not well-reflected in that classification, so in 2011 they updated their system. Education at a Glance 2015 will use that system, but at the time of writing the dissertation it has not yet been issued. Table 2 gives a clear insight on how the higher education system can be modelled. It compares the two classification system as clearly as possible.

Table 2: Comparison of the ISCED classification system of post-secondary education levels

ISCED 1997	ISCED 2011	Description
4	4	Post-secondary non-tertiary education
5	5	Short-cycle tertiary education
5	6	Bachelor's or equivalent level
5	7	Master's or equivalent level
6	8	Doctoral or equivalent level

Source: Based on UNESCO (2012:63)

[24]The ratio is based on the number of education programmes which have adopted the three cycle education process, and the total number of education programmes.

[25] The body of the text were written in 2015.

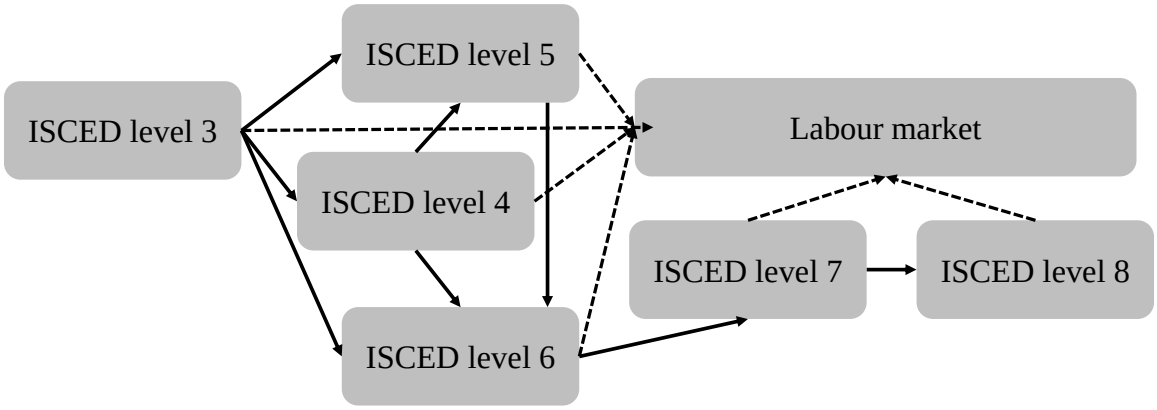
When in OECD Education at a Glance a statistic refers to higher education it refers to ISCED level 5 and 6, which means all students on some level of three education programmes plus advanced research, as Table 2 shows it. If we break this down into individual decision making we will get the decision tree illustrated in Figure 6. After secondary education the individuals have four choices: 1. exit from the education system;[26] 2. begin education on a non-tertiary level; 3. begin education on a short-cycle programme; 4. begin bachelor's studies[27]. From post-secondary non-tertiary education one can: 1. exit to the labour market; 2. begin a short cycle programme; 3. begin a bachelor's programme. For levels 5-7 possibilities are narrower: 1. exit to the labour market; 2. begin an education programme on the next level. The doctorate or advanced research programme is the final stage of higher education. Post-doctorate studies can follow, but they are not yet classified as a separate level. They are strongly connected to academic work, so have more in common with work than with classical education. It is very important that the education statistics are usually aggregates of levels 5-7, so when higher education is mentioned, it is understood as ISCED level 5-7 or level 5 according to the old classification system. Unfortunately, this simplification exists and when higher education choices are examined it can be easily seen as a yes-or-no decision, even though individuals must consider many options[28]. For instance a bachelor's degree is not only a human capital investment that will provide its payoff on the labour market, but has the option for master's education embedded in it. This is important because in Chapter 4 it will be used for an argument for observations that do not fit to the model.

[26]In Figure 6 this is simplified as the Labour market. Of course the labour market is not the only activity outside of the education system. One can remain inactive, but for the sake of simplicity this is not expressed here. The fact that one can enter any level of education from the labour market if the necessary requirements are fulfilled is also left unexpressed. Stepping backwards in the system is also a possibility. For instance someone with a master's degree in engineering can join a bachelor programme in business administration.

[27]There can be long term first degree programmes ending in a master's degree. These programmes can usually be seen as a combination of a bachelor and a master's course where the separation is not efficient, for instance, because the introductory years of the programme are not really valuable to the labour market.

[28]T. Kiss (2010) has a very good introduction to the option value of education, but it should not be confused with the option mentioned here. The option value of education refers to a possibility that a certain skill or knowledge might be necessary, but in many cases will not be. In this case education has more in common with real options then simple financial investments. Usually the option value to education can be extended to NPV calculations.

Figure 6: Decision tree for moving individuals towards and in higher education (a dashed line is an exit from the education system, a continuous line is an entry on a new education programme)



Source: Based on UNESCO (2012:68)

2.1.2. Heterogeneity in Societal Variables

Moreover than the different levels of tertiary education other factors influence education returns. The aforementioned Education at Glance study offers some international data analysis for that, but first a brief introduction of this series of papers must be given.

I use the OECD Education at a Glance database, mentioned and used earlier, for the exploration of the problems specified above. This is probably the widest available collection of statistics on education, certainly as far as education financing data are concerned. The publication Education at a Glance was first issued in 1992, since then it has been published annually, and its constantly updated database is available as a download from the Internet. In addition, each year new statistics and reports are added to the publication. For example, one of the most recent additions has been the presentation of data related to student lending on the subject of education financing, which is a good indication of how current this topic is. However, data processing takes time; therefore the most recent data in the publication of 2014 typically apply to the years 2011 or 2012.

The source of the data is the so-called INES programme, Indicators of Education Systems, which includes data on 34 OECD countries and the non-member G20 countries. In this study we only focus on the OECD countries.

In its collection of the data the INES programme uses several sources:

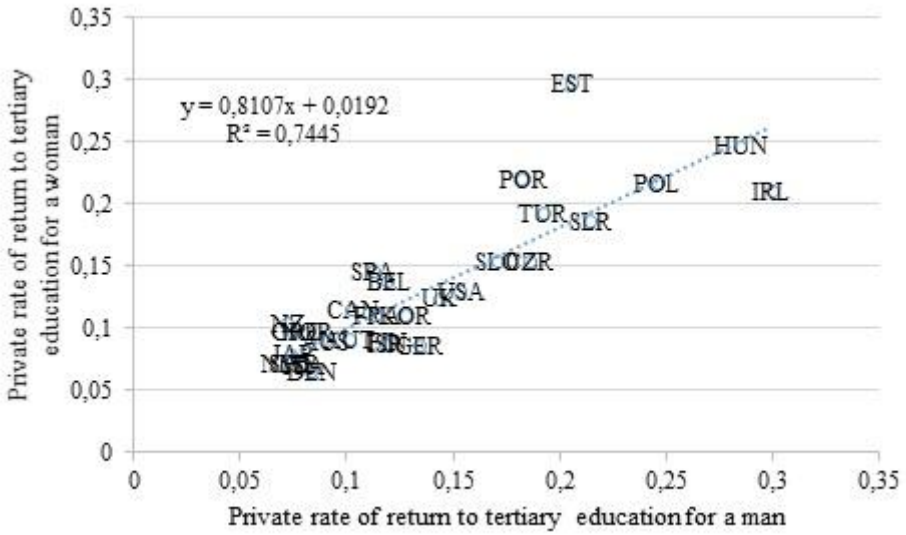
- One of the most important sources is the data of the annual surveys by UNESCO, OECD and EUROSTAT on the typical statistics of education, such as the number of students, staff working in education or education financing.

- The study contains a significant volume of data on skills and competences, which is taken from the results of PISA and PIAAC tests.
- They also analyze the circumstances of teachers and tutors, with data taken from the OECD survey known as TALIS.
- This can be supplemented by ad hoc surveys.

When publishing its data, the OECD strives to ensure comparability, thus in most cases it only communicates ratios and averages, but these are suitable for drawing fundamental conclusions.

We can even compare the private rate of return to education in different countries and between genders, as illustrated in Figure 7. Figure 7 suggests that the private rate of return favours men. The average private rate of return in the OECD countries for women is around 81% of returns for men. The countries above the predicted line are better at equality of returns. This suggests that is a very general problem even in the most developed countries.

Figure 7: Private rate of return for a man or a woman attaining tertiary education (2010)



Source: Based on OECD (2014a:167-168)

Education is at the focal point of many fields of science, which is especially true when such a delicate question is posed, as what constitutes the ripe fruit of human capital investment. There is wide range of literature on each topic that creates heterogeneity, but my opinion is that they can be summarised in the following list:

- Economic disadvantage, usually referred to as working class students;
- Gender disadvantage, usually referred to the situation mentioned earlier;

- Ethnicity or minority disadvantage
- Disability related disadvantage.

It might be important to see that these disadvantages are not policy related. In the 20th century higher education opened up to the mass public. As was mentioned earlier, 20-50% of the young adult generation participates in higher education. This is a challenge that both the higher education institutions and society must answer. As Brock (2010) describes, for a long time higher education served the elite of society (youth from high and middle income families) who entered the higher education system after high quality secondary education and were supported by economically well-endowed families. For many reasons this has changed and now the student demographic is much more diverse. Now some people can enter the higher education system from families where nobody has held a degree before. This is mainly a discussion in the United States, but minorities in higher education is a phenomenon of the late 20th century. It is now a human right to give people the opportunity to get a degree so people with various disabilities can try college education, which is one of the greatest achievements of the past century. The diversification in the student material has also led to the diversification in education programmes. In the US system, for example, 2-year Bachelor programmes have become more popular. Community colleges provide a low-priced education at a local level. The US education system will be discussed in more detail in Chapter 4.

A central question for gender and ethnic studies is disproportionate distribution (Brock, 2010; Hawley et al 2013), i.e. whether some minority is overrepresented in some institution. For example women, Hispanic and African-American demographics are disproportionate at community colleges. This signals that higher education does not offer the same service to different people. This is a problem if what is expected of the higher education system is that it will economically elevate minorities and the disadvantaged. On the other hand, as Long (2012) points out, besides the issue of access another topic has emerged. Referring to the National Bureau of Economic Research she states that 82% of students from high income families attend college, whereas only 52% of students from low-income families do so. These are high numbers for both demographics, but there is large margin between the completion rates: 89% for students from high-income families and 52% for low-income students. She argues that remedial courses are inefficient in helping students to catch up. This is especially important for those students whose native language is not English (Kanno – Harklao, 2012). Magivern et al (2003) followed 23 students at many locations with mental disabilities, and they find that for them it is even difficult to find help if the necessary institutions are established. They are encountering assumptions that they should not be there, they are

incapable of handling themselves, or they use their disabilities to bend the requirements. Even when disadvantaged people get into higher education or successfully finish a programme some disadvantages are possible. STEM is an acronym for science, technology, engineering and mathematical professions. As will be shown in Chapter 4, these professions are highly paid professions, and Crisp et al (2009) even argues that these professions will have an even wider demand in the future. Women and minorities are underrepresented in such courses. Wang (2013) states based on an in depth literature review and his own analysis that the orientation usually comes from secondary school. Financial aid can be a significant motivator but not even very strong compared to others. Lynch – O'Riordan (1998) arrives at a similar conclusion by analysing 144 low-income students' performance in the Irish education system. *They found that the disadvantaged students' success was withheld by economic barriers, social and cultural disadvantage and educational drawbacks. These are significantly interconnected.* These issues appear in some form or other in almost all literature on the topic.
These factors are previously known by the decision-maker, so a Hispanic student would base their decision on the expected return for a Hispanic student with a degree. In that case the scholar who does not control for that variable would overestimate risk. On the other hand, adding more and more control variables will cut up any sample into such small pieces as to make measurement impossible (Hartog 2009).
Dickson – Harman (2011) identifies two main streams of research: 1. research on monetary private returns to education with the emphasis on heterogeneity and risk; 2. the non-monetary returns of education. This dissertation attempts to contribute to the first stream. Altonji (2012) and Hartog (2009) made a thorough literature review of the private rate of return heterogeneity calculations. Altonji (2012) focused on papers calculating data from the United States, while Hartog (2009) focused on European examples. Altonji (2012) listed 9 papers. Five out of nine papers used OLS estimations for the return calculation. Some of the most popular control variables were experience, college selection, majors, ability based on high school accomplishment or SAT scores, and family background. Hartog (2009) reviewed 15 studies which used a risk augmented Mincer equation to calculate returns, usually with occupational and industrial dummies, and sometimes controlling for ability. Cunha – Heckman (2008) estimates that over 50% of income deviations are predictable, if we take into account the information available to the decision maker. Chen (2008) was an influential paper on the topic, because she offered a decomposition of wage differences by uncertainty and unobservable heterogeneity. The motivation for the paper was to understand better the relationship between risk and levels of schooling. *She found that risk does not necessarily*

grow with the level of education. This is essential for the debate presented in the empirical chapter. Mazza et al (2013) applied Chen's model to make international comparisons among the US, the UK and Germany. They found that the risk varies with level of education and by country, so no clear pattern was visible. Koerselman – Uusitallo (2013) examine Finnish data where they found that university education compared to vocational education has a large payoff and this payoff remains the same after risk-adjustment. However, Brown et al. (2012) finds for a US data sample that after risk adjustment much of the higher education advantage disappears and high school education tends to increase in value.

Based on the empirical literature of the topic, considering the limits of the database, I attempt to control for level of higher education, field of education, gender, social background and place of institution.

2.2 Markowitz Portfolio Theory in Economics of Education

"Interestingly, there is relatively little research in the literature that helps us understand how the risk-return trade-off for different human capital investments and for financial investments may compare at the margin. Moreover, the approach adopted in the literature is unsatisfactory and generally invalid. The procedure usually followed is to compare average levels of human capital" (Palacios-Huerta 2003:948) Pointing out this 'white spot' created the research on mean-variance measurements in human capital investment and a little more than a decade brought three thorough analyses of the topic, with a very similar methodology. This interesting line of papers spins off from Palacious-Huerta (2003). He applied the fundamental financial theory of markets for risky investments. The application focused on the Sharpe-ratio which was introduced in Chapter 1. The idea is that people would invest where they get more return for a unit of risk taken. He found that the Sharpe-ratio for education investment is somewhat larger than for capital investment. This was reconfirmed by Dittmar et al. (2014). They conducted leisure studies, and when they incorporated human capital in the models, a high Sharpe-ratio emerged, compared to capital markets. Christiansen et al. (2007) expended this. They followed standard Markowitz theory and examined whether risk and return combinations for various education programmes fit the efficient frontier. They found that some education specializations such as medical doctor, economics or engineering programmes seem to fit the curve, but others do not. Hartog (2009) criticizes the approach for its simple Mincer-equation calculation and the expectation of a fit. He says that there have to be more control variables if we are reasonably going to expect a fit.

This dissertation will contribute to that line of literature with applications for Hungary. While that study will give essential results to the thesis a thorough introduction to these studies is given in this chapter. This section will review them and discuss their methods, databases and results. All these studies were conducted in the most developed countries: the United States, Denmark and Germany.

2.2.1. The Palacious-Huerta study

Palacious-Huerta (2003) introduced the idea of putting human capital investment in a risk-return analysis. He used mean-variance spanning testing. As Kan – Zhou (2012) simply explains, mean-variance spanning is testing to see whether, if a new set of assets is added to or compared to an existing set of assets, the new efficient frontier is better for the investor. It is a very useful tool for financial calculations on hedge fund orchestration and financial innovation. For instance, a hedge fund manager can be interested in whether a smaller set of target assets can be as good as a broader set of assets. Another practical question can be whether it is worth extending portfolio operations, for example, to a foreign country?

In terms of human capital investment mean-variance spanning testing is used in Palacious-Huerta to test the differences between genders, ethnicities, educational levels, and human capital assets[29] and financial assets. He uses two types of tests developed for financial assets: the first is a General Method of Moments based on De Santis (1993); the second is based on a paper by Huberman – Kendal (1987). Furthermore, Palacious-Huerta (2003) lists the distance between the efficient frontier minimum variance points.

He uses a very long panel of both financial and educational data. The financial data is from the US equity index and US Treasury bills for the period between March of 1963 and March 1996. The source of the wage data was from the March Current Population Survey (CPS), also between 1963 and 1996. The population was very large, approximately 1.4 million employees were observed, and were clustered into 2,880 groups by sex, race, years of education and experience. For discounting, the personal consumption expenditure deflator was used. The rates of return were calculated with a marginal rate of return approach as the ratio of following years' wages compared to present wages with one level lower education.

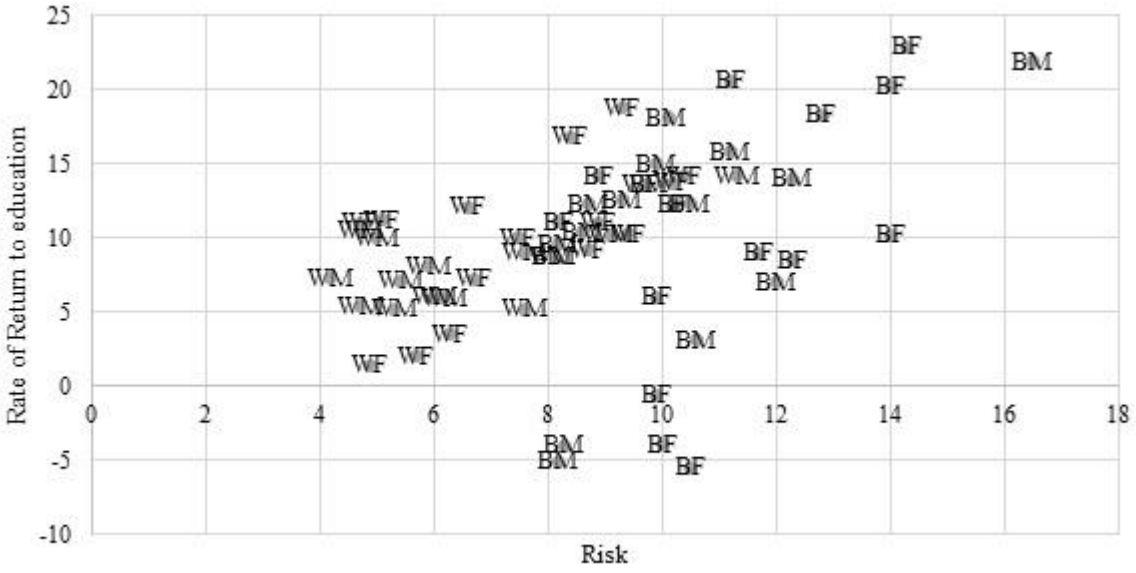
The results of Palacious-Huerta (2003) are for four groups: white females and males, and black females and males. Five levels of schooling are examined from below secondary education to graduate studies, and there is a level for college dropouts. Experience categories

[29]Human capital asset is a term used for a given education. It can be as detailed as the author of the specific paper wants it to be. In the case of Palacious-Huerta (2003), for example, it is being a white male with higher education or a being a black female.

were given as well, with 5 years and 15 years the breaking points between the categories. First, the rates of return to education and their risk adjusted versions were compared. As Palacious-Huerta (2003) claimed, their results are consistent with the literature. He found 5-18% returns across all the human capital assets. Interestingly, negative rates of return appear for black males and females if they finish their schooling before graduating from secondary education; however if they graduate they can experience larger returns than their white counterparts. The risk-return combinations for the different gender and ethnic groups are presented in Figure 8 where a dot represents a risk-return combination for a given experience-education level combination for a gender-ethnic class. The table of data is given in Palacious-Huerta (2003:954).

Figure 8: Risk and return combinations for various human capital assets, 1964-1996, US data collection

(BF – black female, BM – Black male, WF – white female, WM – white male)



Source: Based on Palacious-Huerta (2003:954) Table 1

Figure 8 suggests that the frontiers of risk-return differ for different ethnic groups; they might intersect, but they are not in line. Between a 10-15% rate of return and a 10% risk there is a high density of data, but there are many experiences in every direction away from it. However Palacious-Huarta (2003) made their spanning-test even within the assets presented here. The conclusion was the following*:*

"…there are nontrivial differences across some demographic groups with identical human capital holdings. For instance, net gains for white and black females with respect to other groups tend to arise at high levels of education, whereas for white males they arise at

education levels up to college. Net losses arise for black individuals, typically at lower levels of education and, especially, for high school and college dropouts, and relative to their white counterparts." Palacious-Huerta (2003:955)

Comparing private human capital returns and financial investment returns he states that the returns alone do not seem to justify the great attention paid to education. The average return on US equity investment would have been 7%. As Figure 8 shows, in many cases human capital returns can be lower, but in most cases they are not drastically higher. Consequently, the question is why we do not experience more investment in financial assets. When Sharpe-ratios are examined, there is a very large difference. The Sharpe-ratio for the equity index is 0.55, whereas for human capital investments it is 1 to 2. This might express more clearly why education is so tempting for young adults. It can be maintained for a long period, because the nature of human capital assets does not allow the differences in returns to be arbitraged out.

2.2.2. The Christiansen – Joansen – Nielsen study

Christiansen et al (2007) applied a similar methodology but to different fields of education. Compared to the Palacious-Huerta study it is better able to capture people's choices. In his categorization gender and minorities play a major role, but this does not reflect choice, but rather a question along the lines of whether it would have been better to belong to some other ethnicity. However, choosing a field of education reflects more of a choice, because it is usually assumed to be open to everyone, although we have seen in Chapter 1.3 that it might not be the case for STEM-subjects[30] and in their study it was not reflected.

They conducted their study on register-based panel data for a random sample of 10% of Danes. They also augment their data with working hours from a 2003 survey. They follow their cohort from 1987-2000, and people in the sample are from the age cohort born between 1947 and 1957. This reflects in a mean age of 41.54, and 14.70 years of average experience. They classify the sample into 104 educational groups. These are fields of education that contain at least 50 observations. For the measurement of return they use the Mincer method, based on OLS estimations.

The way they obtain return for educational groups is based on the following idea: the rate of return to a certain field is the residual return after taking into account years of education, experience and the number of normal working hours.

$$lnW_{ijt} = \widehat{\alpha_{0j}} + \widehat{\alpha_{1j}} X_{ijt} + \widehat{\alpha_{2j}} X_{ijt}^2 + \widehat{\varepsilon_{ijt}} \qquad (2.1a)$$

$$\widehat{R_{Xj}} = \alpha_{0j} + \alpha_{1j} X + \alpha_{2j} X^2 \qquad (2.1b)$$

[30] Science, technology, engineering and mathematics

$$R_{Xj} = \widehat{\beta_0} + \widehat{\beta_1} S_j + \widehat{\beta_2} lnH_j + \widehat{R_j} \quad (2.1c)$$

The method is shown in Equation 2.1a to 2.1c, the variable calculated from the equations are marked with a hat symbol. First, Equation 2.1*a* estimates the coefficients for experience, where W_{ijt} and X_{ijt} are the wage and the experience of the *i*-th individual with education *j* at time *t*. Then these coefficients are used to calculate an expected return for given years of experience, with a given *j* education as of Equation 2.1*b*. The experience data is used for the education programmes in Equation 4.9*c*, where S_j is the required years of schooling for the *j* education programme, and H_j is the number of normal working hours for group *j*.

Christiansen et al (2006), the working paper version of Christiansen et al (2007), uses a slightly different method. In fact they offer two in this paper. The first is the average raw logarithmic income in Equation 2.2a, which is basically an average of the logarithmic income, first for each *i* individual within the *j* educational group, and then across the group. In Equation 2.2*b* the residual of the Mincer-equation is the measure of the return.

$$\widehat{R_j} = \frac{1}{n_j} \sum_i^{n_j} \frac{1}{n_i} \sum_t^{n_i} W_{ijt} \quad (2.2a)$$

$$\varepsilon_{ijt} = lnW_{ijt} - \widehat{\alpha_0} + \widehat{\alpha_1} S_{ijt} + \widehat{\alpha_1} X_{ijt} + \widehat{\alpha_2} X_{ijt}^2 \quad (2.2b)$$

The main difference in the system of Equations 2.1*a*, 2.1*b*, 2.1*c* and 2.2*b* is that in Equation 2.1*b* the residual comes from a personal level, while in Equation 2.2*b* it is estimated on an educational group level.

They define a two risk approach.

$$\sigma_j^{TS} = \sqrt{\frac{1}{n_j} \sum_i^{n_j} \sigma_{ij}^2}, \text{ where } \sigma_{ij}^2 = \frac{1}{n_i - 1} \sum_t^{n_i} \left(\varepsilon_{ijt} - \overline{\varepsilon_{ij}}\right)^2 \quad (2.3a)$$

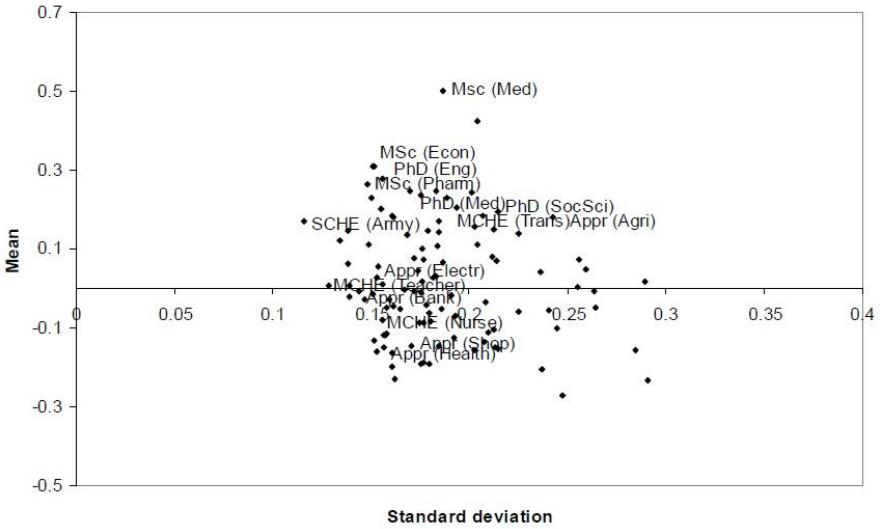
$$\sigma_j^{CS} = \sqrt{\frac{1}{n_j - 1} \sum_i^{n_j} \left(\overline{\varepsilon_{ij}} - \overline{\varepsilon_j}\right)^2} \quad (2.3b)$$

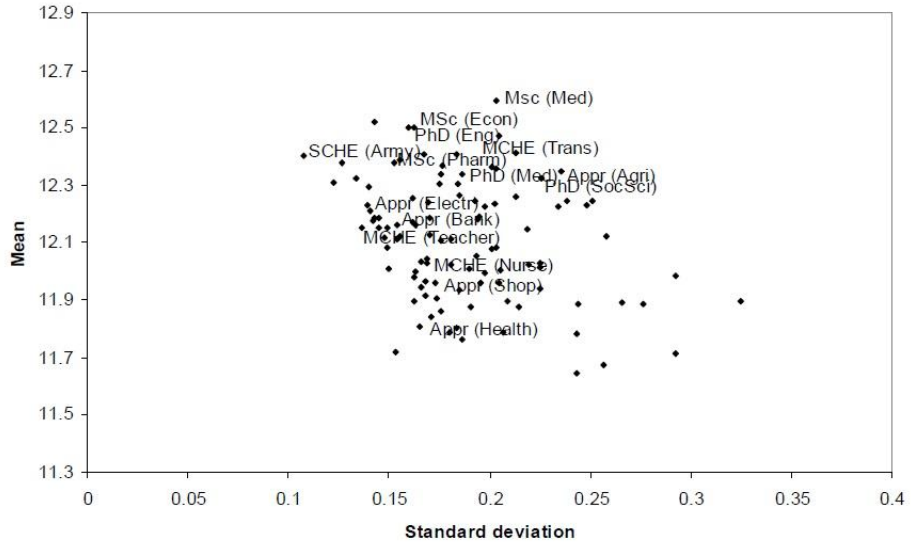
The first is cross sectional, the second is time-series risk. It is basically the variance of the residuals from Equation 2.2*a* of each individual averaged out over the education group. In Christiansen et al (2006) the pair of raw logarithmic income is the log of wage averaged out in the same way. *The disadvantage of this is that a steady rise in wages will emerge as a risk.* This is introduced in Equation 4.2*a*. The second approach is the cross-sectional variance derived from Equation 2.1*a*. They average out the residual $\widehat{\varepsilon_{ijt}}$ from Equation 2.1*a* which is presented in Equation 2.3*b*.

After introducing the measure, the results should be discussed. There are some changes from Christiansen et al (2006) and Christiansen et al (2007), but in terms of risk and return calculation the pattern is changed very little by the recalibration. Here the maps of the working paper are presented, because our calculation is more comparable to those results. As it can be seen on Figure 9, the return-risk combination seems to fit a shape similar to the feasible set of risky investments. However, it is not reasonable to invest in a portfolio within the feasible set, i.e. into a portfolio that is not on the frontier. As they point out for the very similar result in their final paper: *"Long educations with poor performance exist, and short educations with good performance exist. Examples of poorly performing long educations are MCHE Nurse and MCHE Educator. Similarly, high-performing short educations include SCHE Armed forces. When investing in human capital assets, the investor should find the field of education at least as interesting as the level of education."… "The result of the empirical analysis is a classification of educations into efficient and inefficient investments among which the inefficient investments are supposedly chosen for reasons other than investment purposes (e.g. consumption purposes)." (Christiansen et al 2007:979,985)*

Figure 9: Risk and return combinations for various human capital assets, 1987-2000, Danish data collection

Up: Mincer residuals Below: Raw logarithmic income





Source: Christiansen et al (2006:28)

Chapter 4 will give similar maps for a Hungarian Student Loan borrower data sample.

2.2.3. The Glocker – Storck study

Glocker – Storck (2014) conduct similar research to Christiansen et al (2007), however they do not conduct mean-variance spanning tests. They use data from the German Micro Census from 2005 to 2009. The Micro Census is a 1% representative sample of the German labour force population. They restrict their sample only to those who graduated and then entered the labour market. They participated in vocational training (3 years), university applied sciences programmes or university programmes (4-6 years). They also filtered out those over 65. They use hourly earnings, because their dataset contains monthly net earnings and hours worked. In the end their sample included 120,288 men and 87,507 women. They restricted their study to educational fields that have at least 300 individuals, so 75 fields of education were left in the sample.

They used a similar method to Christiansen et al (2007) in 2.2*b*, but they correct with the length of education, and with the probability of unemployment. They also compare their log wage estimation to the average log wage estimation for the total population, much as the Sharpe-ratio advises as a choice of benchmark. The idea is that to choose a given education programme is to give up the average of all the other possible returns. This is the opportunity cost. They use cross-sectional variance and a decomposition for the risk of unemployment.

Figure 10: Risk and return combinations for various human capital assets, 2005-2009, German data collection

Top: Men; Middle: Women; Bottom: Engineering, Men

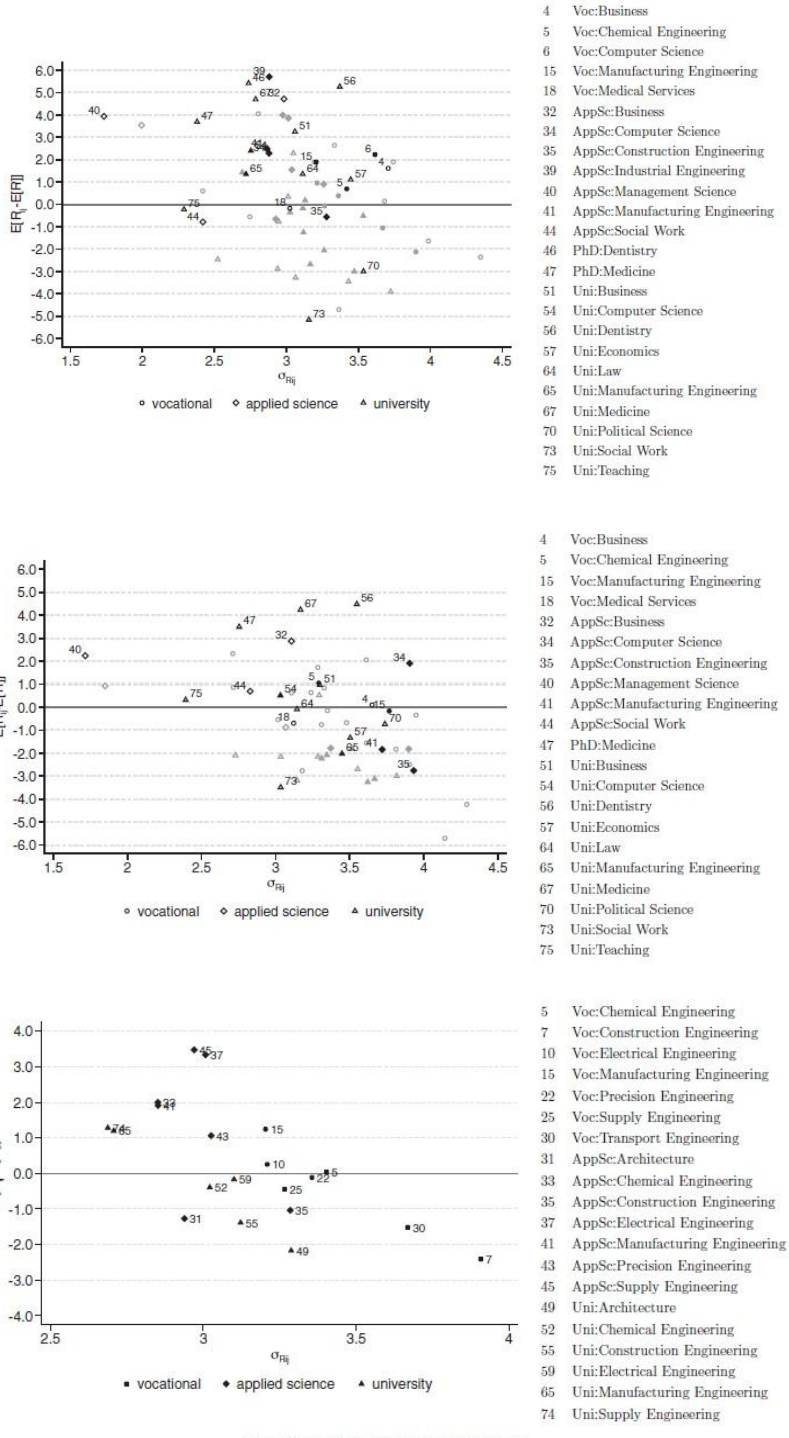


Fig. 3. Mean–variance plot: engineering fields, men.

Source: Glocker – Storck (2006:116-17)

Figure 10 gives the mean-variance results Glocker – Storck (2014) found for their sample. The result is closely related to the findings of previous studies; i.e. that there are heterogeneities in the returns, and that are a significant number of educations that seem not to fit the efficient frontier. This suggests that there is no clear evidence for growing or decreasing risk with an increasing level of education, although the field of education remains very important. They also contribute to a debate over demand for STEM professions. They argue that that there should be very low risk and a large return for all the different engineering study programmes. The bottom mean-variance plot shows only the engineering fields and, surprisingly, it does not show any evidence of a low risk-high return combination. In fact it seems to a have a negative slope. However, they emphasise that their data is from the past and usually those who worry about the undersupply of STEM knowledge are focussing on the future. If we assume the future is fundamentally different from our past experience, the fact that there has been no over-demand in the past does not necessarily mean that it will not appear in the future.

In concluding the overview of the line of studies that have been introduced in this subchapter, it can be stated that mean-variance plotting and mean-variance spanning tests have led to some very interesting conclusions. First of all, the role of risk seems to be important because some educations seem to fit the efficient frontier very well, but some do not. This has not yet been traced back to different variables. The results have not been introduced into decision making models, and the samples tested are still very limited compared to, for example, pure rate of return studies. We are still very far from having comparable data in statistical yearbooks like Education at a Glance. The rest of the paper contributes to that line of literature, by applying the ideas to the Hungarian dataset of the Student Loan Centre. This is essential because clients of the Student Loan Centre have extended social support for financial investment in their education. Student loans postpone some of the cost of education to income earning periods. If they tend to act for non-financial gains then it can jeopardize the repayment of the loan, which will eventually create social costs. In Chapter 3 the Hungarian Student Loan Centre dataset will be introduced and then the results of the empirical analysis will be introduced in Chapter 4.1.

2.3 International Trends in Student Loans

Before the thesis would continue with my own empirical analysis another set of empirical findings should be introduced. The point of this chapter is to draw the connection between student loans and macroeconomics. First some simple empirics on the relationship between

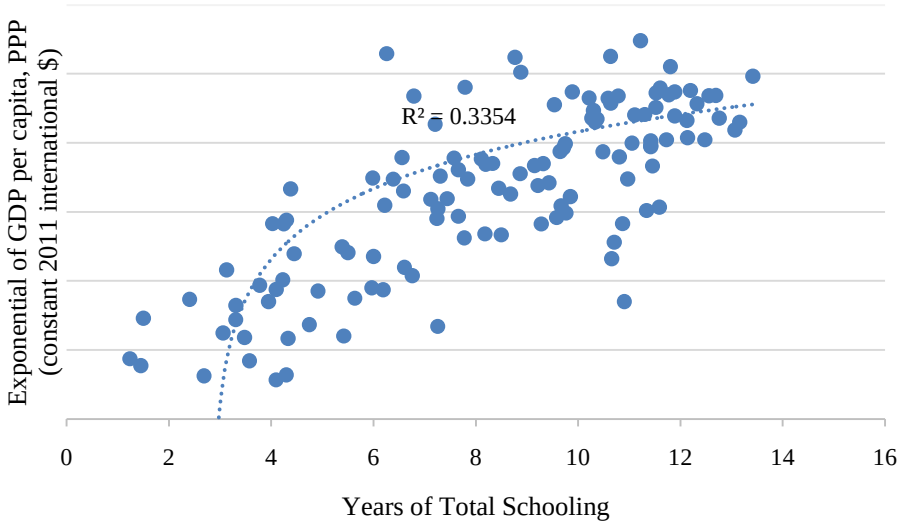
GDP and education will be given. Then the empirics of the financial system of higher education will be briefly reviewed. In the final part of the subchapter student loans will be highlighted and countries with the highest level of student lending will be found. These empirical findings will be used in Chapter 4 where the student loan led macroeconomic crisis will be rejected.

2.3.1. Relationship between Education Investment and the GDP

In Chapter 1 the question of economic growth was discussed. In this section of the dissertation I will show some simple empirics concerning the relationship of the GDP and education investment. It is necessary because some results of the thesis discuss this relationship.

The important issue that raised the interest of economists is represented in Figure 11 where 123 countries' logarithmic GDP and years of schooling data is shown. The source of the data is the Worldbank. Average years of schooling and GDP on PPP are compared. The R^2 of 0.335 shows that large proportion of such a complex variable as the domestic product can be explained by such a simple variable. The field of economic growth is where a great deal of the literature has been devoted to the questions regarding this relationship.

Figure 11: Average years of education (Barro-Lee dataset) and GDP in 139 countries, 2010



Source: Worldbank (2014)

It is a consequence of the human factor involved in production that a higher level of education results in higher GDP in the future, but it should certainly be mentioned that the process is probably circular. The data of Table 3 also prompt us to draw a similar conclusion. Table 3 is

a correlation table that shows, in the intersection of the rows and columns corresponding to the appropriate years, the linear correlation coefficients of the ratio of graduates and the per capita GDP in the 34 OECD countries. It should be noted that a linear relation does not mean causality, but based on the theory, a cause-consequence relationship may be assumed and its direction can also be specified. Moving downwards from the main diagonal of the matrix we can find linear correlation coefficients of medium values (0.4-0.5), which I interpret to mean that there is a positive linear relationship of medium strength between past per capita GDP and the ratio of persons involved in higher education.

Table 3: Correlation table between the ratio of graduates in various years (25- 64 demographic) and per capita GDP (at constant purchasing power, at 2005 prices) in OECD countries

		Per capita GDP (at constant purchasing power, at 2005 prices)					
		2000	2005	2008	2009	2010	2011
Ratio of graduates within the 35-64 demo. Figureic	2000	0.445	0.457	0.427	0.435	0.435	0.441
	2005	0.441	0.446	0.422	0.440	0.439	0.445
	2008	0.450	0.459	0.434	0.454	0.454	0.459
	2009	0.504	0.519	0.499	0.515	0.518	0.524
	2010	0.494	0.510	0.489	0.506	0.509	0.515
	2011	0.522	0.541	0.523	0.537	0.540	0.544

Source: calculation by the author, based on (2014a:231), OECD (2015a)

If we go upwards from the main diagonal, we can register relationships between those involved in higher education in the past and the future GDP figures. It is, perhaps, worth noting that the correlation coefficients are stronger between the higher education ratios at the end of the 2000s and the GDP figures of previous years. I interpret this to mean that in more affluent countries the ratio of persons involved in higher education increased by an even higher degree than in the less affluent OECD countries. With the exception of Chile there is no country that shows a decrease exceeding 1 percentage point between any two consecutive years concerning the student ratios (OECD 2014:45:46).

Table 4: Relation between per capita GDP (2011) and expenditure on higher education as a percentage of GDP (2011) in OECD countries

		Per capita GDP (at constant purchasing power, at 2005 prices)					
		2000	2005	2008	2009	2010	2011
Expenditure on higher education as a percentage of GDP	2000	0.36439	0.369437	0.361048	0.381893	0.407583	0.421458
	2005	0.315214	0.314073	0.321331	0.346271	0.368337	0.368259
	2008	0.252037	0.268346	0.256987	0.279249	0.300916	0.307875
	2009	0.28888	0.302874	0.290481	0.308062	0.329046	0.334196
	2010	0.217978	0.231407	0.224659	0.237232	0.259356	0.26874
	2011	0.216917	0.234362	0.226955	0.241474	0.261512	0.270104

Source: calculation of the author based on (2014a:231), OECD (2015a)

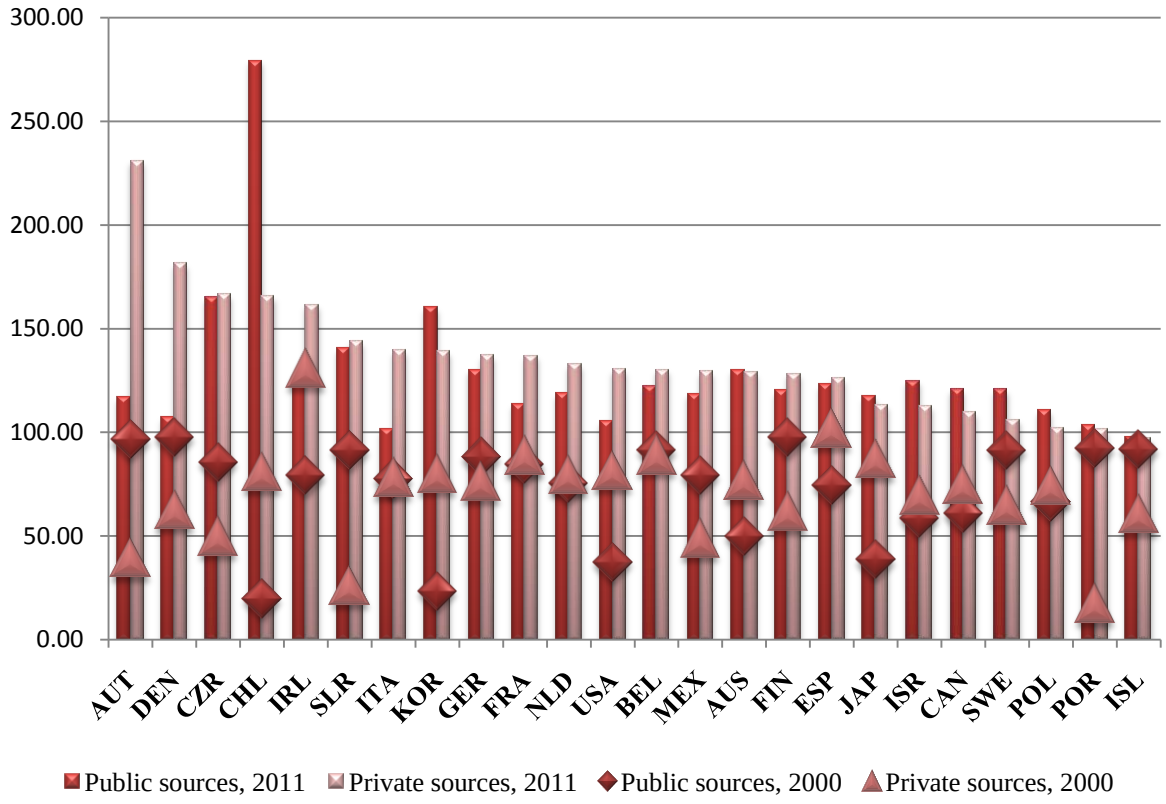
Table 4 can be interpreted similarly to the first one and shows the correlation between per capita GDP and expenditure on higher education as a percentage of GDP, on a sample of 34 OECD countries. Here the correlation is not so strong as in the system of relationships presented in Table 3. Typically, these countries spend 1-1.8% of their annual GDP on higher education (OECD, 2014a:231). According to Table 3.2, those countries that spent a higher ratio of their GDP on higher education at the beginning of the 2000s were the more affluent ones, and this relationship was strengthened. Countries that had spent higher ratios earlier were more likely to catch up with the more developed ones later. However, the correlations clearly weakened significantly. For example, only a weak positive correlation existed between the per capita GDP a decade earlier and the GDP-proportionate expenditure. The correlation with the current spending characteristics is even weaker than it had been at the beginning of the 2000s among instant data.

2.3.2. Private and Public Investment in Higher Education

Since student lending is one way to involve private funds in the financing of higher education, the first point that needs to be explored is how private funds and state funds are distributed in the individual countries and how they evolve over time. In Figure 12 2005 is the point of comparison. For example, in 2000 in Austria the value of private investments was less than 50% of the corresponding value in 2005 (39.1%), but by 2011 it had reached 230% of the value of 2005. A major change took place in the 2000s in private funding. Chile is different, since the involvement of state funds was very significant after 2005; furthermore, the great expansion of higher education in the Czech Republic is also remarkable. The line at 100 can

be considered critical, since "points" above that line indicate a drop in expenditures between 2000 and 2005. We can find examples of this primarily concerning the expenditures of the state, such as in Japan or Israel.

Figure 12: State and private educational expenditures in 2011 and in 2000, as a percentage of the expenditures in 2005, calculated at constant prices



Source: edited, based on OECD (2014a:248)

It can be concluded from Figure 3.2 that there is no, or hardly any, presumable correlation between the involvement of private and state funds. If we calculate a correlation coefficient for the changed data calculated from the two sets of data, then we arrive at correlation coefficients of 0.3 and 0.22 in the changes in private and state expenditures. This implies that although it is more typical that the two values increase simultaneously, the linear relationship is very weak. The Czech Republic, Austria, Portugal, Slovakia and Mexico could be mentioned as cases in point, where significant amounts of capital were involved. The case of Poland is especially interesting, because although in that country there was only an increase of 26% between 2000 and 2005, as the ratio of the value in 2005, the Polish student loan system started operating in 1998, which coincides with a surge in the involvement of private capital. However, by the second half of the decade the involvement of additional capital seems to have reached its limit. Furthermore, the Czech Republic should be mentioned, which was one

of the leaders in the involvement of private capital; even though no state-supported student loan program is operated in the country, there are solutions offered by private banks, but these usually involve the obligation of opening a current account. *Consequently, student lending does not seem to be a necessary or sufficient condition for the growth of permanent private funding.*

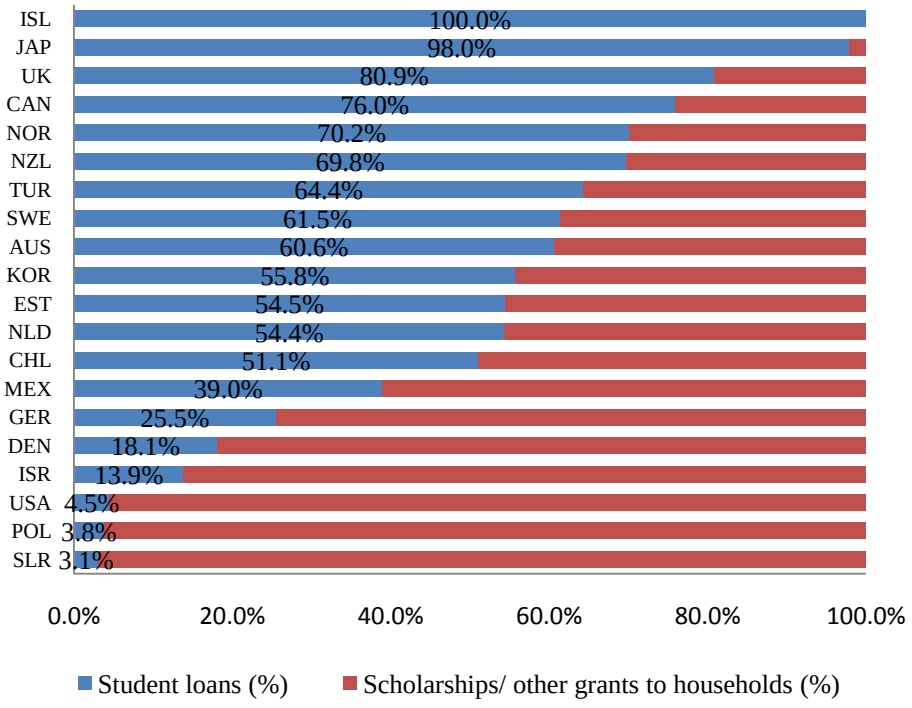
One example of a way of involving private funding which is initially effective is the application of relatively high tuition fees. In Europe really high tuitions, i.e. ones exceeding 5000 Euros are typically only applied in England. On the other hand, in Austria, Germany and the Nordic countries there is no tuition fee or tuition fee may be required only as an option. In the case of the remaining countries the average tuition fee is typically below 1000 Euros (EURYDICE, 2014).

2.3.3. Tuition Fees and Student Loans

The previous chapter has shown some statistics that tuition fees are one way to promote cost-sharing. However tuition fees can increase financial barriers and we have already discussed that is a major issue in educational choices. The government can offer non-reimbursable and reimbursable support. Scholarships and grants are examples of the first while student loans are the example for the second category. Based on the empirical data collection of the Education at a Glance (2014) issue some conclusion can be draw.

Figure 13 show that *student lending can appear heavily in student funding.* Figure 13 only shows those countries for which OECD (2014a) had data and the expenditure on student lending exceeds 0. The case of the United States, which is the system with by far the largest student loan market, is very interesting while student loans as form of support are comparatively small.

Figure 13: Distribution of involvement of the state between student lending (left) and scholarship transfers (right) (2011)[31]



Source: calculation of the author based on OECD (2014a:276)

Table 5 shows the history of student lending. It is a timeline with decades. Countries are listed under decades in which they introduced their system. It is also shown which type of lending it belongs: to the income-contingent repayment type or to the category of annuity lending with mortgage repayment. The table implies that although in the 1950s and 1960s student lending already existed, the major systems widely applied today only emerged gradually and later.

Table 5: State student lending programs according to inception and type. (Mortgage type lending - normal typeface; Income contingent student lending - boldface; Mixed lending - boldface, italics)

before 1960	1960s	1970s	1980s	1990s	after 2000
Japan	Canada	Denmark	**Australia**	Estonia	**Hungary**
Norway	Finland	Mexico	Belgium	***New Zealand***	Poland
	Iceland	***United States***	**Netherlands**	**United Kingdom**	Spain
	Turkey				

Source: edited based on OECD (2014a:274-275)

[31] Country names can be found in Supplement A

Furthermore, I claim, based on Table 5, that governments apply a relatively careful approach concerning the organization of student lending by the state, and although quite a lot of experience has been gathered, perhaps we still do not know enough to consider a state student lending programmes as natural. Probably, in the coming 10 years, several other countries will also join the group of those providing abundant data.

Table 6: Data related to student lending

Country	Average repayment term	Average annual instalment ($)	What percentage of graduates are in debt?
Australia	8 years	n.a.	55.0
Belgium	5 years	276.28	n.a.
Canada	10 years	1057.92	n.a.
Denmark	7 -15 years	1975.00	45.0
Finland	5-10 years	1353.25	38.5
Hungary	10-15 years	1039.30	27.6
Iceland	22 years	n.a.	n.a.
Japan	15 years	1195.71	n.a.
Netherlands	15 years	n.a.	n.a.
New Zealand	6.7 years	1615.00	n.a.
Norway	16.4 years	1987.37	n.a.
Spain	4.4 years	4392.00	n.a.
Sweden	25 years	1130.90	n.a.
Turkey	1-2 years	2576.02	20.0
United Kingdom	14-15 years	n.a.	79.0
United States of America	10-25 years	n.a.	67.7

Source: edited, based on OECD (2014a:275)

Table 6 presents some of the characteristics of the schemes already operating, based on which I conclude that in the case of the average programmes we should expect repayment terms of approximately 5-15 years, and the instalments to total approximately 1000-1500 dollars

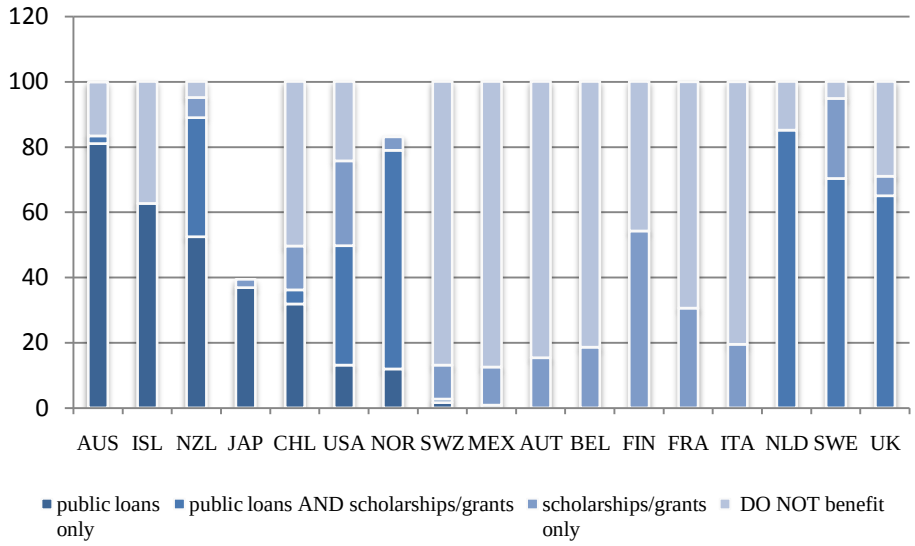
annually. These instalments typically fall due on small debts. If we consider the two values and ignore the time value of money (apart from one or two exceptions, student loans bear a discounted interest, and precisely because of this, their interests are very low), then borrowers of student loans accumulated average debts of between 5 to 25 thousand dollars. This can mainly be compared to debts arising from car loans. In fact, in the United States the market for student loans is the closest to this market in terms of size, as it will be shown in Chapter 4. The significance of such a market is mainly determined by how many are affected by it. In this regard we can find very significant variations, even though there is a scarcity of data. It is difficult to predict how many borrowers a student loan programme will have, but it is an often stated expectation of student lending systems that they should be transparent and flexible. Marcucci – Johnstone (2007) lists the expectations of well-designed and well-executed student loan programme in 6 points: they should be generally available; provide sufficient funds; be need-based; be minimally subsidized; be collectible; and they should be able to tap private capital markets. One possible way to attract the private market is to be very transparent and provide a large set of data on the historical performance of the student loan institution or the features of the student loan market.

Figure 14 provides further details on the question of who is affected. Student lending and scholarships, as forms of support, are not mutually exclusive. Scholarship holders also qualify for borrowing, should they need to do so; furthermore, borrowers of student loans also qualify for scholarships. However, the educational systems differ as to how these facilities are distributed among the individuals affected. Figure 14 provides some guidance. The ratio of those only receiving student loans is very low, with the exception of Australia, Iceland and New Zealand; however, the *scholarship plus student loan combination is more common*. Student lending is probably a frequently applied source of funding among students, when coupled with an appropriate system of scholarships; consider the examples of Sweden or the Netherlands, where students almost exclusively use this combination. Even so, a significant variation has been registered in the range of 30% and 80% exposure. In this way, it is actually quite difficult to predict the exact extent to which student lending by the state becomes a widely applied facility among students in order to cover their costs.

It may be argued that after some time mobility becomes so strong that this kind of student supporting organization should be organized at the European Union level. On a large scale this is rather an opportunity for the more distant future (Berlinger, 2012). A programme called Erasmus+ Masters Loan have started in the summer of 2015, designed to grant loans in the region of almost 3 billion Euros between 2015 and 2022 to those studying on master courses

abroad. It is expected that approximately 200 000 people will take out this loan, which will be an interesting experiment (Europa.eu 2015).

Figure 14: Ratio of students receiving funds from various sources or from a combination of sources[32]



Source: calculations of the author based on OECD (2014a:273)

In this chapter I have pointed out that private funding is complementary to public funding of education. Student loans have various models based on their role in financing education. In some countries it is not even apparent, while in others it is a main line of support. In Chapter 4 a detailed analysis of student loan debt will be given.

2.4 Summary

Chapter 2 of the thesis summarized some of the well-known empirical relationships that can be found in such statistical yearbooks as *Education at a Glance* and took a glimpse at the empirical literature on heterogeneity in the rates of return to education.

Heterogeneity can span from observable and unobservable sources. Observable heterogeneity can be related to societal variables such as gender, family background and ethnicity. These factors can indirectly influence future income as the literature argued. They make their effect through choices of institutions or fields of education. Authors examine disproportionate distributions at curtain levels of education and on special fields of education such as the so called STEM subjects. While the subject is fascinating, direct analysis of the effects of these societal variables, these factors are not considered to be risk factors. They are known by the

[32] For Japan and Norway data on Other sources was not given, this the reason why they do not add up to 100%

decision-maker when they choose their education, so they can set their expectations according to their societal features. However, this topic has to be discussed because risk studies must control these variables. They should be controlled because otherwise the variance in the rates of return would be overestimated.

This thesis will contribute to a line of risk literature that uses mean-variance analysis to evaluate educational choices made by individuals. The line of literature was discussed in detail. They have controlled for gender, ethnicity, field of education and type of education. I will add geographical location of residence and the location of the higher education institution to these variables, but more will be said on that in the next chapter. This line of literature followed rate of return calculation based on the Mincer-equation. While it can be criticized, it is a method generally used in the literature usually explained by data limitations. It will be followed in the case of this thesis as well.

The third part of the thesis provided numbers on the social role of student loans in an international context. The aim was to have an idea about the trends of the international student loan market. The market environment is usually an expending higher education market. In most countries both public and private funding of education is expending slowly and steadily. Student loans follow that process. Result 2 answers Hypothesis 2 of the thesis.

2.4.1 Result 2 of the Thesis Based on Empirical Literature

Hypothesis 2 states that high levels of education investment can be achieved without cost-sharing and a high level of private investment in education. Student loan schemes are introduced slowly and they appear in many models. There are outstanding countries in private investment and in the use of student lending. The summary of the history of student loans and role of student landing in financing higher education is not against this hypothesis. There are countries where student loans have an exclusive role in student support but they are usually mixed with other forms of financial support. The student loan markets are slowly expanding and while these instruments have been used in some countries for 60 years, there are still many countries where they have a marginal role. Based on these data the following result is phrased.

Result 2

With the help of fundamental international data and empirical literature review, it can be stated that student loans are elements of cost-sharing and they tend to increase spending on education. They are the tools of financial support for students. Building up a large student loan market takes decades and the features of a market are difficult to predict. Some

countries, however, stand out; here private investment is relatively high and student lending has an important role and tradition. This result is against the idea of a rapid spontaneous growth of a student loan market.

Result 2 is an important argument against the idea of a student loan crisis and gives fundamentals to narrow down the macroeconomic analysis to some specific countries. In Chapter 4 this result will be used to argue against the possibility of a student loan crisis that can spread through the economy. This result decreases the circle of candidate countries where the student loan market is large enough to be considered a macroeconomic threat.

3. Data and Methodology of the Empirical Analysis

In a very detailed example available in Avery – Turner (2012) they point out that in spite of growing costs and indebtedness, choosing higher education is still a rational and rewarding investment for most; however, they point out it is not universal and there are people who lose out. However it might not be surprising that US investors are more or less financially consequent about their investment in education. As we will see in the empirical section, the US education system is one of those that demand the most private investment. Their tuition fees are high compared to those familiar in the European education systems. However, there are countries where the education system is in turbulent change, data availability is limited and the initial financial investment is low. Hungary is a prime example of this. During the 2000-2010 period the traditional 4 year college and 5 year university system was partially replaced by a 3 stage BSc-MSc-PhD system, which was supplemented by 2-year vocational training. This was called the Bologna process (Haug – Tausch 2001, Sursock – Smidt 2010). The Hungarian higher education system offers full time training and part time training as well. The education programs are available in a state-funded form; however, if one studies for a second degree at a given level or cannot reach the minimum entry criteria[33] then one can participate in the same education programs by making a cost contribution or paying a tuition fee[34]. Even when a full cost contribution is necessary it is mostly around 500-1000 EUR per semester (Stéger-Szövenyi (ed.) 2013). Most recently, 77% percent of students taken on by the system have been in state-funded programs.[35] Those who apply for higher education can choose from a wide variety of education programs, from 2 year programs to 6 year programs. Many of these programs are fairly new and were introduced by the Bologna-process. Most of the applicants have access to state-financed programs. It is very difficult to make decisions in this environment because of the lack of information about the market value of these new types of degree. Financial rationality is the least expected element in such an environment.

For our purposes, Christiansen et al (2006) can be a very useful methodological guide. It was introduced in great detail in the previous chapter. They used financial economic techniques to better understand the risk-return trade off. They used a standard mean-variance analysis, very similar to the analysis of the fundamental problems of finance as introduced in Chapter 1.

[33] This is based on the applicants' secondary school performance, final exam grades, and in some cases entry exams taken for the higher education institute.

[34] Even these education programs have minimum entry criteria, but these are lower than state-financed programs.

[35] http://www.felvi.hu/felveteli/ponthatarok_rangsorok/friss_statisztikak/!FrissStatisztikak/friss_statisztikak.php?stat=1

The original analysis was for risky security investments like shares, bonds or derivatives. They assumed that the available investment possibilities are different kinds of education degrees. The Markowitz theory assumes rational investors invest in efficient portfolios. A portfolio of investments is efficient if it offers the least risk for a given level of return or the most return on a given level of risk. A set of portfolios fulfils these two requirements at the same time. This set is called the efficient frontier. The efficient frontier is part of a parabola in a mean-variance space, but it is more common to graph it in the mean-standard deviation space, where the frontier is a hyperbola like the one we derived based on Merton (1972) in Chapter 1.

Nowadays this is included in almost every financial textbook. Merton (1972) derived Equation 3.1 for the efficient frontier[36].

$$\sigma^2 = \beta_0 + \beta_1 E^2 - \beta_2 E \tag{3.1}$$

Where:

σ^2 – Variance of the portfolio return

E – Expected return of the portfolio.

In the literature of Chapter 2 it was suggested that an education program should be considered as a portfolio of human capital investments. Different education programs offer different enhancements of skills and knowledge. The assumption is that a human capital investor would prefer a field of education over another if it offers the highest return on a given risk level or the lowest risk on a given return level[37].

Christiansen et al (2006) and Glocker – Storck (2014) finds that some types of higher education degree fit this model, but there are some that do not. Some programs, for instance humanities, arts or nursing, do not offer a higher return for more variance, but there are still people who hold these degrees and choose these professions. These programs are not on the efficient frontier but within it. It was pointed out that some assumptions of the original model probably do not hold for the higher education market. The basic assumption of the theory is that students choose their profession based on risk-return reasoning. This is more likely to be true for securities, but for professions it is not that likely.

Table 7 summarizes the assumptions of the Markowitz theory for financial markets and how they should be translated to the education market. Chapter 1 included the assumptions for the

[36] You can also find this in the Hungarian literature in Gáll József – Pap Gyula (2010).

[37] The financial portfolio theory asks what the optimal investment is if we have a given budget X. X is completely devoted to risky investment.

original model. The assumptions were not clearly phrased in the literature but it can be traced back by deduction.

Table 7: Assumptions of the Markowitz theory for financial markets and education

Portfolio Theory for the Financial Markets	Portfolio Theory for the Education Market
Atomic investors (no price influence)	Individuals do not have influence on the return they earn after obtaining a degree
No transfer costs and taxes	It has no cost to change education at any point in time
Investor can invest any amount in any asset	Every possible combination of skills and knowledge can be obtained
Investors fallow Markowitz ordering	Students prefer skill and knowledge combination that offers higher return and lower risk
Optimization for mean and variance and same time-period is used	Every student uses the same evaluation techniques for different education programmes
Participants are fully informed	Everyone knows everything about the different education programmes.

Source: Based on Christiansen et al. (2007) and Glocker-Storck (2014)

If the assumptions are evaluated they seem unrealistic. However they are not realistic for the financial markets as well. These assumptions are useful, because they might offer some explanations if the model does not seem to fit.

We will make a similar examination as the literature in Chapter 2.2 for a data sample from the Student Loan Centre of Hungary. This is not a public database, but no data was provided to me or any of my colleagues that has any reference to the borrowers' identities. Neither do my results have any relation to the business policy or profitability of the Student Loan Centre.[38]

The data sample is for yearly annual gross real income from 2008 to 2012.[39] The Hungarian student loan scheme is income contingent. They receive income data in order to calculate the necessary instalment[40]. The instalment can be 6% or 8% of the income two years prior to the due date of the payment. The first two years instalment is based on the minimum-wage.

[38] For more on the structure of the Hungarian Student Loan Centre see: Berlinger (2009)

[39] The price indices of KSH (2014) were used for real income calculations. The previous year is 100. Year/Price Index: 2009/104,2; 2010/104,9; 2011/103,9; 2012/105,7

[40] Their data is from the Hungarian Tax Authority

Individuals entered the sample if they had recorded income for any of the years in the indicated time period. The focus of the examination is education programs. Those programs were selected where at least 30 individuals' income was recorded for the whole time period. Only state financed and full time education programs were evaluated. Those who participated in more than one type of education program were excluded, as well as those who had no reported income. The equal costs assumption does not apply to those who participated in several different ISCED coded programs. More information on ISCED Codes for fields of education can be found in Supplement C. The final sample contained data for 20,146 individuals in 46,229 observations for 34 education programs.[41]

Table 8: Descriptive statistics of the sample

	2008	2009	2010	2011	2012
Number of obs.	15,775	13,180	10,019	5,878	1,377
Average yearly repayment (HUF)	19,774	74,093	90,666	99,491	111,574
Average real income (S.D.) (HUF)	2,570,001 (2,600,485)	2,559,799 (1,823,263)	2,509,305 (1,851,101)	2,650,229 (1,906,702)	2,734,870 (2,111,241)
Ratio of men (%)	49.19	49.23	48.82	49.74	49.60
Budapest as permanent residence (%)	19.67	19.78	19.52	19.59	18.44
Budapest as the place of study (%)	42.09	41.95	41.58	41.51	40.88
Experience	2,09 (1,35)	2,63 (1,60)	3,16 (1,86)	3,72 (2,08)	4,23 (2,38)

Source: Student Loan Data

Table 8 shows more detailed descriptive statistics for our sample, focusing on the variables that will be used further on in our model. The dataset included some information on the clients' social background. In Chapter 2 it was pointed out - based on the literature - that there are important factors behind heterogeneity, such as gender, ethnicity, college choice, and family background. What the database has offered is gender information, the county of permanent residence, and the county of the college the student is attending. Dummy variables were derived from these data. As a fifth of the Hungarian population lives in Budapest and it is the most economically developed region in the country, it was represented in a dummy variable. 40% of higher education students go to Budapest to study, so college choice was also highlighted with a Budapest-dummy. They were used as control variables in the Mincer equation.

[41] All the data sorting and calculations were performed

The purpose of the analysis was to fit Equation 3.1 to the data, but first a return measure must be defined. Christiansen et al (2006) will be followed. Two types of return will be calculated: average raw logarithmic income and average Mincer residuals. The first is calculated by Equation 3.2, which follows. The expected raw logarithmic income of an education group is the average of the time average of the individual's income. This means we evaluate a high salary as the return to education.

$$R_j = \frac{1}{n_j}\sum_{i=1}^{n_j}\frac{1}{n_i}\sum_{t=1}^{n_i} lnW_{ijt} \tag{3.2}$$

R_j – Expected return (raw logarithmic income) for the education group j

n_j – Number of individuals in education group *j*

n_i – Number of observations for an individual *i*

W_{ijt} – Annual income for individual *i* in education group *j* in year *t*.

It can be argued that average raw logarithmic income is not the actual rate of return because costs and foregone earnings are not represented. As was mentioned earlier the education programs are state-financed, so the tuition fee does not vary by education group. If equal living and travelling costs and the same foregone earnings for different education groups are assumed, then the only variable dependent on the education group in the rate of return calculation is the income[42]. It should also be assumed that income differences between the professions are more or less constant over time, or that the investors do not have better predictions than this assumption. The second type of return we will calculate is the average Mincer residuals, but first the Mincer equation should be introduced. As was expressed in the literature review chapter the rate of return calculation is very data hungry. Mincer (1974) introduced a very simple approach for the rate of return to education. The so called Mincer equation can be expressed in the form of Equation 3.3, if we extend it with the observed variables.

$$lnW_{ijt} = \beta_0 + \beta_1 s_{ijt} + \beta_2 x_{ijt} + \beta_3 x_{ijt}^2 + \beta_4 G_{ijt} + \beta_5 P_{ijt} + \beta_6 E_{ijt} + \varepsilon_{ijt} \tag{3.3}$$

t – year

j – type of education

s_{ijt} – years of schooling for individual *i*

[42] In this paper there will be no emphasis on whether the industry the individual is working is the same she studied for. Job-matching is an existing dilemma, but we have no data to examine such a question. A further dilemma is the obvious cost of loan repayment. The problem is that if we take it into account, it will create negative income for some period and that cannot be used in a logarithmic function. As Table 4.1 suggests,therepayment is relatively small compared to the expected income, so the dilemma of whether to subtract repayment or not, is left alone.

x_{ijt} – experience of individual *i*

G_{ijt} – gender dummy for individual *i* (male = 0, female = 1)

P_{jti} – Permanent residence dummy for individual *i* (Not Budapest = 0, Budapest = 1)

E_{ijt} – College choice dummy for individual *i* (Not Budapest = 0, Budapest = 1)

ε_{ijt} – Mincer residual

It can be shown that if certain conditions are met, the coefficient of schooling (s_i) in the Mincer-equation is the rate of return to education (Heckman et al, 2006). The second return measure will be the expected residual of the Mincer equation for an education group. The individual Mincer residual is defined in Equation 3.4 similar to Equation 2.2b.

$$\varepsilon_{ijt} = lnW_{ijt} - \left(\hat{\beta}_0 + \hat{\beta}_1 s_i + \hat{\beta}_2 x_i + \hat{\beta}_3 x_i^2 + \beta_4 G_{ijt} + \beta_5 P_{ijt} + \beta_6 E_{ijt}\right) \quad (3.4)$$

The Mincer residual can be understood as a redefinition of foregone earnings because it compares earnings to expected earnings with the same years of schooling. It asks whether the individual with a given education can earn more than what is expected purely based on her years of education and experience. An average Mincer residual for education group *j* can be obtained by substituting ε_{ijt} in Equation 3.2 in the place of lnW_{ijt}.

Risk will be measured by the average standard deviation for an education group for both return measures. Both time-series and cross sectional measurement will be performed and presented. Equation 3.5*a* and 3.5*b* is formulated for average raw logarithmic income and for the Mincer residuals as already introduced in Chapter 2.

$$\sigma_j^{TS} = \frac{1}{n_j}\sum_{i=1}^{n_j}\frac{1}{n_i - 1}\sqrt{\sum_{t=1}^{n_i}\left(lnW_{ijt} - lnW_{ij}\right)^2} \quad (3.5a)$$

$$\sigma_j^{CS} = \frac{1}{n_i}\sum_{t}^{n_i}\sqrt{\frac{1}{n_j - 1}\sum_{i}^{n_j}\left(\ln W_{ijt} - \overline{\ln W_{ijt}}\right)^2} \quad (3.5b)$$

where:

lnW_{ij} – average logarithmic income for a given individual *i* in a given education group *j*,

$$lnW_{ij} = \frac{1}{n_i}\sum_{t=1}^{n_i} lnW_{ijt}$$

σ_j – standard deviation of return for education group *j*

$\overline{\ln W_{ijt}}$ – average logarithmic income for a given educational group *j* for a given year *t*

$$\overline{\ln W_{ijt}} = \frac{1}{n_j}\sum_{j=1}^{n_j} lnW_{ijt}$$

Similarly to 3.5*a* and 3.5*b* the standard deviation of the Mincer residual can be defined by substituting ε_{ijt} in place of lnW_{ijt} and ε_{ij} in place of lnW_{ij}. ε_{ij} is the expected Mincer residual of the individual *i*. *It has to be pointed out here that Equation 3.5a is very worrying, because it might be misleading to calculate risk in this way. Standard deviation can be calculated for any set of numbers, but that does not necessarily mean that it is useful. It should be noted that if we take two groups of people, who all have a strictly growing earnings pattern with a fixed growth rate, but one group experiences a higher growth than the other, and Equation 3.5a is calculated for the two groups, then Equation 3.5a will declare the group with a higher growth rate is riskier, whereas neither of the groups experience any kind of risk. Besides these concerns it might be worth calculating this measure and comparing the results to other measures.*

The Student Loan Centre receives its income information for the repayment calculations from the tax authority (Nemzeti Adó és Vámhivatal). However, if an individual has not prepared a tax return, this means he or she has 0 taxable income in Hungary. Many of the clients who pay back their loan belong in this category. In fact, 14.37% of the dataset was the average 0 income ratio among the 34 education groups. There can be several reasons for this phenomenon, including the following:

- The borrower is inactive and does not receive any financial assistance, but uses his savings for repayment
- The borrower is inactive and does not receive any financial assistance, but the family or relatives repay
- The borrower works abroad and does a tax return there
- The borrower has income but does not report it.

The reasons for inactivity can be several; for instance, an individual graduates, but starts the repayment, or waits for better job opportunities, and in some cases it may be that they do not work because they are unable to. Interestingly, as Table 4.2 suggests, there is a strong negative linear connection between the raw log income of the education group and the ratio of 0 incomes.

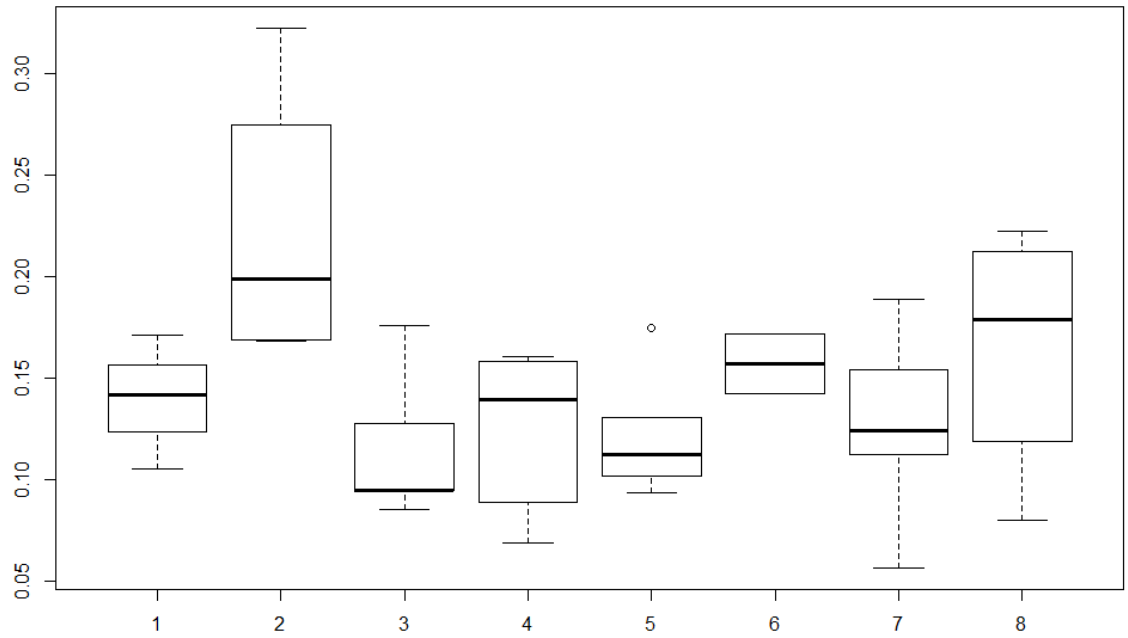
Table 9: Connections between Average Raw Logarithmic Income and the Ratio of 0 income observations

	Estimate	Std. Error	t value	P value
Intercept	1.80375	0.24337	7.412	1.97e-08
Ratio of 0 income observations	-0.11680	0.01712	-6.823	1.02e-07
R^2	0.5258			
N	34			

Source: Based on Student Loan Centre Data

This suggests that 0 income is more of a decision than a risk. The option value of education is a rich field in educational economics as well (Eide – Waehrer 1998). 0 income can be an unexercised option if it is not the product of foreign earnings. Working abroad is very popular among young graduates. The correlation between years of education and the 0 income ratio is -0.18, which means they might be independent, but unemployment and the length of education usually shows a strong relationship. As Graph 8 suggests, there is no connection between the type of education and the 0 income ratio, except maybe that for ISCED type 2, i.e. humanities and arts, where it is higher than for ISCED type 3, i.e. social sciences and arts.

Figure 15: Boxplot of the 0 income ratio by ISCED categories



Source: Based on Student Loan Centre Data

Based on the fact that 0 income does not necessarily mean unemployment or inactivity due to inability to work, it appears preferable to clear the sample of the 0 income data, because it might cause less distortion to leave out some unintentionally unemployed workers than to hugely overestimate the risk and underestimate the return by retaining many of the 0 incomes of those who might have an income or still be studying. All the further calculations are for non-zero income individuals.

4. Empirical Results

The main question of the thesis is: *What is the role of risk in individual higher educational choice and what are the short-term macroeconomic implications of it, namely if individuals on a mass level experience negative rate of return to education, can it cause macroeconomic crisis?* The previous chapters provided theoretical and empirical background to the question. Risk was understood as market risk and the Markowitz portfolio theory was chosen as an analytical framework. Individual higher educational choice was understood as the choice of a field of education. In Chapter 2 it was argued that for risk analysis some societal variables must be controlled. Chapter 3 provided the type of Mincer-equation that is used for calculating the rates of return to the fields of education. That Mincer-equation included dummy variables for gender, place of permanent residence and place of institution. Chapter 1 argued that while the long term economic effect of education is a much discussed area or research short-term effects are less explored. It was introduced that there is a concept where student loan debt can be a crisis factor in the economy. For this reason I have chosen student loan borrowers for a sample for risk analysis. A Hungarian dataset was available for me. The data sample was introduced in Chapter 3. Chapter 1 have set up the hypothesis for the micro level analysis.

Hypothesis 1

Student loan borrowers in Hungary, who paid back their loans during 2008-2012 do not follow Markowitz ordering investment behaviour towards education programmes of different levels and they tend to choose programmes that not belong to an efficient frontier in a risk-return space, defined by measures that are tested in the branch of literature characterised by Palacious-Huerta (2003), Christiansen et al (2007) and Glocker – Storck (2014).

This hypothesis will be tested in Chapter 4.1. Result 3 and Result 4 of the thesis will be phrased based on the results of the analysis of Hypothesis 1. My results confirm even for student loan borrowers the findings of Christiansen et al (2007) and Glocker – Storck (2014) and they are even expended by the analysis of Sharpe-ratios. Even student loan borrowers tend to choose education programmes that seems riskier then what would be justified by their return. However there is the possibility for unobserved heterogeneity and many assumptions of the underlying model does not fit for the reality. Even taking that into consideration it is very hard to reject the possibility of risk accumulation on the student loan market based on micro level observations. Hypothesis 3 was phrased for macroeconomic implications.

In Chapter 2 an answer was found for Hypothesis two concerning the evolution of student loan markets.

Hypothesis 3

Growth on the higher education market is an exponential growth process. Human capital investors overvalue the growth opportunities in their future income, so they pile up current debt at a level that they cannot finance from the earnings on their investment. When they realise the true return on their human capital investment (their true earnings after graduation) they will find that they cannot pay back their student loan debt. This will happen on a mass level. The student loan default rate will be so high that it will affect the financial markets. This can cause financial crises at least on a national level, but a future global crisis is possible.

The second part of the empirical analysis will argue that even tough micro level risk accumulation is possible a student loan crisis would not result in a macro level crisis. For this argument the largest privately funded higher education systems will be analysed. This includes Japan, Great Brittan, South Korea and mainly the United States. The main point is that these markets are relatively small compared to usual crisis factors like mortgage debt or stock market value. Result 5 will be based on this observation.

An exponential growth of the market would change the previous argument. For this reason a second argument is given. It will be argued that the government is very deeply involved with the student loan market and human capital investment has features that are against a rapid expansion. The argument will be summarized in Result 6 of the thesis.

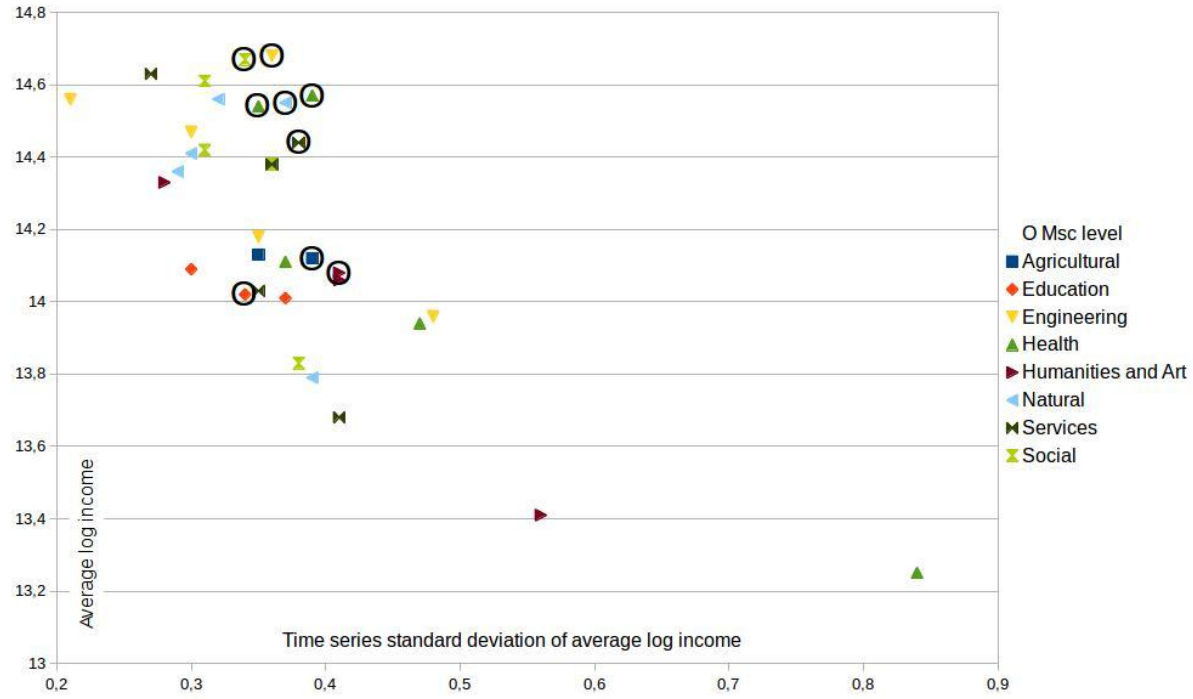
4.1. Risk in Choice among Fields of Education – Application of the Markowitz Theory to a Hungarian Student Loan Borrower Sample

Figure 16 shows the 34 educational groups in the mean-variance space, where the average raw logarithmic income is the return and its time series standard deviation is indicated on the horizontal axis. All data for the plot, and as well as for Figures 17-19 can be found in Supplement D.

If we examine the scatter-plot in more detail the hyperbolic shape indicated by the theory can be seen. It can be observed that MSc Social Sciences and Law and MSc Engineering offer the highest return. It is also notable that MSc programs appear to stand out. Traditional college (TC) and some BSc studies, such as Humanities and Arts are more mixed around the top of the hyperbola. However it is not visible on Figure 16, but it stands out form the data, that Vocational training courses (VT) lie along a part of the frontier that is not optimal according

to the theory because higher return-less risk combinations can be found. They are optimal only according to one criteria, by offering the minimum of risk for the given level of return. The opinion of the author is that there can be several explanations for this.

Figure 16: Scatter-plot of Raw Logarithmic Income and its standard deviation



Source: Based on Student Loan Centre Data

There can be certain kinds of human capital or financial barrier that do not allow individuals to choose longer education programs with favourable risk-return combinations. For instance, MSc Health is one of the best combinations in a risk-return sense. The theory would claim that people must prefer MSc Health over BSc Health or VT in Health Sciences. However, the fact is that these programs exist might suggest that, for example, somebody who studies to be a nurse does not have the human capital requirements to be a surgeon. Another possibility is that foregone earnings might cause different levels of stress for different individuals. For example, someone might not be able to choose to stay out of the labour market for the extended time that a BSc+MSc combination demands, even if it is financially feasible by taking out a student loan.

Table 10: Estimation of Equation 3.1 with Raw Logarithmic Income

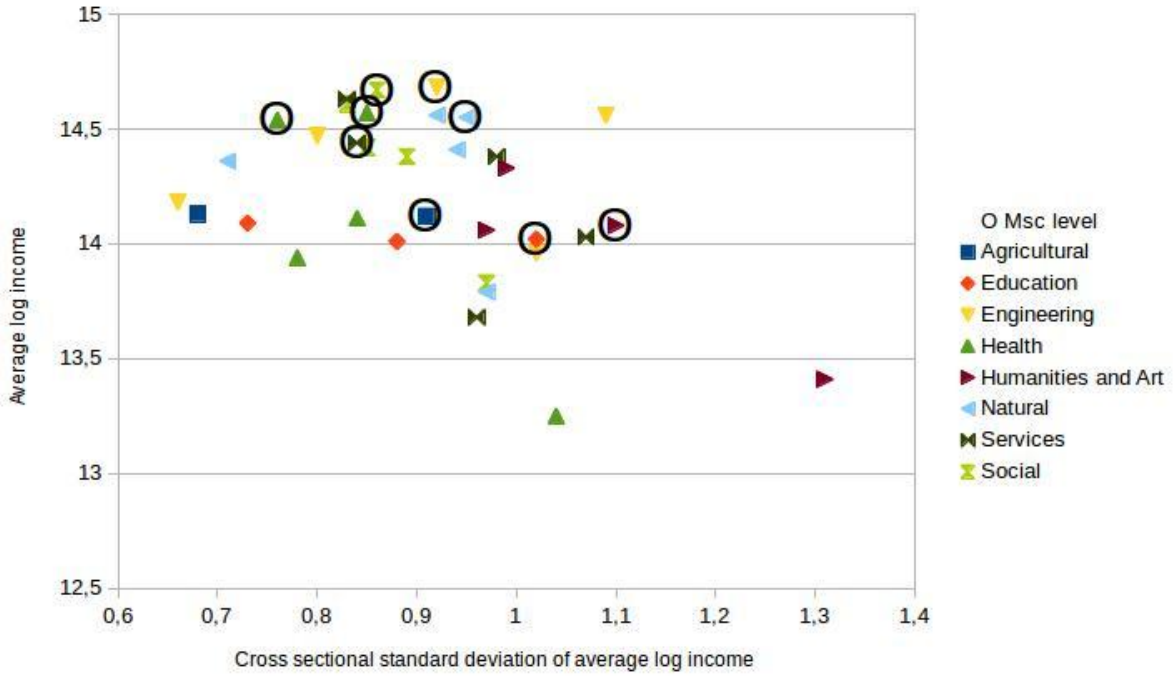
	Estimate	Std. Error	t value	P value
Intercept	77.91218	11.25213	6.924	9.13e-08
(Row Log Income)^2	0.37754	0.05685	6.641	2.01e-07
Row Log Income	-10.84048	1.59992	-6.776	1.38e-07
R^2	0.7908			
N	34			

Source: Based on Student Loan Centre Data

Another possible explanation is that most of these training courses are not the complete education investment people are planning to make, but simply the entry level for a higher level education. For instance, someone who does a BSc in Engineering is very likely to return for an MSc after a few years of work. Some of this theory would be testable by a thorough examination of the more interesting cases through primary data collection.

As can be seen in Table 10, which contains the results appropriate for Equation 3.1, the coefficients are significant on all usual significance level moreover the sign of the coefficients are those that Equation 3.1 predicted. The R^2 statistic is quite high at 0.795. Most of the variance can be explained by the model. Table 4.2 suggests that the education programs fit a model that is based on rational risk minimizing behaviour. For some reason, some of the education programs are non-optimal, because higher returns can be reached through longer education programs with the same level of risk. *As was mentioned previously, there may be various non-financial barriers for some investors. Compared to the results of Christiansen et al (2006) they found more education programs that seemingly do not fit the model. Some of their findings are inside the efficient frontier.*

Figure 17: Scatter-plot of Raw Logarithmic Income and its cross-sectional standard deviation



Source: Based on Student Loan Centre Data

If we apply the cross sectional method we will get a very familiar pattern of the hyperbolic surface, but dense internal shape. The results are given on Figure 17. MSc Health, Social Science and Law and MSc Engineering all point to financial risk-return behaviour, and the "usual" Humanities and Arts, Education, lower level Health training courses are found within it. However, various levels of engineering trainings are less surprisingly found all over the map, such as they were in the Glocker – Storck (2014) study.

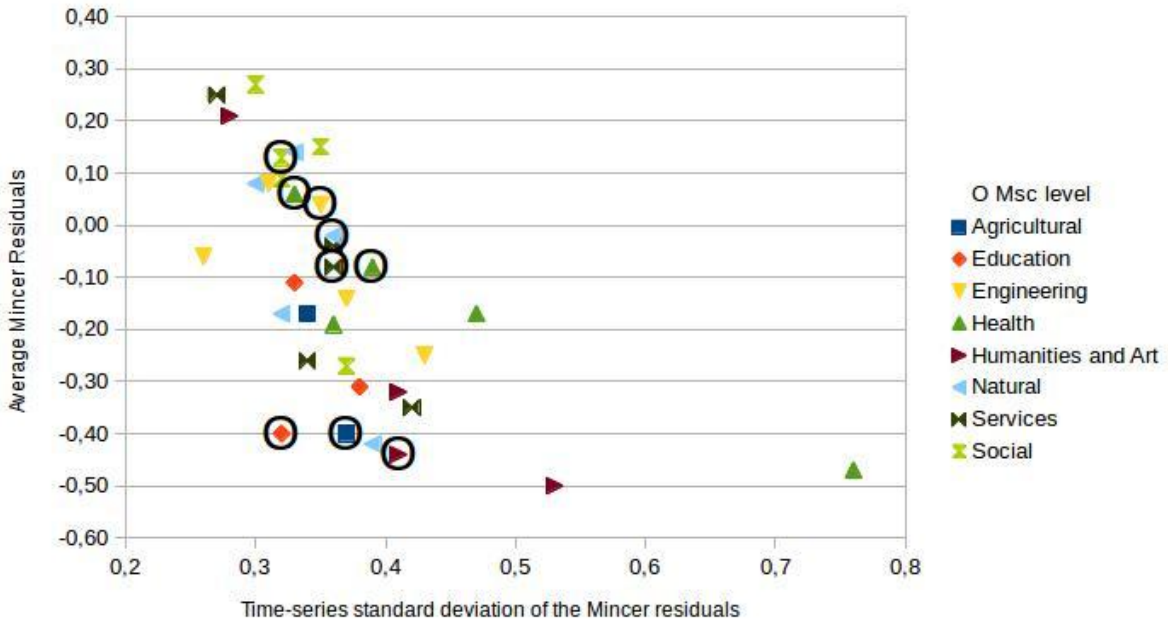
Table 11: Fitting the Mincer Equation

	Estimate	Std. Error	t value	P value
Intercept	11.761822	0.066257	177.52	<2e-16
Schooling	0.130692	0.004089	31.96	<2e-16
Experience	0.395827	0.006982	56.69	<2e-16
Experience^2	-0.045381	0.001096	-41.39	<2e-16
Gender	-0.216407	0.008151	-26.55	<2e-16
Perm. Res.	0.005904	0.011143	0.53	0.596
College Choice	0.235033	0.008985	26.16	<2e-16
R^2	0.1367			
N	46,229			

Source: Based on Student Loan Centre Data

Table 11 introduces the results of fitting the Mincer equation of Equation 3.3. From the results the first thing worth pointing out is that the equation gives us around a 13% rate of return to one year of higher education. If we see that tertiary education lasts 3-4 years, the private rate of return to tertiary education will give around a 40% wage advantage. The 13% rate of return fits the expectations that can be set up based on the empirical review in Chapter 2. There can be some gender discrimination experienced, as the significant negative coefficient suggests. College choice seems to be a good investment and permanent residence seems to have no effect. If the same map is plotted as the previous one with average Mincer residuals, the education programs can be visualized in Figure 18.

Figure 18: Scatter-plot of Mincer Residuals and their time series standard deviations



Source: Based on Student Loan Centre Data

Figure 17 offers the interesting suggestion that those who finish higher education after a Vocational training course tend to underperform compared to the Mincer-model prediction. BSc programs are spread widely, and MSc and Traditional 4 year college programs are concentrated more narrowly around the 0 line. *This seems to suggest that the Mincer predictions might be better for longer education programs. This might be a convincing argument if we assume that education needs an extended period to make an impact on future productivity.*

Table 12: Estimation of Equation 3.1 with average Mincer-residuals and their time series standard deviation

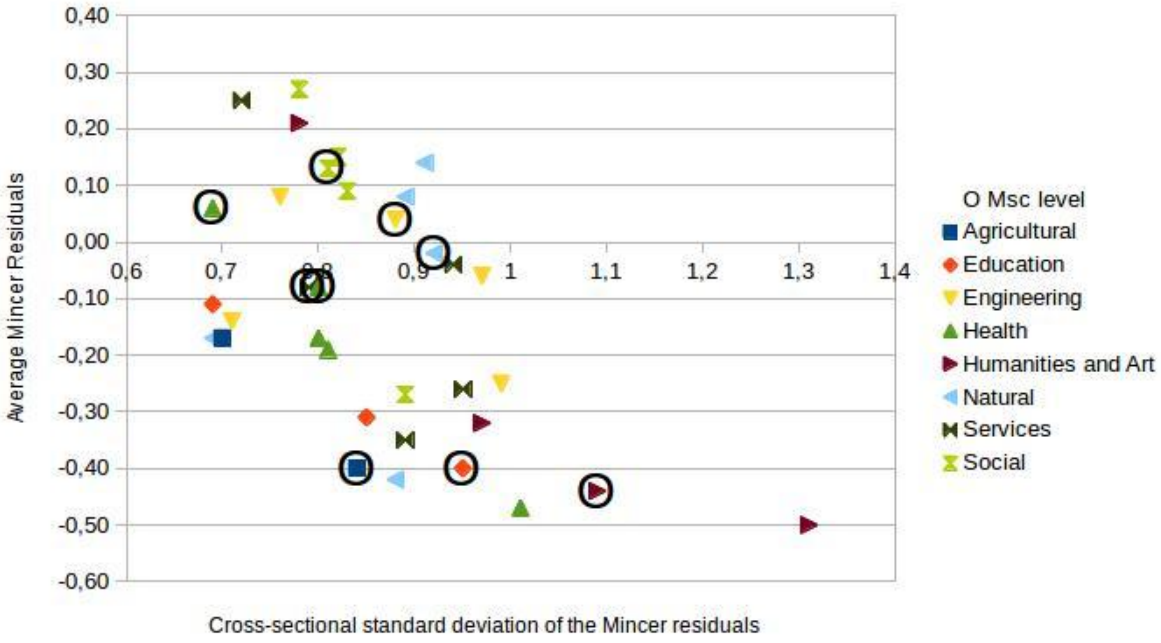
	Estimate	Std. Error	t value	P value
Intercept	0.09986	0.01659	6.019	1.16e-06
(Mincer residual)^2	0.50276	0.26683	1.884	0.0689
Mincer residual	-0.09451	0.08567	-1.103	0.2785
R^2	0.3726			
N	34			

Source: Based on Student Loan Centre Data

Table 12 summarizes the results for fitting Equation 3.1 to the data of Figure 17. The p-values suggest that the coefficients of the Mincer residual are not significant on the usual significance levels, but the squared residual is significant at 10% and the R^2 is at 37.3%, so the model should not be rejected overall; however, this model does not fit as well as the previous one.

The less favourable performance of the Mincer residual was observed by Christiansen et al (2006), as well. *This may suggest that individual earnings and their security play a greater role in the choice of education than the comparative wage advantage over those who have the same level of education, or people do not feel that they are giving up the average return for education. We must also note that the Mincer model does not fit our data very well. If it were possible to include more information on, for instance, family background, this might prove the explanatory power of the Mincer-residual based model, as well. So the weak explanatory power of this model might be caused by a mistaken prediction of the benchmark for wage advantage.*

Figure 19: Scatter-plot of Mincer Residuals and their cross sectional standard deviations



Source: Based on Student Loan Centre Data

Figure 19 gives us the most resemblance to the literature review of Chapter 4.2. It compares the Mincer residual and its cross sectional standard deviation.

After evaluating the literature, performing measurements of multiple return and risk measures and analysis on a special set of data the chapter will end with the conclusions. The study has successfully proved through four different combinations of measurement that even though there was a large transition in education during the first decade of the century, the pattern of risk-return behaviour of those who took student loans from the Student Loan Centre does not significantly differ from students of the United States, Germany or Denmark. According to the knowledge of the author at the time of writing the thesis, no comparable study has been performed for Hungary or any other countries that do not belong among the most developed countries. This study further validated the heterogeneity in return and risk of fields of education observed by Christiansen et al (2007) and Glocker – Storck (2014). For the Hungarian student loan borrower sample it was seen that some fields of education seem to fit the so called efficient frontier, and some lay well within the feasible set of risk-return combinations. Even the pattern was found that social sciences, law, high level health and engineering studies seem to fit the frontier. Short term education programs like humanities and arts studies tend not to fit.

The accomplishment of the study is that in this dataset there arose an opportunity to fit the equation of the Markowitz frontier. Surprisingly this opportunity arose when a fairly simple technique was used. A simple average raw logarithmic income and a simple time series variance were compared, and, for the educational groups of the borrower dataset analysed, the hyperbolic efficient frontier could explain 79% of the variance. However, part of the observations lay on the inefficient part of the curve, which occurs only if the investment opportunities are not only bounded by the feasible set, but by other factors too. This fits the conclusion of previous studies. The contribution here is that this result is found for a population that had access to financial support and used it to fund their education, so this might imply that it is not financial barriers that kept them away from more efficient risk-return combinations. This leads us directly to a difficult to measure or immeasurable heterogeneity, like motivation and/or abilities.

$$SR_j = \frac{\varepsilon_j + n_j \beta_1}{\sigma_j^{CS}} \tag{4.1}$$

Equation 4.1 is a Sharpe-ratio that will be used here to compare different levels of education and different fields of education. As was discussed in Chapter 1 the Sharpe ratio is a return to risk measure. The higher the Sharpe ratio is, the more the investor gets for taking one unit of risk. Equation 4.1 has the length of education multiplied by the coefficient of years of

education from the Mincer equation and the residual, which is divided by the risk of the given field of education.

Table 13 give us the calculated values of the Sharpe-ratio as of Equation 4.1 for the 34 education programmes analysed in this chapter. Table 13 combined with the previous results gives us some important insights. If we look at the bottom row, the Sharpe ratio grows with the level of education, which contributes to the study of Palacious-Huerta (2003) by adding that at least for the Hungarian student loan repaying sample of 2008-2012, the Sharpe-ratio grows with the level of education. However, this does not hold true for some specific fields. Engineering is an interesting case, where BSc studies seem to give the most turnover. Social sciences and law give an exceptionally high return, if studied at a traditional college level, i.e. in law schools and other social science institutes.

Table 13: Sharpe-ratios for education programmes

Mincer-residuals and cross sectional standard deviations were used

Field	VT	BSc	BSc*	TC	MSc	MSc*	Average
Natural	-4.2%	13.6%	54.0%	68.1%	100.1%		46.3%
Education		-1.7%		47.5%	91.4%		45.7%
Health	-21.7%	28.6%		42.0%	79.9%	82.2%	42.2%
Engineering	24.2%	56.7%	39.5%	9.3%	38.0%		33.5%
Humanities and Art	36.1%	49.6%		28.1%	18.8%		33.2%
Social	-7.5%	17.9%	20.5%	86.9%	26.5%		28.9%
Services	6.9%	22.7%	21.5%	4.7%	73.3%		25.8%
Agricultural		3.0%			25.2%		14.1%
Average	5.6%	23.8%	33.8%	40.9%	56.6%	82.2%	

Source: Based on Student Loan Centre Data

Education is one of the fields not on the efficient frontier; however, in the case of Sharpe-ratios it tends to perform better. Basically this is influenced by the role of the state in employing teachers.

4.1.1. Result 3 and Result 4 of the Thesis Based on Empirical Research

The connection between risk and return suggested by Figures 16 - 19 and Tables 10 - 13 makes an interesting addition to the argument set out in Anderberg – Andersson (2003), da Costa – Maestri (2007), Anderberg (2009) and Jacobs et al (2009). It implies that education has an insurance effect up to a point. This point is the minimum point of the mean-variance parabola estimated in Table 10. However, we should not immediately call for subsidization, because lack of finance is not necessarily the reason behind non-optimal investment, as was suggested earlier.

Result 3

With risk and return measured by the simple measures of average raw logarithmic income and the time-series standard deviation on a data sample of Hungarians who paid back their student loan between 2008 and 2012, a great fit for the frontier offered by the Markowitz-theory of risky investment can be found. Some of the risk-return combinations are not efficient. Due to the fact that the sample members are student loan borrowers, the role of financial barriers is not necessarily the explanation for this. There is uncontrolled heterogeneity in the sample and it can impose investment barriers that withhold access to higher levels of education investment. However, the time-series standard deviation of the average raw logarithmic income should be approached carefully because the results of the measure can be misleading. A strictly growing income series will produce a large standard deviation with this measure. Cross-sectional standard deviation is a better measure for risk.

As it is said in Result 3 better measures for risk should be used. Some example for that was shown in the chapter. That led to Result 4.

Result 4

The observation for return and risk of fields of education by Christiansen et al (2007) and Glocker – Storck (2014) was validated on a special sample of data. For the Hungarian student loan borrower sample it was seen that some fields of education seem to fit the so-called efficient frontier and some lie well within the feasible set of risk-return combinations. There is even an observable pattern that social sciences and law, high level health studies, and high level engineering studies seem to fit the frontier and short term education programs, humanities and art studies tend not to fit. The risk-return behaviour of human capital investors seems to be the same as in very developed countries. Sharpe-ratios offered some explanations for heterogeneity. Sharpe-ratios tend to decrease with the length of education;

however, within a field there are mixed results. There is unobserved heterogeneity and there is a need for more sophisticated control variables.

In the following chapter the short-term macroeconomic implications of these results will be evaluated.

4.2. Macroeconomic Implications of Risky Education – Rejection of the Student Loan Market Led Macroeconomic Crisis

Chapter 4.1 was not able to deny the possibility of risk accumulation on the education market. It seems to be that there are people who take too much risk compared to their expected return. This makes it necessary to argue the possibility of a short-term macroeconomic effect of a crisis if risks tend to add up.

Hypothesis: Growth on the higher education market is an exponential growth process. Human capital investors overvalue the growth opportunities in their future income, so they pile up current debt at a level that they cannot finance from the earnings on their investment. When they realise the true return on their human capital investment (their true earnings after graduation) they will find that they cannot pay back their student loan debt. This will happen on a mass level. The student loan default rate will be so high that it will affect the financial markets. This can cause financial crises at least on a national level, but a future global crisis is possible.

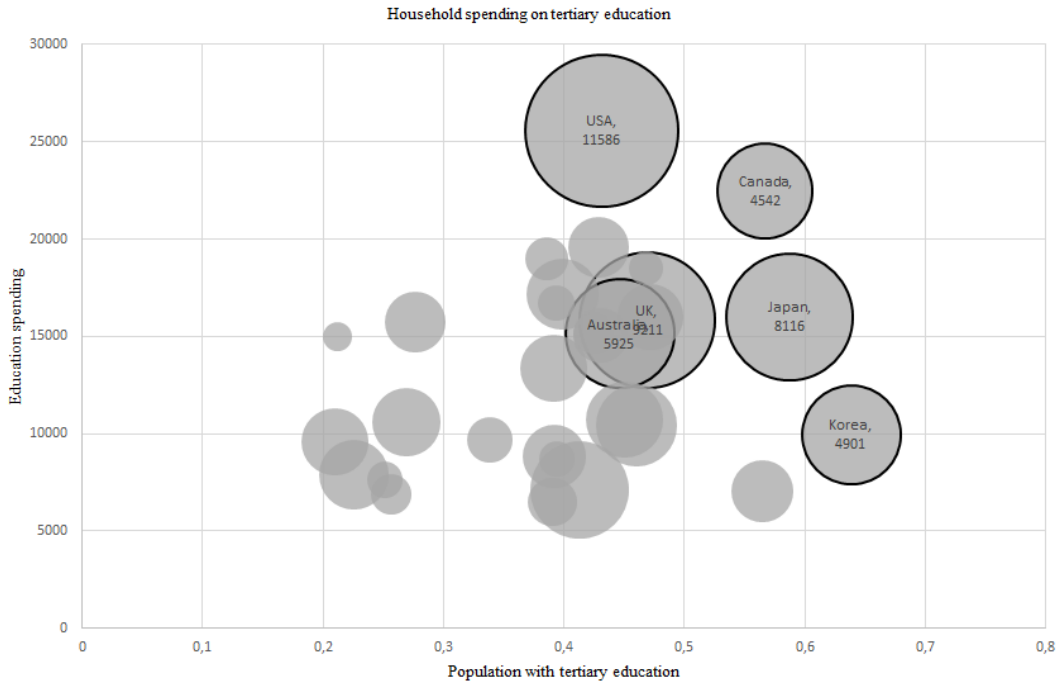
Although some argue that this hypothesis is correct and some are suspicious of it, I believe that no thorough denial of this hypothesis has yet been performed. In this chapter of the dissertation this will be done with the aid of the theories introduced in Chapter 1 and Chapter 2, with research conducted through the literature on this topic and some of my own data collection. In Chapter 4.2.1 it will be argued that the higher education market investment and student debt are not even high compared to other markets in the countries where they have the highest value. There should be extreme growth in the following period. If this is possible, Chapter 4.2.2 argues that the state is so heavily involved with these markets that even in case of defaults, there are established institutions and state guarantees to stop a crisis. Chapter 4.2.3 argues that there are elements in the nature of education as a service that prevent such extreme investments triggering a crisis. Combining these arguments, it can be safely stated that student debt is not a macroeconomic crisis factor; however the microeconomic risks are real.

4.2.1. Size-related Matters

First we look for countries where private investment in higher education can be a major macroeconomic risk factor. These countries should have high investment in higher education and large private investment as well.

The first factor – high investment – is indicated in Figure 3.6 by total spending on tertiary education per student. The second factor – private investment – is indicated by household spending, which is calculated from the ratio of household spending to total spending and the total spending value itself. In a country where higher education can be a risk factor, many people should have invested in higher education. In Figure 20 the population with a tertiary level of education measures this. The 25-34 year old cohort is represented, because they might be the most interesting cohort in terms of future economic tendencies. Those countries are highlighted where total investment per student is high, as is private investment, and a large portion of the population is involved in higher education. The USA stands out as the largest circle with around 11,000 dollars spent per student from the household budget annually. Japan and the UK follow. Canada can be a major market if we look at total spending, but private spending is not that high. Tuition fees in Canada are lower. Canada and Korea are also taken for further examination based on the extensive involvement of the population. In Japan, Canada and Korea more than 50% of the age cohort obtain some kind of degree from tertiary education. If we consider the other countries it can be noted that education expenditure can be high but does not depend on household investment. For the average citizen in most OECD countries, choosing higher education has no greater financial risk than buying a new TV or a notebook computer. Data for the countries are available in Supplement B.

Figure 20: Population with a tertiary level of education, 25-34 years old, % in same age group (horizontal axis); Total spending on tertiary education, US dollars/student (vertical axis); Household spending on tertiary education, US dollars/student, calculated

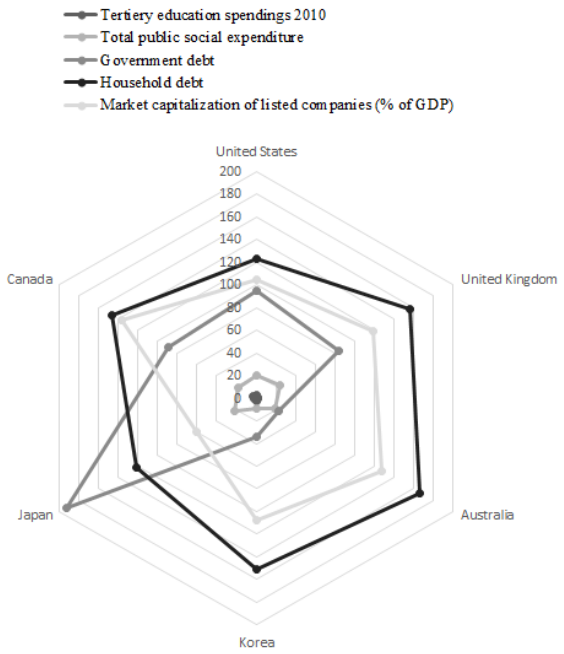


Source: OECD (2013), calculated data can be found in Supplement B

In Figure 20 we can identify mainly the United States, Canada, United Kingdom, Australia, Japan and Korea as the countries where private financing can be a major economic factor. To decide whether this is the case or not, the total tertiary education spending (both private and public together) should be compared to the size of various major factors such as total government spending, total government debt, total household debt and the size of the stock market.

Figure 21 shows that the total spending – private and public as well – are so small compared to major economic factors such as government and household indebtedness, government social spending or the size of stock market companies that it is condensed almost to a dot in the middle of the figure. The total spending on higher education is between 1 and 2.5% of the annual product whereas the social spending is around 20%, the stock market size is around 100% with large differences, and the debt statistics are even larger. If we made an intertemporal comparison, we would find that a regular variance, for example in government debt, can cover the whole of higher education spending. This shows that in extreme cases the government has the ability to intervene in a smaller market such as higher education or the student loan debt market with a regular government bond issue.

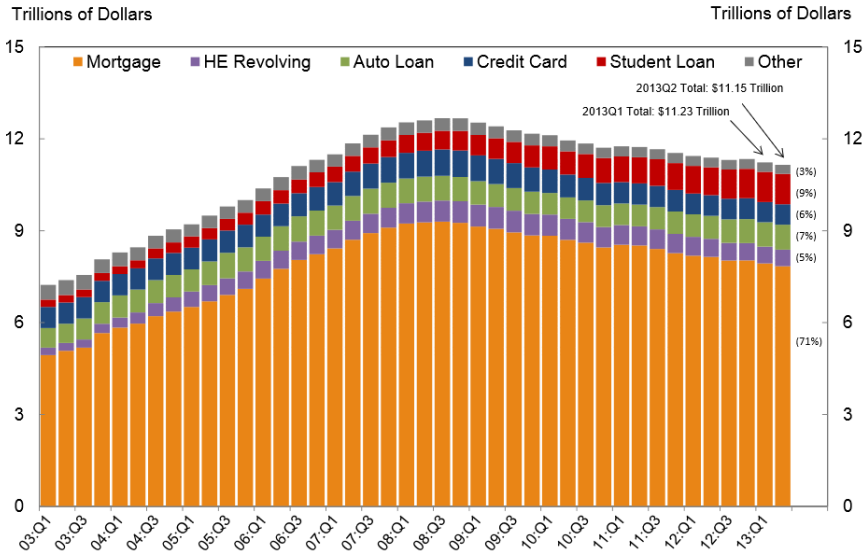
Figure 21: Total government spending, total government debt, total household debt and the size of the stock market



Source: OECD (2014a), OECD (2014b), Worldbank (2015)

In Figure 20 the United States stands out as the country with the largest higher education market. However, if we compare the compiled student loan with the total household debt we see that the share of student loans in the total level of debt has risen from 1% to 9% during the last decade, but it is still small compared to mortgage loans. When the total student loan debt hit the 1 trillion dollar mark in the United States there was intense debate in the press over whether student loans will be the next financial bubble, as was mentioned earlier. However, when we look at Figure 22 it can be seen that even in the United States, where the tuition fees are the highest and the student lending has the longest tradition, only 9% of household debt is made up of student loans.

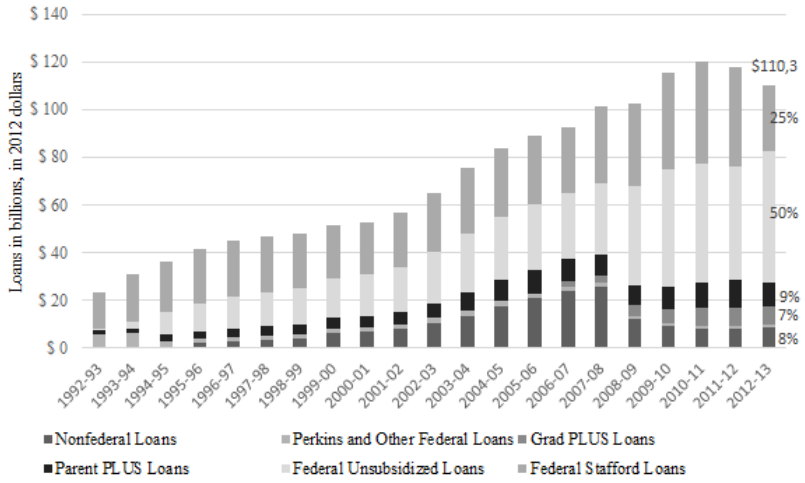
Figure 22: Total Household Debt Balance and its Composition in the United States, from 2003 through 2013



Source: NYFED (2013)

These loans are mostly federal loans, as can be seen in Figure 3.9. In the 2012-2013 educational year 110 billion dollars were lent, but only 8% of this was non-federal. Non-federal loans are not necessarily private loans; they include loans to students from US states and from institutions, in addition to private loans issued by banks, credit unions, and Sallie Mae (CollegeBoard, 2013). The main income of the state is not the repayment and the interest on these loans. The mortgage outstanding is on the balance sheet of private companies such as commercial and investment banks. The current tendency would have to continue for at least 2 decades (i.e. student loans should reach 30%) to become a major macroeconomic risk factor. So we can conclude that the student loan market and higher education spending are small in comparison with the markets that economic analysts pay most attention to when trying to assess the possibility of an economic downturn.

Figure 23: Growth of Federal and Non-federal Loan Dollars in 2012 Dollars, 1992-93 to 2012-13



Source: CollegeBoard (2013:17)

Elliot – Nam (2013) note that "high-income households are more likely to have student loan debt, low-income households carry the greatest student loan debt as a share of household income." Referring to Fry (2012) they point out that nearly a quarter (24%) of the debt of households below $21.044 annual income was student loan debt; however, this figure is 2% for households with income over $124.792. They are less likely to default as well. As Elliot – Nam (2013) speculate they have family support as a safety net. Referring to Stone et al (2012) another interesting feature emerges, which is that those who have student loans tend to postpone other credit-worthy consumptions such as a car, a house or marriage. Elliot – Nam (2013) used 2007-09 panel data from the Survey of Consumer Finances, which was sponsored by the Board of Governors of the Federal Reserve System. The panel data they used collected observations on 3,857 families who responded in 2007 and 2009.

They report the following very important findings:

"About 18 percent of households have outstanding student loan debt, and on average they owe about $26018.27.

Median 2009 net worth[43] for a household with no outstanding student debt ($117.700) is nearly three times higher than for a household with outstanding student debt ($42.800).

Households with outstanding student loan debt and a median net worth of $128.828 in 2007 incur a disadvantage of about 54 percent of net worth to 2009 compared with households with similar net worth levels but no student loan debt.

[43]Net worth is a balance sheet for households where assets are on one side of the balance sheet and debt on the other and net worth equates the two sides.

Living in a household with student loan debt and net worth of $296.802 in 2007 is associated with having $185.995.90 (a loss of about 63 percent) less in net worth in 2009 compared with households with no student loan debt.

"Outstanding student loan debt may reduce the short-term financial health of households by reducing net worth, but more research is needed on this topic." Elliot – Nam (2013:411)

Although these numbers are alarming, and all their regressions suggest a negative correlation with household net value and student loans, one thing must be pointed out in reaction to Elliot – Nam (2013). Student loans are a form of financial aid. So it is not surprising that the households with student loans are in no better position than other households without any student loan debt. They should not be the benchmarks, but rather those households who were left out of college and did not take student loans. Being a four year graduate had a larger coefficient on net worth than student loan use for every percentile in Elliot – Nam's (2013:411) median regression, which suggests it is still better off to be a graduate and having student loan, than being a non-graduate.

This sub-chapter will close with a quotation from Dynarski – Scott-Clayton (2013:78):

"On a per-student basis, average loan debt at graduation has been virtually flat over the past decade. Between 2000 and 2009, the share of graduates with loans has remained stable at 65 percent, and the average cumulative debt among borrowers has held steady at around $25,000. Ninety percent of students who receive bachelor's degrees graduate with less than $40,000 of debt, and approximately one-third borrow nothing at all."[44]

This sums up well the fact that although debt is growing, tuition fees are growing, and maybe the societal role of degrees is changing, comparing it to a speculative bubble is not realistic at this point. However, a fundamental element of something called a bubble is exponential growth. We can make the error of extrapolating a certain trend as a linear trend, and not an exponential trend that we have failed to notice. We approach this by asking "Is a possibility of a euphoric overinvestment inherent in the nature of education?"

4.2.2. Nature-related Matters

Many crises have witnessed speculative growth. On the housing market for instance prices have doubled within 2-3 years in mid-2000s in the USA. Stock markets can be prime examples. The NASDAQ index had over 500% growth between 1996 and 2001, and then all

[44] They get these figures from National Centre for Education Statistics of the United States.

the previous growth disappeared.[45] There are common elements in these kinds of investment and they are the following:

- The asset can be held by anyone, so the investment can be made by anyone.
- There are no limits on the investment, so investors can invest way beyond their financial possibilities or extraordinary positions can be built.
- The asset the investment was made for has no or very little internal value for the investor.
- There is a reasonable possibility that there will be extended demand for the asset in the future.

These are minimum requirements. A good example can be a security. Anyone with a securities account can have securities, and no special ability or knowledge is required. This means an extensive number of people or companies, or a critical mass, can be involved in trading. If only a limited number of people or companies are involved then the crisis in the market will not expend to other markets. For example a financial market crisis can spread very fast, because markets are interconnected and almost all of society is connected to the financial market.

The second point is important because if the positions are limited then it does not matter how euphoric one is, a position will not make one bankrupt. This is especially important on the securities market, because not only individuals but businesses can take positions. Major problems occur when for example a hedge fund fails because of an extraordinary position lose its value. If a hedge fund becomes bankrupt it usually means that thousands of people lose their savings, and experience a significant financial backlash.

A security is a prime example of an asset that has no value beyond the future possibilities embedded in it. If a company goes bankrupt usually the shares have little to no value at all. A house can have value if somebody wants to live in it. If someone invests with speculative purposes, but there is no demand for houses, then it has little value.

The fourth point is crucial. There has to be a legitimate possibility for booming demand for the asset. It is easy to believe that the internet will bring business possibilities never seen before, so the value of internet companies will explode. It is easy to think that some regions will experience doubling or tripling growth in their economy. Sometimes there are neighbourhoods or complete towns which rise up from the ground within a decade. So the housing market can also present possibilities. However you cannot experience speculative

[45]For data collection of indices google finance was used.

bubbles on the milk market. It is impossible to believe there will be booming demand for this kind of consumption good.

Here it will be argued that education does not have any of these features so it is very unlikely that it can create an economic crisis.

1. Human capital investment can only be made by humans. Houses can be built or owned by companies, human capital cannot be. Funding is a different thing, as was introduced in Chapter 1.3. There it was discussed that companies have arguable incentives to invest in education, and they play a very minor role in financing higher education. Human capital cannot be sold, but can only be rented out. Moreover, the owner has to "follow" the human capital. So only those who have time to study and the time to work, and who, moreover, fulfil the requirements for investment, especially finishing secondary education and successfully applying for higher education, can invest in human capital through higher education. These are very difficult restrictions, but still a large section of society is involved in this market.

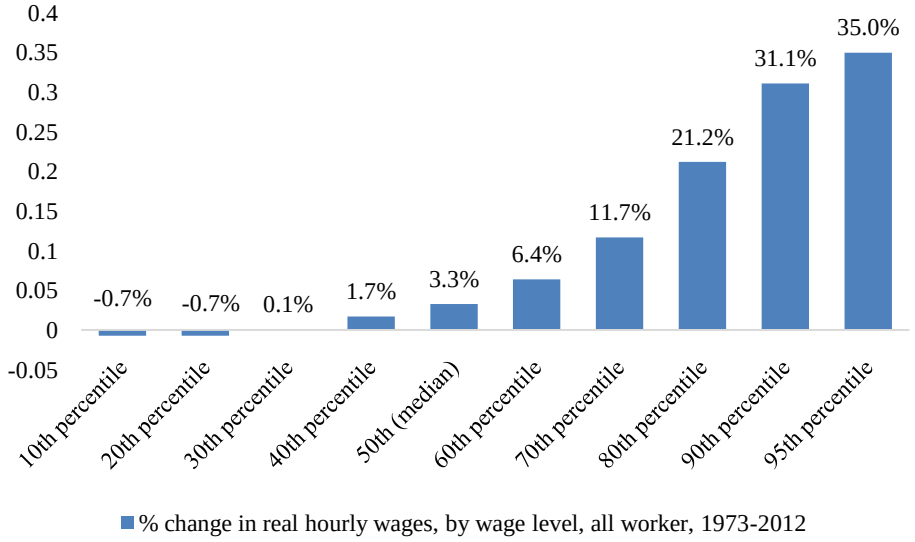
2. There are limited opportunities to overspend on higher education. According to the College Affordability and Transparency Centre of the US Department of Education the most expensive colleges offer education programs for approximately 50,000 dollars a year (CATC, 2015)[46]. So this is the largest amount one can spend on education. On the housing market there is no limit.

3. Human capital investment has internal value. There are people who do not manage to earn more than the average non-degree holder, but this is unusual and for special professions. Human capital investment is far from homogenous.

4. Real wages have changed by around 30% for the upper 20% of society, as can be seen in Figure 24 and this is reflected in a growing demand for higher education. To experience a 4 or 5-fold growth in tuition fees there has to be equal growth in real wage expectations. There is hardly any ground for this.

[46] Landmark College offers the most expensive 4 year education program for $49793, the second is Columbia University in the City of New York; the national average is $23614 for 4 year not-for-profit education programs.

Figure 24: Real wage change in the United States



Source: Based on data of Mishel – Gordon (2012)

Two recent studies will be introduced. Gilpin et al (2015) analyse the recent increase in for-profit education and they can thoroughly trace its source back to labour market changes. Chapman – Launkaew (2015) studies the Stafford loan repayment burden.

Gilpin et al (2015) analysed the growth of for-profit education in the United States. The higher education sector of the United States is characterised by three different type of institutions. There are public institutions, private non-profit institutions and private for-profit institutions (FPI). For-profit institutions have experienced a steady growth in the previous two decades. In 1995 0.2 million people were enrolled in FPI; in 2012 this figure stands at 1.5 million, after a slight decrease in the past couple of years. In 2012 2.7 million people were enrolled in non-profit and 13.5 million were involved in public education. For-profit institution students are usually older and more of them receive financial aid than other types of institutions. Interestingly, only 32% of 4-year bachelor students receive their degree within 6 years of starting these programs, whereas the completion rate is around 60% for other institutions. However the two-year program completion rate is much better and is on a par with non-profit institutions at around 60%. (Kena et al 2014). As Gilpin et al (2015) describes this market, 15 institutions enrol approximately 60% of students. It can be easily seen that for-profit education is filling a niche market. Gilpin et al (2015) argue that FPIs react to labour market changes faster than public institutions. “Community colleges are more likely to have decentralized faculty governance systems with tenured professors, to have financial support that is tied to local voter support, and to have large campuses with high capital costs. For-

profit colleges tend to have more part-time faculty, more centrally administered decision-making, to lease or rent space, to rely more on online courses, and to have fewer constraints when it comes to expanding and removing courses of study." Gilpin et al (2015:62). This means that for-profit education represents a large margin not an overinvestment unconnected to fundamentals. There are even adjustments.

The repayment burden is the ratio that student loan repayment takes out of income. Chapman – Launkaew (2015) finds that for median income graduates the repayment burden is no higher than 7% in any year after graduation. However, there are special cases such as if a law school student works in a public job, the student loan burden can be as high as his or her income if he or she ends up in the 10^{th} quantile of income distribution. A 23% burden is still very high and this is what median income public sector lawyers can experience. However in 10 years it decreases down to a manageable 10%. This indicates that student loans have an important risk embedded in them. There are certain paths that lead to an extreme amount of debt and low income. But this chapter has shown that this is a marginal situation, with special cases. The higher education market and the student loan market are not, by nature, markets where large positions can be accumulated, and a major section of the economy can be involved, and extreme future expectations can be created. Even if a human capital investment has little short run return in the long run it is more likely to have a payoff. There are even more features of the debt market that makes it highly unlikely that student debt will be a source for future crises.

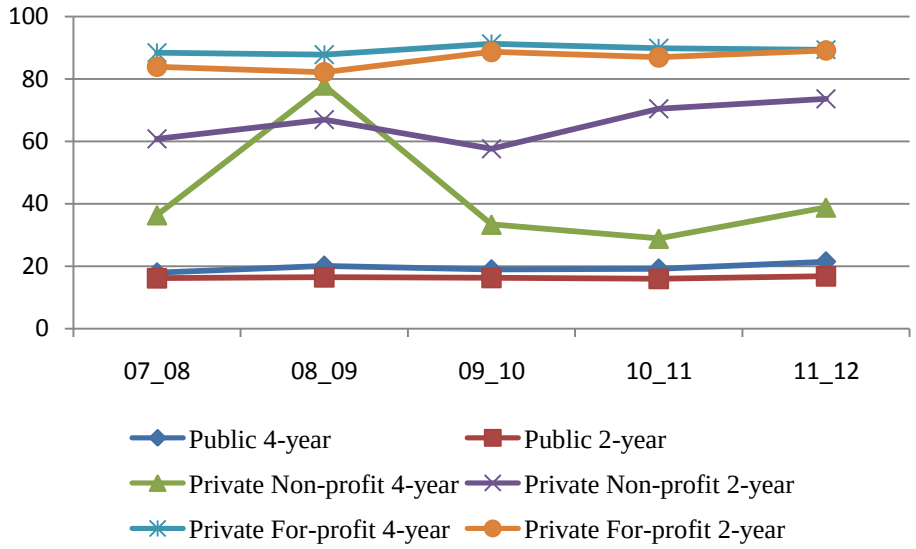
4.2.3. State-related Matters

In denying the higher education based macro-crisis theory it was shown that this market is too small, and has very little potential for bubble-like growth. The rejection will be closed by considering the involvement of the state. As was discussed in Chapter 1, a private capital market would not finance higher education through lending. For this reason the US introduced the Stafford-loan system. Almost all the amount of the outstanding debt is for subsidized or un-subsidized Stafford loans as Figure 23 shows. The federal government guaranteed the repayment of these loans to the lenders. This made student loans just a little riskier then federal treasury bills. There was even a small spread allowed so private lenders could make an almost completely safe profit on student loans and could use them in securitization processes. (Roy, 2014) It is tempting to say that the government gave a cash machine to the capital market, but student lending is heavily regulated. There are loan taking limits and conditions

for loan taking. In 2010 the US Congress voted to take away the financing from the private market and now the Department of Education administers the student loan system and financing comes from the state (Simkovic 2013:35). This means the spread between treasury bills and the student loan stays in the federal system.

In many countries there are state guarantees on student loans, or the lending institution. Unless the student loan market grows so much that it is questionable whether a government can bail it out or not, it is not a macro economic risk factor.

Figure 25: Share of tuition fees and other fees in the revenues of degree-granting postsecondary institutions in the United States



Source: Based on the data of Kena et al (2014) and NCES (2015) Tables 333.10 and 333.40 and 333.55

In the second section I analyse how prone the higher education system is to tuition fees. A crisis in student debt would affect loan taking, which would spill over to a drop in tuition fees. Would that jeopardize the education system? Figure 25 shows that both 2 and 4 year programmes are popular, and are expected to grow. Figure 25 also shows that the financing of the undergraduate programmes rely on tuition fees but for public institutions, which handle the highest traffic in the higher education market, tuition fees are not a major source of financing. A major 50-60% drop in tuition fee revenues would only reduce the total revenue by 10%. This will not likely jeopardize the higher education system. It would, however, have a major influence on private for-profit education. Funding of more than 80% of the private for-profit 2 and 4-year programs comes from tuition fees and other fees. A micro crisis in that system would be more than possible. In the previous chapter, however, we have seen that this is only a niche market of the whole education market.

4.2.4. Result 5 and Result 6 of the Thesis Based on Comparative Analysis

At the end of Chapter 4.2 a brief summary of the chapter will be given. In Chapter 1 of the dissertation it was shown that mainstream economics had accepted that education has a vital role in economics through human capital accumulation. Education is strongly connected to the labour market and all the major participants of the economy, namely households, companies and the state are also involved in the higher education market. It was pointed out that one of the funding mechanisms is lending. In a post-2008 economy it feels natural to argue about the kind of risks present in a market that cuts through society and has a large lending mechanism. It was argued that risk should be analysed separately. One interesting question is the following: can a student debt crisis emerge and can it be a cause for an economic downturn like that experienced in 2008? Chapter 4.2 was dedicated to this question.

Chapter 4.2 was made up of 3 main subchapters.

The method used to answer these questions was an analysis of secondary data collected by the OECD or on the US education market by the US Department of Education. In summary, the future of student lending is rather unpredictable, but its dissemination is inevitable. This also highlights the fact that only a handful of countries have a large size in terms of large population, a high ratio of private investment and high tuition fees. Specifically it is the United States which stands out. Japan, South Korea, Great Britain and Canada can also be candidates. Chapter 4.2.1 focused on these countries and especially on macroeconomic crises. In this chapter a thorough rejection of the macro crisis hypothesis was performed. The rejection included the following logical steps: it was ruled out that even those countries with the largest higher education markets have markets which are as financially large as their household debt or stock markets. This is summarized in Result 5 of the thesis

Result 5

The United States has the largest student loan market. Even after decades of growth that student loan market is smaller than the usual crisis-causing markets such as the equity market, household debt, or government debt. If we compare the compiled student loan with the total household debt we see that the share of student loans in the total level of debt has risen from 1% to 9% during the last decade, but it is still small compared to mortgage loans. In the 2012-2013 educational year 110 billion dollars were lent, but only 8% of this was non-federal. The state is heavily involved in financing higher education and there are existing channels where a bailout can be easily performed. College graduates can expect an income

that is enough to pay back their debt. There is only a possibility of a niche market crisis, such as a for-profit education crisis.

Then it was ruled out that human capital investment is a good candidate for experiencing an exponential and rapid growth of investment. The circle of possible investors is limited even within individuals; the amount of investment an individual can make is also limited, and in the end there is great value in human capital investment because it increases productivity, so even those who default on their student loan are better off than those without education, and lastly the increase in real wages is slow, so there is little possibility for a euphoric investment rush. And the third logical step includes the state. Usually a crisis happens in private markets. Companies going bankrupt and high unemployment are the symptoms of a crisis. Can a rise in student loan defaults bring down financial firms? Can it jeopardize the operation of the higher education system? The state is involved in student lending and higher education funding. In the United States, the prime example of a large private system, only the for-profit higher education institutes depend heavily on tuition fees, and they are only niche providers on the market. Although many students have loans, they also receive many other forms of financial aid, and a Stafford loan debt provides the majority of student loan debt. A Stafford loan debt is guaranteed by the government and is a heavily regulated market. Following this three step rejection process the possibility of a macro crisis triggered by the higher education market can be rejected. However, there is a possibility of a micro level crisis, namely in the for-profit market of the US higher education system. It was mentioned in this section that those who choose student lending can face large debt repayment obligations and the possibility of low income after graduation. These arguments were summarized in Result 6 of the thesis.

Result 6

The higher education market and the student loan market are not,by their nature, markets in which large positions can be accumulated, involving a major portion of the economy, and extreme future expectations can be created. The reasons can be summarized in the following 4 points:

1. Human capital investment can only be made by humans. Institutional investment (hedge funds, banks, pension funds, investment portfolios) can only support humans, but it is not tempting for them, compared to actual ownership of other financial assets.

2. There is a limited possibility to scale up investment in human capital. One cannot invest millions of dollars in education and expect millions back. With other investment assets this is possible.

3. Human capital investment has internal value. Human capital investment produces skills and knowledge that can be sold. Even if a human capital investment has little short run return, in the long run it is more likely to have a payoff. However if Result 4 is taken into consideration, it is arguable that education investment always produces some internal value.
4. Average real wages in society fluctuate very little over time. To experience 4 or 5-fold growth in tuition fees there has to be equal growth in real wage expectations. There are hardly any grounds for this.
The thesis will end with a conclusion that gives a summary of the results and possible future research opportunities.

4.3. Summary

With the help of theoretical literature it was shown that both human capital theory and investment for information can explain the social role of education. Risk can be interpreted in both cases. Result 1 of the thesis was based on the comparison of risk in the two approaches. It was found that education has no return only in extreme cases. An example can be when it gives no information on the productivity of the graduate. Result 2 of the thesis was reached with the help of the empirical literature and it stated that student loan markets evolve slowly and they differ widely on an international level. It is an important result because it gave ground for a search for candidates for risky student loan markets. Chapter 3 introduced the micro level data and the methodology of this section.
This part of the thesis introduced the results of my own empirical research. Two types of research have been carried out to answer the main question and sub-questions of the thesis. The first involved the evaluation of a micro-level dataset. It was provided by the Hungarian Student Loan Centre. I was interested whether the choice of education programmes made by student loan borrowers fits into a Markowitz ordering scheme. In Chapter 1 the Markowitz model was introduced. In Chapter 2 the literature where such an approach was used was presented in great detail. In Chapter 3 the applicability of the financial model was discussed. The assumptions of the model were also given when it is used in an education environment. In Chapter 4 thirty four education programmes were evaluated and in some sense similar results were found than for general samples of international literature. This is important from the aspect of risk because it suggests that even though student loan borrowers might take more risk, they do not seem to act evidently more cautiously toward risks and returns. It was discussed that neither the measures are fully developed nor students must follow only

financial considerations when they choose their higher education studies. This is phrased also in the quotation that opened the thesis.

If some of the student loan borrowers seem to approach education with less care about the risks, then it can have severe financial consequences. Even some famous economists. e.g. Stiglitz, suspect that there is overinvestment in education and student lending can cause macroeconomic problems.

With the help of Result 2 of the thesis, involving macro level data and international comparisons, it was found that the United States stands out with the most extreme student loan market. However, there is a list of arguments against the idea that even in the United States a macro level crisis can be experienced. Result 5 of the thesis has found that the student loan market is too small for such a phenomenon. Moreover, in Result 6 it is pointed out that human capital investments always have some kind of return, even when the rate of return is negative; the state is heavily involved in the education market, so a bail out is easier to perform then on financial markets; at the same time, human capital investment has barriers including its human element, time limitations and growth relations that is against a speculative investment rush.

Some of the implications of these results can be summarized as follows:

- Higher education investment might be an insurance up to a point. Those who invest in education programmes that offer less return and more risk than that point, might face some investment barriers. A deeper understanding of the unobserved heterogeneity can be a major task for future research.
- Policymakers should pay more attention to a seemingly important difference in different education programmes, i.e. that they offer fairly different risk-return characteristics. More understanding of these differences should be reached in the future.
- Student loans are useful tools of financial support for higher education investment, however, a good mix of financial aid programmes should be offered. Some student loan insurance schemes would find demand in the future.

Conclusion

In the conclusion of my thesis the brief summary of the hypotheses and the results will be provided. In the second part of this section some future research possibilities are outlined.

The main question of the thesis was the following: what is the role of risk in individual higher educational choice and what are the short-term macroeconomic implications of it? Namely, can it cause a macroeconomic crisis if individuals on a mass level experience negative rate of return to education?

I have started my analysis with breaking down the above question with the help of theoretical literature. This has led me to Result 1 of my thesis and a series of hypotheses.

At the beginning of the dissertation an exploration of the risks of education investment was pointed out as the motivation for the dissertation. Chapter 1 placed this research in the context of education research. First of all, the economics approach was chosen from among the branches of sciences that conduct education research. Economics offers more than one explanation for educational choice. Human capital theory was chosen but it was also shown with the help of theoretical literature that if we are analysing risk in educational choices the other mainstream theory, sorting, can also be used and leads to the same results. It gave me the first result of the dissertation.

Result 1 was based on the review of the theoretical literature.

Result 1

The literature review of economics of education has showed that two investment-type sets of theories are offered. Risk has different sources in human capital and sorting models but they have not been fully compared yet. The main result of my literature review is that in both theories risks can be summarized in the fluctuating nature of future income. However, in the case of human capital theory education produces some additional productivity irrespective of the credentials. This suggests that even an unfinished education program can have long-term effects. In case of signalling a dropout from education usually means large decrease in the return to education and even successful completion can have a minimal value if too many people have equivalent education signals. This can be attributed to the fact that the cost structure of education does not result in a separating equilibrium. That is important because it has to be taken into consideration in Result 6.

People study for many reasons; human capital theory focuses on one set of them, accumulating skills and knowledge. In fact, the role of formal education in human capital investment and especially education is at the centre of the dissertation. Education as human capital investment was analysed from the point of view of risk. This led to three different hypotheses introduced below::

Hypothesis 1

Student loan borrowers in Hungary who paid back their loans between 2008 and 2012 do not follow Markowitz ordering investment behaviour towards education programmes of different levels and they tend to choose programmes that do not belong to an efficient frontier in a risk-return space, defined by measures that are tested in the branch of literature characterised by Palacious-Huerta (2003), Christiansen et al (2007) and Glocker – Storck (2014).

Hypothesis 1 will be answered by Result 3 and 4 of the thesis.

Hypothesis 2

High levels of education investment can be achieved without cost-sharing and a high level of private investment in education. Student loan schemes are introduced slowly and they appear in many models. There are outstanding countries in private investment and in the use of student lending.

Hypothesis 2 will be answered by Result 2 of the thesis.

Hypothesis 3

Growth on the higher education market is an exponential growth process. Human capital investors overvalue the growth opportunities in their future income, so they pile up current debt at a level that they cannot finance from the earnings on their investment. When they realise the true return on their human capital investment (their true earnings after graduation) they will find that they cannot pay back their student loan debt. This will happen on a mass level. The student loan default rate will be so high that it will affect the financial markets. This can cause financial crises at least on a national level but a future global crisis is also possible.

Hypothesis 3 will be answered by Result 5 and 6 of the thesis.

The hypotheses follow a logical order. Hypothesis 1 concerns micro level risk. If micro level risk is considerable and is not justified with return expectations, then it is worth asking whether lending for such investments can lead to a crisis. Hypothesis 2 is about the trends of the international student loan market and Hypothesis 3 focuses on the possibility of a student-loan-induced macro crisis. If Hypothesis 2 is accepted and Hypothesis 3 is rejected, then the possibility of a student loan crisis can be rejected. That would mean that the student loan debt market is a slowly changing, complex market where sum fundamental features stop exponential growth.

I have started to analyse my hypotheses by reviewing empirical literature. The review gave me the answer to Hypothesis 2. It was Result 2 of the thesis and it is derived in Chapter 2.

In Chapter 2 it was shown that elementary and secondary education are mostly obligatory and a major proportion of the age group takes part in education on those levels. From the point of view of risk in education, higher education is much more interesting. It is voluntary, expensive, and takes a lot of time to finish and adults are making decisions on entering or leaving the education system. Education as human capital accumulation has not only private but public benefits as well. It was shown that there are four participants who have an interest in individuals getting more education. First of all, the individuals themselves, the students. Then there are the households, the family and relatives who support the students. Future employer companies and other private entities can have an interest in a better educated future labour supply. Last, but not least there is the state, which should represent the interests of society in the potential externalities of education and help in overcoming the inefficiencies of the education market, such as information asymmetries and a lack of financing for students. The state should promote equal opportunities and fairness. Public higher education funding works in two ways; either it is higher education institutions that are supported or private entities such as students, households and companies. In many cases the state finances higher education institutions, many of them are state property, and then the institutions offer tuition-free education. Individuals in a human capital model base their decisions on the costs and return of an additional year or level of education.

Tuition fees or other financial costs, including living expenses, are not the only costs. Education is time consuming so the investor must take into consideration foregone earnings as the opportunity cost of education. To the best of our knowledge, the majority of expenses are foregone earnings. Educational choice is risky even if it requires marginal direct costs to enter a programme because the future earnings advantage in many cases does not justify the effort that was made or the earnings that had been given up. In some countries even the direct costs

are fairly high because the state actively shares the costs of education with the private sector. If an education system is built on high tuition fees, there is a system to support the investors. Frequently used types of student aid include grants, scholarships and loans. Student loans are special in the sense that they do not decrease the risk of taking part in an education program, but only help to spread the cost between different time periods. Student lending is also special because it is different from other investment loans as the object of the investment cannot be mortgaged and the usual student borrower has no other possessions to be mortgaged. The second result was the result of the analysis of Hypothesis 2.

Result 2

Student loans are elements of cost-sharing and they tend to increase spending on education. They are the tools of financial support for students. Building up a large student loan market takes decades and the features of a market are difficult to predict. Some countries, however, stand out; here private investment is relatively high, and student lending has an important role and tradition. This result is against the idea of a rapid spontaneous growth of a student loan market.

Result 2 is an important argument against the idea of a student loan crisis and gives fundamentals to narrow down the macroeconomic analysis to some special countries.

Another line of literature focuses directly on the returns of education and questions the apparent heterogeneity in return. The higher education system offers very different opportunities based on gender, ethnicity, college choice, family background and social status. The topic of rates of return to education is very well-researched but foreseeable and unforeseeable heterogeneity has a rich literature as well. As the education system is more open than ever, many people enter it in the hope of a great career. The issue of risk and wage differences deserve as much attention as expected returns. There is a line of literature that directly relates to the risk approach used in the theoretical review. They use Markowitz type of analysis to evaluate educational decisions. The literature suggests that not all educational decisions can be fitted into an efficient frontier predicted by the model. This suggests that some investors take too much risk. Is this true for student loan borrowers?

If these risks add up, it can lead to a crisis. Can it spread to a macroeconomic level? Some - mainly in the United States - suspect that the expending tuition fee and student loan market might be a factor in the next economic crisis. If we are studying risk in education investment this topic must be addressed.

After the analysis of empirical literature, I have remained with two unanswered hypothesis, they were Hypothesis 1 and Hypothesis 3. An empirical analysis of a Hungarian Student Loan borrower sample was performed and a comparative analysis of the big student loan markets was introduced in Chapter 4.

Result 3 and 4 are derived in Chapter 4. In the micro analysis the line of literature of Palacious-Huerta (2003), Christiansen et. al. (2007) and Glocker – Storck (2014) is followed and the focus was on the field of education. An analysis of a data sample from the Student Loan Centre of Hungary was carried out. This is not a public database but no data was provided to me or any of my colleagues that has any reference to borrowers' identities. Neither do my results have any relation to the business policy or profitability of the Student Loan Centre.

The data sample is for a yearly annual gross real income from 2008 to 2012. The Hungarian student loan scheme is income contingent. They receive income data in order to calculate the necessary payment. The payment can be 6% or 8% of the income two years prior to the due date of the payment. The first two years payment is based on the minimum-wage.

Individuals entered the sample if they had recorded income for any of the years in the indicated time period. The focus of the examination is on education programs. Those programs were selected where at least 30 individuals' incomes were recorded for the whole time period. Only state financed and full time education programs were evaluated. Those who participated in more than one type of education program were excluded, as well as those who had no reported income. The equal costs assumption does not apply to those who participated in several different ISCED-coded programs. The final sample contained data for 20,146 individuals in 46,229 observations for 34 education programs.

One of the main results was that if raw logarithmic income and time-series standard deviation was calculated, a set of experiences fits the theory of risky investment by Markowitz in the sense that they lie on the frontier of the feasible set of investment possibilities. Even the equation of the efficient frontier could be fitted, which is completely new to the literature. It fits the results with an R^2 of 0.79. Some programmes lie along a part of the frontier which is not optimal according to the theory because higher return-less risk combinations can be found. They are optimal only according to one criterion, by offering the minimum of risk for the given level of return. There can be several explanations for this. There can be some kind of human capital or financial barrier that does not allow individuals to choose longer education programs with favourable risk-return combinations. For instance, an MSc in Health is one of the best combinations in a risk-return sense. The theory would claim that people

must prefer MSc in Health over a BSc in Health or VT in Health Sciences. It is interesting that we have found this in a student loan borrower sample because they had access to financial aid and they received it, so financial barriers are not necessarily the answer to heterogeneity. Result 3 of thesis was phrased based on these findings.

Result 3

With risk and return measured by the simple measures of average raw logarithmic income and the time-series standard deviation on a data sample of Hungarians who paid back their student loan between 2008 and 2012, a great fit for the frontier offered by the Markowitz-theory of risky investment can be found. Some of the risk-return combinations are not efficient. Due to the fact that the sample members are student loan borrowers, the role of financial barriers is not necessarily the explanation for this. There is uncontrolled heterogeneity in the sample and it can impose investment barriers that withhold access to higher levels of education investment. However, the time-series standard deviation of the average raw logarithmic income should be approached carefully because the results of the measure can be misleading. A strictly growing income series will produce a large standard deviation with this measure. Cross-sectional standard deviation is a better measure for risk.

The literature for rate of return calculations offers control variables such as gender, college choice and family background. In the dataset gender was known, college choice is controlled by the location of the college and social background is controlled by the place of permanent residence. Mincer-residuals and their cross-sectional standard deviation were used for the sample. The result was a similar risk-return map that was observed in the literature and even similar type of education programmes were found to be more fitting to the model. Sharpe-ratios were also examined and it led to the conclusion in Result 4.

Result 4

The observation for return and risk of fields of education by Christiansen et al (2007) and Glocker – Storck (2014) was validated on a special sample of data. For the Hungarian student loan borrower sample it was seen that some fields of education seem to fit the so-called efficient frontier and some lie well within the feasible set of risk-return combinations. There is even an observable pattern that social sciences and law, high level health studies, and high level engineering studies seem to fit the frontier and short term education programs, humanities and art studies tend not to fit. The risk-return behaviour of human capital investors seems to be the same as in very developed countries. Sharpe-ratios offered some

explanations for heterogeneity. Sharpe-ratios tend to decrease with the length of education; however, within a field there are mixed results. There is unobserved heterogeneity and there is a need for more sophisticated control variables.

These results indicate that even for student loan borrowers education can be a risky decision and in many cases the expected return is lower then what would be optimal. This made the comparative analysis necessary. However, as Result 2 stated that student loan markets were slowly developing markets, exponential growth can change that. I compared the features of the student loan markets and human capital investment to other, more threatening in the sense of financial crises, forms of investments. This gave me Results 5 and 6.

Chapter 4 analyses the possibility of a macro crisis triggered by a student loan exponential growth. It is pointed out that candidate countries for such a phenomenon mainly include the United States. The case of the United States is discussed in some detail. Result 5 was phrased in terms of a comparison of higher education spending to other markets, student loan debt to other sources of debt, the debt burden student loan creates and the status of those who have student loan debt over those who do not. *Hypothesis 3 can be rejected by Result 5 and Result 6.*

Result 5

The United States has the largest student loan market. Even after decades of growth that student loan market is smaller than the usual crisis-causing markets such as the equity market, household debt, or government debt. If we compare the compiled student loan with the total household debt we see that the share of student loans in the total level of debt has risen from 1% to 9% during the last decade, but it is still small compared to mortgage loans. In the 2012-2013 educational year 110 billion dollars were lent, but only 8% of this was non-federal. The state is heavily involved in financing higher education and there are existing channels where a bailout can be easily performed. College graduates can expect an income that is enough to pay back their debt. There is only a possibility of a niche market crisis, such as a for-profit education crisis.

There are references to parts of Result 5 in the literature; in fact, it was phrased using them. As far as the author is aware, this kind of counter-crisis evidence collection has not been performed. But Result 5 only states that the current market is not a macroeconomic risk factor and those who expect a crisis predict exponential future growth. So additionally, Result 6 is offered, arguing that education investment cannot be a crisis factor because of its nature.

Result 6

The higher education market and the student loan market are not,by their nature, markets in which large positions can be accumulated, involving a major portion of the economy, and extreme future expectations can be created. The reasons can be summarized in the following 4 points:

1. Human capital investment can only be made by humans. Institutional investment (hedge funds, banks, pension funds, investment portfolios) can only support humans, but it is not tempting for them, compared to actual ownership of other financial assets.

2. There is a limited possibility to scale up investment in human capital. One cannot invest millions of dollars in education and expect millions back. With other investment assets this is possible.

3. Human capital investment has internal value. Human capital investment produces skills and knowledge that can be sold. Even if a human capital investment has little short run return, in the long run it is more likely to have a payoff. However if Result 4 is taken into consideration, it is arguable that education investment always produces some internal value.

4. Average real wages in society fluctuate very little over time. To experience 4 or 5-fold growth in tuition fees there has to be equal growth in real wage expectations. There are hardly any grounds for this.

Results of the thesis can be combined into a concluding remark to answer the research question: *The main question of the thesis can be answered in a nutshell by claiming that based on micro-level data it is very difficult to reject the idea that even some student loan borrowers take more risk than it is justified by future returns, but the possibility of a macro-level crisis triggered by student loan defaults can be rejected.*

The essence of the research was published in Vona (2014a), Vona (2014b), Vona (2015a) and Vona (2015b).

The dissertation concludes with suggestions for further research. Usually a PhD dissertation is a report on certain milestones reached during a research programme. Some results might open up new directions for further research and some can contribute to the work of other researchers. In this chapter possible spin-off research opportunities will be listed for the future, which might individually produce valuable papers if the results match the expectations.

Chapter 4 rejected the potential for a macro crisis to develop from a student loan crisis; however, based on the simple relationships in that section, we can easily highlight cases that

could offer very exciting prospects for processing as a case study. A case in point is that of Chile, which has long been committed to a regime of financing of higher education that is numerically similar to a possible model that we could also recommend to countries following the large state involvement model. For the time being, these ratios are not yet reflected in a high per capita GDP; research with a case study could enable us to identify the economic impacts. The cases of Poland and Estonia lend themselves to case studies. The social embeddedness of the rapid emergence of Estonia could be an interesting topic.

Chapter 4 also highlighted for-profit higher education in the United States. It is a niche market within higher education, where disproportionate distributions can be witnessed; there are large private investments and a high dropout rate, so a thorough and in-depth analysis of that market can contribute to the existing literature.

Furthermore, student loans and their impact on educational choices is also a relatively poorly charted area in the literature. Fortunately, more and more secondary data enabling complex statistical analyses will become available concerning the financing of education. It will be interesting to see the new issue of the OECD's Education at a Glance 2015.

The use of variance in the rate of return to education investment as the measure of risk is commonly accepted in the economics of education literature, both theoretically and empirically as introduced in Chapter 4. However, modern finance uses a different set of risk measures. These measures are quantile-based and focus on the tail of the loss distributions. Value at Risk, for example, answers the question: "What is the maximum of loss incurred in 95% of the best cases of our portfolio over the next two weeks?" (Acerbi, 2002). A similar question from an economics of education perspective would sound something like "What is the maximum of loss incurred in the 95% of the best cases of employment track records 5 years after graduation?" If the right data sample becomes available, interesting results can spin off from such an approach.

As reviewed in Hartog (2009), direct questioning of students is a branch of the literature. Risk-return mapping keeps indicating various education programmes that could provide topics for further analysis. A directed survey of students of health care, education, and economics studies about their motivations, expectations and attitudes could result in an interesting comparison and can be directly connected to the results of this research.

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Supplements

Supplement A: Notation of countries

Abbreviation	Name of country	Name of country in Hungarian
AUS	Australia	Ausztrália
AUT	Austria	Ausztria
BEL	Belgium	Belgium
CAN	Canada	Kanada
CHL	Chile	Chile
CZE	Czech Republic	Csehország
DEN	Denmark	Dánia
EST	Estonia	Észtország
FIN	Finland	Finnország
FRA	France	Franciaország
GER	Germany	Németország
GRE	Greece	Görögország
HUN	Hungary	Magyarország
ISL	Iceland	Izland
IRL	Ireland	Írország
ISR	Israel	Izrael
ITA	Italy	Olaszország
JAP	Japan	Japán
KOR	Korea	Dél-Korea
LUX	Luxembourg	Luxembourg
MEX	Mexico	Mexikó
NLD	Netherlands	Hollandia
NZ	New Zealand	Új-Zéland
NOR	Norway	Norvégia
POL	Poland	Lengyelország
POR	Portugal	Portugália

SLR	Slovak Republic	Szlovákia
SLO	Slovenia	Szlovénia
ESP	Spain	Spanyolország
SWE	Sweden	Svédország
CHE	Switzerland	Svájc
TUR	Turkey	Törökország
UK	United Kingdom	Egyesült Királyság
USA	United States	Amerikai Egyesült Államok

Supplement B: Data for Figure 3.6

	Population with tertiary education, 25-34 years old, % in same age group	Education spending, Tertiary, US dollars/student	Spending on tertiary education, Household, % of education spending
United States	0.4313	25575.89	11586
United Kingdom	0.4691	15862.3	9211
Japan	0.587	16014.84	8116
Australia	0.4461	15142	5925
Korea	0.6382	9971.53	4901
Chile	0.413	7100	4836
Canada	0.567	22475	4542
New Zealand	0.4604	10418.08	3343
Israel	0.4504	10729.74	2926
Netherlands	0.399	17161.34	2560
Mexico	0.2254	7872.39	2436
Portugal	0.269	10578.47	2358
Italy	0.2098	9579.76	2281
Spain	0.3915	13373.27	2244
Ireland	0.4719	16007.62	2207
Poland	0.392	8865.86	2019
Russian Federation	0.565	7039.31	1930
Germany	0.2767	15711	1854[47]
Sweden	0.4286	19562.11	1839
France	0.4301	15067.12	1460

[47] Calculated based on the 2000 total private investment in higher education

Estonia	0.3905	6500.85	1183
Slovenia	0.3381	9692.92	1043
Denmark	0.3858	18976.9	949[48]
Belgium	0.4245	15178	832
Slovak Republic	0.2566	6903.67	805
Czech Republic	0.2513	7635	669
Finland	0.3937	16713.87	669[34]
Iceland	0.3937	8727.82	641
Norway	0.468	18511.67	562
Austria	0.2116	15007	435

[48] Calculated based on the 2010 total private investment in higher education

Supplement C: ISCED Codes for Fields of Education (ISCED 2011)

ISCED-CODE	Examples			
1 Education	14 Teacher training and education science			
2 Humanities and arts	21 Arts	22 Humanities		
3 Social sciences, business and law	31 Social and behavioural science	32 Journalism and information	34 Business and administration	38 Law
4 Science	42 Life sciences	44 Physical sciences	46 Mathematics and statistics	48 Computing
5 Engineering, manufacturing and construction	52 Engineering and engineering trades	54 Manufacturing and processing	58 Architecture and building	
6 Agriculture	62 Agriculture, forestry and fishery	64 Veterinary		
7 Health and welfare	72 Health	76 Social services		
8 Services	81 Personal services	84 Transport services	85 Environmental protection	86 Security services

Source: OECD (2012b)

Supplement D: Results for risk and return calculation for different educational groups

	ISCED	TS SD of RLI	CS SD of RLI	RLI	TS SD of MC	CS SD of MC	Mincer res.	Sharpe - ratio	Nr. Of Obs.	Nr. Of People	Length	Type	Educational Group	Short
1	Humanities and Art	0.28	0.99	14.33	0.28	0.78	0.21	0.26	74	36	14	VT	VT Humanities and Art	VT Hum
2	Social	0.38	0.97	13.83	0.37	0.89	-0.27	-0.30	1963	902	14	VT	VT Social	VT Soc
3	Natural	0.39	0.97	13.79	0.39	0.88	-0.42	-0.48	277	127	14	VT	VT Natural	VT Nat
4	Engineering	0.35	0.66	14.18	0.37	0.71	-0.14	-0.19	146	61	14	VT	VT Engineering	VT Eng
5	Health	0.84	1.04	13.25	0.76	1.01	-0.47	-0.46	90	42	14	VT	VT Health	VT Hea
6	Services	0.41	0.96	13.68	0.42	0.89	-0.35	-0.40	867	405	14	VT	VT Services	VT Ser
7	Education	0.30	0.73	14.09	0.33	0.69	-0.11	-0.16	533	208	15	BSc	BSc Education	BSc Edu
8	Humanities and Art	0.56	1.31	13.41	0.53	1.31	-0.50	-0.38	124	69	15	BSc	BSc Humanities and Art	BSc Hum
9	Social	0.36	0.89	14.38	0.35	0.82	0.15	0.18	1817	746	15	BSc	BSc Social	BSc Soc
10	Natural	0.30	0.94	14.41	0.30	0.89	0.08	0.08	1653	712	15	BSc	BSc Natural	BSc Nat
11	Engineering	0.30	0.80	14.47	0.31	0.76	0.08	0.10	3421	1455	15	BSc	BSc Engineering	BSc Eng
12	Agricultural	0.35	0.68	14.13	0.34	0.70	-0.17	-0.25	432	177	15	BSc	BSc Agricultural	BSc Agr
13	Health	0.47	0.78	13.94	0.47	0.80	-0.17	-0.21	93	41	15	BSc	BSc Health	BSc Hea

14	Services	0.27	0.83	14.63	0.27	0.72	0.25	0.35	757	338	15	BSc	BSc Services	BSc Ser
15	Social	0.31	0.83	14.61	0.30	0.78	0.27	0.35	4750	2061	15.5	BSc*	BSc* Social	BSc* Soc
16	Natural	0.32	0.92	14.56	0.33	0.91	0.14	0.15	577	233	15.5	BSc*	BSc* Natural	BSc* Nat
17	Engineering	0.48	1.02	13.96	0.43	0.99	-0.25	-0.25	859	416	15.5	BSc*	BSc* Engineering	BSc* Eng
18	Services	0.35	1.07	14.03	0.34	0.95	-0.26	-0.27	196	100	15.5	BSc*	BSc* Services	BSc* Ser
19	Education	0.37	0.88	14.01	0.38	0.85	-0.31	-0.36	3028	1309	16	TC	TC Education	TC Edu
20	Humanities and Art	0.41	0.97	14.06	0.41	0.97	-0.32	-0.33	830	360	16	TC	TC Humanities and Art	TC Hum
21	Social	0.31	0.85	14.42	0.32	0.83	0.09	0.11	1323	577	16	TC	TC Social	TC Soc
22	Natural	0.29	0.71	14.36	0.32	0.69	-0.17	-0.24	175	70	16	TC	TC Natural	TC Nat
23	Engineering	0.21	1.09	14.56	0.26	0.97	-0.06	-0.06	181	90	16	TC	TC Engineering	TC Eng
24	Health	0.37	0.84	14.11	0.36	0.81	-0.19	-0.24	1820	788	16	TC	TC Health	TC Hea
25	Services	0.36	0.98	14.38	0.36	0.94	-0.04	-0.04	1518	659	16	TC	TC Services	TC Ser
26	Education	0.34	1.02	14.02	0.32	0.95	-0.40	-0.43	503	226	17	MSc	MSc Education	MSc Edu
27	Humanities and Art	0.41	1.10	14.08	0.41	1.09	-0.44	-0.41	2376	1071	17	MSc	MSc Humanities and Art	MSc Hum
28	Social	0.34	0.86	14.67	0.32	0.81	0.13	0.16	7218	3090	17	MSc	MSc Social	MSc Soc
29	Natural	0.37	0.95	14.55	0.36	0.92	-0.02	-0.02	2474	1102	17	MSc	MSc Natural	MSc Nat
30	Engineering	0.36	0.92	14.68	0.35	0.88	0.04	0.04	3123	1346	17	MSc	MSc Engineering	MSc Eng
31	Agricultural	0.39	0.91	14.12	0.37	0.84	-0.40	-0.47	764	330	17	MSc	MSc Agricultural	MSc Agr

32	Health	0.35	0.76	14.54	0.33	0.69	0.06	0.08	579	262	17	MSc	MSc Health	MSc Hea
33	Services	0.38	0.84	14.44	0.36	0.79	-0.08	-0.10	607	254	17	MSc	MSc Services	MSc Ser
34	Health	0.39	0.85	14.57	0.39	0.80	-0.08	-0.10	1081	483	18	MSc*	MSc* Health	MSc* Hea