

Charles University in Prague

Faculty of Social Sciences
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MASTER'S THESIS

**Efficiency and private financing in public
higher education sector of the Czech
Republic**

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Academic Year: 2014/2015

Declaration of Authorship

The author hereby declares that he compiled this thesis independently, using only the listed resources and literature, and the thesis has not been used to obtain a different or the same degree.

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Prague, July 30, 2015

Signature

Acknowledgments

I am grateful to Mgr. Barbara Pertold-Gebická M.A. Ph.D. for her dedication in supervising my thesis. I would also like to express my thanks to prof. Vincent Vandenberghe Ph.D. His will to share his precious time during our early discussions about financing schemes was of high importance to me. My thanks also go to PhDr. Jana Votápková, with whom I was able to discuss technical issues regarding efficiency analysis. The rest of my gratefulness goes to my family and friends for their love and support.

Abstract

Public higher education in the Czech Republic is financed by general taxation. Due to permanent lack of financial sources in the sector, there should be sought alternative ways of financing, among which private financing is considered to be the best alternative. Nevertheless, it is important that these additional funds are managed efficiently. Thus, next to private financing, the thesis also studies efficiency of the sector as these two areas are interrelated. The results of private funding model indicate feasible realization with relatively low negative impact on private rate of return. Using DEA method, the efficiency analysis reveals that although Czech universities are teaching efficiently, they lack efficiency in research. This suggests that current financing scheme should be adjusted accordingly. Higher education is also studied from theoretical perspective and discussed are such topics as quality, mass education or the recent reform proposal.

JEL Classification H42, H52, I21, I22

Keywords education economics, higher education, universities, Czech Republic, efficiency, Data Envelopment Analysis (DEA), private financing

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Abstrakt

Veřejné vysoké školství je v České republice financováno z veřejných daní. Kvůli permanentnímu nedostatku finančních zdrojů v sektoru by měly být vyhledávány alternativní způsoby financování, mezi nimiž bývá považováno soukromého financování za nejlepší alternativu. Nicméně je důležité, aby tyto dodatečné zdroje byly spravovány efektivně. Proto práce studuje vedle soukromého financování i efektivitu sektoru neboť tyto dvě oblasti jsou provázané. Výsledky modelu soukromého financování indikují, že realizace tohoto kroku je dostupná a má relativně malý dopad na soukromou míru návratnosti. Za použití metody DEA analýza efektivnosti odhaluje, že ačkoliv české vysoké školy vyučují efektivně, postrádají efektivitu v oblasti výzkumu. To naznačuje, že současné nastavení financování by mělo být vzhledem k výsledkům upraveno. Vyšší vzdělávání je také studováno z teoretického pohledu a diskutována jsou taková témata jako kvalita, masové vzdělávání či nedávný návrh reformy.

Klasifikace JEL

H42, H52, I21, I22

Klíčová slova

ekonomie vzdělání, vyšší vzdělávání, vysoké školy, Česká republika, efektivita, DEA, soukromé financování

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Acronyms

AC Accreditation Committee

CFSC Coefficient of Field of Study Cost

CSU Czech Statistical Bureau (Český statistický úřad)

CZK Czech Koruna

DEA Data Envelopment Analysis

DMU Decision Making Unit

DMUs Decision Making Units

HCC Human Capital Contracts

HE Higher Education

HEIs Higher Education Institutions

HPSs Higher Professional Schools

ICL Income Contingent Loan

ICLs Income Contingent Loans

MSMT Ministry of education, youth and sports (Ministerstvo školství, mládeže a tělovýchovy)

OECD Organisation for Economic Cooperation and Development

OLS Ordinary Least Squares

PRR Personal Rate of Return

RIV Information Register of R&D results (Rejstřík informací o výsledcích)

SIMS Database of students of tertiary education (Sdružené informace matrik studentů)

SVP The Education Policy Centre (Středisko vzdělávací politiky)

UJAK Univerzita Jana Ámose Komenského

ZCU Západočeská Univerzita v Plzni

Master Thesis Proposal

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Specialization:	Economic Theory	Defense Planned:	June 2015

Proposed Topic:

Financing higher education: the case of the Czech Republic

Motivation:

Higher education is the great source of development of human capital promoting economic development in a country. Data on higher education in the Czech Republic witness a tremendous rise in enrollment during the past 20 years. Such an expansion, however, puts a great pressure on public budget which leads our society to find other sources of funds for tertiary education and to figure out optimal level of participation we are willing to accept. On one hand, higher education is clearly a personal investment so it is reasonable for students to participate on their financing of studies. But, at the same time, higher education brings also great benefit to a society. Clearly, this problem has to be examined more in detail.

In the Czech Republic, discussions on a reform of tertiary education started about in 2006. Since then, proposal of a new higher education act was prepared in 2011 and communicated with representatives of higher education and experts in the field. The proposal was accepted with great discontent and protests. Next to planned structure of university management or amount of influence of students in academic senates, one of the main criticisms was also focused on tuition fees which were settled at 10 000 CZK per semester at maximum. In 2012 the reforming process was shut down. Currently, there have been some signals on restoration of the reform, but tuition fees are inadmissible for current government according to its prime minister.

To the extent that this is a political question and hard task to do, the reform of higher education financing seems to be inevitable. Public schools are recently underfinanced and there are many voices who call for higher impact on quality of graduates. In this thesis I would like to describe existing schemes of funding of universities, make a comparative study on them and propose the best scheme that would suit the Czech environment. In the theoretical part of my thesis various alternative schemes will be introduced and current experience from other countries, especially UK and Australia, will be studied. The practical part will deal firstly with efficiency analysis of the Czech public higher education sector using DEA analysis (frontier analysis). Secondly, using data from EU-SILC, I will employ measures similar to those introduced by Vandenberghe, Demand (2008) who model various schemes of financing using microdata from Belgium, Germany and UK. Authors assess amount of additional funds available as well as probability of their payback under income contingent terms.

According to our current knowledge, there has not been published such study that would study either quality of Czech universities or impacts on individuals using modeling similar to Vandenberghe, Demand (2008) in the Czech republic. Also, the reform proposal was developed during an era of crisis and therefore under different circumstances. I believe that modern literature, approach to data and experience from countries using alternative schemes of financing may bring additional light into discussions about refinancing higher education. This thesis will thus be able to serve as a new springboard for these discussions with respect to current standards in quality of higher education and with respect to its highly profound basis and data evidence.

Hypotheses:

Here is a list of 3 principal hypotheses that are planned to be tested in my thesis. The list is not final and may be adjusted during my research.

1. Private funding of higher education is feasible for all groups under the best scheme.
2. There are minimal risks connected to the case of private financing under the best scheme.
3. Private return to education does not depend significantly on contribution fee

Methodology:

The practical part will primarily consist of two analyses.

First analysis will be performed to observe outcomes of existing financing scheme from a qualitative perspective. For this purpose, I choose to conduct frontier analysis. Existing literature suggests that DEA approach should be used. Results of this analysis will inform us about performance (efficiency) of individual institutions according to chosen criteria. I expect to observe wide heterogeneity among institutions which will call for different financing treatment. I will use publicly available data (MŠMT, ČSU) for this stage.

Second analysis will employ approach of Vandenberghe and Demand (2008) who study financing under income-contingent loans and human capital contracts (also equity loans) using income of working individuals. Firstly, to generate life-long income of different groups, I will use OLS regression to compute average net and gross income. The probability of paying back will be computed under logit regression. Then I will be able to compute maximal contributions under each of the schemes. Hypothesis 1 will be rejected if there will be some group for which private financing is not feasible, that is their contributions are immensely low compared to other groups, and their private rate of return is extremely low. Hypothesis 2 will be rejected if there is in average <90% level of probability paying back. The hypothesis 3 comes directly from computation of PRR on different contribution fees. The difference should be less than 1 per-cent unit change. For this analysis, data from EU-SILC will be used.

Expected Contribution:

This thesis will study alternative schemes of financing higher education. Outcomes will estimate sustainability of current funding and the best schemes of financing will be found for the Czech Republic. There have been many diploma theses on this topic in the Czech Republic, but none of them study this area on more elaborate basis. The results of this work will primarily serve government officials and research in the area, but also general public, students or loan providers will possibly benefit.

Outline:

1. Introduction
2. Overview of the topic
 - (i.) Basic of higher education
 - (ii.) Financing schemes
 - (iii.) Higher education in the world
 - (iv.) Criticism of alternative funding schemes
3. Higher education in the Czech Republic
 - (i.) About the system
 - (ii.) Description of existing financing scheme
 - (iii.) Discourse about refinancing
4. Empirical part
 - (i.) Literature overview
 - (ii.) Data
 - (iii.) Methodology
 - (iv.) Efficiency analysis
 - (v.) Private funding scenario
 - (vi.) Statistical analysis of performance indicator – OPTIONAL

5. Conclusion

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Chapter 1

Introduction

Labor markets today are demanding and pose tremendous requirements on skills for individuals entering them. Often, many of these skills can be obtained through participation in the tertiary education sector. This implies that affluent and stable investment into tertiary education is a necessary task for any country intending to promote its competitiveness in today's globalized world.

However, recent trends in the sector of public tertiary education show lack of financial resources not only in the Czech Republic but in many European countries. For example, EUA (European University Association) Funding Forum held in the October 2014 came with conclusion that amount of funds which were cut during the period of Great Recession can no longer be expected to be restored. Yet, quality requirements are remaining despite rising relative numbers in enrollments into universities. Such collision obviously poses severe pressures for institutions of higher education. Thus, with respect to current situation, optimal way for inflow of additional funds to the sector needs to be found to stabilize the sector and boost its performance.

Within the list of alternative resources, private financing, i.e. financing for tuition by students and/or their families, is considered to be most efficient and feasible. The introduction of private financing in the sector, however, needs to be encompassed by multiple analyses. One of the most crucial tasks to do is to closely examine financial situation of all involved parties, especially students and graduates, and assess impact of additional contributions on their returns to education.

The issue however spreads furthermore. Will additional funds be spent efficiently? Thus it is needed to evaluate current financing scheme and identify possible inefficiencies. What design of private financing should be chosen? Is it

fair for students to pay for their study? And what is actually so wrong about publicly funded education sector at all?

In this thesis, I follow these and several other questions and connect them with the situation in the Czech Republic. Therefore, the goal of this thesis is to assess possibility of introduction of private financing in our tertiary sector with respect to financial situation of graduates. But also, because the idea of private financing is not distant from questions about quality of education, the thesis estimates current efficiency in the sector - in other way, it estimates consequences of current financing scheme.

Chapter 2 describes selected key topics in the higher education such as theory, quality or rationale for private financing. Several types of alternative financing schemes relying on private contributions are described. Then I write about development of higher education in the world and about current practice from several countries which have or have not introduced private financing and thus can serve as an inspiration.

Chapter 3 provides literature review for empirical part.

Chapter 4 analyzes current situation in the Czech Republic. The chapter starts with basics of the system and situation of graduates in the labour market. Then financing scheme is described and analyzed. The chapter follows with brief review of national strategy and most severe problems of the sector.

The introduction of tuition fees in the Czech tertiary sector is however not a new topic - several years ago there was a heavily discussed government reform proposal which included not only introduction of tuition fees but also changes in the organization of the Higher Education (HE) system. The chapter also touches this experience and tries to identify possible reasons of the reform denial. This experience is introduced also to stress out political sensitivity of the topic in the Czech Republic.

The empirical part then follows. **Chapter 5** analyses efficiency of Czech universities using DEA method separately from two perspectives, namely teaching and research. **Chapter 6** makes use of model borrowed from Vandenberghe & Debande (2008) to analyse for case of private funding in the Czech Republic using data from EU-SILC survey. In particular, the chapter focuses on effects on various income groups and ability of financing tools to provide for equality in payments. Personal rate of return from education is calculated and its sensitivity to various levels of tuition fee is estimated.

The implications of results of empirical part are discussed in **Chapter 7**.

Chapter 8 then concludes.

I wish the ideas of this thesis will inspire current policy makers and that the thesis will contribute positively to current way of thinking about the Czech higher education sector.

Chapter 2

Topics in higher education

Any discussion about higher education should begin with proper understanding of the field. This section therefore deals with understanding of the concept of higher education and focuses on specific topics which are relevant to the scope of this thesis.

2.1 Theoretical background

Institutions of higher education (Higher Education Institutions (HEIs)), such as universities and colleges, are non-profit institutions which provide non-compulsory education to individuals who are willing to further expand their knowledge and skills in a certain field of interest. There may be several reasons why individuals become involved in university studies:

1. *Obtaining better qualification* - HEIs allow to obtain skills and qualifications necessary for highly skilled professions (physicians are a good example). As documented in Barr (2004), requirements on skill in many professions, which did not require a university diploma before, have risen in recent times as technological change continues.
2. *Signaling* - due to prevalent information asymmetry in the labour market, owning a university degree is a great asset as its owners are able to signal their abilities to future employers. The logic of signaling goes that owners of a university diploma are probable to own desired abilities due to the fact that completion of university studies is supposed to be a demanding and costly process.
3. *Consumption reasons* - in spite of this view, one derives his utility from

pure knowledge and reasons to apply the knowledge gained on labor market may be of secondary importance. Thus, contrary to previous reasons, which go very likely hand in hand with prospects of better earnings, consumption reasons put labour market needs at a secondary importance.

The view of human capital theory is such that “a school is an institution specializing in the production of training”, while universities offer a large and diverse set of skills (Becker (1964)). The same author also correctly documents that there are several types of trainings which require different interaction between practical and theoretical part. While some studies need on-the-go practical application, other types of studies require mastering theoretical knowledge first which requires years to gain. Some studies are profiled from the beginning, other provide rather general knowledge and its applicants profile themselves on internal labour markets (for example this is a case of physicians, but also of economists and many other fields).

If the education is a good, and investment into it can be considered as similar to investment into physical capital, then one can immediately start looking for tools which can be applied to analyze its profitability. These tool are presented for example in Psacharopoulos (1995) who introduces basic concepts of their measurement both from private and social perspective. The measurement is done either by calculating Personal Rate of Return (PRR) from realized wage premiums of graduates over graduates of secondary education, or by estimation of the slope coefficient from so-called Mincerian equation. This thesis makes use of only PRR metric.

The PRR can be calculated using two methods. In the first method called basic method, PRR is equal to the interest rate $prrr$ which equalizes benefits and costs related to education (see Psacharopoulos (1995) for more details):

$$\sum_{t=1}^T \frac{W_{g,t} - W_{ng,t}}{(1 + prrr)^t} = \sum_{t=1}^S (W_{ng,t} + C_t)(1 + prrr)^t \quad , \quad (2.1)$$

where $W_{g,t}$, $W_{ng,t}$ is annual income of graduates and non-graduates respectively, thus $(W_{g,t} - W_{ng,t})$ is graduates' annual earnings premium, T is the total length of economically active years, S is the total length of studies and C_t are annual costs related to studies (expenses on tuition, books, fares and other additional fees and costs). This rate of return is referred to as PRR_{basic} .

The second method, a short-cut method (Psacharopoulos (1995)), allows to approximate returns to education in an easier way by using following formula:

$$pr_{sc} = \frac{\bar{W}_g - \bar{W}_{ng}}{S \cdot \bar{W}_{ng} \cdot (1 - \gamma)} \quad , \quad (2.2)$$

where bar reflects mean value of the variable. Vandenberghe & Debande (2008) also use additional parameter γ to account for share of foregone earnings which are possible to be earned by students during their period of study (such as seasonal works, student part-time jobs etc.).

The latter method has however some serious drawbacks in comparison to other methods as it does not account for varying pattern of lifetime earnings, and that it does not apply any form of discounting, which leads to same weights in calculation of average earnings in each point in lifetime. I present this value, however, to provide for estimation of robustness of PRR_{basic} with respect to choice of other method, and to match results with those obtained by Vandenberghe & Debande (2008), who study PRR using short-cut method in Belgium, Germany and UK.

Needless to say, HEIs have much wider roles in society than mere tuition. Although there is no list of these competencies, research is usually another great role, especially in case of universities which connect teaching activities with research ones (contrary to colleges who are more oriented more on teaching). The rest of competencies are mostly community services, such as providing information to public, third-age education, regional development and other activities.

Benefits of higher education in form of positive externalities are vast. Economic growth probably plays the greatest role according to Chapman (2006) who investigates a related literature. But there are also other great external virtues which are applauded especially by economists, such as better informed public debate, judgement or sophisticated voting behavior (Chapman (2006)).

2.1.1 Myths in higher education

Barr (2004) identifies and discusses some often asserted propositions (to use his words: “blind alleys”) which are of importance to clarify before one dips more into the topic.

Higher education is a right and therefore should be free. - As Barr (2004)

writes, food is also a right, but everyone has to pay for it. Rather, from equity perspective, there should be no barriers to enter the system, especially for those coming from a disadvantaged background.

Elitism in university education is false. - This is not true. In comparison to social elitism, intellectual elitism is desirable and there is no harm in the fact that some institutions require more involvement from their students.

University education is a public good and thus should be tax funded. - Whether higher education is a public or private good is a right question. Psacharopoulos (1994) has studied returns and provides evidence that private returns from university education exceed social ones. This line of argument could be criticized as some very positive externalities could not be taken into account (for example in case of some revolutionary discovery). Psacharopoulos (2008) nevertheless provides argument that university education is actually far away from traditional concept of public good as people are willing to invest in it in return for higher earnings in future. Furthermore, funding of universities by taxes is not only efficient but also not equitable (but this is commented further in later sections of this chapter).

2.1.2 Universities in a modern context

The university sector has perceived many changes during the last century. The initial idea of university stems from Humboldtian concept which originated in 19th century in Germany and prevailed to nowadays. Its tradition remains in Germany but over the time has spread also into the rest of the world. The ideology of German system follows three unities (Pritchard (2004)):

- Unity of teacher and learners - they constitute a democratic monopoly, nobody has monopoly of knowledge. They constitute personal relationship and work together in pursuing knowledge.
- Unity of teaching and research - as these two factors are integrated and should go hand in hand.
- Unity of knowledge - role of philosophy as a supreme integrative discipline standing above all other disciplines.

The system also pursues idea of *Bildung* which can be translated as “personality development through education” (Pritchard (2004)), which is led by

self-motivation and non-utilitarian approach. The academic freedom and university autonomy is a matter of course.

The concept has during the second half of 20th century inevitably met with rising demand of tertiary education in the world. This process, described by U.S. philosopher Martin Trow as a move from elitist over mass to universal systems of education, necessarily leads to revisiting Humboldtian ideals and their transformation into a form which would be practical for needs of modern university nowadays.

Martin Trow, together with Burton Clark, have been considered for a long time doyen of research on higher education. Table 2.1 summarizes his main concepts which were collected in Brennan (2004). As noticed in Pabian (2008) it should be clear from the table that rising numbers of students influence all other aspects of tertiary education. As the education moves from elitist to universal, role of shaping minds ((ii)) moves towards practical application of skills, forms of instruction ((iii)) become more fuzzy and responsibility for curriculum is borne more by students. Also focus is reoriented from relative high academic standards ((vii)) towards value added. Like Pabian (2008) writes: “ *the question is not how students can achieve academic quality but what higher education can bring to them*” . As the system enlarges, there is also a larger share of external participants in the university management and administration ((ix) and (x)) and the system gains in importance in political debates.

Table 2.1: Main concepts of Martin Trow

	Elite (0-15%)	Mass (16-50%)	Universal (over 50%)
(i) Attitudes to access	A privilege of birth or talent or both	A right for those with certain qualifications	An obligation for the middle and upper classes
(ii) Functions of higher education	Shaping mind and character of ruling class; preparation for elite roles	Transmission of skills; preparation for broader range of technical and economic elite roles	Adaption of “whole population” to rapid social and technological change
(iii) Curriculum and forms of instruction	Highly structured in terms of academic or professional conceptions of knowledge	Modular, flexible and semi-structured sequence of courses	Boundaries and sequences break down; distinctions between learning and life break down
(iv) The student “career”	“sponsored” after secondary school; works uninterrupted until gains degree	Increasing numbers delay entry; more drop out	Much postponement of entry, softening of boundaries between formal education and other aspects of life; term-time working
(v) Institutional characteristics	Homogenous with high and common standards; Small residential communities; Clear and impermeable boundaries	Comprehensive with more diverse standards; “Cities of intellect” - mixed residential/commuting; Boundaries fuzzy and permeable	Great diversity with no common standards; Aggregates of people enrolled but rarely or never on campus; Boundaries weak or non-existent
(vi) Locus of power and decision making	“The Athenaeum” - small elite group, shared values and assumptions	Ordinary political processes of interest groups and party programmes	“Mass publics” question special privileges and immunities of academe
(vii) Academic standards	Broadly shared and relatively high (in meritocratic phase)	Variable; system/institution “become holding companies for quite different kinds of academic enterprises”	Criterion shifts from “standards” to “value-added”
(viii) Access and selection	Meritocratic achievement based on school performance	Meritocratic plus “compensatory programmes” to achieve equality of opportunity	“open”, emphasis on “equality of group achievement” (class, ethnic)
(ix) Forms of academic administration	Part-time academics who are “amateurs at administration”; elected/appointed for limited periods	Former academics now full-time administrators plus large and growing bureaucracy	More specialist full-time professionals. Managerial techniques imported from outside academe
(x) Internal governance	Senior professors	Professors and junior staff with increasing influence from students	Breakdown of consensus making institutional governance insoluble; decision-making flows into hands of political authority

Not one member of academia would easily applaud Trow's concepts due to their high relevancy during modern times. Generally, governments and universities have been coping with the modern shape of HE by applying neo-liberal ideas of market and choice. Universities are more management-influenced and there is a great deal of focus on efficiency in teaching or research. To be able to compete for students, universities create new attractive programmes and are also active in marketing activities. To be able to compete also in area of research in a globalised world, they focus on supra-national tasks and cooperate on international basis.

2.1.3 Financing higher education

Public HE has been traditionally financed by taxes. It is only in about last 25 year when idea of private financing has been realized on national level (first realizations were done already in 1970s in Yale university and in a limited way in 1980s in Sweden) although the idea of private participation in study costs using insurance against downside tracks back to 1955 to Milton Friedman. Friedman suggested to prefer income contingent mechanisms rather than loan finance. His proposal was a variant of graduate tax such that a graduate pays a specified percentage of his income for a specified time. In what follows, this idea is referred to as Human Capital Contracts (HCC).¹

Rationale for private financing

The reason why general tax funding is false comes from both equity and efficiency reasons. The source of inequity stems from the fact that general tax-burden ignores whether an individual benefits from higher education or not. Therefore, those who went to university are better-off compared to those who did not. To see more discussion on inequity, see Psacharopoulos (2008) or Barr (2004).

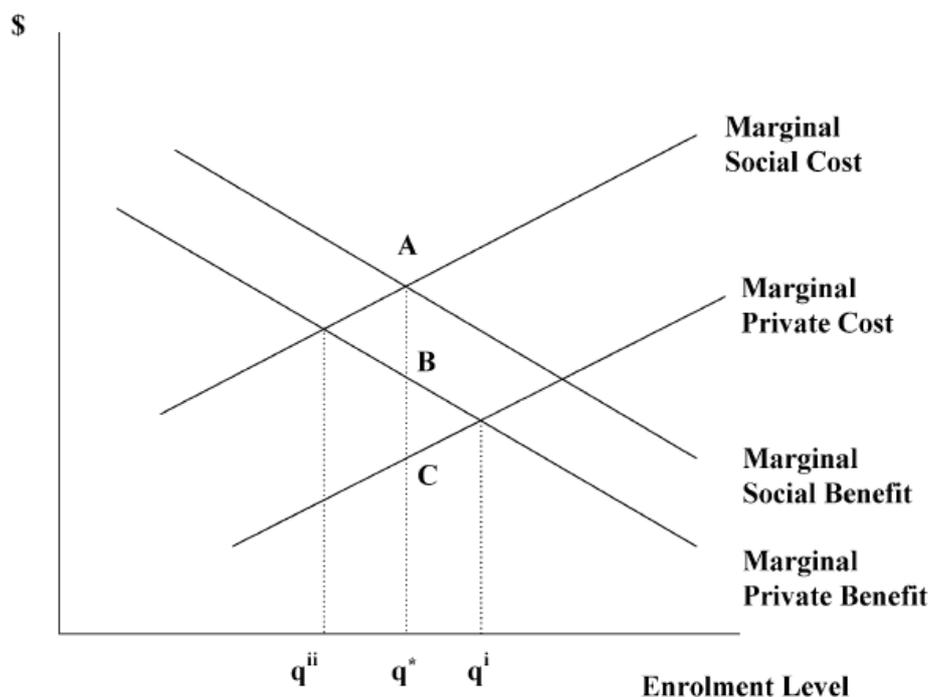
The tax system financing also produces inefficiency. For example, money collected by taxes go to state budget and from this pool they are redistributed towards universities. The distribution of every year is however followed with discussions over the final amount of funds available the next year. This is often a long and tedious process into which there may enter other factors than

¹This is a term used in Vandenberghe & Debande (2008). Due to not developed terminology one could put the scheme easily under the group of Income Contingent Loans (ICLs). Moreover, logic of the Friedman's tool is also similar to graduate tax.

current sector fundamentals and needs, such as budget of other ministries, pure politics or even personal preferences. Furthermore, there are many different universities which are of different setting or even different quality and thus should be financed differently. Financial flow from the state budget might however ignore this.

Efficiency imperfections and need for private contributions are documented in the model in Chapman (2006). The model is represented graphically in Figure 2.1 under assumption of zero tuition fees. Marginal benefits are downsloping because of lower wages due to higher numbers of graduates. The difference between private and social benefits is equal to externalities. The optimal level of enrollment is in q^* which is equal to social equilibrium. The private optimum is q^i which is a clear over-enrollment, thus inefficiency. However, if students were to pay for full costs (i.e. social costs), the model equilibrium would lie in q^{ii} which would in turn lead to under-enrollment. To obtain optimal number of students, the government should impose optimal tuition fee equal to distance between B and C in the Figure 2.1.

Figure 2.1: Private and social costs of higher education and benefits from it



Source: Chapman (2006)

The model therefore shows that without the government participation in

setting private contributions to the system, results of unregulated market forces may be inefficient. There are however questions about the extent of externalities (i.e. difference between social and private benefits). Measuring this kind of impact is generally a very hard task to do and its extent is not yet well known.

The massification of the HE sector in the world has been described above with its consequences. From what is above it should be also clear that what the sector may need is to implement several market concepts in the financing because central planning (Barr (2004)) in the growing sector is no more able to provide full efficiency. Thus, private participation in funding universities with universities being able to set their tuition fees is a preferable way of funding. It is argued in the existing literature that benefits of private financing are following:

- Tuition fees serve as a price signal whether HEIs / study programmes are desirable or not. This leads to optimal choice of university by students.
- Tuition fees lead to higher responsibility in choosing career path.
- Pressure on (healthy) competition between universities, thus pressure on quality.
- Alleviation to public budgets.
- Equity reasons commented above.

On the other hand, Jacobs (2002) points on two disadvantages of private financing

- Asymmetric information - students and government have different set of information
- Risk - there are potential efficiency losses in case students default on their payments

Necessary to point out, the funds collected by private financing should not generally compensate for decrease in state funds. They should be understood rather as funds additional to existing support by state.

Market failures

Are individuals and capital markets ready to invest their money into education in universities? We shall start work from scratch. Take as an example a young smart man, let us call him Steve, who wants to enter university with a great idea to construct a revolutionary operating system. Unfortunately, Steve is not endowed with enough financial resources. Thus he has several possibilities - either i) to enter labour markets without qualification from university, or ii) postpone the education until he has enough money to cover tuition fee, or iii) if he is sure his studies will pay off, take a loan and pay off from his future wage on a mortgage-like basis. If Steve is risk averse or uncertain about his future earnings, first two sub-optimal options will be probably chosen. Unfortunately, a bank (or any other institution in the capital market) will be unwilling to lend money to a young man without a collateral.

This short episode can be understood as an instruction into problematic of investment into human capital. There are generally two main problems regarding this investment:

- *Credit constraints* - students may not have means to finance their studies or they miss a collateral. The fact that they have family background does not have to necessarily solve this problem. There are also different fields of study which bear different costs² so many students could be tempted to enroll in less costly fields of study.
- *Uncertainty and risk* - due to many reasons, there is vast uncertainty that students will be able to repay their debts. The reasons are that students may find their field of study not interesting and quit. Furthermore, if they stay and graduate, they may have hard times being employed later or find suitable job. Or they may find a job they are suitable for, but may not receive satisfactory wage. Thus, uncertainty about the shape of future labor markets also plays its role.

Nevertheless, there are also another problems in providing loans to finance human capital which are summarized in Table 2.2.

²Recent Eurostudent survey showed that, in the case of the Czech Republic, students of law have the highest expenditures regarding their studies.

Table 2.2: Difference between investment into physical and human capital

	Investment into physical capital	Investment into human capital
Information on asset bought	Well informed	Poorly informed
Risk of default	Low	High
Underlying asset as a collateral	Yes	No
Availability of information about the investor	High	Low
Tenure of investment	Short-medium	Long

Source: The author based on various sources.

General concepts

The previous factors which make investing into education (and human capital in general) less feasible have to be overcome. Thus, optimal financing instrument should follow several necessary concepts written below:

- *Tuition fees* - Universities should be free to individually set their tuition fee. The price of the tuition fee serves as a price signal (driven mostly by quality of education or earnings prospects).
- *Granted loans* - Loans should be granted by state (or other authority) with minimal interest rate
- *Postponed payments* - Student should pay only when they become economically active. This is a perfect way to overcome liquidity constraint.
- *Income contingency* - To avoid personal bankruptcies, graduates should be insured against unexpected downturn in earnings. Risk should be borne either by taxpayers or the group of graduates.
- *Money to universities* - To foster efficiency, the money collected should go directly to universities.
- *Role of government* - The government should serve as an insurer against default on payments. Furthermore, the government should also control quality, collect data and other information and provide them to the public.

- *Equal access* - The design of providing loans to students should not harm access to HE. Thus it should be counted on e.g. social stipends.
- *Access to information* - This factor was especially stressed out by Barr (2004). Future students need to obtain information about study programmes and to know whether their choice is optimal.

2.2 Financial instruments in higher education

Problems with potential defaults on loans have led researchers to orient towards designing loans which would insure against damaging outflow of funds. These loans are described as *income contingent* as they overcome liquidity constraints and still protect individuals against the risk of low income.

The family of income contingent loans comprises of different types of loans with slightly different forms. These are Income Contingent Loan (ICL) (in a narrow meaning), graduate taxes and HCC or equity contracts. It is necessary to note that terminology is not yet unified. For example, Rey & Racionero (2010) call graduate taxation as ICL with risk-pooling to stress out transfer of risk. The terminology was taken from Vandenberghe & Debande (2008).

2.2.1 Graduate taxation

The first form of income contingency, graduate taxation, is similar to that of general taxation. The logic of graduate taxation goes that students who graduate will pay higher tax in the future and they will rise the sum of collected taxes. While this may be true and the idea seems to be more equitable than general taxation, the question of *how* collected taxes will be redistributed is still in place. Thus (in)efficiency issue remains.

It is also necessary to say that we are living in a mobile world in which workforce is free to move from one country to another. So there is no guarantee that the citizen will become a tax payer of the same country. Yet, another problem is that graduate tax is paid life-long and contributed funds do not correspond to individual's investment into education. Barr & Crawford (2005) introduce a so-called "Mick Jagger" problem. Mick Jagger spent 1 and a bit year in LSE. If he was to pay graduate tax, the amount would be immense and it would not correspond to the length of his studies.

2.2.2 Income-contingent loans

Under ICL schemes, students raise their capital to cover for tuition fee in exchange for a promise that it will be repaid in the future contingent on the difference between actual income and some predetermined income-threshold (fix or floating such as mean income of non-graduates). The installments thus depend on the propensity of graduates to earn extra money over non-graduates. In case their income falls below a certain threshold, they are forgiven to pay. The length of these contracts depends on final design, but there is no reason for their duration to vary differently than, for example, in the case of mortgage (e.g. 25 years). In case of commercial loans, payments from interest rate may be subsidized by state, thus interest rate is equal to zero. Barr (2004) nevertheless argues that this cause price distortions and that to be efficient, the interest rate should be set at the level of government's borrowing costs.

According to transfer of a risk, ICLs break down into:

- *Risk-pooling* ICL - the risk is pooled within a cohort of graduates. Vandenberghe & Debande (2008) further divide the risk pooling into risk pooling with separation and without separation. The separation issue considers separation from less relevant group, e.g. men from women, masters from bachelors, etc.
- *Risk-sharing* ICL - unpaid loans are covered by the state, i.e. taxpayers.

Question of which design is better is investigated in the literature. Generally, risk-sharing type brings less adverse events than in the former case. To demonstrate why, Chapman (2006) argues that in the case of tuition fees equal to T and fraction d of students who do not pay back, the government can set the new tuition fee to $(1 + d)T$. Thus there is no downside risk for borrowers, as they do not pay unexpectedly for their less successful colleagues but they do so already in the initial (higher) fee.

On the other hand, ICLs with risk-pooling are criticized as the behavioral consequences of it may induce adverse selection and moral hazard. A group of students interested in this type of scheme is probable to be the one with worse future prospects.

2.2.3 Human Capital Contracts

The idea of HCC contracts follows closely initial ideas of M. Friedman. The idea of these contracts is that students in exchange for funds promise to com-

mit in future a certain percentage of their income for a specified time horizon. Contributions can be adjusted in a similar way as in the case of ICLs such that below certain level of income, graduates have a right not to contribute. Palacios Lleras (2007) also defends these contracts against a popular idea that they are a version of slavery. The point is that promise goes towards individual's income, not activities. The insurance is again made as graduates are protected against downsize in their earnings. With decreasing earnings, contributions also decrease. For more information about these types of contracts, see Palacios Lleras (2007).

2.3 Quality in higher education

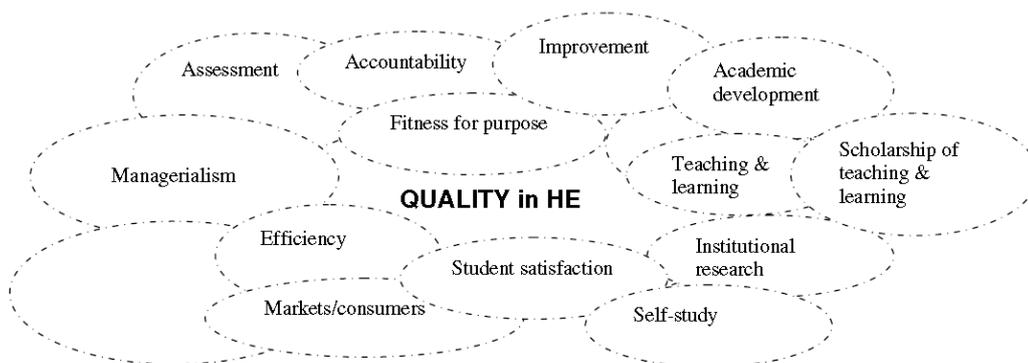
With rising numbers of enrollments into universities, governments in the world have started to assess their quality. But how to measure quality of institutions such as universities?

Universities are rare types of institutions with very specific characteristics. Most importantly, they are non-profit types of organizations which are “producing” human capital on one hand and research on another. Considering spillover effects which are hard to measure, their nature therefore makes it somewhat difficult to assess their quality or efficiency, because there is no single measure which would indicate so. Nevertheless, government institutions need to be provided with relevant feedback regarding performance. For example, the Ministry of education, youth and sports (Ministerstvo školství, mládeže a tělovýchovy) (MSMT) long term strategy plan between years 2011-2015 suggests orientation toward qualitative measures in financing. HEIs should also “develop [internal] systems of evaluation of quality assessment” (MŠMT (2010)). But the question remains - how does such quality look and what measures should be employed to measure it?

Filippakou (2011) studies the idea of quality in higher education from the perspective of philosophical area of discourse analysis and suggests that it is ideologically constructed. The author views the discussion about quality in HE as a network of discourses, in which there are two major ones: the discourse of quality assurance and the discourse of quality enhancement. The other discourses are described in Figure 2.2. The author argues that the existing view on quality provides too narrow view and she reveals that the concept is much broader. To understand the term, the author says, we must understand first the ideological formation which underlies it. Under pragmatic point of view,

for example, we may think about quality university as the one whose graduates are easily employable and well-paid in the labor market.³ These requirements however do not fulfill the potential which contemporary universities have.

Figure 2.2: Quality as a network of discourses



Source: Filippakou (2011)

Contemporarily, there are two main quantitative approaches which are used to study quality of HEIs:

- Performance indicators
- Estimation of production frontier

Performance indicators are classical indexes measuring excellence of institutions in several areas of interest. These indexes can be also used to create final score. All scores can be then organized in so-called league tables, as is for example customary in United Kingdom, which present qualities of institutions across different areas. The funding scheme of the Czech Republic uses a variation of performance indicator (more about that in Chapter 4).

Estimation of production frontier on the other hand estimates production possibility from assumed technology. This leads to inference about efficiency of individual units (in the professional terminology these are called Decision Making Units (DMUs)). The methodology of this thesis focuses on this approach, DEA specifically, as it is less demanding in terms of choice of areas of interest and data availability. Furthermore, the method has been dominant in studies on education efficiency and has other advantages over other methods,

³Such an orientation on performance in higher education can be also seen in works of French philosopher Jean-Francois Lyotard. In his analysis of postmodern society the desire for knowledge is replaced by the desire to fulfill needs of society, leading to material enrichment of an individual.

for example better ability to trade-off between different educational outcomes (Worthington (2001)). The method is discussed in detail in Chapter 5.

2.3.1 Criticism

Stress on performance, influenced by neo-liberalist concepts, is constantly changing university policies and working practice of academics. Jauhiainen *et al.* (2009) analyzed situation in Turku University, Finland. The teachers reported that the new structural change has brought stress, fighting between departments for funds and too much thinking in economic terms. The teachers also reported their worries about academic freedoms under existing targets which imposed on them from above, and dilemma of research vs. teaching, the latter being “academic suicide”.

Measurement of research has been under critique for a relatively long time. Problems with Czech assessment of research performance are documented in Stöckelová & Vostal (2015). Relative dissatisfaction of academics with metrics has resulted in publishing Leiden manifesto in Nature (Hicks *et al.* (2015)).

It can be hard to estimate what has been the impact of the metrics on output of universities, i.e. their students. While this is not a focus of this thesis, the reader involved in this topic might be interested in the book *Academically Adrift*. The authors have tested 2,300 undergraduate students in U.S. colleges and universities have performed extremely bad in learning soft skills, such as capacity for critical thinking or complex reasoning.

It can be concluded that incorporating metrics into university operations is very questionable. While the metrics may work properly in a business life, universities have quite different setting and objectives. At the same time, performance needs to be measured. A balance between these two factors in building optimal methods of quality assurance thus needs to be made.

2.4 Higher education in the world and its financing

The intention of this block is to provide a very brief overview of financing schemes in selected countries. Application of best practices from abroad is not the goal of this thesis. However, mentioning practical realization of theoretical concepts from above can shed better light on the problem.

2.4.1 United States

The system of tertiary education in USA divides into colleges and universities. Colleges offer bachelor's degrees, universities which are research-oriented offer also master's degrees and doctoral degrees. Main sources of finances of state universities come partly from state's budgets and partly from tuition fees set by each individual university. Private universities are financed exclusively from private sources (tuition fees, private donations).

To cover tuition fees, students have the possibility to use scholarships, study loans or grants. Loans are provided by government in a William D. Ford Federal Direct Loan Program. Student may however raise money also from commercial institutions, these are however not guaranteed by state. The loan can be used for education purposes only, undergraduate students receive lower interest rate than graduate students. The U.S. government subsidizes loans of students with proven financial need, and guarantees both subsidized and unsubsidized loans. Loans to parents of students are also available. Grace period is the same, i.e. their repayment can start also after graduation from university.

Repayment starts at latest 6 months after students graduate. Payments are on a monthly basis, fixed and they last for 10 years at maximum. Thus, the form of loan is ICL with the minimum monthly payment is 50 USD. However, if students are expected to struggle with repayment, they may qualify for the income based repayments plan (IBR). Under IBR, students pay 15% of disposable income (gross income minus 1.5x gross poverty line) for next up to 25 years after which the loan is forgiven. Thus ICLs may turn into HCC. However, there are also several other products possible such as Pay As You Earn Plan which is also a form of HCC or income contingent repayment which is a mix between ICLs and HCC. Cancellation of loan repayments is possible for some teachers or those who work in public service organizations.

Pabian (2008) writes that the U.S. HE sector is admired by European HEIs while it is criticized in the country. The object of these impression is adaptability to the population. According to the author's words, the tertiary system of USA is criticized for inability to provide quality education for universal share of population entering universities (over 50%) whereas it is admired in Europe for its ability to adapt to a mass share of students (over 15%-50%).

2.4.2 United Kingdom - England

The UK has adopted ICL system in 1998. Initially maximum tuition fee was set at 1,000 GBP per year. But in 2004, it was raised to 3,000 GBP per year and currently, the annual tuition fee charge at English universities can be set to even 9,000 GBP. To foster market principles in the sector, it is proposed that universities caps on admission rates for universities should be completely abandoned. Student loans are primarily provided by government and they are further managed by Students Loan Company. Students are also eligible to receive maintenance loans to cover for living costs.

The repayment was initially designed in a ICL scheme, with threshold set at 85% of average annual earnings and the interest rate equal to inflation. But the system was criticized as the repayment period was quite short. The reform in 2004 changed repayments into HCC scheme with the 9% rate and the interest rate equal to lower of either of BoE base rate + 1% or inflation rate. The reform in 2012 adjusts this rate to be progressive such that it is between inflation rate and inflation rate + 3%. The standard duration of contract for young students is 25 years.

Despite recent increase in the limit of tuition fees up to 9,000 GBP, there are higher enrollments in English universities than ever before. This is due to many factors, such as higher share of students with A-levels exams or acceptance of BTEC qualifications by some of the universities. Also, another significant factor may be that unemployment in Great Britain among young people is very high. The university education may therefore be a safe haven for some of them. See Dorling (2015) for more information.

2.4.3 Australia

The Australia adopted ICL scheme with a risk-sharing system in 1989 as the first country in the world. The system of loans is called HECS (Higher Education Contribution Scheme). Deep analysis of it can be found in Chapman (2006). Jacobs (2002) writes that around 23% of direct costs of education are paid. The same author also mentions that the introduction of private financing did not have impact on enrollment. Also nearly all outstanding debts have been successfully repaid.

With rising numbers of students and vast underfinancing of HEIs, deregulation of the system has been proposed by Australian government to obtain enough financial resources and stabilise the sector. The reform has however

been repeatedly voted down by the Senate. To promote drivers in demand for HE, the deregulation would untie limits on numbers of students with limits in tuition fees abandoned (which would raise the tuition fee about twice). The reform also plans to increase interest rates of student loans.

It is interesting to compare development of Australian sector with that of England. England has firstly deregulated tuition fees and then numbers of students, the approach in Australia has been absolutely opposite.

2.4.4 Sweden

Higher education in Sweden is free of charge, the government nevertheless demands HE sector to be competitive in terms of quality. In 2011, the reform of Sweden's universities brought greater freedoms, for example, universities had autonomy in developing their structures. 85% of funds come from government.

Although there are no tuition fees for home students, the OECD reports that every student has benefited from public loans or grants. Indeed, to finance their studies, students obtain grants (3,063 EUR/month in 2012)⁴ and are furthermore also allowed to obtain loans (6,712 EUR/month in 2012)⁵ to cover their living expenses which are repaid on an income contingent basis (Rey & Racionero (2010)). The system is very well developed - the main administrative body is the Swedish National Board of Student Aid, and funding from the state was 2.01% of national GDP⁶, one of the highest in Europe. Maybe also this factor allowed the entry rates into education to be nearly 70% in 2013 (source: OECD). On the other hand, there are also some voices which criticize the system. The problem is prioritizing elite research before teaching in the terms of financing or early specializations. According to study made by Bienenstock *et al.* (2014), the system needs to orient towards excellence in combining teaching and research activities and to develop personal skills of students.

The Swedish tax system is progressive, thus it is expected that the students will benefit later in a form of contributions in higher taxes.

⁴Source: EC (2014b). 67% of students received grants in 2012.

⁵Source: EC (2014b). For more information on study fees and grants in Europe, interested reader advised to be redirected to this document.

⁶Source: Eurostat

2.4.5 Conclusion

Higher education and its financing is treated in many countries in different ways. On one hand, there are systems with private financing (political terms also call it cost-sharing) which complements public funds. This is the example of Australia, United States or England. In all systems, ICLs are provided with also vast support for students to promote equity. On the other hand, there are generous systems of publicly free tertiary education with grants and benevolent study loans such as in Sweden and other Nordic countries.

Despite the diversity, however, all HE systems are identical in their orientation on efficient management and labour market needs. There are also emerging new programs of financing. One such initiative, for example, is called Funding for Excellence. Its idea is to finance selected universities outside the core financing scheme to foster their quality, make the university visible in international rankings or to match labour market needs.

There are also many questions on consequences of private financing schemes and behaviour of students and universities in cost-sharing regimes. The European Commission has investigated this task in 2014 in nine European countries with private financing regimes (EC (2014a)). One finding of the study is that private financing schemes have successfully brought additional funds. Another finding is that students were almost not repelled by private contributions at all, but study aid is an important feature of the system. The behavior of HEIs also is not necessarily affected under private financing, the study says, because a sort of student-seeking behavior is present even under public financing schemes. However, improvement in quality due to inflow of additional funds, measured as student-teacher ratio, was not confirmed.

Chapter 3

Literature review

This brief chapter presents overview of existing literature relevant for the empirical part. The organization into two sections follows organization of empirical part which is also twofold.

3.1 Estimations of efficiency

Empirical assessment of performance of universities received much attention in academic literature. To mention several studies which make use of DEA, Flegg *et al.* (2004) measure technical efficiency of British Universities by multi-period DEA between 1980 and 1992. The authors find that the efficiency was rising, most noticeably in late 80s. Using Malmquist approach, the study reveals that the rise was accompanied by significant rise of total factor productivity. Abott & Doucouliagos (2003) study technical and scale efficiency of Australian universities to find that universities in the sample are reasonably efficient. In the context of the Czech Republic, Flégl & Vltavská (2013) study efficiency of Czech faculties of economics using DEA and index approach. Leitner *et al.* (2007) study performance of natural and technical science department in Austria. They find that both small and large universities perform efficiently and that linear scale effects do not exist.

The application of DEA however exceeds the level of pure measurement of performance. St. Aubyn *et al.* (2009) study tertiary sector in EU Member States using DEA and SFA methods with approximately same results. The authors further use efficiency results in regressions on institutional variables and conclude that such factors as good secondary system quality, autonomy of universities and output oriented funding leads to more efficient tertiary sector.

Sarrico & Dyson (2000) combine efficiency scores from DEA analysis with the BCG matrix¹ and show its applicability in management decision making. Worthington (2001) provides overview of other studies which employ DEA method in the field of education.

The design of hypothetical production function is made upon inspiration by other studies or by pure economic rationing. There are however also some studies which use linear regression and factor analysis (Leitner *et al.* (2007)) or which simply include as many indicators as possible to reduce risk of omitting important component (Kuah & Wong (2011)). “Diagnosis” of models can be then done by a type of sensitivity analysis which tests effects of adding more or less inputs or outputs in the model (e.g. Abbott & Doucouliagos (2003)).

3.2 Financing models

The analysis in this thesis is heavily inspired by Vandenberghe & Debande (2008). The authors assess impact of ICLs and HCC on lifetime earnings using data for Belgium, Germany and UK. Their results suggest proportional impact of increasing contributions from ICLs and HCC schemes on lifetime earnings across different income groups. The authors also show that private rate of return from education is not significantly affected by rising contributions in all three countries. Vandenberghe & Debande (2008) are inspired by Jacobs (2002) who creates a model which quantifies implications of private financing in more detail (such as redistribution of income, social gains) also across fields of study. His model shows that income-contingent loans reduced income risks significantly compared to standard loans. The author also notices great amount of similarity between graduate tax and ICLs with risk pooling. The heaviest burden of repayment is reported to be for students of arts, health or teacher education.

Several theoretical models were built. García-Penalosa & Wälde (2000) study efficiency and equity in various financing systems. They prove that the traditional tax system cannot deliver equity and efficiency in the same time and that in the presence of uncertainty graduate tax is preferable to ICLs with risk-sharing regime. Also Rey & Racionero (2010) show that for optimal participation, graduate tax (although named ICLs with risk-pooling in this article) is most efficient in the presence of risk-aversion, provided it covers for fore-

¹BCG - Boston Consulting Group. BCG matrix is very well known tool in the management field.

gone earnings and financial costs of education. Kadlecová (2014) who employs model of Rey & Racionero (2010) for the case of the Czech Republic nevertheless challenges the question whether efficiency is indeed the only criterion and notices that in practice risk-sharing regime is used.

Chapter 4

Higher education in the Czech Republic

4.1 Description and fundamentals

Higher education has a long tradition in the Czech Republic. The oldest university, not only in the country, but also in the whole Central Europe, the Charles University in Prague, was founded in 1348. The sector nowadays is composed of 26 public, 2 state, and 44 private universities¹ which fall in International Standard Classification of Education (ISCED) under ISCED 5A², as well as multiple vocationally oriented Higher Professional Schools (HPSs) (in Czech language they are known as “Vyšší odborné školy”) which fall under ISCED 5B category. The main difference between 5A and 5B category is in 1) practical orientation of graduates, and 2) the fact that graduates from HPSs cannot continue their studies towards graduate (master and doctoral) programs; acceptance of some of the courses attained at HPSs in undergraduate study programmes of HEIs is also problematic. This thesis deals exclusively with public institutions of ISCED 5A category. The public higher education sector is under control of the Ministry of Education, Youth and Sports (MSMT)

¹According to MSMT. The term “university” is somewhat misleading in this context, as the laws of the Czech Republic distinguish between a university (univerzita) and a college (vysoká škola, literally “higher school”) according to the specialization of the institution. The term “university” is used furthermore to represent all types of schools, i.e. both colleges and universities. Some authors, such as Koucký (2012), also use for these reasons the term “institutions of higher education”, abbreviated as HEIs, to avoid potential misunderstanding. I also use this term interchangeably with “universities”.

²According to ISCED 97, the international classification system of education developed by UNESCO.

and is supervised by the Accreditation Committee, the mission of which is to approve study programmes and control quality.

Czech higher education system follows the Bologna process in full since its entry in 1999 by offering bachelor, master and doctoral programmes. Bachelor studies are between 2-4 years in duration and wrap up with final examination and thesis defense. Master studies orient towards theoretical aspects of a study field. They either follow bachelor studies and are 1-3 years in duration (the student has to own bachelor diploma in this case), or they form complete study programme and endure for 4-6 years (in this case, bachelor degree is not required). Graduates of master programmes also have to pass final examinations as well as defense of their master thesis in most of the cases.

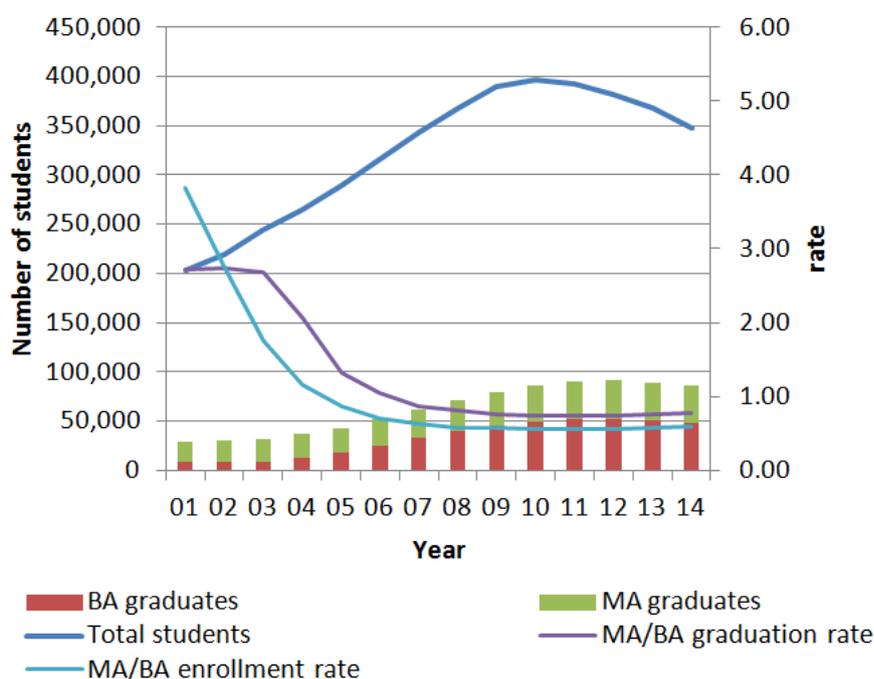
The study at public HEIs is in the Czech Republic free of charge for most students. Public HEIs are therefore tax-subsidized, while private HEIs set their tuition fees freely. The public system is nevertheless not completely without fees. The public institutions can set fees for admission, for exceeding standard duration of studies (by more than 1 year for first studies, 0 years for other), for simultaneous studies, or for study programmes in foreign language. These fees, as well as their amount, are specified in Higher Education Act. The calculation rests on the “base for fees” set as 5% of per student non-investment expenditures from MSMT given in a year. To give an example, in an academic year 2013/2014, the base was set at around 100 EUR, fee for exceeding studies at the Faculty of Social Sciences at Charles University was 519 EUR per semester, annual fee for other studies was 37 EUR, admission fee was between 13 and 18.5 EUR and foreign language studies (other than doctoral) ranged between 6,000 - 7,800 EUR annually.

Between years 2001 and 2014, there was witnessed a boom in total number of students and graduates in the Czech higher education sector. This is shown in Figure 4.1. The number of students has almost doubled from 203,000 students in 2001 to 396,000 students in 2010 from when it has been decreasing towards level of around 350,000 students. The number of graduates has more than tripled from 30,096 graduates in 2001 to 93,870 in 2012 where it met its peak and it is also slowly decreasing due to decreasing number of students.³ The decline in 2012 is due to dramatic fall in natality in first half of 1990s which is documented in Figure 4.2. Absolute number of births fell between 1990 and 1996 from 130 thousand down to 90 thousand babies and stayed at this level for

³Comparison of these numbers is a bit unfair, as there was larger share of master programs in 2001 compared to 2012 as is evident from the figure.

the next 5-6 years. It is not without doubt that such decline will have impact on number of students entering universities during following years. The quality of HE may be thus threatened because, to keep number of students the same, universities may be tempted to loosen their requirements of entry to attract additional students. See Koucký & Bartušek (2011) for deeper analysis and forecasts of future numbers of students.

Figure 4.1: Evolution in numbers of students and graduates

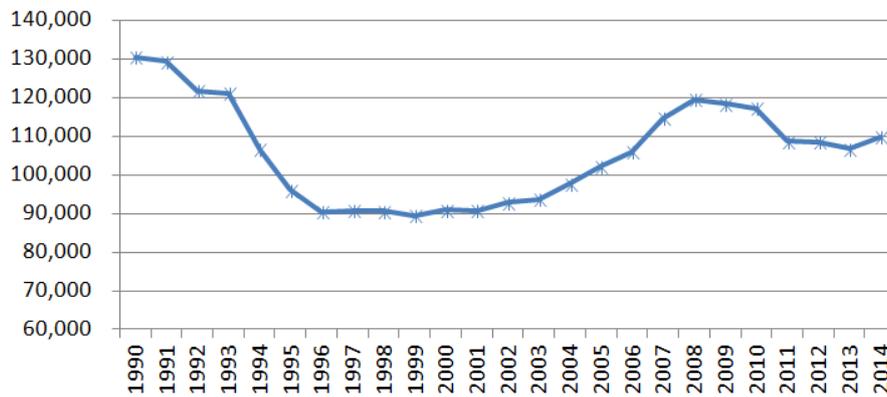


Source: Database of students of tertiary education (Sdružené informace matrik studentů) (SIMS). Data are taken for public and private universities. Right vertical axis is instrumental for rates.

The rising number of students has also went hand in hand with entry rates into tertiary education. Figure 4.3 shows that rising entry rates in the Czech Republic have been in harmony with the average of the OECD countries since 2008. The figure also compares the rate to other countries. Visegrad countries had their entry rates close to that of the Czech Republic except for Poland, which had its entry rates near 80% in 2012.

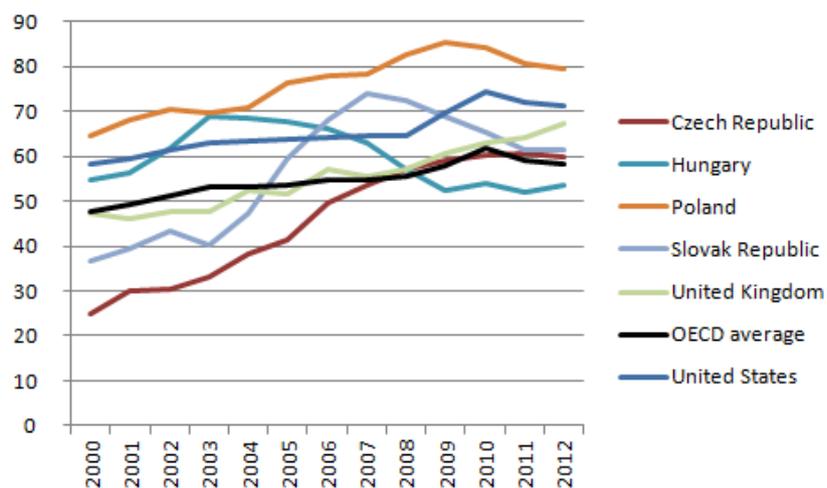
Finally, distribution of students according to their field of study is shown in Figure 4.4. The data suggest that during the recent years Czech tertiary system has witnessed substantial growth in numbers of students who applied to such fields as economics or social studies, whereas the share of students who applied for technically oriented fields or educational studies has dropped.

Figure 4.2: Number of born infants in time



Source: Czech Statistical Bureau (Český statistický úřad) (CSU).

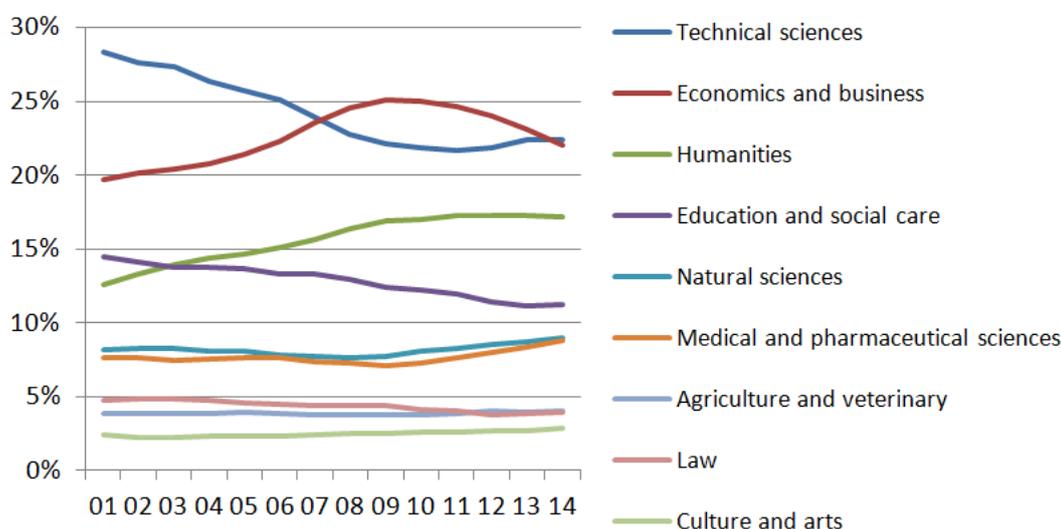
Figure 4.3: Entry rates in tertiary education across several countries in time



Source: Organisation for Economic Cooperation and Development (OECD). Calculated for 5A type of education and advanced research programmes. Entry rate computed for typical age cohort entering higher education.

Nevertheless, it seems that in recent period these trends have stabilised or even reversed, as is the case of economics and business field.

Figure 4.4: Distribution of students according to their field of study



Source: SIMS. Data represent all types of students of all types of universities (public and private). The numbers represent % points of total number.

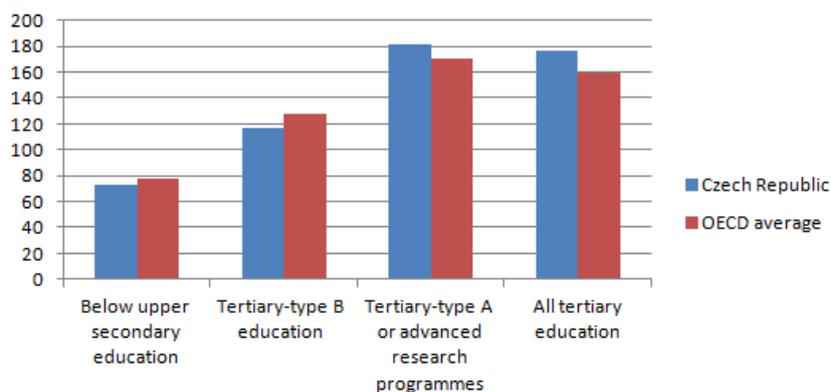
4.2 Graduates in labour market

To understand labour market forces in better detail, analysis of graduates' situation now follows. As Figure 4.5 shows, attaining degree from tertiary education is not without reason. According to OECD tertiary education in average brings additional 76% of income of those who obtained secondary education (compared with 59% as an average of the OECD countries). Type A and advanced research programmes bring even more - additional 81% compared with 70% as an average of the OECD.

Figure 4.6 presents standardized average rates of unemployment among graduates of all public HEIs who graduated between September 2012 and September 2013.⁴ A great variation of unemployment between individual HEIs is found. The best results are obtained for AMU, Charles University and VŠE for unemployment between 3.6% and 6.7%. The worst results were obtained by VŠPJ, AVU and MendelU. With lower number of graduates however, the rates are

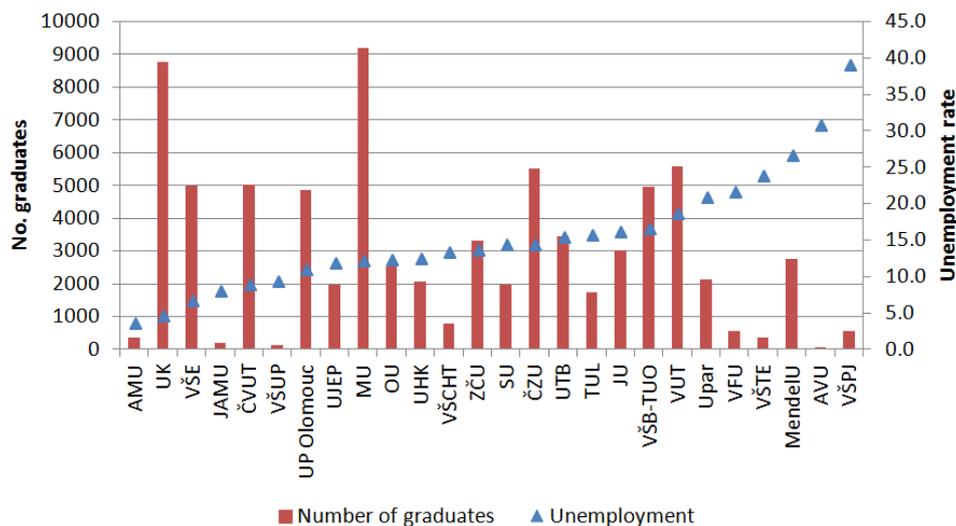
⁴Unemployment rate of graduates is collected among other institutions also by SVP and the data can be found on its website. For better comparison, the unemployment rate is standardized for regional differences by SVP. The number represents share of total number of graduates (all types).

Figure 4.5: Relative earnings in 2012 (upper secondary education = 100), all genders, 25-64 years



Source: OECD.

Figure 4.6: Unemployment among all types of graduates of public universities.



Source: The Education Policy Centre (Středisko vzdělávací politiky) (SVP). Unemployment dated as of September 2013 for one year horizon of graduation (i.e. graduations between Sep 2012 and Sep 2013). Number of graduates was obtained from SIMS for 2013.

more sensitive and thus are more likely to be biased. Therefore the graph also includes number of graduates in 2013.

Public universities resulted with standardized rate of unemployment of 13.2% in average while private universities resulted with 7.9%. The higher rate could suggest lower quality of public institutions, however, students of private universities are mostly older than the students of public universities (according to Zelenka & Koucký (2013), average age of graduates of private institutions is 5.5 years higher) thus they are more probable to own a job due to their comparably extended experience.

Recent studies that deal in closer detail with students and graduates of Czech HEIs are REFLEX 2013 and Eurostudent, both realized in 2013. REFLEX focuses on employability, systemic efficiency, supply and demand in tertiary sector; Eurostudent focuses on the other hand more on living conditions and attitude of university students.

Full scope of results of REFLEX study can be obtained in Koucký *et al.* (2014). The study reveals that nowadays continuously larger share of graduates work more in fields which historically did not, and even today do not, require higher education. Although some employers require higher education, it is rather their will to attain highly skilled workers while it remains that having university degree is not of a necessity. The oversupply of graduates has, according to authors, began in 2007 when “there was a rise in number of which did not take into account, but even completely ignored real absorption possibilities of Czech economy” (Koucký *et al.* (2014), pp. 42). Authors also add that not only number of graduates is a problem, but also structural composition does not reflect labor market demands. They come to this conclusion by finding evidence of rising share of graduates who attain jobs with lower qualification requirements. Self-perceived prospects of students are, however, quite positive. It was revealed in the Eurostudent survey that about 57% of students on average expect that they will be accepted well on the national labour market. Students of agriculture, arts and social studies believed so little however (from 28% to 34%). Most confident are the students of medical studies (75%), who are also the most confident on foreign markets (59%), and law (70%). See (Fischer *et al.* (2013), pp. 34) for more information.

The REFLEX study also provides a valuable analysis of graduates' monthly gross wages. Table 4.1 shows that, firstly, there was narrowing of gross wages difference between economic and technical fields between 2010 and 2013 so that

these wages nearly leveled. Secondly, there was a drop in wages of bachelor and master level graduates between years 2010 and 2013. This could happen due to the recession, but the reality is unknown. On the other hand, graduates with doctoral degree have received much higher wages in 2013 compared to 2010 or 2006. The last important notion is that there are two main categories of studies which differ by gross wage. The first category comprises graduates of natural, technical and medical sciences as well as graduates of economics, business and law who earn significantly more (between 36,000 and 38,000 Czech Koruna (CZK) monthly in 2013) than second category which covers graduates of agriculture, social and humanity studies, educational studies and sport, and culture and art studies who earned between 26,000 to 29,000 CZK monthly in 2013.

Table 4.1: Gross wage across fields and levels of education

	2006	2010	2013	2013*
Graduates in total	27,703	34,870	34,635	31,239
Type of study				
Bachelor	24,914	29,958	28,498	25,660
Master	28,079	36,087	34,934	31,619
Doctoral	30,038	35,150	50,380	46,262
Field of study				
Natural studies	30,367	34,983	37,526	34,662
Technical studies	29,121	34,234	37,979	33,621
Agricultural and veterinary studies	20,471	27,631	26,143	24,771
Medical studies	27,077	32,853	37,552	33,525
Social and humanity studies	22,323	32,144	28,882	27,163
Economics and business	32,332	43,120	38,460	34,202
Law studies	29,142	38,439	36,491	32,368
Educational studies and sport	21,811	25,823	27,866	25,361
Cultural studies	21,037	28,040	28,761	25,801

Source: Koucký *et al.* (2014). Data are included for graduates after 4 or 5 years from graduation. The column 2013* presents data on graduates with 1-5 years from graduation.

The Eurostudent survey presents factors which play role in choice of university. These priorities are listed in Table 4.2 and show that they differ across study programmes. For example, students of education value most financial accessibility of studies and distance from their homes. On the other hand, students of law were led in their choice by interest the most and did not care much about finances compared to others. Good employment expectations are prior-

ity for students of technical studies, economics and business and law, whereas they are not given such focus by students of social sciences or arts.

Table 4.2: Priorities in choice of university

Field	Financial access	rank	Interest	rank
Education	61	1	78	5
Medical	59	2	74	7
Social	54	4	81	3
Law	18	9	90	1
Economics	48	6	77	6
Natural	49	5	80	4
Technical	44	8	81	2
Agricultural	55	3	68	9
Arts	44	7	71	8

	Employment	rank	Distance	rank	sum of ranks
Education	72.1	5	64.6	1	12
Medical	76.4	4	60.6	3	16
Social	53.9	9	61.8	2	18
Law	83.2	2	44.7	7	19
Economics	79.4	3	49	4	19
Natural	69.2	6	49	4	19
Technical	86.6	1	37	8	19
Agricultural	68.4	7	46.3	6	25
Arts	56.3	8	15.6	9	32

Source: Fischer *et al.* (2013). Data are reported in percentage points of those who responded on a scale 1 (highest priority) - 4 (lowest priority) as 1 or 2.

Financial situation of students is also studied in the Eurostudent survey. Students of public universities raise money by 48% from work and by 35% from their families in average while students of private universities finance their living from 78% by work and only 11% by contributions of their families.⁵ Mean value of the income is 11,826 CZK, median value is 7,700 CZK. Financing by earnings from employment is common mainly among students of law (80% of total income), social studies and economics (both 65%). On the other hand, students of technical studies, medical studies and agriculture need to orient on other sources (mostly family income) as more than half of them does not have any private income. These students also have lowest monthly sources

⁵It was already provided for explanation that students of public and private universities differ in their age. This factor might elucidate higher share of income from employment of students of private universities.

(median value of medical studies - 5,600 CZK, technical studies - 7,000 CZK). In contrary, students of law dispose with highest sources - they form 11,000 CZK (median), with students of economics and business, social studies and educational studies being being second with equally high median value of 9,000 CZK.

Average living costs and costs of study are shown in Figure 4.7. Average costs almost double for students of private universities. This is not surprising because (i) private universities are privately financed therefore there are higher costs of study, and (ii) students of private universities are older, thus they are probable to have higher living costs. The Box 4 in the figure shows how these costs vary across various fields of study.

The study also briefly mentions fees and costs related to study. In the Box 1 amount of study costs connected with study at public universities is only 357 CZK per month. The report states that half of students has zero costs of study materials, and another 38% has costs below 1,000 CZK. This is very surprising result, because it could be rationally expected that study costs will be much higher. Other costs related to study are null for 84% of students. Tuition fee and other fees and penalty fees are not paid by 87% of students (which is approximately a share of students of public universities to total number of students in 2013).

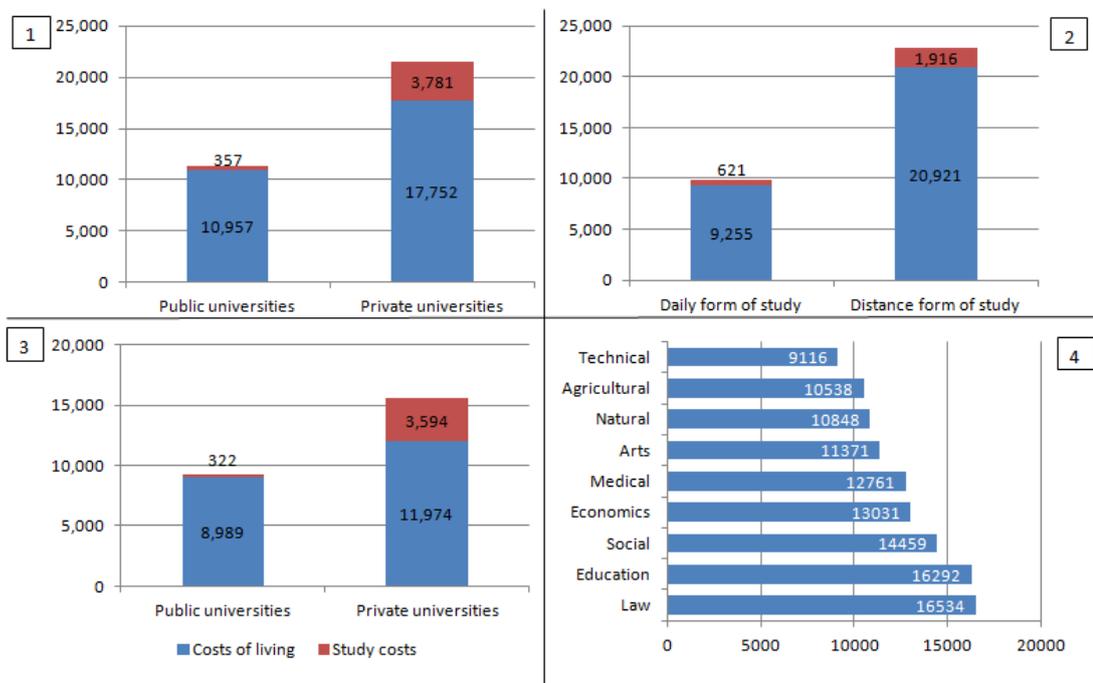
4.3 Financing scheme

Public universities in the Czech Republic are financed from the budget of MSMT. Current financing system is embodied in the Higher Education Act, which has its roots in the beginning of 1990s.⁶ This period is characterized mostly by liberalization of the education system. The universities have restored their academic freedom and independence in managing their existence. To increase participation during those times, the state had to introduce measures to promote enrollment into tertiary studies (such as per capita funding). Koucký (2012) claims that this source of motivation clearly worked between 1990 and 2011 as numbers of students have risen and leveled in percentage terms with enrollment in other OECD countries (see Figure 4.3).

Before presenting statistics which relate to funding, it is necessary to introduce logic of the financing scheme. Total funding divides into 4 main areas

⁶The evolution of the tertiary system and financing is well documented in Koucký (2012).

Figure 4.7: Students' costs per month.

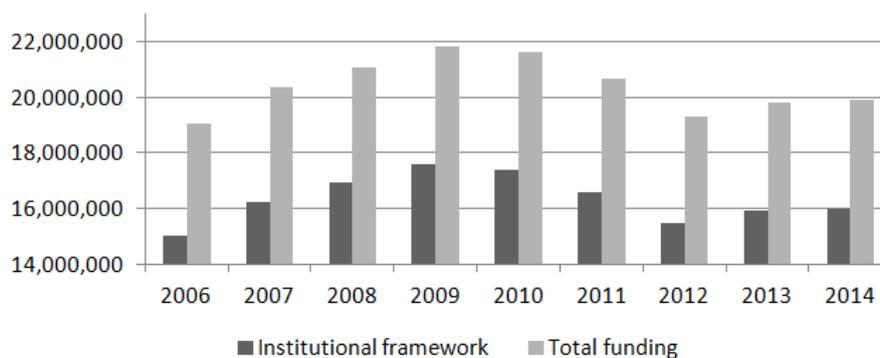


Source: Fischer *et al.* (2013). Box 1 presents data for all types of studies (daily and distance). Box 2 presents data for all types of universities (public and private). Box 3 presents data for only daily type of study. Finally, Box 4 presents monthly costs of students of daily type of study.

(budget circuits, or *BCs*). The first circuit, also called *institutional framework*, makes for about 80% of total funds and is therefore most important. It consists of two indicators. The first indicator *A* is a form of per capita funding, the second indicator *K* (probably to suggest term “kvalita” (quality) in Czech) is a version of performance indicator. Lately in 2013 and 2014, relative weight of the *A* indicator was 77,5%. Thus, per capita funding is the prevailing factor in university financing in the Czech Republic. For more detail description of the financing system see Appendix C.

Evolution of budget devoted to financing public universities can be seen in Figure 4.8. The rise of total funds before 2009 was followed by a sharp decline until 2012 probably due to the presence of recession during that period. The trend in amount of funds might have very well followed trend in numbers of students enrolled in public universities, evolution of which can be seen in Figure 4.1. The overall impact on per student financing is presented in Figure 4.9 which shows that these trends have overall resulted in decreasing funds available per student (for both absolute and normative⁷ numbers of students) between years 2006 and 2012. Only from 2012 it seems that the per student funds are getting back to its pre-recession values.

Figure 4.8: Evolution of budget of public universities

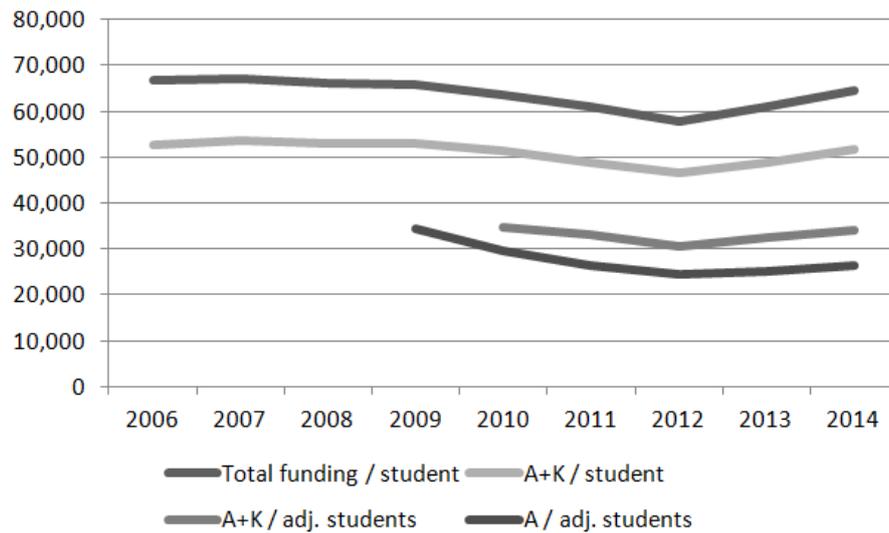


Source: MSMT. Data in thousands of CZK. Share of institutional framework on total funds has been moving steadily around 80%.

It remains to compare share of these funds on national GDP with trends in the world. This is done in Figure 4.10. Historically, the OECD countries show higher share than the Czech Republic, but there was an optimistic narrowing of the gap in 2011.

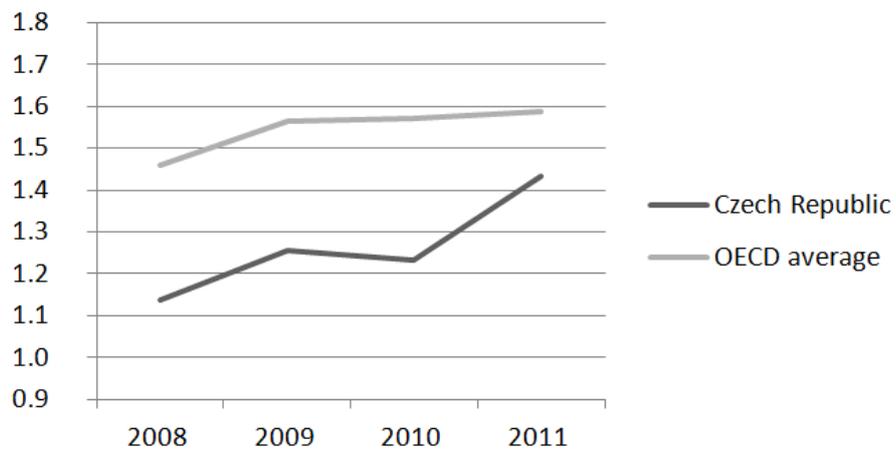
⁷For explanation of normative number of students see Appendix C.

Figure 4.9: Funds per students in time



Source: MSMT. Data in CZK. Adj. students refer to adjustment by weighting by Coefficient of Field of Study Cost (CFSC). Please refer to Appendix C.

Figure 4.10: Share of expenditures on tertiary sector as % of GDP.



Source: OECD. Data until 2011 due to availability reasons.

4.4 National strategy

The strategy in tertiary education is documented in two long-term strategy documents which were prepared for periods 2011-2015 MŠMT (2010) and 2016-2020 MŠMT (2015) by the Ministry of Education of the Czech Republic (MSMT). These documents also discuss financing and quality issues in the sector. I believe that brief comparison of these two documents will provide the reader with deeper understanding of thinking of government officials in horizon of the last 5-6 years.

In a brief overview, the early document (MŠMT (2010)), among other, summarizes past performance, describes growth in numbers of HEIs and faculties as well as of students. Other phenomenons, such as inflation in degrees or forecasts that number of students will exceed the number of appropriate jobs in the future, are also mentioned. Although the quality of the system is not criticized, a worry about decline is expressed due to lowering number of students in future under prevailing system of financing.

Financing system was found an important tool for managing quality. It was expected that the scope of change would be of a large scale and thus not without problems. However, it was admitted that such a large scope is necessary, because there is no reason to further increase numbers of students. Parameters of financing were thus promised to be based more on performance than so far.

Support was promised for types of institutions which orient on elite research and demanding study programmes as well as for those which focus on bachelor programmes and are of regional character. Thus both types of institutions, each at the end of a hypothetical spectrum of universities, were considered equally important.

It is interesting to compare previous document with the recent one (MŠMT (2015)) as mentions on a reform of financing are largely missing. The document instead states that *substantial changes in this sector involve consensus on political and governmental grounds* which implies rather slow adjustment. Transition from quantity to quality is promised, it is however more in hands of universities than of the ministry (effective management of universities, system of quality assurance, diversification, ensuring high standards). Ministry also claims to strengthen weight of quality indicators in total financing with

commitment for better use of data analytics. Next chapters of this work (i.e. empirical part) employ such advanced measures and could be thus possible inspiration for the ministry.

4.5 Problems of the system

Probably the main problem of the Czech public HE sector are the implications of current setting of the financing framework. The system obviously motivates universities to accept and keep maximum number of students possible. Despite the limits which are set every year by MSMT based on previous performance, the quality can be still hard to achieve. Setting up the bar of requirements is therefore not optimal behavior due to potential drain of pool of students which means lower inflow of funds. During next years, situation may be worsened due to smaller cohorts of students which are expected to apply.

It is argued that the current system of providing funds for research does not lead to optimal results. The results in case of the Czech Republic, such as an inflation of academic publications without value, artificial boosting of impact factor⁸, founding new publishing organizations and journals, or orientation on quantity rather than quality in some fields, are documented in Stöckelová & Vostal (2015). The problem is however not local. Recent “Leiden Manifesto for Research Metrics”, published in Nature by Hicks *et al.* (2015), documents worldwide abuse of research metrics principles by too much reliance on mechanical calculations, missing individual judgment, push from regional to world research and other problems. The authors provide a list of several best practices.

Problems connected to quality of studies were experienced in history with public as well as private institutions. Quite famous are scandals at Západočeská Univerzita v Plzni (ZCU), Pilsen in 2010 which were related to many cases of plagiarism, problems with accreditation or to students who graduated inadequately quickly. Some private universities were also criticized for quality of their study programmes and were accused of for-profit behaviour as an expense to quality. To give an example from recent period, in 2015, studies at Univerzita Jana Ámose Komenského (UJAK) were found of a low quality by Accreditation Committee (AC) as 1/4 of students graduated before standard duration of studies of 3 years (some of them graduated even within half a year,

⁸The term which is usually connected with this phenomenon is a “coffee grinder” (kafemlejek in Czech) to reflect the method of repeating references.

see Accreditation Committee (2015)). Other problems with understaffing and diploma theses were reported. Fortunately, problems with quality have been mostly connected with private universities in recent period.⁹

Other problems are commented briefly. Graduates employability was commented above so it will be skipped in this section. Recent development in distribution of students according to field of study (see Figure 4.4), particularly higher share of students of social sciences and economics, lower share of students of technical and education sciences, was considered by some as unhealthy (Koucký *et al.* (2014)). Nevertheless, Table 4.1 shows that market forces may have played certain role. For example, demand for economic programmes may have been driven by wages between 2006-10. Downgrade of educational studies can also be explained by the table because the graduates earned relatively low wage compared to the rest of the group. On the other hand, the table fails to explain the decline in numbers of students of technically oriented fields. Despite the rise of wages between 2006 and 2013, relative numbers of students had been declining until 2011 and were stabilized since then.

Remotti & McAdory (2013) mention relatively poor salaries of academics because limited funds do not allow public universities to pay for top professors. The current system thus leads professors to attain multiple academic positions, sometimes at different institutions (some of them being also private) despite their never-ending competition for grants.

The last problem, which may be of importance according to the author of this thesis, is a lack of information sources which would serve future students responsibly assess quality of studies and their employability. There are indeed several relevant studies, such as Reflex or Eurostudent, but they are not easily accessible to broader public because of their rather academic nature. On the other hand, what is close to ideal source of information are league tables provided every year by *Hospodářské noviny*, a Czech newspaper. A professional will however find them as indicative at most, as they are prepared by journal itself and the methodology has not been validated by any official institution.¹⁰ Therefore, it seems that a good source of information which would combine surveys similar to Reflex or Eurostudent with application and analytics of HN

⁹However, this is not completely true. Recently, Faculty of Economics of University of Economics (Národohospodářská fakulta VŠE) had experienced troubles with accreditation of its study programmes due to lack of academic personnel.

¹⁰Access to these informations is another issue. Due to lack of it, the methodology could not be investigated more.

is missing.¹¹

4.6 Reform proposal

This final section briefly describes the process of reform of tertiary system in the Czech Republic which was initiated by issuing the White paper on tertiary education in 2009 (MŠMT (2009)) and lasted more or less until 2012. The description below focuses on some aspects of ideological framework of the reform and design of private financing. It is then followed by description of discussions and protests which followed and finally led to rejection of major part of the reform.

The first ideas of reform occurred in 2005. Publication of the White paper of tertiary education, accepted in 2009, then brought an idea of system reformation accompanied by private financing using the ICLs design. Private financing was however supposed to play role in the new financing system as a support to prevailing per capita funding and R&D funding. The system would assume that each student would be provided with a study grant and an ability to obtain a study loan used to cover studies. Tuition fees would be capped to provide for competition only in downward direction at maximum level of 10,000 CZK per semester. Contingency of loan payments as a % of premium income would last even for 25 years. There would be also setting of interest rate however on minimal level, just to cover administration expenses and other costs and to motivate students to pay as soon as possible. The specification of dealing with risks, such that either risk-pooling or risk-sharing, was not done. To account for fields in which market forces do not work well in setting adequate wage (doctors, teachers, public security) the employer (mostly government) would contribute instead of the graduates.

New financing scheme was advocated in the White paper, suggesting that it will bring higher motivation of students, impact on quality and rationality, as well as elements of market behavior by providing universities with signaling tools by allowing them to set tuition fee flexibly. It is however necessary to notice that the financing scheme was accompanied by reforms also in other parts of the sector, thus the financing part was built on assumption of fostered

¹¹A Slovakian project “Lepšie školy” (Better schools) can be an inspiration. The project serves to inform students who are in the process of choice of their university. The data provide applicants with full information regarding not only university itself but also wages of graduates or forecasts of labour market. For more information see: <http://www.lepsieskoly.sk>

institutional aspects of the whole sector (strengthening of AC's authority, providing information relevant to students, fostered quality assurance and many other steps). It was thus highlighted that new system of financing must go hand in hand with other aspects of the reform.

The White paper was developed in a for-reform oriented political atmosphere in 2009 by national experts in economics, sociology or education, with close cooperation with the OECD. The realization of the reform was however accepted with concern by students and academics. The main reasons were, among others, discontent about tuition fees and worries of losing independence due to strengthened role of external stakeholders and lowered role of students in academic senates (UWN (2012)). The protests of students and academics then followed, which led to abandonment of the reform and its revise by subsequent minister. Tuition fees have been redirected towards entrance fees and penalty fees for extending standard period of study.¹² The idea did not have time to develop and was later abandoned.

Political development in following years was rather unstable which was unfavorable for the reform and many revolutionary ideas (long-term financing, scope of schools - either academic or vocational) have quietly been thrown away in time. Current legislative innovations in tertiary sector have only a little to do with what has been originally suggested.

Why was the reform unsuccessful? From large amount of sources investigated by the author, the source of problems seems not to be grounded in intellectual background of the reform, i.e. the White paper. Conversely, the document was consistent, deeply-oriented and, moreover, also advocated by the OECD. It is more probable that worries in the academia about lowering quality (due to involvement of external subjects in management of universities and other factors) in combination of increased funds of students (there were many arguments that education obtained at university is a public good) have been blended into explosive mixture which was then easily triggered by fatal mistakes in communication. For example, rectors and other representatives of academia complained that their comments were ignored. Moreover, financial part was, according to their words, even not discussed with them at all. Such an experience could be easily seen as despise of those in charge and worries were thus free to easily grow.

¹²What is actually different between tuition fee and entrance fees, besides wording, is the amount of the entrance fee - about 5,000 or 6,000 CZK per year. ČRo (2012)

One would consider this at least an unfortunate evolution of otherwise a thought-out plan to raise quality of HE studies in one country. Issues of governance in universities could be easily discussed among all stakeholders. Instead, the sector does not seem to experience major changes for last years and the issue seems to be extremely politically sensitive. Besides political reasons however, there seem to be no other barriers that would indicate that the topic of private financing cannot be opened again. The current government, however, does not plan to introduce any such measures and the matter of reform finds itself in something that was in Remotti & McAdory (2013) called as *legislative limbo*.

Chapter 5

Efficiency analysis of universities

*[An economic efficiency is...]
... a concept which has a very
clear meaning in textbook
analyses of the theory of the firm
but that becomes quite cloudy in
the world of public schools.*

Hanushek (1986)

The current and the next chapter constitute empirical part of this work. The present chapter evaluates two areas of universities' output (teaching and research) from efficiency perspective. The reason of this analysis is to track partial effects of the current financing scheme on performance of universities which draw and benefit from these funds. It is assumed that under efficient funding scenario the universities will attain efficient score, set at 80% level, in both parts.

5.1 Methodology

The main part of the DEA analysis is an appropriate choice of variables which play crucial role in the production function of universities, i.e. inputs and outputs. The choice is rather loose as there is no consensus on specific variables. Johnes (1996) breaks down the output of universities into following areas:

- output from teaching activity
- output from research activity

- output from consultancy
- cultural and social outputs.

On the other hand, inputs which should be accounted for are according to the same author following:

- raw materials
- labour services
- human capital services
- physical capital services
- consumables
- institutional characteristics
- environmental factors.

Choice of outputs must be based on data availability and existence of plausible measure. Most studies focus on measuring teaching and research activities (e.g. St. Aubyn *et al.* (2009), Leitner *et al.* (2007), Abbott & Doucouliagos (2003)) as these are in the core of activities done by most of the universities. When the outputs are set, relevant inputs are usually chosen according to data availability and economic justification.

The assessment of the Czech HE system goes also according to the same two dimensions in this thesis. Below is a brief discussion on the production function, inputs and outputs.

1. *Teaching assessment:* Universities are given funds intended to be spent on tuition, wages of academic staff and other operational costs to perform educational activities and “create” graduates. Intuitively, the more funds a university obtains, the more graduates it should have. The analysis thus measures effects of funds for students with number of graduates as an output to track throughput and possible waste of financial resources when the rate of throughput is low.

The analysis also controls for quality of graduates by incorporating two means of rising their overall level. These are:

- hiring quality academic staff

- more intensive programs

with employability of graduates as an output. The employability part (also with throughput) was argued in Johnes (1996) as appropriate measures for teaching output. The lack of efficiency in the part of qualitative measurement would thus lead to conclusion that there is waste of resources by either providing too much intensive programs, or that the programs are not demanded by the labor market.

2. *Research assessment*: Next to educational activities, academics are supposed to produce articles, patents and provide consulting activities to general public. Thus, a higher number of academic staff and their wages should optimally lead to higher production of research.

Generally there are two ways of models which can be applied within the family of frontier methods: a non-parametric DEA approach with origins in operations research and linear programming, and parametric SFA (Stochastic Frontier Analysis) approach with rather econometric nature. The DEA approach is more popular because it allows to infer production frontier directly from the data. This property is clearly favorable as the true production function of universities is not yet well specified due to several complexities and, as Hanushek (1986) claims, it may never be known.

The description below draws from Coelli *et al.* (2005) who provide a classical description of the CCR model of DEA which has been used and further extended from its initial presentation in 1978 by Charnes, Cooper and Rhodes. The original model proposed CRS (constant returns to scale) assumption, but some years later the model was extended also for VRS (variable returns to scale) condition.

For the problem, assume that there are N inputs, M outputs, and I DMUs. Thus the input matrix \mathbf{X} has $(N \times I)$ dimension, the output matrix \mathbf{Y} has $(M \times I)$ dimension, and $\mathbf{x}_i, \mathbf{y}_i$ are columns of matrix \mathbf{X} and \mathbf{Y} respectively. Using duality in linear programming, we may write the central problem as either *multiplier form* or *envelopment form*.

Under CRS assumption, the multiplier form is obtained by solving for following mathematical problem:

$$\begin{aligned}
 & \max_{u,v} (u\mathbf{y}_i), & (5.1) \\
 & \text{s.t. } v'\mathbf{x}_i = 1 \\
 & \quad u'\mathbf{y}_j - v'\mathbf{x}_j \leq \mathbf{0}, \forall j \in \{1, 2, \dots, I\} \\
 & \quad u, v \geq \mathbf{0},
 \end{aligned}$$

where u, v are weights for inputs and outputs respectively. An alternative view on this by envelopment form is following:

$$\begin{aligned}
 & \min_{\theta, \lambda} \theta, & (5.2) \\
 & \text{s.t. } -\mathbf{y}_i + \mathbf{Q}\lambda \geq \mathbf{0} \\
 & \quad \theta\mathbf{x}_i - \mathbf{X}\lambda \geq \mathbf{0}, \\
 & \quad \lambda \geq \mathbf{0},
 \end{aligned}$$

where λ is a $(I \times 1)$ vector and θ is an efficiency score (measured as a scalar) of the i -th Decision Making Unit (DMU) according to Farrell definition. According to Coelli *et al.* (2005), this version is preferred as it involves less constraints than the multiplier form, and is thus preferred. An intuition behind this approach is to radically contract input vector of i -th DMU \mathbf{x}_i as much as possible while still remaining within the feasible input set.

The VRS assumption extends a set of constraints in Equation 5.2 by imposing for $\mathbf{J}'\lambda = 1$, where \mathbf{J} is a vector of ones with length I . This constraint ensures that the DMU will be benchmarked against other DMUs of a similar size. For a reference to practical example as well as intuition background see Coelli *et al.* (2005).

From the above stated it follows that what is needed for successful delivery of analysis is a list of inputs and outputs, assumption about economies of scale and the choice of efficiency measure (either input or output efficiency). The list of inputs and outputs was discussed above. In the case of decision about economies of scale, there is no consensus in the literature about what type of returns to scale should be applied. Abott & Doucouliagos (2003), Leitner *et al.* (2007) and St. Aubyn *et al.* (2009) use variable returns to scale, while Flégl & Vltavská (2013) use constant returns to scale. Due to unknown technology

of universities and with respect to previous studies, the following analysis uses variable returns to scale.

For purpose of better clarity, all efficiency measures below are reported in the form of input efficiency. Thus, to give better idea of interpretation, $x\%$ efficiency measure means that particular DMU should be able to produce exactly the same amount of output with only $x\%$ of input according to underlying standards.

Lastly, but not the least, there are indeed some drawbacks of the DEA approach. One of them may be that measurement is relative, thus there may be no specific DMU with ideal production function. Consequence of this is that when there is a DMU with efficiency score of 1, it does not yet have to mean that it is efficient. It is only efficient “within the sample”. Another drawback is that a DMU can appear efficient by simply behaving different (so that there is no good peer to be compared with). It therefore follows that results obtained by DEA should be interpreted with caution.

For the later analysis, following set of assumptions is used.

Assumption 5.1. A DMU is efficient in the particular area if, and only if, it exceeds the level of Farell efficiency of 80% in that area.

Assumption 5.2. A DMU is efficient if, and only if, it is efficient in both areas.

These assumptions will be used later in discussion about extent of efficiency in the sample of universities.

5.2 Data

The data were obtained from publicly available sources. Data on number of students and graduates were collected from the SIMS database, data on total number of academic staff (including Ph.D. students) and their wages were obtained from the MSMT as well as funds spent on teaching activities. The database of SVP provides data on employability of graduates (unemployed students who graduated not more than 1 year ago compared to total number of students who graduated not more that 2 years ago). Finally Information Register of R&D results (Rejstřík informací o výsledcích) (RIV) points were collected as a proxy of research output. RIV points are an evaluation of research institution provided every year by Research, Development and Innovation Council

which is an advisory body to the Government of the Czech Republic. The data were gathered from the website of the institution.

All data were collected as of 2013 in per university terms. Furthermore, some adjustments of these data were made. The number of students as well as of graduates was adjusted by CFSC and the data on employability were adjusted by SVP for regional differences.

Average wage of academic staff at a particular university was used as a proxy for quality of academic staff. Intensity of study programs is calculated as a staff-to-student ratio:

$$\text{staff-to-student ratio} = \frac{\text{number of academic staff}}{\text{number of students (scaled by CFSC)}}$$

so that higher numbers of academic staff per one student lead to more intensive studies. The final list of inputs and outputs is provided in Table 5.1.

Table 5.1: Inputs & outputs

Area of interest	Inputs	Outputs
Teaching	Teaching funds	Number of graduates
	Staff-student ratio	Employability
	Average academic wage	
Research	Number of academic staff	RIV points
	Total academic wages	

Source: The author.

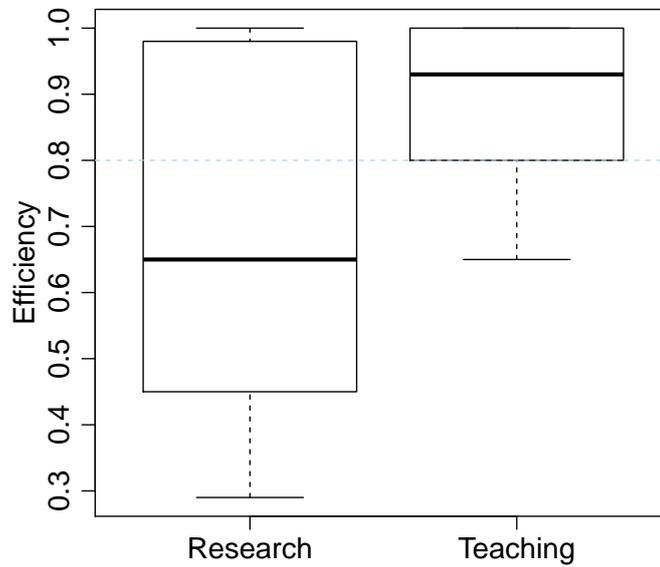
The analysis was conducted using R software with application of **Benchmarking** package developed by Peter Bogetoft and Lars Otto.

5.3 Results

Efficiency scores were calculated according to specified methodology and their distribution is presented in boxplots in Figure 5.1 and in histograms in Figure 5.2. The teaching efficiency results quite nicely as there is majority over 80%, with mean at 90.1% which suggests efficient overall performance. On the other hand, the research efficiency is more widely spread ranging from 20% efficiency up to full efficiency with mean at around 67.7% and median at 65%, both suggesting low efficiency. Indeed, as boxplots would suggest, more than

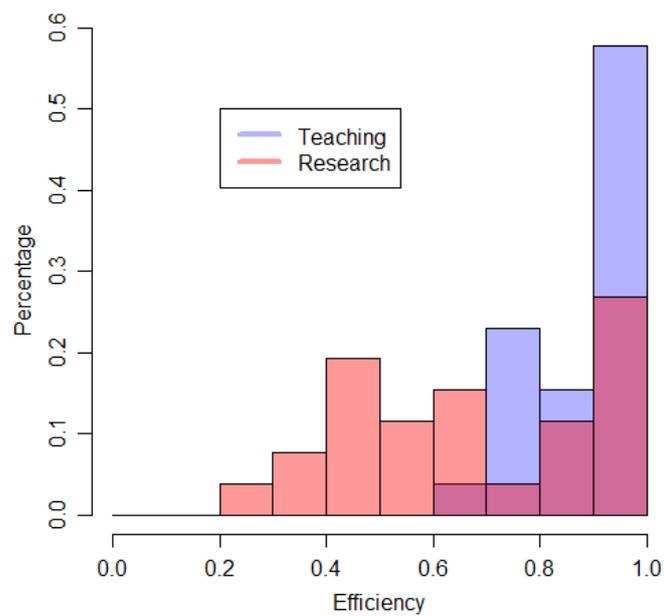
3/4 of universities (77%) are teaching efficient, while only 38% are research efficient.

Figure 5.1: Boxplots of efficiency scores



Source: Author's computations.

Figure 5.2: Distribution of teaching and research efficiency scores

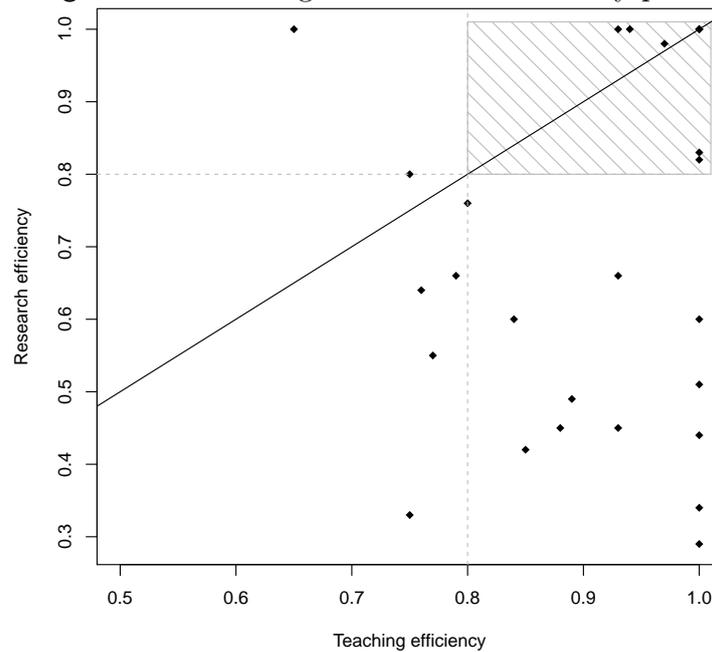


Source: Author's computations.

Figure 5.3 allows to observe efficiency scores by individual universities. The

solid line represents equal score for both efficiencies. If universities delivered equal output in both aspects, we would expect observations to be scattered around this line. Dashed lines on the other hand represent 80% efficiency bottom lines, as were stated in Assumptions 5.1 and 5.2. In case of full efficiency, observations would be allocated in the area delimited by dashed rectangle in the upper right corner.

Figure 5.3: Teaching and research efficiency plotted



Source: Author's computations. Names of universities have been purposely omitted.

The figure shows that there are only few universities allocated in the efficiency area in the upper right corner. This means that efficient results in both teaching and research are delivered scarcely at the same time. While there are many universities who do well from teaching perspective, they perform poorly in research. The opposite case is also interesting - there are not many universities which succeed in research, but most of those who do also succeed in teaching.

Chapter 6

Analysis of private financing

This chapter deals with hypothetical scenario of private financing. The goal of this chapter is to compare different types of financing schemes - particularly ICL, HCC and pure tuition fees. The comparison is done from individuals' perspective. Thus, contributions of several income groups are calculated and compared to their lifetime earnings. PRR perspective is also used to analyze for sensitivity of different values of contributions relative to lifetime earnings.

6.1 Methodology and the model

To compare lifetime contributions of individuals to different systems of higher education financing, the model developed by Vandenberghe & Debande (2008) is used.¹ These authors propose to relate loan repayment (under ICL) or contract payments (under HCC) to individuals' lifetime earnings. It is, however, worth of question whether one ought to use lifetime earnings, which would normally range in average from 24 to 65 years of life, or a more relevant time period. I suggest that it is more plausible to consider earnings which last in about the same long as a duration of an average job contract. In the model below, the duration of the contract is assumed to be 25 years, thus, from now on, I will use the term prime-age earnings instead lifetime earnings to reflect earnings accumulated between 24th and 49th year of life.² During this period investment into education is repaid.

Lifetime earnings are calculated as a discounted sum of yearly earnings of individuals from different socio-demographic backgrounds across several levels

¹The notation also more or less follows the one of authors'.

²24 years is a standard year of graduation for a graduate student in the Czech Republic, therefore also an ideal end of grace period of the contract.

of obtained education (master, bachelor and other type). Estimation of expected income in a particular point in life is done by simple Ordinary Least Squares (OLS) regression:

$$y_{i,k} = \epsilon_0 + \epsilon_1 a_{i,k} + \epsilon_2 a_{i,k}^2 + u_{i,k} \quad , \quad (6.1)$$

where k reflects group, and i stands for individual in a particular group.

The fitted values obtained by Equation 6.1 are summed up on a discounted basis for different groups of graduates k to obtain prime-age earnings Y_k :

$$Y_k = \sum_{a=24}^{24+D} \hat{y}_k(a) \left(\frac{1+\tau}{1+r} \right)^{(a-24)} \quad , \quad (6.2)$$

where r is a discount rate and τ is a parameter representing total productivity factor gains. Table 6.1 provides list of parameters used in the model applied for both types of graduates.

Table 6.1: Calibration of the model parameters

Parameter	Value
Cost per semester	5,000 CZK
Bachelors years of study	3.5
Masters years of study	5.5
Average years of study	5.15
INV (in PV)	57,126 CZK
D	25
r	2%
τ	1%

Source: The author. The cost per semester is set at a half of what was suggested by the Czech government during reform discussions. Years of study were set at a standard duration plus one semester. Average years of study result as weighted average of bachelors and masters in the sample. INV is then an outcome of the previous parameters. D is set at 25 because it is a reasonable time length of such contract, and because the same value is also used by Vandenberghe & Debande (2008). Cost of loans should be minimal, thus the interest rate was set at 2%, which is both short-term and long-term inflation target of the Czech National Bank. Finally, the growth of wages was chosen to be at 1%³ Vandenberghe & Debande (2008), on contrary, choose $r=4\%$ which was historical return on risk-free European bonds, and $\tau = 2\%$.

The regression in Equation 6.2 is applied on EU-SILC data obtained in 2013. This method, i.e. using single year cross-section to forecast future earnings, is of course not without limitations. The main assumption is that the technique

presumes that future earnings of graduates' will be kept at the current level adjusted for technology growth. The future evolution is however uncertain, thus earnings may go off current trends. Investigation of future evolution of the labour market would however require much thorough analysis which is beyond scope of this thesis.

The results obtained in Equation 6.2 are then used in modeling HCC and ICL schemes. The logic of each system is as follows.

Under each instrument, the student pays a certain fee inv for each year of the study, thus the total amount of what student needs to pay is:

$$INV = inv(1 + r)^5$$

after 5 years of study in PV at the point of graduation.

Under HCC, INV is to be repaid in yearly installments that are equal to fraction θ of graduates' g earnings:

$$INV = \theta Y_g \quad . \quad (6.3)$$

Thus the goal of the analysis is to find a real value of θ , θ^* , such that real Czech graduates can repay the tuition fees within 25 years since graduation.

Under ICL, INV needs to be repaid in annual installments Ω contingent on individual's ability to pay which is met when earnings exceed specified threshold Θ . On average, this threshold is exceeded with probability M_g for a certain group

$$INV = \Omega M \quad , \quad (6.4)$$

$$M_g = \sum_a \left(\frac{\mu_g(a)}{(1 + r)^{(a-24)}} \right) \quad , \quad (6.5)$$

where $\mu_i(a) = I(y_i(a) > \Theta)$ is a binary variable indicating whether the graduate is able to pay in the given year (i.e. whether she has income above a certain threshold Θ). The Θ can be set either fixed (in what follows $\Theta = 20,000 \cdot 12$ for average monthly wage of 20,000 CZK⁴), or floating (in what follows, $\Theta >$ average wage of an individual with secondary education). Below this threshold, no payment is required. The goal is to find real value of Ω , Ω^* , such that real Czech graduates can repay the tuition fees within 25 years since graduation.

⁴Regarding Table 6.4 which compares implied monthly earnings of graduates, this value seems to be a reasonable threshold.

Having found realistic parameters, θ^* and Ω^* , the analysis can proceed, i.e. it can be observed what this means for individual groups. To do so, the parameters θ^* and Ω^* , previously obtained for students in average, are applied in calculation of contributions of several groups of students g according to their socio-demographic status and level of education. The contributions for each scheme, C_HCC and C_ICL , are then calculated as follows:

$$C_HCC_g = \theta^* Y_g \quad (6.6)$$

$$C_ICL_g = \Omega^* M_g \quad , \quad (6.7)$$

and compared to prime-age earnings to calculate what fraction of prime-age earnings these groups repay under each scheme.

Finally, to obtain profitability of university studies, both versions of PRR described in Chapter 2 are calculated. Obtaining value of PRR is a convenient step to analyze profitability and compare it to other types of (capital) investments. Also, the number obtained allows to apply sensitivity analysis of impact of different values of INV on the PRR which can be a helpful tool in setting optimal value of tuition fee.

6.2 Data

This analysis makes use of the dataset from EU-SILC (European Union Statistics on Income and Living Conditions) survey collected by CSU in 2013. The data contain stratified survey of individuals and households living in the Czech Republic which is focused on their income, education, occupation, health status or happiness. Unfortunately, the dataset does not include information about name of attended university or field of study.⁵

The data are used to obtain distribution of income across age groups and levels of education and to calculate prime-age earnings of graduates. For this purpose, only economically active individuals younger than 70 are chosen. There was adjustment of earnings by linear extension in case of individuals who reported their earnings for period shorter than 12 months. Earnings of bache-

⁵This kind of information would otherwise be tremendous boost for analyzing graduates' income as comparison of lifelong income would be possible also for graduates across different universities.

lors and secondary educated individuals have been edited for outliers, in the earnings of master graduates, no outliers have been found. See numbers of observations across gender and level of education in Table 6.2.

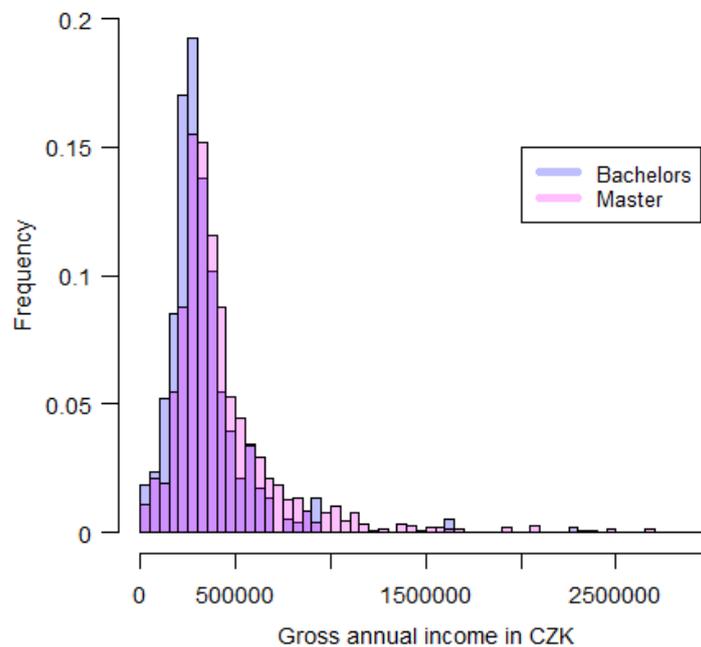
Table 6.2: Numbers of observations

	males	females	total	Prague	
				males	females
Bachelors	106	131	237	12	15
Masters	646	527	1173	147	86

Source: EU-SILC.

Figure 6.1 presents histogram of annual incomes of graduates. Traditionally, master studies empirically bring higher income as the distribution of their income is skewed more towards higher values compared to their peers from bachelor studies.

Figure 6.1: Distribution of graduates' annual income



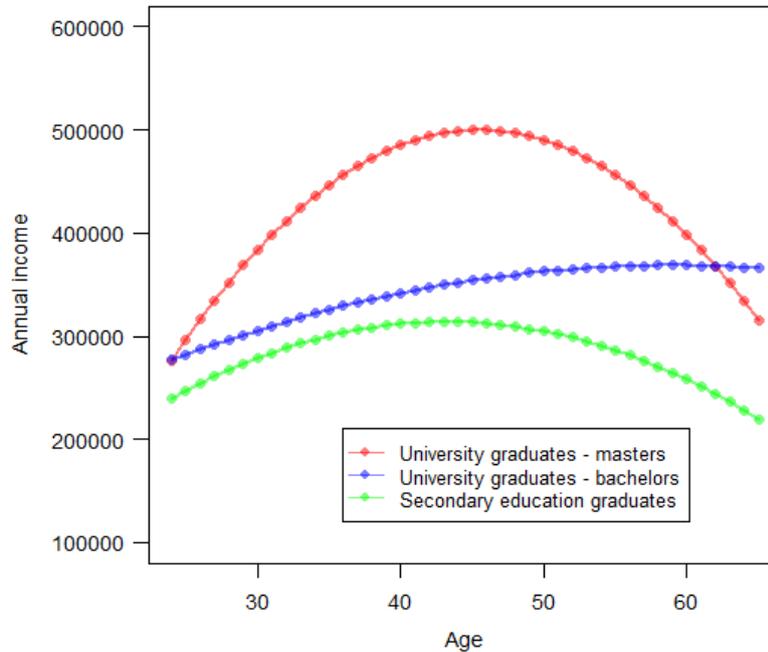
Source: EU-SILC, the author's computations

The analysis was conducted mostly using R software. For analyzing EU-SILC data, I applied `survey` package, developed by Thomas Lumley, which is suitable to be applied on similar surveys as it allows to employ valid statistical methods for stratified data.

6.3 Results

The income of graduates Y_g was estimated from existing data using OLS regression (see Figure 6.2). Technical details of regressions can be found in Appendix A in Figure A.1, Figure A.2 and Figure A.3.

Figure 6.2: Predicted annual income



Source: EU-SILC, the author's computations.

The parameters used in Equation 6.6 and Equation 6.7 were calculated using data on income and they are listed in Table 6.3. The results show that graduates would pay in average 0.6% of their income accumulated between their 24th and 49th years of life (i.e. prime-age earnings) under HCC scheme. For the case of the ICL scheme, two parameters were computed. The first parameter, Ω_1^* , is computed under floating threshold which is set at average level of secondary educated workers in the particular age group. Quite oppositely, Ω_2^* is computed under fixed threshold of 20,000 CZK.⁶ Clearly, $\Omega_2^* < \Omega_1^*$ which suggests that the fixed cap brings less probability of non-payment than the floating cap.

The next step in the analysis is to apply the parameters to compute contribution for different income/risk groups such as in Equation 6.6 and Equation 6.7. The character of data does not allow to split the sample across fields of study. However, it is possible to divide it according to the degree (master vs.

⁶For (undiscounted) probabilities of payments consult Figure B.1 and Figure B.2 in the Appendix B.

Table 6.3: Outcomes of the model (pooled graduates)

Scheme	Parameter	Parameter value	Note
HCC	θ^*	0.6%	% of period income
ICL	Ω_1^*	4,331 CZK	Annual payments, floating cap
		361 CZK	Monthly payments, floating cap
	Ω_2^*	3,548 CZK	Annual payments, fixed cap
		296 CZK	Monthly payments, fixed cap

Source: The author. Monthly payments are included for illustrative reasons by simply dividing annual payments by 12.

bachelor), gender (male vs. female) and region (Prague vs. non-Prague). This step thus allows to create 8 groups. Their income and risk profile are shown in Table 6.4 and Table 6.5 respectively. Values in Table 6.4 have been obtained using OLS regression. The details of this regression can be viewed in Appendix A in Figure A.4, Figure A.5 and Figure A.6. The table presents known facts that earnings are higher for men than for women, that master graduates earn significantly more, and that the Prague region provides generally with better earnings.

Table 6.4: Accumulated and monthly income between 24-49 years of life (non-discounted)

Sex	Region	Secondary	Bachelor	Master
prime-age earnings				
males	Prague	7,430,400	8,895,942	11,482,018
	non-Prague	6,669,055	8,056,954	9,495,923
females	Prague	5,535,584	6,234,790	8,614,046
	non-Prague	4,774,239	5,395,802	6,627,950
implied monthly income				
males	Prague	24,768	29,653	38,273
	non-Prague	22,230	26,857	31,653
females	Prague	18,452	20,783	28,713
	non-Prague	15,914	17,986	22,093

Source: EU-SILC, author's computations. Monthly wages were obtained from accumulated earnings by dividing by $12 \cdot D$.

Table 6.5 shows that the most risky group (from payment schedule perspective) are women who live out of Prague together with those Prague women who own a bachelor's degree. (For detail on (undiscounted) probabilities of

payments among groups consult Figure B.3 for the case of bachelor graduates and Figure B.4 for the case of master graduates in the Appendix B).

Table 6.5: Accumulated probability of payments between 24-49 years of life (non-discounted)

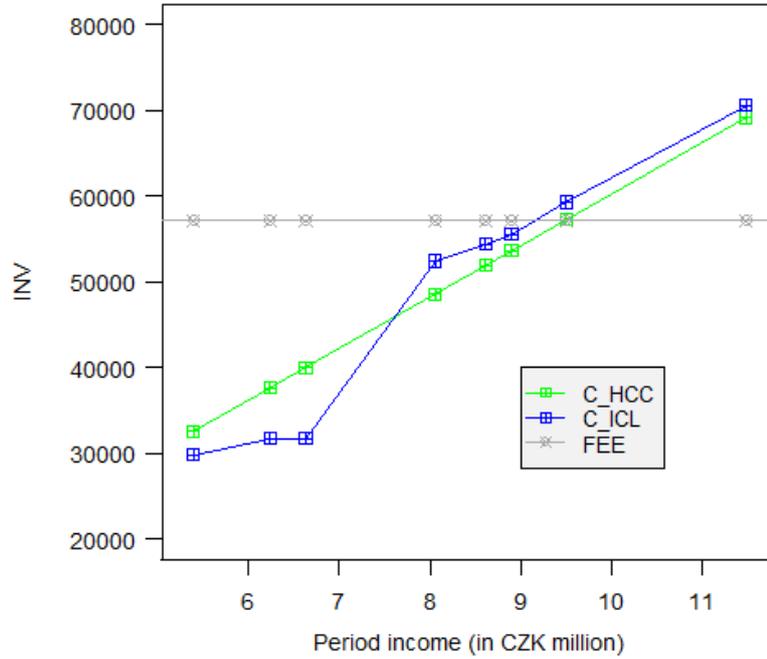
Sex	Region	Floating cap		Fixed cap	
		Bachelor	Master	Bachelor	Master
males	Prague	14.49	22.04	18.92	23.59
	non-Prague	16.96	19.49	21.27	22.53
females	Prague	8.97	17.45	13.04	21.05
	non-Prague	11.43	13.62	16.32	19.26

Source: EU-SILC, author's computations. Values in the table are summed probabilities of payment in each year. Thus, a maximum value to obtain is 25.

The Figure 6.3 shows how contributions of INV vary across different income groups. Clearly, low income groups contribute much less than their peers from higher income groups. These contributions are furthermore compared with the income from the prime-age period in the Figure 6.4. What is immediately visible from the figure is that there is a great deal of proportionality of both HCC and ICL schemes which means that all groups of students contribute similar fraction of their prime-age income. On the other hand, the FEE instrument (pure tuition fee) is highly regressive because the students with lower lifetime income contribute relatively higher share of their lifetime income than their peers from higher income groups.

Finally, using methods described above, two types of PRR for groups of graduates and undergraduates were calculated using data from EU-SILC (see Figure 6.2). Results are summarized in Table 6.6. Reported percentages are representation of earnings such that annual earnings equal to the initial value of investment (per year) times the reported percentage. The basic version of PRR considering discounted premiums across years has shown to be 5.2% and 8.2% for undergraduate and graduate studies respectively. The short-cut method, adjusted for costs of study, has resulted with 8.3% and 9.5% for the same two groups respectively. Although higher numbers of the second method were expected due to missing discounting (as was stated in the Methodology section) the difference between two methods in case of undergraduates is quite high. This could be due to wider premiums in later years of life which are given higher weight in the PRR_{sc} than in PRR_{basic} due to averaging.

To observe impacts of different levels of investment (more particularly, dif-

Figure 6.3: Contributions to INV across different income groups

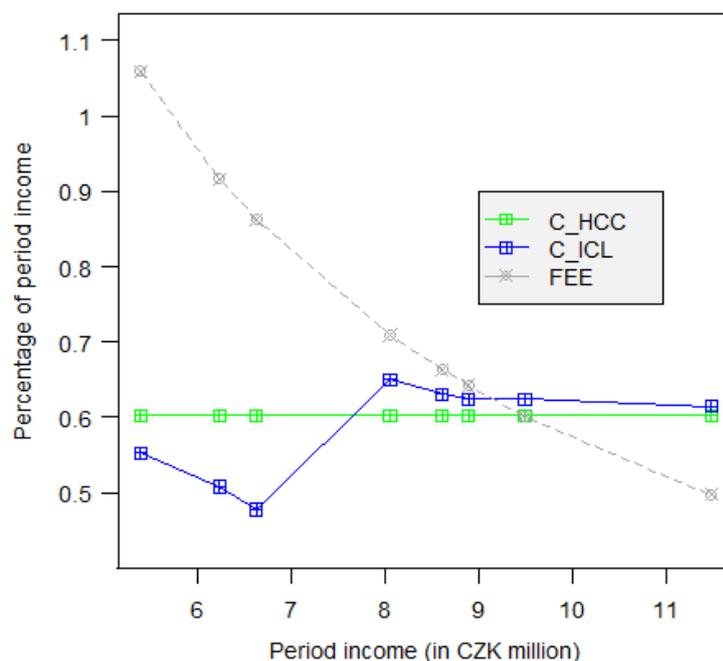
Source: Author's computations. Implied contribution to INV varies across the income groups and there is great amount of similarity between contributions from HCC and ICL. The higher the income group, the higher the contribution.

Table 6.6: PRR across groups and methods

Group	PRR_{basic}	PRR_{sc}
Undergraduates	5.2%	8.3%
Graduates	8.2%	9.5%

Source: Author's computations, using EU-SILC data. Assumptions: $t \in \langle 22, 65 \rangle, \langle 24, 65 \rangle$ and $dur = 3$ or 5 for undergraduate and graduate students respectively, $r = 2\%$, $\gamma = 0$, $C_t = 20,000$.

Figure 6.4: Contributions to INV as percentage of prime-age earnings



Source: Author's computations. There is a great portion of proportionality in HCC and ICL schemes. On the other hand, classical tuition fees are highly regressive.

ferent amounts of contributions resulting from these investments) the sensitivity analysis of short-cut version of PRR was conducted. The results are written in Table 6.7. The table shows that gradual increase of annual payments in order of thousands has generally very low effect on the PRR_{sc} . Undergraduates show a bit higher sensitivity than graduates due to lower earnings premium. However, with additional annual costs of 5,000 CZK which is an “upper cap” to payments obtained in Table 6.3, undergraduate students loose 0.6 percentage points while graduate students loose only 0.3 percentage points of rate of return.

Income-contingency schemes are of course not without risk. To assess price of this risk (or equivalently to estimate the cost of income-contingency) one may compare annual installments Ω^* (calculated under pooled conditions) with installments from a hypothetical scenario without a default (i.e. for $\mu = 1$ in Equation 6.5) - Ω^{rf} . This is shown in Table 6.8. The table suggest that at each 1CZK spent on annual installment, there is connected price of risk of 0.55 and 0.27 respectively which are due to the insurance costs.

Table 6.7: Sensitivity of PRR_{sc} with respect to annual contributions

Annual installment	PRR graduates	PRR undergraduates
0	9.5%	8.3%
1,000	9.4%	8.1%
2,000	9.4%	8.0%
3,000	9.3%	7.9%
4,000	9.2%	7.8%
5,000	9.2%	7.7%
6,000	9.1%	7.5%
7,000	9.0%	7.4%
8,000	8.9%	7.3%
9,000	8.9%	7.2%
10,000	8.8%	7.1%
11,000	8.7%	6.9%
12,000	8.6%	6.8%
13,000	8.6%	6.7%
14,000	8.5%	6.6%
15,000	8.4%	6.5%

Source: Author's computations, EU-SILC data. Assumptions: $t \in \langle 22, 65 \rangle, \langle 24, 65 \rangle$ and $dur = 3$ or 5 for undergraduate and graduate students respectively, $r = 2\%$, $\gamma = 0$.

Table 6.8: Annual payments and their risk profile

Par.	Value	$\Omega_x^*/\Omega^{rf} - 1$	Note
Ω^{rf}	2,783		
Ω_1^*	4,318	0.55	Floating cap
Ω_2^*	3,548	0.27	Fixed cap at 20,000CZK

Source: Author's computations, EU-SILC data. Assumptions: $t \in \langle 22, 65 \rangle, \langle 24, 65 \rangle$ and $dur = 3$ or 5 for undergraduate and graduate students respectively, $r = 2\%$, $\gamma = 0$.

Chapter 7

Discussion of results

This chapter discusses results obtained in Chapter 5 and Chapter 6. Some results are also put together with findings from Chapter 4.

Results of efficiency analysis suggest that Czech public HEIs obtain good results in teaching while they perform poorly in research. Interestingly, many of those universities which perform well in research also perform well in teaching - an opposite statement is however not necessarily a correct one. These findings thus go in line with the ideas of reform discussions that institutions should be officially divided according to their main purpose into teaching- & research-oriented and teaching-oriented. Reorganization of current financing scheme should also be made so that teaching-oriented HEIs would be rewarded for research probably in a less scale than nowadays. Another version is that local universities, because of regional nature of many, would be awarded for local/regional activities or research but not for global activities. This is another implication of findings from above.

It should be nevertheless admitted that the framework suggested for the analysis is one of the first steps in the field in the context of the Czech Republic. Calculations of efficiencies in teaching and research are quite original, especially in the first case. Moreover, the results could not be compared with any relevant source because, to the author's best knowledge, there does not exist any similar study with such a scope. The robustness of these results therefore still remains an issue.

It should be also noted that with respect to common institutional framework, only Czech universities were considered. Thus the reference (of best practice) is located in the sample. But this reference of best practice might not be an optimal one, its performance is only the best out of all universities

considered. Efficiency scores could thus easily fall globally if an efficient institution (possibly from abroad) was incorporated. The pitfalls of measuring efficiency in the context of university sector were also commented in Chapter 2.

As for the private financing scheme, the results have validated those obtained by Vandenberghe & Debande (2008). Similarly to the authors, both ICLs and HCC instruments work well in their indexation towards lifetime income. The analysis also showed that payment scheme and designation of loans should be accommodated to different lifetime earnings. As was shown in Chapter 4, there are basically two groups with different earnings. In the group of high-earners there are graduates of law, economics or natural and technical sciences while the the group of low-earners consists of graduates from social sciences, cultural studies, education or agriculture. The analysis of income has also shown that there are income differences across sexes or residency in and outside of Prague. Such income inequalities should be treated by an ideal financing system. As was also shown, students decide about their future studies on a highly diverse basis across fields of study. It can be thus concluded that students form a very heterogeneous group which needs to be treated accordingly in a new financing system considering private contributions.

The PRR obtained was 8.3% and 9.5% for undergraduate and graduate studies respectively using short-cut method of PRR calculation. The results lie at the upper boundary of results of Vandenberghe & Debande (2008) who calculate PRR of graduates (not specified) in Germany to be 8.8%, UK 6.8% and Belgium 4.7% using the same method. Such comparison implies that higher education in the Czech Republic is very well rewarding and could be attractive also for private investors. Also, similarly to Vandenberghe & Debande (2008), the PRR has shown a low sensitivity towards rising contributions which suggests low cost of private financing.

Chapter 8

Conclusion

This thesis touched the problem of financing public higher education and estimating its efficiency.

Theoretical part studied several topics regarding HE sector: theory, financing, quality and experience from foreign countries. Theory part showed examples of incorrect beliefs about higher education, Trow's concept of transition from elitist to universal system and original idea of university. Theoretical benefits of private vs. public financing were explained. Investments into human capital are however subject to several market failures mainly due to liquidity problems and lack of collateral. Thus key concepts of private financing were pointed out.

The chapter then continued by introducing several concepts of income-contingency schemes in their broad perspective (i.e. covering graduate taxation, ICLs and HCC). However, because financing is closely related with quality, the latter has been briefly discussed. The results of this discussion is that the concept of quality is highly elusive and it is hard to define it. Governments nevertheless need quality indicators which are criticized by the academics. The reason is that the sector, which has been traditionally academically free from strict monitoring, is becoming to be controlled not differently from any other business organizations. While the monitoring is surely important, it is of question whether the impact on efficiency does not destroy academic spirit. This was part of criticism of quality regimes.

The analysis of the Czech public HE sector revealed that the sector is underfinanced compared to average expenditures in the OECD and that share of students of economics or social sciences has been rising on the account of technically or educationally oriented studies. There is great variation across

graduates' wages as well as students' priorities across fields of study which should be taken into account in case of private financing. The section also notices that, besides special editions of nationally published journals, there is no good source of information which would allow students to choose their field of study on a better informed basis. Data exists but they are scattered around different sources.

The empirical part studied efficiency of Czech universities and possibility of private financing.

The efficiency part has shown that most Czech universities are teaching efficient while only few are research efficient. It is thus questionable whether rewarding for research in some of the Czech HEIs is a good practice. Furthermore, those HEIs which were research efficient were also teaching efficient.

The private-financing part suggests that the idea of private financing is not impossible to realize. In case of investment of 5,000 CZK per semester, students would pay only 0.6% of their total prime-age earnings (earlier defined as earnings between 24th and 49th anniversary) under HCC scheme, or around 3,548 CZK annually under ICL scheme with fixed cap of 20,000 CZK. The limit of 20,000 CZK is followed with higher contributions than the limit set by average wage of secondary educated individuals. Accompanying analysis also showed that private rate of returns is 5.2% and 8.2% for undergraduate and graduate studies respectively. Unfortunately, nothing certain can be said about the final impact on quality of the education or even quality of graduates' lives.

Lastly, but not the least, this thesis has also investigated the reform discussions between 2009 and 2012. It is somewhat disappointing that the reform, which was costly both in terms of funds, effort and time was not implemented. There was probably not single reason of its rejection. It was rather mix of several features, one of them being worries about future quality, another one being improper communication between politics and their voters. However, I believe that the reform is still relevant, thoroughly elaborated, and it could be resurrected easily if properly managed and communicated with all the respect towards academia, future students and their parents. Of course, protests can be expected; it seems that they are just natural part of any process of changes.¹

¹ *"in early 1990s lots of people said oh this is awful we're not doing it you know it's just we, don't need to do it . . . I suppose any system, once you introduce a new system, people find it difficult at first and then you get used to it, it becomes natural and it just becomes part of what you do so. (Senior assistant registrar in an pre-1992 university)"* Source: Filippakou (2011)

I believe that the thesis has contributed well by shedding new light onto understanding of HE sector and its current trends equally in theoretical as well as empirical part. The literature has been collected from multiple sources and provides broad overview of the sector. Current policy makers can also be inspired by the methodological approach in DEA efficiency assessment. Assuming existence of relevant data, the approach may be included in current evaluation methods in the education sector (thus not only universities, but also secondary schools). The private funding analysis is somewhat coarse as it does not go into detail. It however delivers some interesting remarks: (i) paying tuition fees using pure loans (i.e. without income-contingency) is highly regressive and thus the idea should be abandoned; (ii) there is great variation in prime-age income even within the group of graduates, the implications for policy are such that these income groups should be treated differently; and (iii) both ICLs and HCC provide with proportional payments across different income groups.

The thesis is limited in its scope, thus there are many possible steps for the future research. One possibility is to obtain data by faculties (either from SIMS or MSMT) and analyze efficiency across fields (similarly to Flégl & Vltavská (2013) who analyze faculties of economics). A good research may emerge from the use of SVP data on graduate's wages and study economic benefits of studies. The private funding scenario can also be extended by developing professional financial model which would treat contributions and risks in much greater focus. The model would serve as an alternative to already existing financial model developed by MSMT during planning period of reforms. However, it is of question whether such effort would be appreciated by current government officials, which have already declared their vows against introduction of tuition fees.

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Appendix A

Technical appendix

Figure A.1: Results of OLS regression of lifetime income prediction - bachelors

```
Call:
svyglm(formula = Income ~ VEK + VEK2, design = regdesignBA)

Survey design:
svydesign(id = ~1, weights = silc$koef[BA], data = silc[BA, ])

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) 108232.23  147121.78   0.736   0.463
VEK          8833.18    7888.88   1.120   0.264
VEK2         -74.87    101.98  -0.734   0.464

(Dispersion parameter for gaussian family taken to be 25987889604)
```

Source: R software.

Figure A.2: Results of OLS regression of lifetime income prediction - masters

```
Call:
svyglm(formula = Income ~ VEK + VEK2, design = regdesignMA)

Survey design:
svydesign(id = ~1, weights = silc$koef[MA], data = silc[MA, ])

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -501707.37  108109.32  -4.641 3.86e-06 ***
VEK          44052.18    5413.56   8.137 1.02e-15 ***
VEK2         -484.23     62.08  -7.800 1.36e-14 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Source: R software.

Figure A.3: Results of OLS regression of lifetime income prediction - secondary education

```
Survey design:
svydesign(id = ~1, weights = silc$koef[secondary], data = silc[secondary,
])

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -42855.50   30885.30  -1.388   0.165
VEK          16291.50    1638.55   9.943  <2e-16 ***
VEK2         -187.66     19.92  -9.419  <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Source: R software.

Figure A.4: Results of OLS regression of lifetime income prediction - bachelors (detailed)

```
Call:
svyglm(formula = Income ~ VEK + POHL + PRAHA, design = regdesignBA)

Survey design:
svydesign(id = ~1, weights = silc$koef[BA], data = silc[BA, ])

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  370750      69290   5.351 0.00000209 ***
VEK           3020       1212   2.492   0.0134 *
POHL        -108476     24624  -4.405 0.000016113 ***
PRAHA        52909      51169   1.034   0.3022
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Source: R software.

Figure A.5: Results of OLS regression of lifetime income prediction - masters (detailed)

```
Call:
svyglm(formula = Income ~ VEK + VEK2 + POHL + PRAHA, design = regdesignMA)

Survey design:
svydesign(id = ~1, weights = silc$koef[MA], data = silc[MA, ])

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -273943.0   105403.3  -2.599 0.009467 **
VEK          42226.2    5208.3   8.108 1.29e-15 ***
VEK2         -466.9     59.7   -7.821 1.17e-14 ***
POHL        -144393.4   17428.5  -8.285 3.21e-16 ***
PRAHA        97866.2    26937.5   3.633 0.000292 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Source: R software.

Figure A.6: Results of OLS regression of lifetime income prediction - secondary education (detailed)

```
Call:
svyglm(formula = Income ~ VEK + POHL + PRAHA, design = regdesignSec)

Survey design:
svydesign(id = ~1, weights = silc$koef[secondary], data = silc[secondary,
])

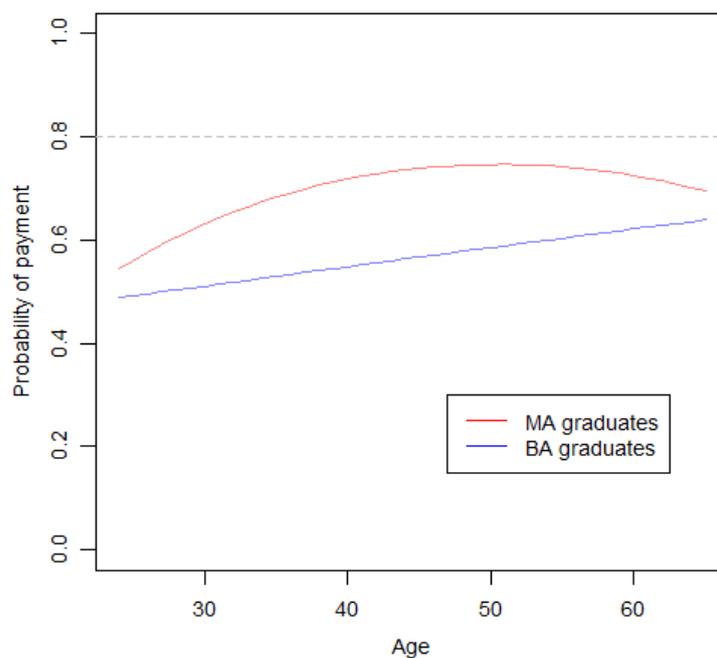
Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) 378740.9    13179.8   28.736 < 2e-16 ***
VEK           968.0       252.5    3.833 0.000129 ***
POHL        -90200.1     6405.0  -14.083 < 2e-16 ***
PRAHA        29182.9     12517.8    2.331 0.019801 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Source: R software.

Appendix B

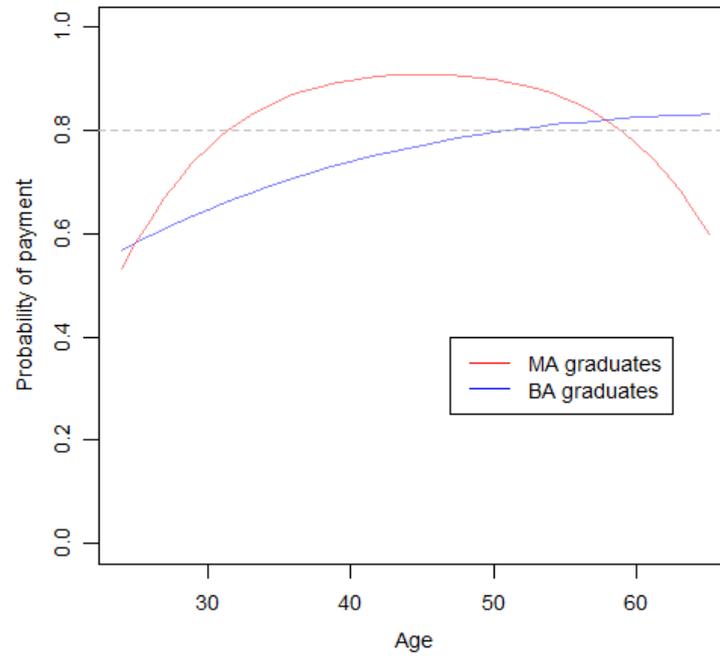
Private funding - supplementary charts

Figure B.1: Probability of payment, floating threshold



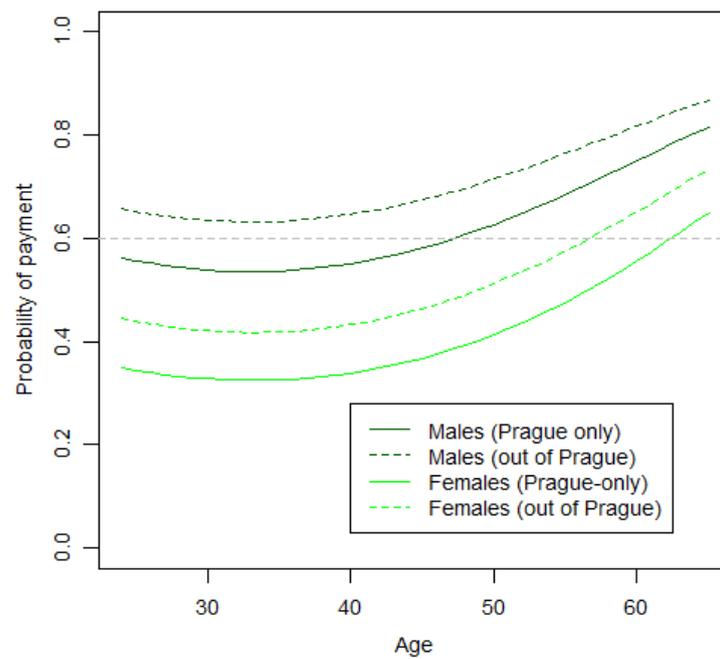
Source: Author's computations.

Figure B.2: Probability of payment, fixed threshold (20,000 CZK)



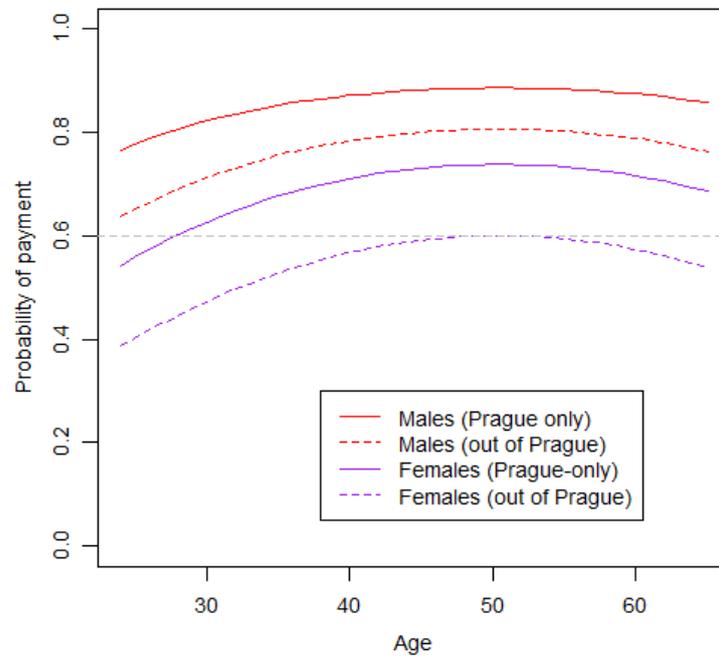
Source: Author's computations.

Figure B.3: Probabilities by groups of BA graduates at floating threshold



Source: Author's computations.

Figure B.4: Probabilities by groups of MA graduates at floating threshold



Source: Author's computations.

Appendix C

Financing scheme in brief

This section describes institutional part of current financial scheme in a detailed manner. The goal is to provide the reader with understanding. Several details, which are more technical than central are thus omitted. The system is rewritten using mathematics to provide balance between parsimony and exactness.

The budget of a particular calendar year, *Budget*, consists of 4 parts, so-called budget circuits, *BCs*.¹

$$Budget = BC_1 + \dots + BC_4 \quad (C.1)$$

The first budget circuit, BC_1 is of main importance and thus it is described in more detail after this paragraph. The second budget circuit, BC_2 , is used for support to students by providing study grants to doctoral students, accommodation and catering subsidies to students and social stipends. BC_3 part of budget is used for development of educational activities and institutional plans. Finally, BC_4 serves for financing other activities of universities (international activities, university of third age, third party activities, etc.)

BC_1 (the institutional part) breaks down into A , an indicator of number of students, and K , a performance indicator.

$$BC_1 = A + K \quad (C.2)$$

To obtain number of students available for financing needed at a particular university, S , number of students S' as of 31st October of year $t - 1$ is compared

¹The terminology draws from MŠMT (2014).

to the limit L calculated by ministry or alternatively set at bilateral discussions with HEIs. The limit L , for groups $G = B1, M1, N1, P1$ ($B1 =$ first-year bachelors, $M1 =$ first-year masters (short-term), $N1 =$ first-year masters (long-term), $P1 =$ first-year doctoral students, $SP2+ =$ other students) in time t , makes use of two variables: (i) number of students available for financing in previous years, $S_{G,t-1}$, and (ii) a version of performance indicator PI set on purpose for the A indicator (do not interchange with K). The number is implicitly calculated as follows:

$$L_{G,t} = \left[\alpha S_{G,t-1} + (1 - \alpha) \left(\sum S_{G,t-1} \right) \frac{PI_{G,t-1}}{\sum PI_{G,t-1}} \right] (1 - U_G) \quad , \quad (C.3)$$

where α is given (for B1, $\alpha = 0.95$, for M1,N1, $\alpha = 0.9$, for P1, $\alpha = 0.8$)², $\sum S$ is sum across all institutions (similarly for $\sum PI$), and U_G is standardized rate of unemployment of students of given university.³

Final number of students available for financing is done in the following conditional way:

$$S_{G,t} = \begin{cases} L_{G,t} & \text{if } S'_{G,t} \geq 0.9 \cdot L_{G,t} \\ S'_{G,t} + 0.1 \cdot L_{G,t} & \text{otherwise} \end{cases}$$

for groups $G = B1, M1, N1$ and $P1$. The first condition serves as an insurance against overcrowding, second condition serves as a safe net for those universities which experience sudden fall in applications from students. The dynamics of this process are such that with increasing PI , universities are provided with higher $L_{G,t}$, while opposite is true for those universities with low K . For group $G = SP2+$, the equation is.

$$S_{G,t} = \begin{cases} L_{G,t} & \text{if } S'_{G,t} \geq \cdot L_{G,t} \\ S'_{G,t} & \text{otherwise} \end{cases}$$

Universities are then rewarded for number of normative students S^* . The number is obtained weighting S using CFSC to reflect costs associated with studies (see Table C.1) for each level of studies:

²Methodology for SP2+ group is based on throughput of B1,M1,N1 and P1 groups in historic years.

³If U exceeds some specified level, this numbers is then applied globally. The levels is set at 7% for B1 group, at 5% for M1 and N1 groups, and at 0% for P1 group.

$$S^* = \begin{pmatrix} B1 & M1 & N1 & P1 & SP2+ \end{pmatrix} \cdot \begin{pmatrix} k1 \\ k2 \\ k3 \\ k4 \\ k5 \end{pmatrix}, \quad (\text{C.4})$$

where $k1 \dots k5$ are included to stress weighting by CFSC, thus they are results of weighted average of CFSC for each group.

Table C.1: Coefficients of field of study

Field of study	CFSC
Humanities, Economy	1.00
Philosophy, Education	1.20
Technology	1.65
Agriculture, Forestry	2.25
Chemistry, Medicine	2.80
Veterinary medicine, Stomatology	3.50
Arts	5.90

Source: Koucký (2012).

A university i then obtains funds A_i as

$$A_i = \frac{S_i^*}{\sum_i S^*} * F_A$$

where F_A are funds available for BC_1 . Share of these funds was 77.5% of BC_1 in 2014.

Calculation of performance indicator, K , consists of evaluation of 11 factors divided into three main areas: performance, quality, and international mobility. The relative importance of these aspects are presented graphically in Figure C.1 and in Table C.2 in detail. Furthermore Figure C.2, Figure C.3 and Figure C.4 graphically presented share of these factors within their category.

K indicator made in 2014 22.5% of BC_1 . Funds which are given to university for a particular indicator can be obtained by multiplication of total amount of funds, K , by the relevant percentage from Table C.2 and furthermore multiplied by share of the university in the pool of universities in the particular indicator.

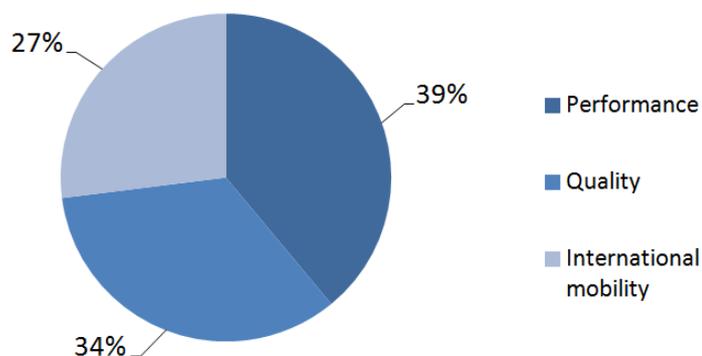
inflow of funds from indicator = $K \cdot (\text{indicator share on } K) \cdot (\text{share on pool})$

Table C.2: Breakdown of performance indicator K

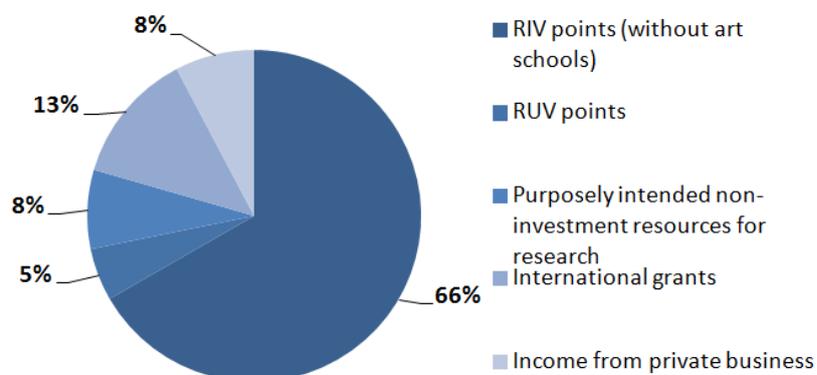
		% in K	% in BC1
Performance	RIV points	26%	5.9%
	RUV points	2%	0.5%
	Purposely intended non-investment resources for research	3%	0.7%
	International grants	5%	1.1%
	Income from private business	3%	0.7%
	Quality	Number of professors and docents	2%
	Employability of students	32%	7.2%
International mobility	Number of foreign students	2%	0.5%
	Privately financed programmes	3%	0.7%
	Students dispatched in mobility programmes	11%	2.5%
	Students accepted in mobility programmes	11%	2.5%

Source: MŠMT (2014).

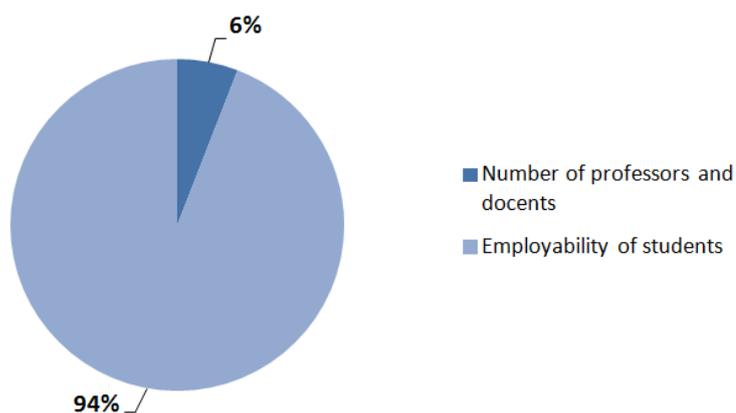
Figure C.1: Breakdown of indicator K



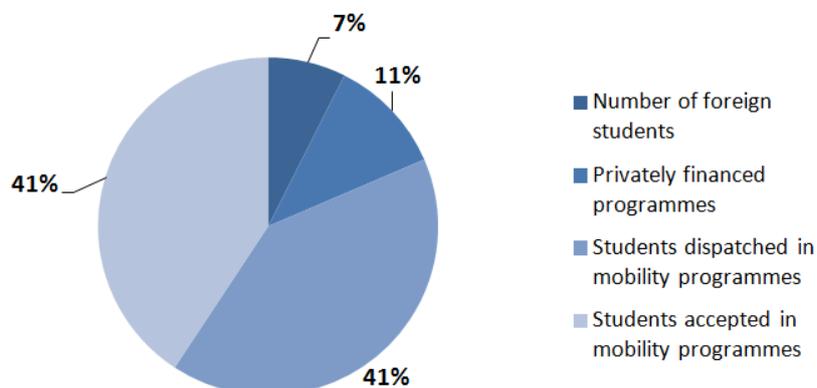
Source: MŠMT (2014).

Figure C.2: Breakdown of performance part of indicator K 

Source: MŠMT (2014).

Figure C.3: Breakdown of quality part of indicator K 

Source: MŠMT (2014).

Figure C.4: Breakdown of international mobility part of indicator K 

Source: MŠMT (2014).