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BACHELOR THESIS

Why should the Czech Republic reform its current policy of financing higher education?

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Declaration of Authorship

The author hereby declares that she compiled this thesis independently, using only the listed resources and literature. This thesis was not used to obtain another academic degree.

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Prague, May 14, 2014

Signature

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Abstract

The Czech Republic has traditionally financed higher education out of general taxation and in the form of *per capita* funding. This system has led to inefficient allocation of funds, long-term underfunding and decreasing quality of education. We present three alternative financing schemes which rely on larger contribution from students: pure student loan, risk-sharing income-contingent loan and risk-pooling income-contingent loan. By using a theoretical model and calibrating it to the Czech reality, we show that financing schemes have significant impact on higher education participation and the quality of accepted students. While pure loan and risk-pooling induce optimal participation, international experience suggests that risk-sharing is the more feasible option.

Keywords	Financing schemes for higher education, tax-subsidy funding, income-contingent loans, higher education participation

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Abstrakt

Česká republika financuje vysoké školství tradičně ze státního rozpočtu a ve formě dotací na studenta. Tento systém způsobil, že zdroje nejsou alokovány efektivně, vzdělání je dlouhodobě podfinancováno a jeho kvalita se snižuje. Práce se věnuje třem alternativním způsobům financování: prosté studentské půjčce, tzv. příjmem podmíněné půjčce typu risk-sharing a příjmem podmíněné půjčce typu risk-pooling. Na základě teoretického modelu a jeho kalibrace na českou skutečnost ukazujeme, že způsob financování má významný vliv na počet a kvalitu studentů vstupujících na vysoké školy. Zatímco čistá studentská půjčka a půjčka typu risk-pooling vedou k optimální účasti, na základě mezinárodní zkušenosti se zdá být přijatelnější půjčka typu risk-sharing.

Klíčová slova	Financování vysokého školství, daňová podpora, příjmem podmíněné půjčky, účast ve vysokém školství

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Bachelor Thesis Proposal

Author	Pavlína Kadlecová
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Proposed topic	Why should the Czech Republic reform its current policy of financing higher education?

My thesis proposal The thesis will be concerned with financing higher education, with a particular focus on the Czech Republic. At the beginning, a description of the development of funding higher education in the Czech Republic and possible areas for improvement will be given. The aim of the second part is to introduce alternative financing schemes and discuss how successful they have been on the international level. The third part analyses the effects of different financing systems on the participation in higher education and shows why tax-subsidy is not the optimal scheme for the Czech Republic. The data for this analysis is obtained from OECD and CZSO.

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Supervisor

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Acronyms

AUD	Australian dollar
CNB	Czech National Bank
CZK	Czech koruna
CZSO	Czech Statistical Office
ICL	Income-contingent loan
MEYS	Ministry of Education, Youth and Sports
OECD	Organisation for Economic Co-operation and Development
PBF	Performance-based funding
PL	Pure loan
RS	Risk sharing
RP	Risk pooling
TPO	Tuition Postponement Option
TS	Tax-subsidy

Chapter 1

Introduction

This thesis is written in the light of recent passionate debates over a new way of financing higher education in the Czech Republic. Higher education institutions have been financed out of general taxation and in the form of *per capita* funding since 1990s. In the last decade, however, two aspects of this approach have been questioned. First, the system allocating funds to universities according to the number of accepted students is criticised for creating the wrong incentives and causing an overall decrease in the quality of higher education. Second, tax-subsidy does not generate enough funds to cover the increasing demand, so higher education is constantly underfunded. Allocating more funds from the state budget is unlikely, because higher education competes with other social investments, such as compulsory education or health care, which are enjoyed the whole population.

These criticisms reflect a significant change in the perception of higher education which took place in the course of the past three decades. Instead of the notion of education as a service provided, controlled and financed solely by the government, it is now more often seen as a regular investment decision where the student is the investor who bears the risks. Indeed, even international institutions such as the OECD have begun to evaluate higher education returns by the net present value or the internal rate of return: instruments commonly used for equity investment. There are, nevertheless, crucial differences between investing in higher education and investing in equity. To recognise these differences, governments have introduced innovative ways of financing higher education. Finding out which of these schemes induces optimal participation level and maximum efficiency has been the subject of several economic papers

in the last decades.

The purpose of this thesis is to use these methods to find the optimal scheme for the Czech Republic. First, using statistical evidence from the OECD, we analyse the current state of Czech higher education and outline areas in which the Czech Republic lags behind its international competitors. In particular, we look at the increasing entry rates into higher education institutions, inefficiencies in the allocation of funds and general underfunding. We then outline the main features of three alternative financing schemes used internationally: a pure student loan and two types of income-contingent loans, risk-sharing and risk-pooling. In addition, we describe several forms of uncertainty associated with investing in higher education.

Under the assumption of perfect capital markets and rational individuals, we then introduce a model with wage, ability, cost of education, and probability of success to find the most efficient financing scheme. We compare threshold ability levels for each scheme and prove that tax-subsidy has the lowest acceptance requirements on higher education applicants. We find that participation is optimal for pure loan and risk-pooling, but excessive for both tax-subsidy and risk-sharing. Because efficiency is not the single criterion to be taken into account, the optimal scheme is then discussed in relation to other important areas, such as equity, moral hazard and adverse selection. We show that tax-subsidy is neither optimal nor sustainable in the long-term and advocate the implementation of risk-sharing as an alternative. In addition, we outline areas which need to be considered in order to make a successful reform.

The thesis is organised as follows: chapter 2 provides an overview of fundamental literature regarding the main topics of our analysis. A brief summary of funding higher education in the Czech Republic and main problems associated with it are presented in chapter 3. In the following chapter we describe main features and provide examples of a pure loan and income-contingent loans. Chapter 5 is devoted to the introduction and derivation of the model which we calibrate in chapter 6. Finally, chapter 7 concludes the work.

Chapter 2

Literature Review

There are two major streams of literature particularly relevant to this paper. The first, practical one, is focused on the Czech Republic and involves mainly empirical studies, historical reviews and practical recommendations. The second one discusses the main features of alternative financing schemes and their international applications. Finally, the third - theoretical - one consists of studies discussing different ways of modelling these schemes and attempting to find the optimal one.

2.1 Focus on the Czech Republic

Because the first one is fairly narrow and often more sociological than economic, it is less emphasized in the thesis. It includes, however, an important piece of work elaborated by Koucký (2013) who provides a critical analysis of the historical development of higher education funding in the Czech Republic. Analysing the Czech annual expenditure in comparison to other European countries, the author gives reason for concern that tax-subsidy financing is not a long-term solution and opens the debate on the introduction of tuition fees. In the same year, Remotti and McAdory (2013) published an article particularly critical of the Czech higher educational system which they characterise as 'legislative limbo'. Whereas students protest against high tuition fees and privatization of higher education, the government is unable to find sufficient resources to fund public education. According to the authors, the defects in Czech funding will soon result in academic stagnation and Czech universities will fall behind international competitors. The main conclusion drawn from their analysis is that the Czech government cannot adequately support free

higher education and is of desperate need of alternative sources of funding.

Furthermore, Remotti and McAdory (2013) point out that funding based on student enrolment generally decreases the quality of education. In this aspect, they are in accordance with Čermáková Z and Urbánek (1994) who offered criticisms of 'formula funding' shortly after its introduction. Recent publications by MEYS (2010) acknowledge this fact but offer only vague solutions. Concrete alternatives which include the introduction of an income-contingent loan system are mentioned in (OECD, 2011) as well as (Ryška, 2009). Both sources provide valuable statistical evidence and comparison between the Czech Republic and other developed countries. Their results confirm that the Czech Republic should take an example from abroad and consider an alternative financing scheme.

2.2 Background of alternative financing schemes

The first propositions of such alternative schemes can be found in a 1955 article by Milton Friedman. The author is concerned with taxpayers paying for a service from which they do not directly benefit and suggests a scheme where students are not charged tuition fees, but agree to pay a fixed proportion of their future income (Friedman, 1955).

This idea has evolved into different directions. First, Garcia-Penalosa and Walde (2000) depart from the original idea and analyse the effects of a 'graduate tax' on participation and higher education efficiency. They find that a graduate tax is closest to the optimal case because it induces greater insurance, efficiency and equity.

A modified version of Friedman's propositions, where students effectively took a loan from the university and repaid back once their income exceeded a prespecified amount was introduced at Yale University in 1971. Because this was the first experiment of an income-contingent repayment, it provided valuable lessons for the future implementations of similar financing schemes. The effects of the Yale experiment are examined with a great detail in (Chapman, 2006) and (Lleras, 2007). We use the terminology by Chapman (2006) and consider four financing schemes: tax-subsidy, pure loan, risk-sharing income-contingent loan and a risk-pooling income-contingent loan. We follow Lleras (2007) to

comment on the qualitative issues associated with investing in human capital, such as fairness or sustainability, but depart from theoretical models to discuss efficiency.

2.3 Theoretical model for higher education financing schemes

The first version of the model we use was proposed by Garcia-Penalosa and Walde (2000). The authors focus on the insurance properties of three financing schemes - tax subsidy, income contingent loans, and a graduate tax. They evaluate these in respect to three policy targets: equality of opportunity, equality of lifetime incomes, and efficiency. Using a model where individuals differ in inheritance, the authors propose optimal participation levels that relate to these three targets and conclude that there is a trade-off between efficiency and equity. While the social optimum implies that everyone studies, full participation is not efficient for the economy, because both skilled and unskilled labour force is essential for production. The authors also examine several issues associated with general taxation such as reverse redistribution and overeducation. As would outlined in the preceding section, they propose the implementation of a graduate tax where former students agree to pay a proportion of their income to the state budget.

A similar conclusion is reached by Rey and Racionero (2010). whose analysis is focused on the insurance role of financing schemes and assumes an economy with no externalities. However, these authors consider individuals who differ in their ability to accumulate human capital. This modification has fundamental implications for our discussion, because it allows to study the effects of financing schemes on the participation in higher education. For each scheme, Rey and Racionero (2010) determine a threshold ability level, above which it is optimal for an individual to study. They also propose an optimum threshold ability level for the whole economy which defines the ideal participation. We follow the same technique to calibrate the model to the Czech reality.

Taken as a whole, it appears that although much has been written about higher education in Czech Republic as well as the theoretical side of funding, the connection between the practical and analytical area has not yet been

well developed. Hopefully, this thesis will provide a good basis to undertake further analysis of the financing situation in the Czech Republic. One area which may require further research is the choice of the measure of ability. This thesis takes the IQ test scores as a proxy for ability, but General Comparative Examinations might be a more appropriate alternative if they continue to be used on an increasing number of schools. Further research could be also done on the effects of graduate overeducation or in the area of practical implementation of income-contingent loans.

Chapter 3

Financing higher education in the Czech Republic

3.1 Introduction

For policymakers anywhere in the world, striking the right balance between providing sufficient support to higher education and maintaining efficiency is challenging. This decision influences the state budget and shapes to a large extent the amount of students who will enrol in higher education. Both for students and for the government, investment in education is associated with a large degree of risk and uncertainty. In addition, factors such as social values and the country's history have to be taken in account.

3.2 Per capita funding

The Czech Republic has traditionally financed higher education out of general taxation. Until the end of communist era in 1989, Czech education system had been controlled by Central authorities with student participation planned according to the forecasted development of the Czech economy (Koucký, 2013). After the change of the regime, participation in higher education began to increase gradually. On one hand, young people benefited from new opportunities. On the other, the Ministry of Education introduced *per capita* funding, *i.e.* financing universities according to the number of students they accept. This reform encouraged higher participation in tertiary education and the trend continued until 2011. Figure 3.1 shows the increasing entry rates in the Czech

higher education in 2000-2011.[1] A detailed table of tertiary entry rate, provided in the Appendix, shows that although the current entry rates are at the OECD average, the dynamics have been much larger than in other OECD countries.

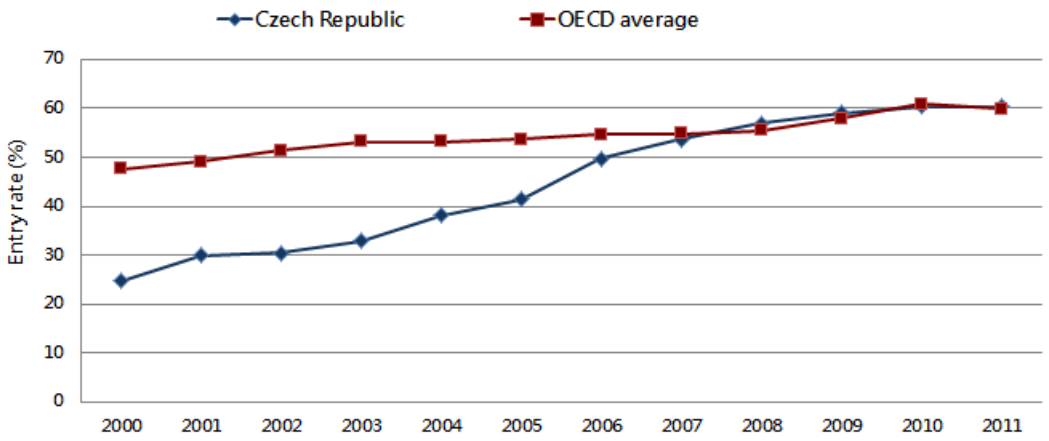


Figure 3.1: Trends in higher education entry rates (2000-2011)

Source: Author based on (OECD, 2013), see Figure C.1 in Appendix C for the original table.

Per capita funding has one key undesirable outcome. It encourages universities to accept as many students as they can manage instead of directing their funds and energy towards quality teaching. As a result, there is a pressure to reduce requirements on acceptance, and so the quality of students degrades as well as the quality of education.

Even though this danger was already discussed in (Čermáková Z and Urbánek, 1994), no practical measures were taken until 2009 when 9% of the state funding became 'performance based' (PBF) and thus reflective of the university quality (Koucký, 2013). Since 2012, several new mechanisms to increase competition were introduced; the share of the PBF increased to 20% and quality parameters such as students' evaluations were taken as criteria (MEYS, 2011). Other measures are planned in the strategic priorities (MEYS, 2010) which also call for changes in the funding of higher education. The main problems of Czech funding are the inefficient allocation of funds and continuous underfunding.

[1]Entry rate is the 'proportion of people who are expected to enter a specific tertiary education programme during their lifetime' (OECD, 2013, p. 292)

3.3 Efficiency problems

Even though there is a trend to increase efficiency and competition, the changes are too slow and too subtle. As suggested bz Lleras (2007), governments need to shift financing from universities to students if they want to allocate funds more efficiently. This translates mainly into the provision of grants and scholarships which motivate students and widen access to education for those coming from low-income backgrounds, *i.e.* ensure equity. In the Czech Republic, an overwhelming majority of funding still goes directly to higher education institutions. Figure 3.2 shows that this situation is fairly anomalous at the OECD level; no other OECD country devotes such little share of expenditure to grants and scholarships.

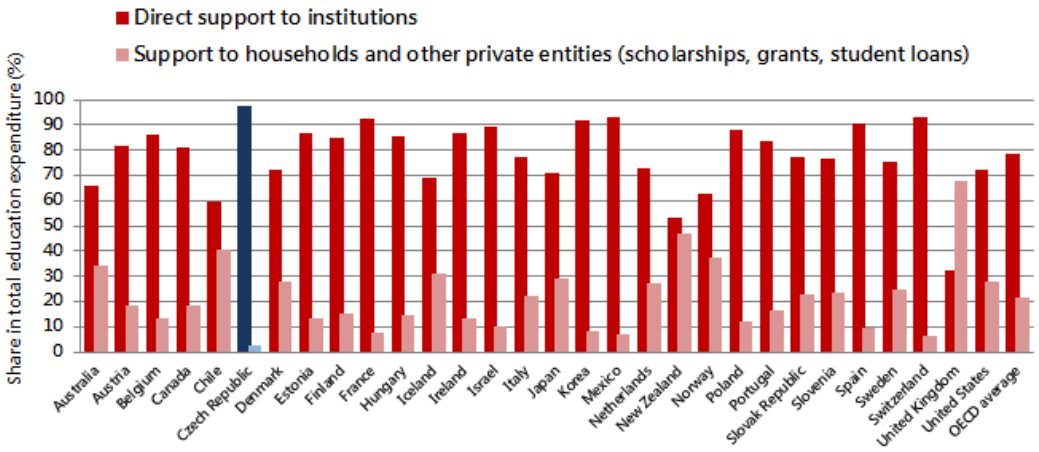


Figure 3.2: Public support for households and other private entities as a percentage of total public expenditure on education (2010)

Source: Author based on (OECD, 2013), see Figure C.2 in Appendix C for the original table.

3.4 Underfunding

However, even a better allocation of government funds and the introduction of mechanisms of competition does not fully resolve the problem of unsustainability. Figure 3.3 shows that the Czech Republic has very low expenditure on higher education in proportion to its GDP. This leads to long-term underfunding of the core services and the ancillary services such as accommodation facilities (Pabian et al., 2006).

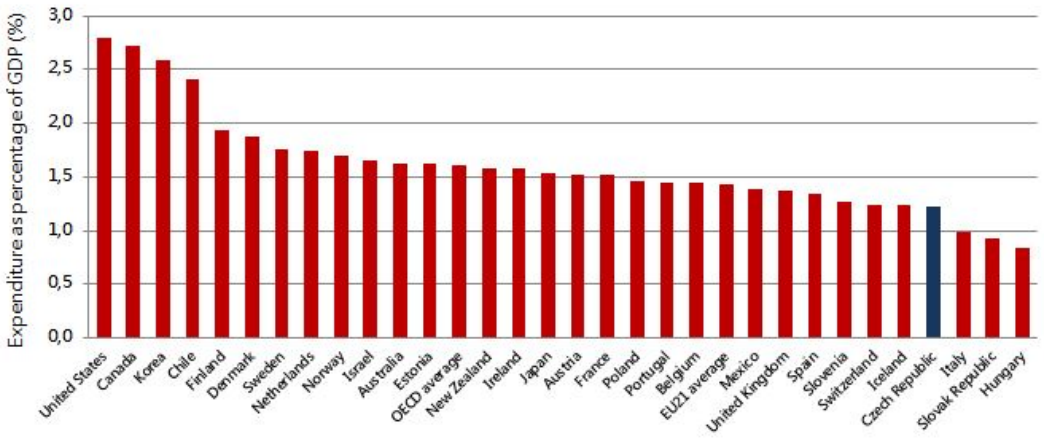


Figure 3.3: Expenditure on tertiary educational institutions as a percentage of GDP (2010)

Source: Author based on (OECD, 2013), see Figure C.3 in Appendix C for the original table.

3.5 Criticism

The problems above have been acknowledged on both international and domestic grounds. The OECD warned against inefficiencies and the 'over-reliance on public resources' in 2009 (OECD, 2009, p.43), the issues were discussed also in public media. In a 2012 article particularly critical of the Czech financing policies, Remotti and McAdory (2013) discuss the Czech 'legislative limbo', where students protest against tuition fees, but the government in unable to adequately support higher education. They conclude that unless at least modest student contributions are introduced, Czech universities will fall behind international competitors.

Fortunately, the awareness of these problems increases also in the Czech Republic. In 2010, The Ministry of Education elaborated a *Strategic Plan for 2011-2015* which explicitly calls for a change in funding and characterizes the existing rules as 'outdated' and having 'no rationale' (MEYS, 2010, pp. 25-26). First concrete attempts to find an alternative system were proposed in *White Paper on Tertiary Education* and tuition fees were subject to discussion during the governance of every education minister in the course of the last few years. Even though a detailed discussion of the political propositions would be both relevant and useful, the material would be sufficient to form a whole additional thesis. It suffices to say that overall reactions have been typical to

anything new and without precedent. Negative public opinion and the reluctance of politicians to take unpopular measures caused that every proposition has eventually been rejected and the situation remained stagnant.

From a great part, these reactions have been caused by hasty and poorly thoughout propositions on one hand and public misapprehension on the other hand. For this reason, we first offer a theoretical background to the topic and then look at lessons we can learn from systems used in other developed countries. We then attempt to find the most efficient scheme for the Czech reality. Our concluding discussion is based on efficiency as well as other criteria mentioned throughout the thesis, which are critically important to defining the optimal scheme for the Czech Republic.

Chapter 4

Alternative schemes for financing higher education

4.1 Shift from public to private support

When other countries found themselves in the similar condition as the Czech Republic, *i.e.* unable to sustainably finance higher education and maintain its quality, they began exploring alternative sources of funding. Findeisen and Sachs (2012) examine that the structure of higher education finance differs greatly across countries. On the one hand, Denmark, Finland or Sweden have very generous public subsidies for higher education and their university students pay low or none tuition fees. These subsidies are financed from highly progressive tax systems.

By contrast, high tuition fees are charged in the United States or the United Kingdom where the main part of educational costs lies on students themselves. These countries highlight individual benefits of education and see the student as a private investor. Nevertheless, governments subsidize higher education even there, where the emphasis is put on private financing. This happens because investing in education is fundamentally different from, for example, equity investment. To illustrate different forms of uncertainty, Barr (2001, Chapter 11) and Lleras (2007, Chapter 2) compare the individual's decision to pursue higher education with the decision of buying a house. The author outlines the main point as follows:

Unknown benefits

While equity investors usually have a clear idea of what a house looks like and what feature it should have, students do not have a first-hand experience with higher education studies and so they may not know exactly what to expect from it. This is particularly true when it comes to students from low-income families who do not have a direct role model (Lleras, 2007).

Uncertain value

Whereas a house is unlikely to fall down, the value of a student's education might. If too many people choose one particular field of study, the labour market might become saturated and graduates forced to work in a completely different area. In the Czech Republic, this is the case of over 20% of gradates, according to REFLEX 2010 expertise study by Zelenka, M. and Ryška, R. (2011).

Illiquid investment

In case the graduate finds herself in a financial distress and unable to make repayments on her loan, she could sell a house. She cannot however, sell education once it has been acquired[1]. This is associated with the fact that human capital cannot serve as collateral.

On the other hand, those who provide funds for education (government or private investors) also face substantial risks among which we shall mention two.

Asymmetric information

While the value of a house can be easily determined by an external authority, students themselves know the best their capabilities, ambitions and intended career paths (Lleras, 2007). This phenomenon, known as imperfect or asymmetric information, produces the problem of adverse selection. Because lenders have less information than the borrowers, they will charge risk premiums to cover this uncertainty which results to inefficiencies in lending (Barr, 2001).

[1]In this thesis, we refer to one student as 'she.' This pronoun is not meant to be restrictive and is used only to avoid any confusion associated with using 'he/she' or 'they.' It also accounts for the fact that a majority of Czech university students are female.

Absence of collateral

The investors face higher risk because education or human capital cannot serve as collateral. This is creates further pressure on increasing risk premium and thus makes loan less desirable to students.

Because of these reasons, commercial mortgage-type loans are not suitable for the majority of students. If no other funds are available to students in need, the situation results in a 'capital market failure' with inefficient investment in education (Jacobs and van Wijnbergen, 2007). As a result, countries that have left behind the idea of funding purely from the tax revenue and introduced tuition fees, proposed three alternative financing schemes which shall be discussed and analysed in this thesis. These can be divided into types - pure loans and income-contingent loans.

4.2 Pure loans

Pure loans are in fact very similar to regular commercial loans. They are, however, either supported or directly provided by the state at advantageous terms. As a result, students can obtain funds despite problems such as the absence of collateral or asymmetric information. In turn, they do not have to pay a high premium and can repay the debt after leaving university (Rey and Racionero, 2010).

Nevertheless, the penalty for default is still extremely high, which is now a problem particularly audible in the UK. Even students who do not finish their studies or remain unemployed have to repay the debt. The strict policy was introduced in 1998 because the government was in urgent need of new resources (Barr and Crawford, 1998). Nowadays, bigger loans can be charged up to 3% above inflation (Prestidge, 2013). As a result, over 40% of students default on their loans and the rate increases with every year (The Guardian, 2014). Pure loans are therefore often guaranteed by the government and written off after 25 years (Bolton, 2014). Nonetheless, the defaults are associated with financial hardships such as damaging credit scores and the impossibility to obtain another loan. These problems create barriers to entry and challenge the equity principle in higher education, which seeks to ensure fairness and equality of opportunity regardless of the student's financial situation (Chapman, 2006). However, our model presented in Chapter 4 abstracts from these issues and

considers the simplest case of pure loan where all students repay their debt after they leave university.

4.3 Income-contingent loans

The alternative to pure loans which shall be discussed in the thesis is the income-contingent loan scheme (ICL). An ICL provides students with the necessary funds to cover the higher education cost, but its essential and defining feature it that 'the collection of the debt depends on the borrowers' capacity to pay' (Chapman, 2006, p. 1437). In practice, the graduates start repaying the debt only if their income exceeds a pre-specified level. Additionally, the instalment constitutes of a fixed proportion of monthly earnings and if the loan is not repaid in a given time horizon, the rest of the debt is written off.

Even though the ICLs have been first implemented in 1970s, the idea was introduced in a 1955 paper by Milton Friedman. In *The role of government in education*, the author is concerned with imperfect capital markets where either all taxpayers bear the cost of higher education, or there is underinvestment in human capital. As a solution, he offers a scheme where the borrower agrees 'to pay the lender a specified fraction of his future earnings' (Friedman, 1955, p. 10). In his proposition, there is no maximum time horizon or a cap on the regular repayments, so successful students compensate the defaults of the unsuccessful ones.

4.3.1 Risk-pooling ICL

The scheme of income-contingent repayments was first put into practice in 1971 at Yale University. As part of the Yale Tuition Postponement Option, or TPO, students could defer payments for tuition if they agreed to pay 0.4% of their annual income per every $1000 received (West, 1976). The interest rate was variable and reflected Yale's own cost of capital and the administrative cost of the programme. Moreover, the loan was 'mutualized'. In other words, borrowers were grouped into cohorts and their obligation ceased once the balance of the cohort was zero. As a result, high-income earners were responsible for repaying the loan of the defaulted fellow students on top of their own debt.

This was the main feature of the scheme and also the most controversial one. Unexpectedly high default rates (around 15%) created a further pressure on students who were still paying and many of them eventually decided to cover the 150% of their loan and withdraw from the programme. The application of TPO also revealed two issues related to behavioural economics - adverse selection and moral hazard. These issues, discussed by Chapman (2006) and Nerlove (1975) create the wrong incentives for students and can eventually threaten the viability of the whole system.

In the context of ICLs, it means that high-ability individuals are not likely to choose risk-pooling scheme (where they expect to pay more than the cost of education) over different alternatives. On the contrary, students who expect low future earnings will be interested in such a scheme, because their repayments will be subsidized by others. At the risk of stating the obvious, these effects can be severely damaging to the university's reputation. Furthermore, once the student is accepted at the university, she may be discouraged to 'do her best,' especially in case that the default rates of fellow students are higher than she expected. A similar problem arises after the student leaves the institution - because repayment is calculated on the basis of declared income, risk-pooling scheme is likely to affect the individual's choice between pecuniary and non-pecuniary income. Last but not least, the scheme relies on the existence of an efficient authority, which is capable of collecting payments at a low cost. As this was not the case of Yale TPO, many adults avoided the repayment obligation, which put further pressure on those who paid properly.

Overall, the plan was not a great success and it was discontinued after seven years (Rey and Racionero, 2010). Because of a negative public opinion and frustration of those who were still paying, the remaining debt was forgiven in 2001. Nevertheless, the Yale experience provided a very valuable insight into what is the terminology of Chapman (2006) known as a risk-pooling (RP). It showed that a scheme where the risk *pooled* from the unsuccessful to the successful is feasible, but constitutes serious challenges in terms of student behavioural responses and sophisticated implementation.

4.3.2 Risk-sharing ICL

The other type of ICL which has become popular in Australia and New Zealand is known as a risk-sharing income-contingent loan (RS). Unlike the first type, risk sharing does not rely on the high-income earners in financing the unsuccessful students (Rey and Racionero, 2010). Instead, the debt of the defaulted is paid out of general taxation: the risk is *shared* among whole population.

The most famous and cited example of a risk-sharing ICL plan is certainly the Australian Higher-Education Contribution Scheme (HECS) adopted in 1989. The main factors leading to the radical reform in Australian's higher education financing policy, as outlined by Lleras (2007), are very similar to those in the Czech Republic. In 1970s, the demand for higher education increased beyond the edge of sustainability and many Australians began to question whether state-financing is the ideal type of funding. Despite initial concerns, the programme has been very successful and we shall briefly discuss its main characteristics. They can serve as valuable information in the discussion of financing reforms in the Czech Republic.

Upon its implementation, the HESC began to charge all undergraduate students a tuition fee of 2 442 AUD (equivalent to about 45 000 CZK at the current exchange rate) that accounted for 23% of the full-time higher education cost per student. Students could choose between taking out a loan and paying up front, in which case they were offered a reduction of the fee. The majority of students (about two thirds) decided to postpone the payments. For them, the repayments of the debt were deferred until they were earning at least the average taxable income of 27 675 AUD a year (Chapman, 1997). Above this threshold, the charges became progressive as is shown in Figure 4.1, so that high-income earners would pay their debt more quickly.

To avoid repeating the situation from Yale, the real interest rate was set at zero so that the nominal only reflected inflation. This was one of the key features that helped make HECS a success.[2] Another one was that payments were collected by a tax authority which already had in place collection mechanisms (unlike the Yale University). As a result, administrative costs for the whole scheme were extremely low at around 0.5%.

[2]In 1991, New Zealand adopted a more market-oriented version of the ICL scheme which carried a market interest rate. Strong criticism, however, forced the government to eventually reduce the real interest rate to zero, similarly to the Australian HECS (Lleras, 2007)

Table 4.1: Income-contingent repayments in HECS, 1996

Taxable income per month in AUD	Taxable income per month in CZK	Annual repayment rate
0 - 2 306	0 - 42 605	0%
2 307 - 2 619	42 606 - 48 025	3%
2 620 - 3 669	48 026 - 67 235	4%
3 700 and more	67 236 and more	5%

Source: Author based on (Lleras, 2007)

Note: Australian dollars are converted into Czech crown using the exchange rate as to May 2014: 1 AUD = 18.325 CZK.

Over the first seven years that HESC was in place, it generated an additional revenue worth 1.6 billion AUD (over 29 billion CZK). Another success was the evidence that HESC did not marginalize disadvantaged students: the proportion of high, medium and low income-students in 1993 remained the same as in 1988 (Chapman, 1997).

Having discussed international experience with these schemes, we now turn to the Czech Republic to see whether implementing the ICLs would be feasible and in which ways they would shape higher education participation and graduates' abilities.

Chapter 5

Model

5.1 Introduction

The goal of this model is to find out predicted participation in Czech higher education under alternative financing schemes. We build on the model that was first suggested by Garcia-Penalosa and Walde (2000) and later revised by Rey and Racionero (2010). We first derive and present the model and then calibrate it to the Czech reality using mainly OECD data from 2011. By calibrating the existing tax-subsidy scheme, we find the parameters that correspond to actually observed participation. The calibrated parameters are then used to retrieve participation for the alternative schemes.

To predict the participation under each financing scheme, we first calibrate the corresponding threshold ability level which determines participation. Then we focus on the optimal level of participation. In case of the financing schemes, this level defines individuals who are *willing* to invest in higher education. In the following section, we use it to find out which threshold ability level induces maximum *efficiency*.

5.2 Framework

We consider an economy in which the total population of N individuals live for 2 periods. The whole population pays taxes to the government and the tax revenue is distributed according to the state budget. Up to the beginning of the first period, education is compulsory and the full cost is paid by the

government. We exclude this part from the model.

At the beginning of the first period (P1), individuals decide between working for a low-skilled wage w_L (*i.e.* forever leaving the education system), and undertaking higher education studies. It is assumed that individuals differ in their ability a which is a continuous random variable distributed according to the density function $f(a)$. We further assume that this ability is either measurable by the individual herself or by an academic examination. In the ideal state, only individuals above a certain level (referred to as the 'threshold ability level') decide or are accepted to enter higher education. We do not distinguish between these two scenarios.

Individuals who decide to study forego earnings w_L in P1. The *per capita* cost of higher education is E and the extent to which E is paid by students and the state varies in different financing schemes.

In the second period (P2), which is considerably longer than the first one, all individuals work and earn income. If the individual did not go to university, she continues to receive the low-skilled wage. Earnings of individuals who invested in education are uncertain. This uncertainty exists in two major forms: either a student might not graduate or she might not be employed as a high-skill worker in spite of being a graduate. This can be a result of a wrong assessment of the student's ability as well as of concepts known from the economic theory (e.g. excessive supply of graduates, time-inconsistent preferences of the labour market or information asymmetry).

For simplicity, we assume that a student is successful (*i.e.* receives high-skilled wage w_H) with probability p and is unsuccessful (*i.e.* receives w_L) with probability $1 - p$. We further assume that:

1. wages are exogenously given, with w_H increasing in student ability and $w_L < w_H(a)$ for all a
2. we know the minimum and maximum ability denoted as a_{MIN} and a_{MAX} respectively
3. probability p is independent on a, because as was suggested above, the

reason for being unsuccessful is not necessarily associated with student's ability.[1]

Consequently, there are three possible states: the individual studies and is successful, she studies and is unsuccessful, or she does not study at all. We denote these states S, U, and N respectively. H^j, where j represents one of the four funding schemes, stands for the number of individuals who enrol in HE. Table 5.1 summarises variables used in our model:

Table 5.1: Variables description

E	Cost of education	Annual expenditure on tertiary education per student
H^j	HE participation	Number of students who enrol in higher education
N	Population	Total amount of individuals who pay taxes

In the following sections, we treat education as a regular investment that can be evaluated by a simple cost-benefit analysis. Theoretically, a rational individual will invest in education if her expected earnings net of the cost of education exceed her lifetime income as a non-student. In this analysis, we are particularly interested in the marginal individual who is indifferent between investing or not. If y_U and y_S denote lifetime income of an unsuccessful and successful student and y_N that of a non-student, then the marginal individual is characterized by the threshold ability level $\hat{a}$ which satisfies the following:

$$(1-p)y_U + py_S(\hat{a}) = y_N$$

Or, for each financing scheme j:

$$(1-p)y_U^j + py_S^j(\hat{a}^j) = y_N^j$$

The threshold ability level varies across different schemes and we will derive it for each of the schemes in the following sections. Because we calculate all cash flows from the point of view of P1, all future earnings are discounted at rate R.

[1]The main reasons for which Czech students tend to drop out of universities are discussed in (Mouralová and Tomášková, 2007).

5.3 Tax-Subsidy

In the tax-subsidy (TS) system, the cost of education is financed out of general taxation in $P2$.[2] Each individual thus pays $\frac{H^{TS}E}{N}$, irrespective of whether she studies or not.

Table 5.2: Tax-subsidy

Denomination	Earnings in P1	Earnings in P2	Education Cost
y_U^{TS}	0	w_L	$\frac{H^{TS}E}{N}$
y_S^{TS}	0	$w_H(a)$	$\frac{H^{TS}E}{N}$
y_N^{TS}	w_L	w_L	$\frac{H^{TS}E}{N}$

Source: Adapted from (Rey and Racionero, 2010)

Expected lifetime income of a student of ability a:

$$(1-p)\left[R\,w_L\,-\frac{H^{TS}\,E}{N}\right]+p\left[R\,w_H(a^{TS})-\frac{H^{TS}\,E}{N}\right]$$

$$R\big[(1-p)w_L+pw_H(a^{TS})\big]-\frac{H^{TS}E}{N}$$

Threshold ability $\hat{a}^{TS}$ satisfies:

$$R\big[(1-p)w_L+pw_H(\hat{a}^{TS})\big]-\frac{H^{TS}E}{N}=(1+R)\,w_L-\frac{H^{TS}\,E}{N}$$

$$w_H(\hat{a}^{TS})=\frac{w_L+pRw_L}{pR}$$

$$\boxed{w_H(\hat{a}^{TS})=w_L+\tfrac{w_L}{pR}}$$

We assume that, *ceteris paribus*, the relationship between skilled wage and ability is perfect linearity, *i.e.* $w_H = k\,a$, where k is a parameter. In other words, if we hold factors such as the field of study, location of the job, *etc.* equal, then the difference in skilled wage of two individuals can be attributed to the difference in their abilities.[3]

[2]Note that we do not consider specific fees for prolonged studies or English programmes as these are neither obligatory nor very common.

[3]One of the violations of this assumption is gender discrimination. In the Czech Republic, the gender wage gap accounts for over 15% (OECD, 2013).

5.4 Pure Loan

With a pure loan (PL) scheme, students borrow necessary funds before they start studying and repay the cost of education back whether they are successful or not. In this scheme, non-students do not contribute at all.

Table 5.3: Pure Loan

Denomination	**Earnings in P1**	**Earnings in P2**	**Education Cost**
y_U^{PL}	0	w_L	E
y_S^{PL}	0	$w_H(a)$	E
y_N^{PL}	w_L	w_L	0

Source: Adapted from (Rey and Racionero, 2010)

Expected lifetime income of a student of ability a:

$$(1-p)\left[R\,w_L\,-E\right]+p\left[R\,w_H(a^{PL})-E\right]$$

$$R\big[(1-p)w_L+pw_H(a^{PL})\big]-E$$

Threshold ability $\hat{a}^{PL}$ satisfies:

$$R\big[(1-p)w_L+pw_H(\hat{a}^{PL})\big]-E=(1+R)\,w_L$$

$$w_H(\hat{a}^{PL})=\frac{w_L+pRw_L+E}{pR}$$

$$\boxed{w_H(\hat{a}^{PL})=w_L+\tfrac{w_L}{pR}+\tfrac{E}{pR}}$$

5.5 Risk-sharing

With risk-sharing ICL (RS), all students borrow E. Successful students repay the amount in full, whereas the debt of unsuccessful students $(1-p)H^{RS}E$ is paid by the whole population from general taxes.

Table 5.4: Risk-sharing

Denomination	Earnings in P1	Earnings in P2	Education Cost
y_U^{RS}	0	w_L	$\frac{(1-p)H^{RS}E}{N}$
y_S^{RS}	0	$w_H(a)$	$E + \frac{(1-p)H^{RS}E}{N}$
y_N^{RS}	w_L	w_L	$\frac{(1-p)H^{RS}E}{N}$

Source: Adapted from (Rey and Racionero, 2010)

Expected lifetime income of a student of ability a:

$$(1-p)\left[Rw_L - \frac{(1-p)H^{RS}E}{N}\right] + p\left[Rw_H(a^{RS}) - E - \frac{(1-p)H^{RS}E}{N}\right]$$

$$R\left[(1-p)w_L + pw_H(^{RS})\right] - E\left[p + \frac{(1-p)H^{RS}}{N}\right]$$

where:

$$p + \frac{(1-p)H^{RS}}{N} < 1$$

because $Np + (1-p)H < N$. We assume that $H < N$ (higher education will not be undertaken by the whole population N) and $p < 1$ (some students will not be successful). Because non-students contribute to finance the part of their debt ($\frac{(1-p)H^{RS}E}{N}$), students do not expect to pay the full cost of education at the beginning of the first period.

Threshold ability $\hat{a}^{RS}$ satisfies:

$$R\big[(1-p)w_L + pw_H(\hat{a}^{RS})\big] - E\left[p + \frac{(1-p)H^{RS}}{N}\right] = (1+R)w_L - \frac{(1-p)H^{RS}E}{N}$$

$$R\big[(1-p)w_L + pw_H(\hat{a}^{RS})\big] - pE = (1+R)w_L$$

$$w_H(\hat{a}^{RS}) = \frac{w_L + pRw_L + pE}{pR}$$

$$\boxed{w_H(\hat{a}^{RS}) = w_L + \tfrac{w_L}{pR} + \tfrac{E}{R}}$$

5.6 Risk-pooling

Finally, with a risk-pooling ICL (RP), successful graduates pay their own debt as well as the debt of unsuccessful students $\frac{(1-p)H^{RP}E}{pH}$.

Table 5.5: Risk-pooling

Denomination	Earnings in P1	Earnings in P2	Education Cost
y_U^{RP}	0	w_L	0
y_S^{RP}	0	$w_H(a)$	$E + \frac{(1-p)H^{RP}E}{pH}^*$
y_N^{RP}	w_L	w_L	0

Source: Adapted from (Rey and Racionero, 2010)
Note: $^*\, E + \frac{(1-p)H^{RP}E}{pH} = \frac{E}{p}$

Expected lifetime income of a student of ability a:

$$(1-p)Rw_L + p\left[Rw_H(a^{RP}) - \frac{E}{p}\right]$$

$$R\big[(1-p)w_L + pw_H(a^{RP})\big] - E$$

Threshold ability $\hat{a}^{RP}$ satisfies:

$$R\big[(1-p)w_L + pw_H(\hat{a}^{RP})\big] - E = (1+R)w_L$$

$$w_H(\hat{a}^{RP}) = \frac{w_L + pRw_L + E}{pR}$$

$$\boxed{w_H(\hat{a}^{RP}) = w_L + \tfrac{w_L}{pR} + \tfrac{E}{pR}}$$

5.7 Optimal level of participation

If we focus exclusively on efficiency, then the optimal threshold ability level $\hat{a}$ is such that the expected future earnings of individuals *above* $\hat{a}$ net of the cost of their education exceed the earnings they would earn as non-students. On the contrary, individuals *below* $\hat{a}$ earn more if they do not study. The marginal individual is defined as:

$$R\big[(1-p)w_L + pw_H(\hat{a})\big] - E = (1+R)\,w_L$$

which yields the optimal participation of

$$H^* = \int_{a_{MIN}}^{\hat{a}} f(a)\,da.$$

Since we assume that skilled wage is increasing in ability (*i.e.* $k > 0$), we can compare threshold ability levels and participation for different schemes:

$$\hat{a}^{TS} < \hat{a}^{RS} < \hat{a} = \hat{a}^{RP} = \hat{a}^{PL}.$$

$$H^{TS} > H^{RS} > H^* = H^{RP} = H^{PL}.$$

Therefore, we can conclude that the tax-subsidy scheme requires the lowest ability level of the marginal individual and induces excessive participation in higher education. It is also the scheme which requires the highest contribution from non-students. The situation is similar for the risk-sharing scheme, although to a lesser extent. From the purely efficient view, both risk-pooling and pure loan schemes are optimal: only students whose expected future earnings net of the cost of education exceed their earnings as non-students are willing to study. In both of these schemes, non-students do not contribute at all to finance the cost of education. Under risk-pooling scheme, successful students are worse off than in case of risk-sharing, because they share the debt of the unsuccessful students. For the unsuccessful students, the situation is reverse.

To see how these conclusions hold in the Czech higher education system, we now calibrate the model to the Czech reality.

Chapter 6

Calibration for the Czech Republic

6.1 Data used for calibration

6.1.1 Ability

In the following analysis, we chose the intelligence quotient (IQ) as a proxy for ability. We do so for two main reasons.

First, the IQ is a standardized and recognized method to asses an individual's intelligence. Unlike acceptance examinations tailored by each institution specifically to measure the quantity of the applicant's knowledge in a given field of study, IQ tests are not restricted to one university or a particular group of individuals. They assess a person's general intellectual ability to understand ideas and process information (Discovery Channel, 2013). Because these skills are extremely important on the path to a successful career, they seem to be a good proxy for ability. As a result, we are able to assess the threshold ability levels and participation for each scheme on the national level rather than concentrating on individual universities. Moreover, as the IQ tests are conducted internationally, our results could easily be compared with those obtained worldwide.

Second, IQ is by definition normally distributed in the population; a feature that will prove useful in computing the optimal higher education participation. By convention, the population mean of IQ score is defined as 100 with the standard deviation of 15 IQ points. It follows from the statistical theory that the IQ scores of 68.26% of population lie between 85 and 115 and that of 95.44% between 70 and 130 (Healey, 2011, p. 111). This is illustrated in Figure 6.1.

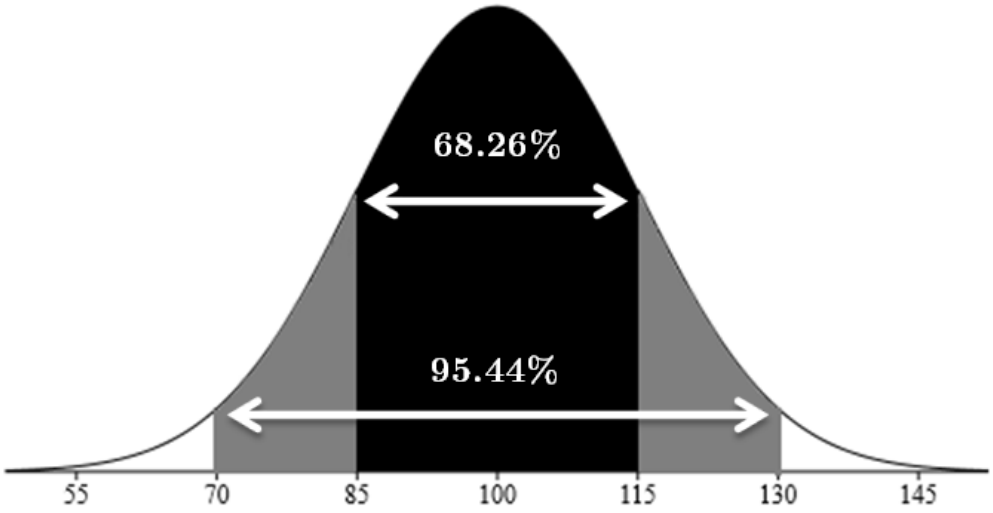


Figure 6.1: Distribution of IQ

Source: Author

6.1.2 Low-skilled wage

When computing the low-skilled wage, one important question has to be answered. When does an individual make the decision of undertaking higher education studies? In the following analysis, we assume that this decision is made at any point during primary or secondary education. Therefore, we compute the low-skilled wage as a weighted average of incomes of individuals whose highest attained education is primary or secondary (including programmes both with and without accomplished 'maturita' exams).[1] Table A.1 in the Appendix summarizes data for this calculation, from which we obtain the low-skilled wage of 296 479 CZK.

6.1.3 Discount factor

In order to properly discount the individual's earnings in the second period, we need to take into account that the periods are of not the same lengths. We assume that the first period lasts approximately 4 years (the average duration of tertiary studies is 4.1 years in the Czech Republic, OECD (2013, p. 178)) and the second period 40 years (based on the predictions of retirement age of a person born in 1991), *i.e.* it is ten times longer. We assume that 296 479 CZK

[1] 'Maturita' is a leaving certificate obtained at some secondary school. It roughly corresponds to General Certificate of Secondary Education (GCSE)

represents the income of a low-skilled individual in $P1$ and discount earnings in $P2$ according to the following formula:

$$f + f^2 + ... + f^{10} = R$$

where f is the annual discount factor.

We use $f = 0.96$ as it is a typical value of the annualized time discount factor used for the calibration of models, see for example (Edmond, 2004), (Gomme and Rupert, 2007) or (Choi et al., 2008). Therefore, we get:

$$0.96 + 0.96^2 + ... + 0.96^{10} = R = 8.04$$

6.1.4 Probability of success

We use the OECD indicator of 'completion rates' as a measurement of the probability of success, which was 0.72 for year 2010 and the Czech Republic. The OECD defines a completion rate as 'the proportion of new entrants into a specified level of education who graduate with at least first degree at this level' (OECD, 2013, p. 71). Therefore, we consider the first type of uncertainty as discussed in section 5.2: the probability that a person who entered a higher education institution leaves with a degree. Because the completion rates are reported from the true cohort, they are fairly accurate to measure this probability.

6.1.5 Cost of education

To determine E, the *per capita* cost of higher education, we use OECD data on the 'annual expenditure per student by educational institutions for core services, ancilliary services and R&D' from 2010 (OECD, 2013, p. 175). We convert the original amount of 7 635 USD into CZK using the exchange rate from 31.12.2010 (CNB, 2010) and obtain 143 164 CZK.[2] We do not consider any other expenses on top of tuition fees such as accommodation and transportation, even though they might constitute an important part of a student's

[2]The reason why we consider the annual expenditure instead of the cumulative expenditure over the whole length of tertiary education is to be consistent with our calculation of the low-skilled individual's wage.

budget.[3] They are, however, paid by non-students as well as students, which is why they are excluded.

6.2 Calculation of the threshold ability level and participation

In this section, we calibrate the model to the Czech reality. The data we use are summarized in the Table 6.1.

Table 6.1: Variables used for the calibration

Variable	Figure	Source
E	143 164	OECD (2013, p. 178)
N	10 486 731	CZSO (2011b)
p	0.72	OECD (2013, p. 71)
R	8.04	Author based on (Gomme and Rupert, 2007)
w_L	296 479	Author based on CZSO (2011a)
H^{TS}	59%	OECD (2013, p. 302)

6.2.1 Calibration for the tax-subsidy

We use the tax-subsidy system for calibration, because this system is currently in place in the Czech Republic and thus we observe the actual participation rate. Assuming that the actual rate corresponds to the rate predicted by the model, we use the equation describing the marginal individual to retrieve her wage. Under the assumption that wage is a linear function of ability, we can then parametrize the function $w(a)$.

Computing $w_H(\hat{a}^{TS})$

From the equation for tax-subsidy, we get:

$$w_H(\hat{a}^{TS}) = w_L + \frac{w_L}{pR}$$

$$w_H(\hat{a}^{TS}) = 296\,479 + \frac{296\,479}{0.72 \cdot 8.04}$$

$$w_H(\hat{a}^{TS}) = 347\,695$$

[3]For students in the UK who are not living with parents, for example, these expenses make up for more than three times the tuition fees (Eurostudent, 2014).

This is the annual wage of the individual who is indifferent between getting higher education or not. If we compare it to the average wage of a low-skilled individual - 296 479 - we find that the implied higher education premium, or the percentage increase in wage associated with getting higher education, accounts for 17%. This corresponds to the estimates of the college wage premium in other studies which vary between 15% and 20% (Walker and Zhu, 2007).

Computing $\hat{a}^{TS}$

Because we assume that density function $f(a)$, a_{MIN} and a_{MAX} are given and we know that the participation for the TS system is 59%, we can compute $\hat{a}^{TS}$ from the following equation:

$$H^{TS} = \int_{a_{MIN}}^{\hat{a}^{TS}} f(a)\, da$$

We now use the fact that ability (measured by IQ test scores) is normally distributed with mean 100 and standard deviation of 15. We can use statistical tables or a computerized system to compute the threshold ability:

$$\hat{a}^{TS} = 96.593.$$

The precise computation is provided in Appendix B and the graphical demonstration in Figure 6.2. We take the TS participation and the TS threshold ability as benchmarks for the future discussion on alternative financing schemes.

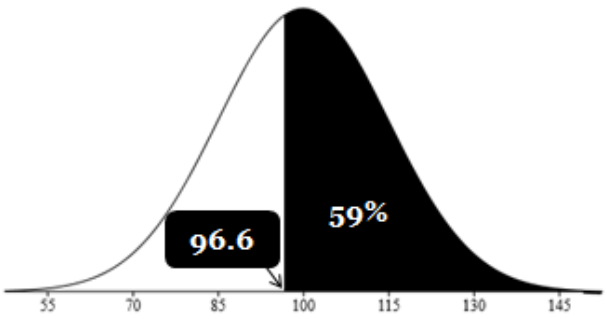


Figure 6.2: Threshold ability and participation for tax-subsidy

Source: Author

Computing k

Since we now obtained $w_H(\hat{a}^{TS})$ and $\hat{a}^{TS}$, we can calibrate the parameter k from $w_H = k\,a$:

$$k = \frac{347\,695}{96.593} = 3\,600$$

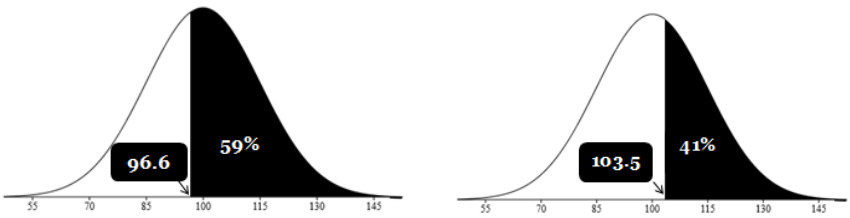
We use this parameter to calculate the participation and threshold abilities for other financing schemes in the following section.

6.2.2 Calibration for alternative schemes

We use a similar technique for the other schemes. We compute $w_H(\hat{a}^j)$ and use the parameter k to calculate the threshold ability levels $\hat{a}^j$. Resulting participation rates H^j are shown below:

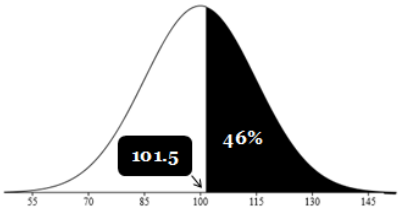
Table 6.2: Calibration results

Scheme j	$w_H(\hat{a}^j)$	$\hat{a}^j$	H^j
TS	347 695	96.6	59%
PL	372 426	103.5	41%
RS	365 501	101.5	46%
RP	372 426	103.5	41%

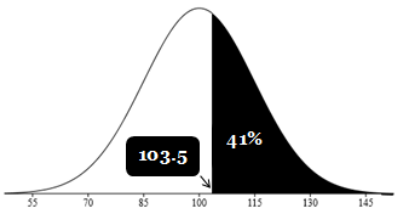


(a) Tax-subsidy

(b) Pure loan



(c) Risk-sharing



(d) Risk-pooling

Figure 6.3: Calibrated threshold ability levels and participation for alternative financing schemes.

Source: Author

6.3 Discussion

Our results confirm the popular notion that 'it has never been easier' to be accepted to a Czech higher education institution. Indeed, threshold ability levels, which can be also interpreted as the 'minimum ability requirement', are the lowest for the tax-subsidy scheme and highest for pure loan and risk-pooling. This is in accordance with our theoretical proposition in the previous section. If the threshold ability level increases by approximately 5 IQ points, the effect on participation is substantial and accounts for 13 percentage points.

In case of risk-sharing, resulting participation is lower than under tax-subsidy, but higher than under pure loan and risk-pooling. This reason is that risk-sharing provides greater insurance to students. In both ICL plans, unsuccessful students pay the same amount as the rest of the population. In risk-sharing, however, the amount paid by high-income earners is limited to the full cost of education 143 164 CZK while in risk-pooling, successful students share the debt of the defaulted. As was outlined in section 4.3, this fact is associated with equity issues and the problems of moral hazard and adverse selection.

6.4 Sensitivity analysis

In this section, we analyse how sensitive our results are to changes in parameters. If we follow the suggestions by Chamon et al. (2010) or Herrera and Restrepo (1990) and assume an annual discount factor 0.97, we get the following results:

Table 6.3: Calibration results for f=0.97

Scheme j	$w_H(\hat{a}^j)$	$\hat{a}^j$	H^j
TS	344 980	96.6	59%
PL	368 401	103.1	42%
RS	361 843	101.3	47%
RP	368 401	103.1	42%

Source: Author

Our results change only slighty, so they are not sensitive to very small changes in the discount factor. We now examine what happens if we change the value of p, the probability of success, and let the discount factor have the original

value of 0.96. Using the data collected from an expertise study by Bartušek and Koucký (2012), we assume $p = 0.63$ which is the average probability that a student at the Charles University will successfully finish the programme she entered. Results are shown in Figure 6.4.

Table 6.4: Calibration results for p=0.63

Scheme j	$w_H(\hat{a}^j)$	$\hat{a}^j$	H^j
TS	355 012	96.6	59%
PL	383 276	104.3	39%
RS	372 818	101.4	46%
RP	383 276	104.3	39%

Source: Author

As we can see, the participation under pure loan and risk-pooling schemes changed relatively more than the participation under risk-sharing. This happens because in risk-sharing, the debt of the unsuccessful students is shared among the whole population, so the probability of success has lower effect on the successful students. An opposite situation occurs under risk-pooling: a decrease in the probability of success translates into higher financial burden on the successful students, who are responsible for the debt of the defaulted. This means that the marginal individual needs to have higher ability and receive higher wage on condition that her situation is equal to that of a non-student.

Chapter 7

Conclusion

In order to answer the question 'What is the best financing scheme of higher education?' one must first ask 'Why does the tax-subsidy financing policy have to be changed in the first place?' The main quantitative reasons for its inefficiency were outlined in chapter 3 and our results confirm them. All of the alternative schemes require students to share the cost of their education, although to different extents. This would bring more resources to the state education budget and solve the problem of underfunding.

Second, we showed that financing higher education solely from the tax revenue results in relatively low ability requirements on higher education applicants. As a result, the participation is suboptimal because more people study than the labour market and the economy as a whole need. Capital (human as well as financial) is not allocated efficiently, because the demand for higher education does not match the demand for graduates. The extensive study REFLEX 2013 elaborated by Zelenka, M. and Ryška, R. (2011) showed that many graduates work outside their fields of study or at occupations below their qualifications.

Third, while the whole population pays for the service, only 59% undertake the studies and, as was pointed out by Lleras (2007), 'those who attend are also the ones who enjoy higher incomes afterwards.' Even though in reality, there are public benefits to the society, such as more knowledge-based society, faster economic growth, or creation of new technologies, these 'spill overs' are marginal in comparison to the invididual's benefits, as argued by Friedman (1955).

Our analysis showed that the most efficient schemes are pure loan and risk-pooling. The latter has been advocated by Rey and Racionero (2010) as the optimal scheme, but whether efficiency is the only deciding factor is disputable.

For example, is there a rationale for the fact that the debt of the unsuccessful students is paid by the high-income earners who also had to borrow to pay for their education? This defining characteristic of risk-pooling has never been properly justified and it was one of the main reasons why the Yale TPO was discontinued (West, 1976). In addition, the behavioural issues of adverse selection and moral hazard are particularly problematic with the risk-pooling scheme and can seriously threaten its viability.

A different problem is raised in the case of pure loan. Is a scheme that offers *no* insurance to students more desirable than one that offers *full* insurance? Bank loans including mandatory up-front payments solve the situation of an immediate need for funds, but the repayments are associated with future hardships. The case of United Kingdom shows that this financial arrangement is not feasible in the long-term, because a fraction of students inevitably defaults and the government is eventually forced to guarantee the loans, even though it was not the initial intention.

Therefore, the practical experience shows that risk-sharing is the most feasible alternative. It is more efficient than the existing tax-subsidy and capable of adequate funding of higher education. It protects borrowers from excessive risk due to its insurance nature, but has more attractive properties than risk-pooling, for it does not require graduates to pay more than the cost of their education. In addition, it respects equality of opportunity, because no up-front payments are neccessary. Nevertheless, risk-sharing involves contribution from taxpayers, which raises the question of equity and fairness. A concrete proposition of how to make this contribution proportionate to the 'spill overs,' created by higher education graduates in the form of public benefits, requires further research. In order to finally implement a viable reform of funding policy including income-contingent loan scheme, a particular emphasis needs to put on the threshold income level, annual repayment percentage and interest rate charged on the loan.

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Appendix A

Computation of the low-skilled wage

As was outlined in chapter 5, we compute the 'skilled wage' w_L as a weighted average of individuals who attained primary or none education, secondary vocational school (without 'maturita' exam) and secondary schools with 'maturita' exam. The calculation is described below:

Table A.1: Calculation of low-skilled wage

Education	**Average monthly wage**	**Population**
Primary/none	18 450	121 518
Secondary without 'maturita'	21 804	570 414
Secondary with 'maturita'	28 494	637 916
Total 'unskilled'	—	1 329 848

Source: Author based on (CZSO, 2011a)

We now follow the formula for the weighted average:

$$weighted\,avg_{w_L} = \frac{\sum_{i=1}^{3} w_i x_i}{\sum_{i=1}^{3} w_i}$$

where x_i is the monthly average wage for each level of education and w_i is the weight, *i.e.* population that attained the corresponding level of education.

$$weighted\,avg_{w_L} = 24\,706$$

The weighted average per month is 24 706 CZK, so the *annual* unskilled wage is 296 479 CZK.

Appendix B

Precise calculations for the TS calibration

The fact that the real participation in higher education for the TS scheme is 59% means that 59% of the respective age cohort have ability above certain threshold ability level. This ability, as measured by the IQ test, is normally distributed with mean 100 and standard deviation 15. The threshold ability which we call $\hat{a}^{TS}$ is such that the probability that a randomly chosen person from the age cohort will have ability above $\hat{a}^{TS}$ is 59%. In other words, the probability that a randomly chosen person from the age cohort will be *below* $\hat{a}^{TS}$ is 41%. We will use the latter formulation to proceed. Therefore, we look for $\hat{a}^{TS}$ such that

$$P(a^{TS} < \hat{a}^{TS}) = 0.41$$

where a^{TS} is a random variable drawn from the IQ scores distribution. In the text, we calculate $\hat{a}^{TS}$ using a computerized statistical system (HyperStat, 2014). Here we provide a more detailed 'manual' calculation of $\hat{a}^{TS}$. Because we want to use statistical tables for the Standard Normal Distribution, we need to normalize the problem, i.e. rewrite it as follows:

$$P(a^{TS} < \hat{a}^{TS}) = 0.41 \Leftrightarrow P\left(z < \frac{100 - \hat{a}^{TS}}{15}\right)$$

where

$$Z = \left(\frac{100 - \hat{a}^{TS}}{15}\right)$$

is a standard normal random variable. This follows from

$$z = \frac{\mu - X}{\sigma}$$

where μ is the mean and σ is standard deviation - see (Bartoszynski and Niewiadomska-Bugaj, 2007). Using statistical tables for normal distribution, we find that

$$z = \left(\frac{a^{TS} - 100}{15}\right) = -0.23$$

$$\hat{a}^{TS} = 96.55.$$

For completeness, the result when using (HyperStat, 2014) was 96.593.

Appendix C

Additional tables

Figure C.1: Trends in entry rates at the tertiary level type 5A (1995-2011)

	Tertiary-type 5A[1]												
	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
OECD countries													
Australia	m	59	75	72	71	70	82	84	86	87	94	96	96
Austria	27	34	34	31	34	37	37	40	42	47	45	53	52
Belgium	m	m	32	33	33	34	33	35	30	31	31	33	33
Canada	m	m	m	m	m	m	m	m	m	m	m	m	m
Chile	m	m	m	m	m	m	46	42	41	46	44	47	45
Czech Republic	**m**	**25**	**30**	**30**	**33**	**38**	**41**	**50**	**54**	**57**	**59**	**60**	**60**
Denmark	40	52	54	53	57	55	57	59	57	59	55	65	71
Estonia	m	m	m	m	m	m	55	41	39	42	42	43	43
Finland	39	71	72	71	73	73	73	76	71	70	69	68	68
France	m	m	m	m	m	m	m	m	m	m	m	m	39
Germany	26	30	32	35	36	37	36	35	34	36	40	42	46
Greece	15	30	30	33	35	35	43	49	43	42	m	m	40
Hungary	m	55	56	62	69	68	68	66	63	57	53	54	52
Iceland	m	66	61	72	83	79	74	78	73	73	77	93	81
Ireland	m	32	39	39	41	44	45	40	44	46	51	56	51
Israel	m	48	50	57	58	58	55	56	57	60	60	60	60
Italy	m	39	44	50	54	55	56	56	53	51	50	49	48
Japan	31	40	41	42	43	42	44	45	46	48	49	51	52
Korea	41	45	46	46	47	49	51	59	61	71	71	71	69
Luxembourg	m	m	m	m	m	m	m	m	m	25	31	28	m
Mexico	m	24	24	25	26	27	27	28	29	30	31	33	34
Netherlands	44	53	54	54	52	56	59	58	60	62	63	65	65
New Zealand	83	95	95	101	107	86	79	72	76	72	80	80	76
Norway	59	67	70	75	75	72	73	70	70	71	77	76	76
Poland	36	65	68	71	70	71	76	78	78	83	85	84	81
Portugal	m	m	m	m	m	m	m	53	64	81	84	89	98
Slovak Republic	28	37	40	43	40	47	59	68	74	72	69	65	61
Slovenia	m	m	m	m	m	m	40	46	50	56	61	77	75
Spain	m	47	47	49	46	44	43	44	43	43	46	52	53
Sweden	57	67	69	75	80	79	76	76	73	65	68	76	72
Switzerland	17	29	33	35	38	38	37	38	39	38	41	44	44
Turkey	18	21	21	23	24	26	27	31	29	30	40	40	39
United Kingdom	m	47	46	48	48	52	51	57	55	57	61	63	64
United States	57	58	59	61	63	63	64	64	65	64	70	74	72
OECD average	**39**	**48**	**49**	**51**	**53**	**53**	**54**	**55**	**55**	**55**	**58**	**61**	**60**
EU21 average	**35**	**46**	**47**	**49**	**50**	**52**	**53**	**54**	**54**	**54**	**56**	**59**	**59**
Other G20													
Argentina	m	m	m	m	m	m	m	m	m	47	56	60	m
Brazil	m	m	m	m	m	m	m	m	m	m	m	m	m
China	m	m	m	m	m	m	m	m	m	m	17	17	19
India	m	m	m	m	m	m	m	m	m	m	m	m	m
Indonesia	m	m	m	m	m	m	m	m	m	m	22	22	24
Russian Federation	m	m	m	65	63	68	67	66	66	68	69	66	72
Saudi Arabia	24	23	25	28	43	42	37	39	40	42	43	48	53
South Africa	m	m	m	m	m	m	m	m	m	m	m	m	m
G20 average	**m**	**m**	**m**	**m**	**m**	**m**	**m**	**m**	**m**	**m**	**51**	**52**	**52**

Note: Columns showing entry rates for the years 2001-04, 06, 07 (i.e. Columns 3-6, 8-9, 16-19, 21-22) are available for consultation on line (see StatLink below).
Please refer to Annex 1 for information on the method used to calculate entry rates (gross rates versus net rates) and the corresponding age of entry.
1. The entry rates for tertiary-type A programmes include advanced research programmes for 1995 and 2000-03 (except for Belgium and Germany).
2. Break in time series between 2009 and 2010 due to methodological changes (see Annex 3 for more details).
3. Break in time series between 2008 and 2009 due to a partial reallocation of vocational programmes into ISCED 2 and ISCED 5B.
4. Entry rates may be overestimated as it includes students who enrolled in the first year of a programme, instead of for the first-time in tertiary-type A or B programmes.

Source: (OECD, 2013, p. 301)

Figure C.2: Public support for households and other private entities as a percentage of total public expenditure on education, for tertiary education (2010)

	Notes	Direct public expenditure for institutions	Public support for education to private entities						Public support for education to private entities as a percentage of GDP
			Financial aid to students						
			Scholarships/ other grants to households	Student loans	Total	Scholarships/ other grants to households attributable for educational institutions	Transfers and payments to other private entities	Total	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
OECD									
Australia		**65,9**	12,2	21,9	34,2	0,7	n	**34,1**	0,39
Austria		**81,8**	11,0	a	11,0	m	7,2	**18,2**	0,30
Belgium		**86,3**	13,7	n	13,7	4,2	n	**13,7**	0,20
Canada	1	**81,3**	4,3	12,7	17,1	m	1,6	**18,7**	0,35
Chile	2	**59,6**	15,5	20,3	35,8	15,2	4,6	**40,4**	0,36
Czech Republic		**97,4**	**2,6**	**a**	**2,6**	**m**	**n**	**2,6**	**0,02**
Denmark	3	**72,1**	23,9	3,9	27,9	n	n	**27,9**	0,67
Estonia		**86,8**	4,7	8,5	13,2	m	n	**13,2**	0,16
Finland		**84,8**	14,9	n	14,9	a	0,3	**15,2**	0,33
France		**92,3**	7,7	m	7,7	2,8	a	**7,7**	0,10
Germany		**m**	m	m	m	m	m	**m**	m
Greece		**m**	m	m	m	m	m	**m**	m
Hungary		**85,7**	14,3	m	14,3	n	n	**14,3**	0,14
Iceland		**69,0**	m	31,0	31,0	a	n	**31,0**	0,51
Ireland		**86,9**	13,1	n	13,1	n	n	**13,1**	0,19
Israel		**89,5**	10,1	0,4	10,5	9,7	n	**10,5**	0,11
Italy		**77,5**	22,4	n	22,5	10,3	n	**22,5**	0,19
Japan	3	**70,8**	0,7	28,5	29,2	m	n	**29,2**	0,22
Korea		**91,5**	3,4	4,8	8,1	3,0	0,3	**8,5**	0,07
Luxembourg		**m**	m	m	m	m	m	**m**	m
Mexico		**93,0**	3,9	3,1	7,0	1,8	a	**7,0**	0,07
Netherlands		**72,8**	10,4	16,5	26,9	n	0,3	**27,2**	0,45
New Zealand		**53,4**	14,2	32,4	46,6	m	n	**46,6**	0,91
Norway		**62,5**	10,7	26,8	37,5	m	n	**37,5**	0,98
Poland		**87,8**	11,7	0,4	12,1	m	n	**12,2**	0,14
Portugal		**83,4**	16,6	m	16,6	m	m	**16,6**	0,19
Slovak Republic	3	**77,1**	19,3	1,2	20,5	m	2,4	**22,9**	0,19
Slovenia		**76,6**	23,4	n	23,4	m	n	**23,4**	0,32
Spain		**90,6**	9,2	0,3	9,4	2,0	n	**9,4**	0,11
Sweden		**75,5**	9,6	14,9	24,5	a	a	**24,5**	0,50
Switzerland		**93,4**	2,0	n	2,0	m	4,6	**6,6**	0,09
Turkey		**m**	m	m	m	m	m	**m**	m
United Kingdom		**32,3**	0,3	33,5	33,8	x(4)	33,9	**67,7**	0,69
United States		**72,3**	24,0	3,7	27,7	m	m	**27,7**	0,39
OECD average		**78,3**	**11,4**	**9,8**	**19,8**	**3,1**	**2,0**	**21,7**	**0,31**
Other G20									
Argentina		**98,8**	1,2	n	1,2	m	0,1	**1,2**	0,01
Brazil		**92,4**	3,9	2,7	6,6	x(2)	1,0	**7,6**	0,07
China		**m**	m	m	m	m	m	**m**	m
India		**m**	m	m	m	m	m	**m**	m
Indonesia	2	**m**	m	m	m	m	m	**m**	m
Russian Federation		**m**	m	m	m	m	m	**m**	m
Saudi Arabia		**m**	m	m	m	m	m	**m**	m
South Africa		**m**	m	m	m	m	m	**m**	m
G20 average		**m**	**m**	**m**	**m**	**m**	**m**	**m**	**m**

Source: (OECD, 2013, p. 236)

Figure C.3: Expenditure on education institutions, by service category, as a percentage of GDP, tertiary level (2010)

	Notes	Primary, secondary and post-secondary non-tertiary education				Tertiary education				
		Expenditure on education institutions			Private payments on instructional services/goods outside education institutions	Expenditure on education institutions				Private payments on instruction services/goods outside educational institutions
		Core education services	Ancillary services (transport, meals, housing provided by institutions)	Total		Core education services	Ancillary services (transport, meals, housing provided by institutions)	Research & development at tertiary institutions	Total	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
OECD										
Australia		4,26	0,09	**4,35**	0,09	0,95	0,06	0,62	**1,63**	0,13
Austria		3,47	0,17	**3,64**	m	1,05	0,01	0,46	**1,52**	m
Belgium		4,28	0,12	**4,40**	0,15	0,88	0,03	0,52	**1,44**	0,22
Canada	1, 2, 3	3,66	0,20	**3,86**	m	1,92	0,13	0,68	**2,72**	0,12
Chile	4	3,16	0,23	**3,39**	m	2,27	x(5)	0,14	**2,41**	m
Czech Republic		**2,60**	**0,22**	**2,81**	**0,05**	**0,99**	**0,01**	**0,22**	**1,23**	**0,03**
Denmark	2	x(3)	x(3)	**4,80**	m	x(8)	a	x(8)	**1,88**	m
Estonia		x(3)	x(3)	**3,91**	m	0,97	x(5)	0,64	**1,62**	m
Finland		3,71	0,43	**4,15**	m	1,13	a	0,80	**1,93**	m
France		3,52	0,55	**4,07**	0,17	0,95	0,08	0,48	**1,51**	0,07
Germany		m	m	**m**	m	m	m	m	**m**	m
Greece		m	m	**m**	m	m	m	m	**m**	m
Hungary	3	2,50	0,30	**2,80**	m	0,55	0,11	0,18	**0,84**	m
Iceland		x(3)	x(3)	**4,92**	n	x(8)	x(8)	x(8)	**1,23**	n
Ireland	3	4,69	0,08	**4,77**	0,03	1,14	m	0,43	**1,57**	m
Israel		4,05	0,21	**4,26**	0,29	1,47	0,19	m	**1,66**	n
Italy	3	3,12	0,11	**3,23**	0,41	0,61	0,04	0,34	**0,99**	0,14
Japan	2	x(3)	x(3)	**2,96**	0,79	x(8)	x(8)	x(8)	**1,53**	0,04
Korea		3,77	0,46	**4,24**	m	2,12	0,02	0,45	**2,59**	m
Luxembourg		3,26	0,24	**3,50**	0,06	m	m	m	**m**	m
Mexico		x(3)	x(3)	**3,99**	0,19	1,16	m	0,22	**1,38**	0,05
Netherlands		4,10	n	**4,10**	0,15	1,09	n	0,64	**1,74**	0,07
New Zealand		x(3)	x(3)	**5,08**	0,03	1,34	x(8)	0,24	**1,58**	m
Norway		x(3)	x(3)	**5,09**	m	0,99	0,02	0,70	**1,70**	m
Poland	3	3,63	0,03	**3,66**	0,22	1,23	n	0,24	**1,46**	0,04
Portugal	3	3,83	0,07	**3,89**	0,11	0,87	x(8)	0,58	**1,45**	m
Slovak Republic	2	2,69	0,39	**3,08**	0,32	0,66	0,13	0,14	**0,93**	0,20
Slovenia		3,65	0,26	**3,91**	m	1,01	n	0,26	**1,27**	m
Spain		3,13	0,17	**3,30**	m	0,91	0,05	0,39	**1,35**	m
Sweden		3,57	0,42	**3,98**	m	0,82	a	0,94	**1,76**	m
Switzerland	3	x(3)	x(3)	**4,05**	m	0,54	x(8)	0,69	**1,23**	m
Turkey		2,41	0,10	**2,51**	m	x(8)	x(8)	m	**m**	m
United Kingdom		4,08	0,71	**4,78**	m	0,80	0,11	0,46	**1,37**	0,11
United States		3,71	0,32	**4,02**	a	2,15	0,34	0,31	**2,80**	a
OECD average		**3,53**	**0,24**	**3,92**	**0,18**	**1,13**	**0,06**	**0,45**	**1,61**	**0,08**
EU21 average		**3,52**	**0,25**	**3,83**	**0,17**	**0,92**	**0,04**	**0,45**	**1,44**	**0,11**
Other G20										
Argentina		x(3)	x(3)	**4,67**	m	x(8)	x(8)	x(8)	**1,47**	m
Brazil	3	x(3)	x(3)	**4,33**	m	0,83	x(5)	0,05	**0,88**	m
China		m	m	**m**	m	m	m	m	**m**	m
India		m	m	**m**	m	m	m	m	**m**	m
Indonesia		m	m	**m**	m	m	m	m	**m**	m
Russian Federation		x(3)	x(3)	**2,11**	m	x(8)	x(8)	x(8)	**1,60**	m
Saudi Arabia		m	m	**m**	m	m	m	m	m	m
South Africa		m	m	**m**	m	m	m	m	**m**	m
G20 average		**m**	**m**	**m**	**m**	**m**	**m**	**m**	**m**	**m**

Source: (OECD, 2013, p. 194)