SIGNALLING WITH TUITION FEES

– A SENDER-RECEIVER GAME –

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Abstract

Universities increasingly compete against each other to attain the best students and by doing so they try to maximise their reputation, which is a function of tuition fees, intrinsic value and feedback. However, due to information asymmetries, students are not able to observe the true intrinsic value of a university a priori of attending the university. Thus, universities might have an incentive to signal their underlying intrinsic quality to students with the help of their tuition fees. This paper analyses how a sender-receiver game can be used to explain the behaviour of universities. The model that is developed shows that a separating equilibrium exists, in which the good university charges high tuition fees, and the bad university charges low tuition fees. Furthermore under a different set of assumptions, pooling equilibria in high and low tuition fees may exist as well.

Keywords: University, Tuition Fees, Signalling Theory, Sender-Receiver Game

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1. INTRODUCTION

"Never regard study as a duty, but as the enviable opportunity to learn to know the liberating influence of beauty in the realm of the spirit for your own personal joy and to the profit of the community to which your later work belongs."

Albert Einstein (n.d.)

It is without a doubt that the ongoing globalisation is not only an economic or financial phenomenon, but rather a trend framed and supported by laws and other types of rules or institutions that is reflected in most aspects of every-day life. A rather recent development is the globalisation of the higher education sector, where higher education is the "education beyond high school, specifically that provided by colleges and graduate schools, and professional schools" (Dictionary.com, 2006). The European decision to adopt the Bologna Process in 1999 can be considered as a first step towards achieving internationally comparable standards when it comes to higher education. The implementation phase lasts until 2010, whereupon most European countries are expected to have a Bachelor/Master/PhD structure within their education system. One result of this, which is already observable, is an increased competition on both the student and the university (also referred to as an institution of higher education) side. On the one hand, students compete to receive offers from prestigious schools. As universities become internationally comparable, students do not only look for universities on a national, but also on an international level in order to find the optimal mix between what a university offers and what the individual student needs. On the other hand, universities are also forced to compete amongst each other to attain the best students in order to improve their quality and in doing so universities try to optimise what they supply that is the quality of research and teaching, and what they demand, such as good students and tuition fees. However, both the student and the university are subject to asymmetric information since the market for higher education does not function perfectly, one reason being that higher education is considered an 'experience good' (Nelson, 1970). Even though one has some prior belief about the quality of a good, in this case education, it can only be fully evaluated after one has experienced it. It is therefore of interest to both the buyer and the seller of the good to overcome informational asymmetries. For the two players in this thesis this implicates that whereas the university may find it difficult to observe the true human capital or ambitions offered by each student, the individual student does not know the true quality of a university a priori of attending a university but only upon having finished his study or having worked for a certain time.[1] Therefore both parties have an incentive to find a way to signal their respective intrinsic quality. For the university, one way of doing so is to signal quality with the help of the tuition fees – when observing high tuition fees, it can be assumed that the university is of higher quality than when a university charges low or zero tuition fees. This said the question arises whether universities of lower quality have an incentive to charge high tuition fees in order to mislead outsiders and to pretend that they are of better quality.

The general aim of this thesis is thus *to examine the mechanisms of signalling the intrinsic quality of a university with the help of setting tuition fees*. The paper adds to the existing literature by introducing a signalling model, which explains the incentives and constraints both the university and the student face, to the broad topic of university quality and tuition fees. In this thesis we develop a sender-

[1] We refer to the students as being male (by writing he, him and his). However, we want to underline that we do not wish to discriminate, but rather chose the male form for simplicity reasons.

receiver game in which we take the perspective of a university. In this, universities are able to choose two different levels of tuition fees in order to indicate their intrinsic value to the student and to overcome the existing information asymmetries.

The remainder of the paper is organised as follows. First, a literature review provides an introduction to the topic by presenting an overview of the recent development of tuition fees and the existing literature on universities. Section 3 shortly discusses the theoretical background regarding signalling literature. Third, the set-up of the model is explained, the principal variables and the possible actions of the players are further defined and the model is solved. Fourth, the equilibria and their implications are analysed and discussed. The final part consists of limitations and indicates ideas for further research, before a conclusion summarises the main findings of this thesis.

2. Literature Review

The field of higher education and the behaviour of students and universities is a relatively new field in the academic world of economics. Therefore, there exist only few articles of high relevance to this thesis, particularly because no previous research has yet used a game-theoretical signalling model to study the effects tuition fees can have on the behaviour of students and universities. As an introduction, we briefly summarise some stylised facts about the international development of tuition fees and subsequently the relevant literature of higher education.

2.1. Tuition Fees – Definition and Development

In accordance with Marcucci and Johnstone (2007) we define tuition fees as "a mandatory charge levied upon all students (and/or their parents) covering some portion of the general underlying cost of instruction" (p. 26). As one might expect, the higher the quality of a university, the higher the tuition fees the university can charge without a significant drop in students' demand. Exemplifying for this are two German universities, though examples can be found in most countries: the European Business School in Oestrich-Winkel (EBS), one of the top ranked private business schools not only in Germany, but also in Europe, and the public University Essen-Duisburg, which is subject to a rather low ranking place. Whereas the EBS charges 13,000 Euros per semester for its Master program, the tuition fees of the University Essen-Duisburg amount to only 1,000 Euros (European Business School, 2008; Universität Essen-Duisburg, 2008). Today there exist relatively few universities and countries in the Western world where no tuition fees are charged, one of the rare exceptions being public universities in Sweden.

The phenomenon of charging students and their parents for higher education has been a rather recent one. Historically, students in general, but particularly the brightest ones, were supposed to receive free education because education was not only regarded as a fundamental right but also supposed to be independent of both social classes and the income of parents (Marcucci and Johnstone, 2007). Rather recently however, there has been a shift in this argumentation and universities have started to charge for the service they offer, due to the fact that the benefits of receiving higher education (a well-paid job or an increased reputation) are assumed to be substantially higher than the costs associated with going to university. Charging for education not only implies that students are likely to put more effort into their studies, but also that they select a university more carefully, as not everybody is willing or able to pay a certain amount for higher education (though the aspect of university selection by the student is not explicitly taken into account in this thesis). The result for universities is an increase in competition for students and this in turn is likely to have positive effects on the operating efficiency and quality of universities, as is analysed to greater extent in the paragraphs below. Even though this

argumentation is intuitively appealing, increasing tuition fees have only truly emerged eleven years ago in Western Europe, when universities in the United Kingdom decided to raise their fees for the first time by more than the nominal increase of the inflation rate. Only The Netherlands and Portugal charged fees already before 1997, however, as those were usually very small amounts, this is often neglected (Johnstone, 2005). Since then, though, tuition fees have risen constantly in many countries: Ehrenberg (2001) finds an average annual increase of 2-3 percentage points above the inflation rate for reasons discussed later.

If a particular university decides to charge tuition fees, those can be paid at two points in time: either up-front that means before the start of the academic year or deferred when the student has completed higher education. The argumentation for the former policy, as it is currently implemented in for example The Netherlands, assumes that it is the parents' responsibility to (help) pay their children's education. On the contrary, countries which choose a university policy with no, for instance Sweden, or deferred tuition fees, such as the 'Graduate Endowment Scheme' in Scotland, are of the opinion that parents are either not responsible for paying for higher education or cannot afford to do so. Alternatively such countries may acknowledge that students cannot be expected to study and earn money at the same time in order to pay the fees. It further has to be taken into account that parents may just not be willing to pay fees, even though they have the financial ability to do so. However, the two approaches are by far not the only ones; other countries use a combination of upfront and deferred payments. Kenya or Russia for example have implemented dual-track policies where "university places are awarded by the government based on some criteria and other places are available to qualified, but lower-scoring students on a tuition fee paying basis or special continuing education or professional courses are set up by universities for which they charge tuition fees" (Marcucci & Johnstone, 2007, p. 33). Others, for example The Netherlands, simply charge non-EEA (European Economic Area) students more than national or EEA students. For the academic year 2008/2009 the tuition fees amount to 1,565 Euros for national and EEA-students, whereas non-EEA citizens have to pay 8,000 Euros, the difference thus being about 6500 Euros (Universiteit Maastricht, 2008). Additionally, whereas the fees for EEA students have only risen slightly over the last years, the fees for international students have increased drastically at the same time and resultantly also the difference: four years ago EEA students had to pay 1,476 Euros and non-EEA students 4,340 Euros (Universiteit Maastricht, 2004). In general, within the EU the cost of higher education has risen particularly in those countries, which experienced a greater inflow of foreign students, since these countries subsidy "the net sending countries" (Biffl & Issac, 2002, p. 434).

Rising tuition fees as such are a rather recent phenomenon, as Ehrenberg (2001) states. Furthermore, according to Van Riper (2007), the rise in tuition fees is completely disproportionate to the inflation rate, measuring the average increase in the cost of living. As an example, he states that the ten most expensive schools in the United States have increased their tuition fees by 52% from 1999 to 2006. At the same time, the cost of living has only risen by 21%, thus less than half. Ehrenberg (n.d., as cited in Van Riper, 2007) claims that most schools' focus is not to lower costs, but simply to be classified among the top schools. Thus, the growth of tuition fees above the inflation rate can be attributed to the failure of universities' management to effectively keep costs low (Ehrenberg, 2001). Further, many of the well-known universities have far more applicants than places available, thus universities experience no direct need to decrease costs, as long as students are willing to pay ever-increasing fees. Additionally, federal government policies can also have an effect on the increasing tuition fees, an example being the United States, where the maximum amount of the 'Basic Educational Opportunity Grant' has not increased alongside the rise in inflation. This implies that providing financial aid becomes more and more the responsibility of the institution, therefore resulting in increased pressure to

raise tuition fees. Furthermore, despite the rising tuition fees, it has to be kept in mind that especially public colleges rarely fully cover their production costs of providing education with only the income from tuition fees. Winston and McPherson (1991) claim that in 1991 only 30% of the operating costs at public universities or colleges were covered by revenues being made up of tuition fees.[2] This implies that other sources of income such as endowments and donations account for a substantial part of total income and hence students are not required to pay the entire costs of education but only a reduced rate.

As can be inferred from above tuition fees are often set as some percentage of instructional costs; yet this may be misleading and problematic, since even within one university, costs may vary among programs and institutions and further, because it is difficult to correctly spread and specify the overall institutional costs across the different schools and programs. Therefore, some countries, for example South Africa or China, base their tuition fees on the costs of a particular program. Further, it is also common to charge fees according to the reputation that can be gained from attending certain programs. According to Marcucci and Johnstone (2007) this (amongst others) explains why medical schools are usually more expensive than arts colleges. Apart from the high costs associated with offering such a program, being a doctor is viewed to be a prestigious job by the majority of the society. Again other countries, such as Germany, decide to impose a fine on students who need more than average time to complete their studies in addition to the regular study fees to further cover costs.

Interestingly enough, current research which has been conducted across various countries so far indicates that the "demand for higher education is relatively inelastic in the face of price increases" (ibid., p.37). However, at some point in time there may be a change in the proportion of students enrolled from lower income families. The introduction of tuition fees in parts of Germany (starting in 2005) has not only been met with protest but has also resulted in approximately 18,000 high-school students, who obtained their high-school degree in 2006, not attending university, the largest fractions being women and students from low-income families (Spiegel, 2008). Yet, rising tuition fees often also have another important impact in that many students have to work besides studying in order to afford the fees and can thus concentrate less on their studies. Nonetheless, more extensive research on the effects and impacts of tuition fees is needed in order to draw general and more internationally valid conclusions.

In sum it can be stated that the recent abnormal increase in tuition fees is viewed critically by scholars, who in turn mostly blame the inefficient cost management of universities for this. From the side of the students, the introduction of tuition fees has been met with criticism. Nonetheless, universities and academics view it as necessary to charge students in order to cover some proportion of the costs of providing education. Next to donations or university endowments, tuition fees provide the main sources of income for a university and are thus an important contribution to the university's operations.

2.2. University Literature

Higher education is part of a specific industry and as such has several features that distinguishes it from other sectors and industries. Fraja and Iossa (2002) identify three differentiating characteristics: Firstly, the market for higher education is not easily understood and thus the underlying principles with which it functions are not always obvious, in that most universities allocate their available places

[2] Newer figures derive similar, yet more volatile results and range from an average of 23% in the region of British Columbia, Canada to 45% for the New Jersey's Science and Technology University, USA (Legislative Session of the Canadian Parliament, 2001; New Jersey's Science and Technology University, 2006).

based on admission criteria and not necessarily take into account the market price for higher education. Secondly, the quality, or output, of a university depends to a large extent on the quality of its students as the input. Students themselves thus have an impact on the quality of the education they receive, which is why this is referred to as the peer-group effect. Lastly, universities cannot be considered to act as true profit-maximisers.[3] Winston (2003) further adds to this that universities utilise unconventional revenue sources such as donations in order to balance the school's budgets and to close the gap between production costs and sales price.[4] Especially in the United States the importance of private, as well as public donations should not be underestimated: according to Winston 75% of the total educational revenues are composed of voluntary past and present contributions.

The literature with regard to universities and their tuition fees can be said to have started with a paper by Rothschild and White (1995), who deploy economic theory and examine in how far this theory can be applied to the practical world of higher education. The authors develop a model for service organisations, where the experienced output depends to a large extent on the customers as input. Universities are regarded as profit-maximisers and students contribute to and benefit from the education they receive in that an individual student not only increases his own human capital during the study period but also that of his fellow students. A university can internalise this externality by offering each student an individual financial aid package. The produced human capital is thus allocated among the students, where the net price to each student is the tuition fee less a value for his input (that means the effect of his human capital on his classmates). Consequently, qualified students have to pay a smaller amount than less qualified ones because the former contribute more to the overall quality and thus receive more financial aid. According to the authors, these prices charged are both competitive and further support efficient allocations, albeit they acknowledge that the introduction of market imperfections might cast doubts on the results obtained.

Rather than examining in how far economic theory can be fitted to reality, Winston uses the exact opposite approach in his 1999 published paper. He examines the economic "realities of higher education to see how far toward useful theoretical precisions they can be pushed" (p. 14). He observes the following aspects: Firstly, the majority of universities are non-profit organisations, which does not mean that they run at a deficit, but only that they are not owned by someone to whom their revenues should be distributed. Secondly, as already stated above, universities rely heavily on the peer-group effect which "cannot be bought from anyone other than its own customers" (p. 18). This also explains why universities have to compete for students as their own quality depends to a large extent on the human capital imported by their students. Lastly, Winston claims that there exists a hierarchy among universities, where the university with the highest number of donations is at the top and thus can choose its students more carefully and exercise control over students' quality to a larger extent than a school without a lot of funding. From this he then draws the following two conclusions: Universities depend on the input of their own students (analogous to Rothschild and White's finding) and therefore aim to have a high influence on whom they accept, as the quality of the current students also has an effect on the quality of next year's applicants. Moreover, the approach of teaching (for example lecture based versus group work and small group tutorials) should be altered depending on the funds available and the quality of students attending that university.

[3] One of the reasons being that universities seldom have one single owner to whom they are responsible or to whom they have to pay out their profits.

[4] From: *Toward a theory of tuition: prices, peer wages, and competition in higher education*, by G. C. Winston, 2003, Williamstown: Williams Project on the Economics of Higher Education. Cited with permission of the author.

One of the more recent papers is written by Gary-Bobo and Trannoy (2007), in which the authors focus on different selection criteria (or screening instruments) universities can use, in order to select the students which bring along the highest amount of human capital. They show that in addition to selecting students with the help of tuition fees, various other admission criteria such as entry tests are useful if there exists some asymmetric information between the university and the student. However, as soon as the information set of the student contains that of the university that is when the student perfectly knows about his own talent, only tuition fees should be utilised in order to determine the right students.[5] This means that admission criteria and standards, such as a specific grade point average or social activities besides school, are useless and that tuition fees are the optimal self-selection instrument. In an older version of this paper, Gary-Bobo and Trannoy (2004) further demonstrate that the optimal tuition fee "can entail an element of direct subsidy […] which is an increasing function of the university's information accuracy" (p. 27). This in turn implies that the tuition fees can be smaller than the marginal costs of providing the education and that the two may only be equal if the information set of a student includes that of a university. This also sheds light on the importance of donations from outsiders to balance the universities' budgets.

Del Rey (2001) develops a model in which universities compete for students both because of their human capital, as well as their financial resources, either in terms of tuition fees or via the government.[6] In Europe, universities are often assigned a fixed amount of money from the government, depending for example on the number of students, which they can distribute between their departments and schools, or use for teaching and/or research. Del Rey develops a two-stage game between competing universities that both teach and research and thus have to allocate their funds accordingly. In order to reach a certain quality level, the university will only admit the brightest students, as fewer professors are susequently required to reach the desired quality outcome. Del Rey finds four symmetric equilibria which are full-time teaching, full-time research, research and mass teaching and research and only selective teaching. Further, through selective policies, the government is able to influence the research and education budget to some extent, so that it has a minor influence on the quality of both aspects.

One of the rare papers to actually examine a game between a university and a student is the paper by Epple, Romano, Sarpça and Sieg (2006). The authors take a closer look at a two-stage game between a single college and its applicants. Based on the application package received from each student the university makes its decision as to whether to accept a student or not. The student (after having received offers from more colleges) then decides which college to attend. Students also have the chance to negotiate about favourable financial aid conditions during which the university can obtain further information about the student. Epple et al. demonstrate that it might be better for students to reveal outside offers during the bargaining process, as this further underlines their ability. This is emphasised by the fact that universities usually respond with a better offer, which is in line with results obtained in prior research.

Evidently the research area with respect to higher education, tuition fees and students is still a relatively new field. Though there exist various strands within this field, where some of them focus on the actual selection of universities, while others look at the budget decisions universities face until today, there exists no paper that truly responds to our research objective, namely, the mechanisms behind the university's ability to signal its intrinsic quality with the help of tuition fees. Moreover, even though

[5] This holds as long as the loan market for students functions perfectly. However, discussing the effect of student loans and possible imperfections of the loan market is beyond the scope of this paper.

[6] Even though we do not deal with competition among universities in this thesis, her paper is of interest as it is one of few to actually examine signaling games in combination to institutions of higher education.

some authors have dealt with the level of tuition fees on a qualitative setting, in addition to articles in newspaper which focus on the implications of high or low tuition fees, a sender-receiver game, aiming to describe the action between the student and the university with respect to this issue has not yet been developed.

3. THEORETICAL BACKGROUND

In 1970, Akerlof laid the foundation for the signalling theory and was the first to discuss the impacts of asymmetric information and what happens to the market when one player knows more than the other. The two general solutions to this problem are screening, proposed by Stieglitz in 1961 and signalling, introduced by Spence in 1973. Spence's paper about job market signalling, in which he analyses the job market from the perspective of the employer, as an example for a situation where uncertainty is prevalent, influenced all other signalling papers following thereafter. He describes individuals having either high or low ability, who can attempt to show this ability via their choice of education, where obtaining education is expensive, and therefore seen as a costly signal. The individuals can thus choose to invest in higher education and the employer, upon receiving the signal, can attempt to estimate the underlying productivity and in turn pay a wage according to this productivity.

In general, signalling games are made up of two players, where one has an informational advantage over the other, which influences the action taken by the second player and the outcome of both players (Dutta, 1999). In the literature, the first player is called the 'sender' and the second player the 'receiver', which is why the games are often referred to as sender-receiver games. After nature chooses a state for the sender, where the sender is well-aware of his own state, he can then send a message or signal to the receiver, who tries to interfere something from this message in order to take the appropriate action. The payoffs for both players thus depend on the signal sent by player 1, the sender, and the action chosen by player 2, the receiver.

The relevant equilibrium for signalling games is the perfect Bayesian equilibrium (PBE) and is made up of three distinct requirements: Player 1 has to play best response, player 2 also has to play best response and in all cases there has to be a correct estimate revision. As one can see, the PBE is a development of the Nash equilibrium because it adds the restriction that the uninformed player is allowed to incorporate new information obtained throughout the game. The definition of the PBE thus "no longer consists of just a strategy for each player but now also includes a belief for each player whenever the player has the move but is uncertain about the history of prior player" (Gibbons, 2007, p. 142). One can distinguish two types of PBE: on the one hand a separating equilibrium, where senders can be differentiated because they send out different messages and on the other hand a pooling equilibrium, where distinction is impossible because the same signal is sent out (ibid.).

A further development of signalling games are those influenced by noise. De Haan, Offermann and Sloof (2008) give two reasons why such a noise may exist: either there are problems with the production technology or the receiver has difficulties in understanding the signal due to asymmetric information. The first important contribution with respect to noisy signalling was written in 1983 by Matthews and Mirman, who introduce a noisy signal to a limit pricing game. They find that the equilibrium differs from the standard signalling equilibrium in three main aspects; firstly, there is a finite number of equilibria and usually there exists only one; secondly, the equilibria depend on prior beliefs of the signal's observer; and thirdly, the equilibrium obtained is rich in comparative statistics because "different amounts of information are conveyed in different separating equilibria, so that the signal observer's welfare is affected by changes in the equilibrium signalling function" (Matthews & Mirman, 1983, p. 982). Carlsson and Dasgupta (1997) further develop Matthews' and Mirman's idea in

that they let the noise vanish and focus on games that are noise-proof. Their main results are that noise proofness is a robust and strong notion. The equilibria obtained always belong to the subset of "never-a-weak-best-reply" criterion and are often unique, yet never separating (ibid., p. 434). The paper by de Haan et al. (2008) further adds to this and develops a noisy signalling game in which both separating as well as pooling equilibria exist. The implications are that the introduction of noise into the game leads to fewer pooling as well as separating equilibria. The noisier the signal, the fewer chances there are to observe a separating equilibrium until it disappears for very high levels of noise. This is in line with the results obtained already by Matthews and Mirman whose paper is often considered as path-breaking.

In general, the fascinating aspect about signalling games is the tension developing between the sender and the receiver of the message due to the fact that the former controls the information, whereas the latter is responsible for the final action taken which determines payoffs. Therefore "the receiver wants to deduce the sender's type from the sender's message, and the sender may have an incentive to mislead the receiver" (Meunier, 2006, p. 3).

In the model that is developed in the section below, there exist two types of universities, good universities and bad ones. Since their quality cannot be observed from the outset both types of universities have an incentive to signal their intrinsic value in order to overcome information asymmetries. For universities there are various ways to signal quality. Firstly, new or renovated facilities can provide a useful signal for prospective students. Not only does the university seem to have enough money to focus on its facilities, but it may also show that the institution is confident that students acknowledge and appreciate this. Secondly, universities are further able to signal with the help of marketing tools such as brochures and flyers that are sent out to prospective students or to alumni. Lastly, a university can also signal through the price it charges for its education, namely the tuition fees. In this thesis we leave aside other potential forms of signalling and only concentrate on the latter, which is also one of the most prevalent forms to signal quality in the higher education sector. Further, this makes intuitivly sense as well, since good/bad universities usually have better/worse facilities and also spend more/less money on marketing tools to attract different types of students.

4. THE MODEL

The introduction already indicated that the aim of this thesis is to develop a sender-receiver game in which the university attempts to signal quality and the student, upon receiving the signal, takes the appropriate action in order to receive the highest payoff. In this section we elaborate on our rationale for developing such a model, as well as the main assumptions before the action sets of the two players are explained. As a final step, the model is developed and solved.

4.1. RATIONALE AND ASSUMPTIONS

Before describing the model in detail, the general objective of developing such a sender-receiver game needs to be clarified. The underlying intention is to use the well-known fact that students have imperfect information about universities' quality; for example students are not able to perfectly observe the true quality of a certain university prior to attending the institution. Therefore, as was suggested above, one way to resolve this issue is for the university to convey some meaningful information to the student with the help of signalling. The perspective of the developed model is that of a university, which means that with the help of the model we try to examine if universities have the ability and/or the incentive to signal a certain quality level to students with the help of the tuition fees

they charge. Thus, the goal is to examine if a signalling equilibrium exists under which all parties behave honestly and do not deviate from the proposed strategy.

The model below distinguishes between good and bad universities, however, such a differentiation on the basis of quality is difficult. Not only do universities vary in their mission but also in the students they (aim to) attract. Thus, the only true comparison one can draw is between schools with the same mission and the same clientele, and even this may turn out to be challenging. Another issue that has to be taken into account and was mentioned previously is the peer-group effect, which influences both the quality and the reputation of a university. Thus when attempting to compare universities, it also has to be acknowledged that students with a similar amount of human capital attend the schools which are evaluated against each other. All this said one should additionally not forget that every observer is subject to his own personal judgement and subconscious subjectivity. Therefore, we are well aware of the fact that any decision about what constitutes a good or a bad university is vague and therefore may be subject to criticism. In order to limit the potential criticism on this model, we therefore decide to only focus on schools and universities offering business programmes. Furthermore, it is important to notice that we restrict our analysis to Master programmes, thus the model assumes that each student has already acquired some prior higher education, most likely a Bachelor degree. Moreover, the quality of a university is measured as its intrinsic value, which is often tried to be captured with international rankings. However, quality as such is defined rather broadly and it encompasses next to the quality of teaching also further aspects such as the offering of language-courses, the opening times of the library, the possibility of having an exchange semester and so forth. The precise distribution of good and bad universities in the population of all institutions of higher education is described in more detail below.

In order to hold the model as simple as possible, it is assumed that admission criteria and related issues of universities trying to select the best students are exogenous to the model. Further, universities have only one single department and are endowed with market power with regards to providing higher education. Students are assumed to be willing to attend any university, thus the question of students applying for different universities and selecting their own optimal university is not treated in the model. The model's focus lies on the signalling aspect of universities only, rather than on developing an overall and complete model of the university's and the student's behaviour. Furthermore, we only take into account direct costs for the student, which means the tuition fees he has to pay. Since indirect costs the student occurs, such as foregone earnings or personal costs of moving to a different place are not only difficult to estimate but also do not play a role in this thesis, they are therefore left aside. Lastly, both players are assumed to be rational and this is further assumed to be common knowledge.

4.2. THE GENERAL SET-UP

The sender-receiver game that is developed in this thesis consists of two players; a university, the sender, and a student, the receiver, who engage in a dynamic signalling game with asymmetric information. In line with the general set-up of signalling games, nature first selects the quality level of the university to be either *good (G)* or *bad (B)*, according to the probability distribution $p(t_i)$ and given this distribution, the student has some prior beliefs about the university's type. A university is good with probability $p(t_G)$ and bad with probability $p(t_B)$, where $p(t_B) = 1 - p(t_G)$. Further, we define a good university in line with the dictionary's definition of a world class university that means "ranking among the foremost in the world; of an international standard of excellence" (The Free Dictionary, 2008). Thus, quality differences between the different types of universities are explicit and substantial.

After nature has determined the state of a university, the university is aware of its own quality, and subsequently wants to communicate this to the outside world. In order to do so, it selects the level of its tuition fees, denoted as *TF*, to be paid up-front, and hence at the beginning of each period to be either *high (H)* or *low (L)*, the message thus being $m_j = \{high, low\}$. The student receives the message without knowing the true underlying quality of the university. Given the observed level of tuition fees, the student is able to update his prior beliefs about the university and consequently also able to decide whether to accept the university's offer or not. The updated beliefs of the student are denoted as μ_H (the student's belief that a university is good, given that he observes high tuition fees) and μ_L (the student's belief that a university is good given that he observes low tuition fees).[7] The payoffs for the university and the student depend thus on the underlying quality of the university as determined by nature and the signal it sends, as well as the action that the student takes in response to the observed signal. The setup for the model is depicted in Figure 1 below, where *A* implies that the student accepts the offer of the university and attends and *NA* that the student does not accept the offer and thus refrains from attending. All other variables are explained to greater extent in the following sections.

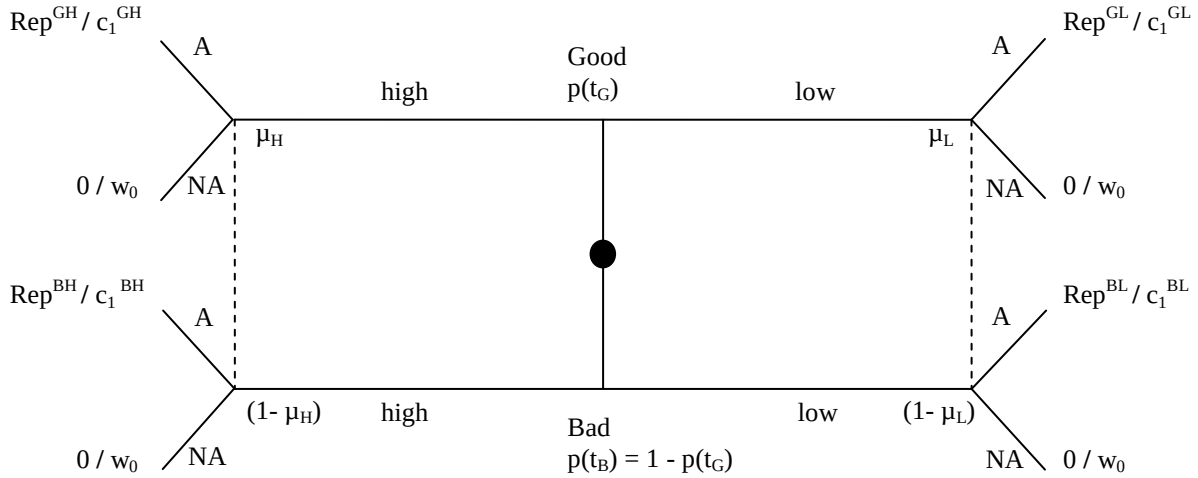


Figure 1: The general setup of the model

4.3. THE UNIVERSITY

As already stated above, in this model two distinct types of universities with different quality levels (good or bad) are assumed to exist, that means $T = \{t_G, t_B\}$. Each university independently sets the level of tuition fees ex-ante and in doing so tries to signal its quality level to the students, as the student is unable to observe the university's quality from the outside. Only thereafter does the student respond according to his own behavioural strategy by deciding whether to attend the university or whether to start working immediately. Universities are further assumed to be infinitely living. [8]

In general, the development and selection of the appropriate university objective function is essential to the final outcome of the model. However, the choice may be problematic and is nearly always met with criticism, as has been argued by Gary-Bobo and Trannoy (2004). Therefore, we neither attempt to arrive at our own complete and comprehensive utility function (which would further include every objective and constraint a university might have and face) nor do we use an already existing one (due

[7] Accordingly, $(1 - \mu_H)$ and $(1 - \mu_L)$ denote the student's belief that a university is bad given that he observes high/low tuition fees.

[8] The assumption about an infinitely living university can be explained by the hypothesis that there constantly exists a positive probability that the university will continue to exist in the next period.

to the fact that each existing academic paper tries to capture individual and very specific aspects with its university utility function which are however not applicable for our purpose). Rather we try to limit the discussion by assuming that universities care about reputation *(Rep)* ceteris paribus of any other effect. Roberts and Thomson (2007) found that "several studies […] show that wider or embedded reputation is a stronger factor in influencing student choices" (p. 4).[9] Since universities are well aware of this fact, we assume their utility to be a function of its reputation, where actions are taken at discrete times *t*, which can be depicted as follows:

$$u = f\ (Rep_t) \tag{1}$$

Further we assume that the university discounts the reputation in each period, with a discount factor φ, where $1 > \varphi > 0$, thus equation (1) can be rewritten as:

$$u = \sum_{t=0}^{\infty} \varphi^t Rep_t \tag{2}$$

As reputation is difficult to measure per se, we make it dependent on three distinct, independent variables, as can be seen in equation (3), being the level of tuition fees is, the intrinsic value (*IV*), and feedback.

$$Rep_t = \epsilon\, TF_t + IV_t + \tau\, Feedback_t \tag{3}$$

The intrinsic value is defined as the true underlying quality level of a university, which is however a priori only known to the university itself, where quality, as mentioned before, also encompasses aspects not directly linked to education itself. Feedback is defined as the response of students about the accuracy of the tuition fees a university charges in comparison to the underlying intrinsic quality level of that university; this feedback is assumed to be exogenously given. Reputation is thus positively correlated with the level of tuition fees it charges, its intrinsic value and a feedback component. Further, ϵ and τ capture the relative importance of the tuition fees and feedback respectively, where it is assumed that $1 > \epsilon > 0$ and $1 > \tau > 0$ holds, since an increase in the amount of the tuition fees or feedback is believed to have at maximum a one-to-one effect on the reputation of a university. Additionally, it has to be pointed out that the variables TF and feedback influence reputation likewise and independent of the scale, meaning that ϵ and τ are comparable.

The underlying practical and theoretical reasoning behind this equation and the relation between the three independent variables and reputation can be explained as follows. First, as was already stated in the literature review, the existence of a positive correlation of tuition fees and a university's reputation as measured for instance by its ranking place can be found by merely looking at the highest and lowest ranked universities in one field and examining the difference in their respective level of tuition fees. Further, a recent study by Aghion, Dewatripont, Hoxby, Mas-Colell and Sapir (2007) demonstrates the existence of "a strong positive correlation between the university budget per student and its Shanghai research performance"[10], and the authors conclude that money evidently helps improve performance. This relationship is also important since the cost of research for a university has been growing in the past due to "the increasing complexity and cost of scientific research" (Altbach, 2004). Since the number of published papers influences ranking positions, higher tuition fees help a university to have more resources at its disposal which then in turn can positively influence its reputation.

[9] From: *University league tables and the impact on student recruitment*, by D. Roberts and L. Thompson, 2007. The knowledge partnership. Reputation Management for universities, Working Paper No 2. Cited with permission of the authors.

[10] The Shanghai research performance is measured in the Shanghai Jiao Tong Academic Ranking of World Universities (Aghion et al., 2007).

Second, the intrinsic value or quality of a university is characterised by a combination of research and teaching and the relative standing of those in comparison to other institutions. Evidently, the better a university is the better is also its reputation. Third, the reason behind the feedback component is that in general former students and exchange students play an important role when elucidating the reputation of universities. Depending on their past experience, they may for instance contribute to funds by either donating privately or by becoming a corporate sponsor of the university via the company they work for. Alternatively they may provide feedback to current students directly or in an indirect way via responding to ranking questionnaires.[11] This reasoning was empirically highlighted by Monk and Ehrenberg claiming that "changes in an institution's ranking do influence its […] financial aid bill. […] As a result, institutions have an incentive to take actions that will positively influence their ranking" (1999, as cited in Ehrenberg, 2001, p. 94). Thus, universities are concerned about the effects of their actions and the feedback they receive which consequently influences their reputation.

Therefore, with the help of the objective function depicted in equation (1) and (2) and the clarification of reputation in equation (3), the possibility of dishonesty when it comes to the behaviour of a university is tried to being captured. Intuitively speaking, no high quality university has the rationale to charge lower tuition fees as this would understate its true intrinsic value and would lead to no obvious advantages but rather result in a loss of potentially high qualified students and obviously reduced income, which would then in turn imply that quality actually takes a turn to the worse.[12] In case a good university still does charge low tuition fees, it is assumed that its reputation is smaller, yet again positive, as students are still satisfied with the education they receive. Therefore, only a bad university potentially has the incentive to signal a higher quality level and thus cheat. In case a university deceives when setting its tuition fees, this model assumes that such actions will feed back into the reputation in succeeding periods.[13] For simplicity reasons, the model focuses on a static university objective function, where only a single point in time is examined. For the feedback component in equation (3), this means that the expected feedback a university receives in the future only depends on the actions at one point in time and is discounted and taken into account by the universities already at that particular point in time. For this reason, this setting attaches a harsh signalling cost to false behaviour, as this ultimately reduces the university's reputation. This also highlights the importance for each university to try to correctly signal its intrinsic value to today's students, as negative behaviour today severely influences the future feedback the university obtains.

The university's expected utility in terms of reputation only depends on the payoffs of a particular action taken by the student, thus in case the student agrees to attend a university, the payoff in terms of utility is equal to the reputation it receives. In case the student prefers another university or chooses not to go to university at all, the institution does not gain anything by that particular student, neither in terms of quality, nor in terms of tuition fees representing a part of income to the institution implying a payoff of zero. Furthermore, and intuitively speaking, high tuition fees are always assumed to be preferred to low tuition fees by the university implying $u(TF^{High}) > u(TF^{Low}) > 0$ and positive feedback is preferred to negative feedback, which implies that $u(Feedback^{Positive}) > u\,(Feedback^{Negative})$. A summary of the four possible outcomes for both types of universities is depicted in Table 1 below, where the superscripts of reputation denote the university's quality, good/bad, in combination with the tuition fees, high/low, it charges. The same holds for the super-

[11] The Financial Times Ranking "Master in Management 2008" for instance contacted 9,907 alumni, out of which 4,331 responded (Financial Times, 2008).
[12] The fact that a good university may be forced to charge low tuition fees (for example by the government) is disregarded and not assumed to exist in the model.
[13] The importance of such feedback loops has been highlighted, for example, by Spence (1973).

scripts of tuition fees and intrinsic value, which can both be high and low, and for the feedback which is positive or negative. Hence, for the remainder of this paper these variables are assumed to be of ordinal scale.

Type of University	Level of Tuition Fees	University Payoff Functions
Good	High	$Rep^{GH} = \epsilon\, TF^{High} + Intrinsic\, Value^{High} + \tau\, Feedback^{Positive}$
	Low	$Rep^{GL} = \epsilon\, TF^{Low} + Intrinsic\, Value^{High} + \tau\, Feedback^{Positive}$
Bad	High	$Rep^{BH} = \epsilon\, TF^{High} + Intrinsic\, Value^{Low} + \tau\, Feedback^{Negative}$
	Low	$Rep^{BL} = \epsilon\, TF^{Low} + Intrinsic\, Value^{Low} + \tau\, Feedback^{Positive}$

Table 1: The payoffs for the university

As can be seen in the table above, the good university always attempts to charge high tuition fees, since this increases the revenues to further enhance quality and thus ultimately the reputation. For the bad university it depends on the assumption of the difference between Rep^{BL} and Rep^{BH}. In case $\epsilon\left(TF^{High} - TF^{Low}\right) < \tau\left(Feedback^{Positive} - Feedback^{Negative}\right)$ the bad university attempts to charge low tuition fees, whereas if the opposite holds, the bad university finds it more optimal to charge high fees. If the two are equal, the university is evidently indifferent.

Before describing the student's behaviour in more detail, the following aspect needs to be pointed out: in the model, the university's utility depends on its reputation only, which in turn however means that with the help of its reputation, a university tries to attract the best students possible. Consequently the university tries to signal its quality to the students. As described above, the peer-group effect highlights this reasoning, as more qualified students lead to a positive externality for other students and in turn increase the overall quality of the university. However, since the model which is developed does not differentiate between good or bad students, universities signal their quality to everybody, which means that any student is willing to accept the offer in case his utility derived from attending the university is bigger than his reservation utility. This also means that selection criteria on behalf of the university are not part of the model. However, one can still argue that a good student has a larger incentive to study at a good university than a bad student. The reason behind this is that firstly, we can assume that a bad student will be expelled from the good university if he does not achieve certain standards in terms of academic success. An example of this is that most universities have some rules in the form that a certain number of credits needs to be obtained within a year (for example within the first year), or that exams cannot be repeated infinitely. Secondly, one can further argue that a self-selection mechanism might exist, in which unqualified students (or at least a portion of those) do not choose to pay high tuition fees which are associated with a high quality university and thus rather abstain from studying, an argument which was stressed by for instance Gary-Bobo and Trannoy (2007). Thus, it can be argued that despite the fact that heterogeneous students are not explicitly modelled, there exists some evidence that a good/bad student will rather attend a good/bad university which corresponds to his true human capital than the other way around.

4.4. THE STUDENT

In our model all students are assumed to have homogenous beliefs and demands, where their population is normalised to one, implying that a symmetric consumption allocation exists among all students of a given population in any time period. Decisions are made at the beginning of a period. Furthermore, an efficient consumption allocation, in which all endowments are consumed during the maximisation process is assumed (McCandless & Wallace, 1991).

An individual student's preferences can be depicted by the following inter-temporal utility function:

$$u = E[logc_t + logc_{t+1} + logRep_t] \quad (4)$$

Assuming $t = 1$, the student's utility is positively correlated with his expected level of consumption in period one (c_1) and two (c_2), as well as the expected reputation of the university (Rep_1).[14] Three important aspects need to be clarified. Firstly, we take for granted that students mostly derive a higher utility from going to college and completing a Master program than from abstaining, and thus working and obtaining a base wage w_0. This is confirmed by various studies and researches which indicate that the starting salary for Master and Bachelor students may differ by up to 20% (Friedrichsen, 2008). Titus (2007) further concludes in his paper that "receiving a master's degree in business/management results in an 11% [excess] return" whereas when taking into account "variables reflecting labour market experience […] receiving a Master's degree in business/management results in an 21% [excess] return" (p. 506). There exists however one exception to this that is when the student has the opportunity of attending a bad university which charges high tuition fees. In this case, working is assumed to be preferred to studying, the reason being that the foregone earnings and the high amount of fees are assumed to be larger than the wage premium he can obtain from studying.[15] Additionally, as the student has already earned a Bachelor degree, he can be assured to earn a reasonable income. The student can also advance in his career during the time that his fellow students are still enrolled in higher education. We therefore assume that $c_1^{BH} < w_0 < c_1^{BL} < c_1^{GH} < c_1^{GL}$. This equation not only depicts the statement that the student prefers to work instead of going to an expensive (high tuition fees) but bad university but it also shows the relative ranking of preference of the student: an excellent university with low tuition fees is the most preferred university, since the student is able to reap the full benefits of the quality of the university in addition to saving on tuition fees. The participation constraint of the student is thus $\bar{u} \geq c_1^{BH}$ and is assumed to be fulfilled. Secondly, we define w_0 in terms of c_1^{BH}, that is $w_0 = \beta * c_1^{BH}$, where for the time being only $\beta \geq 1$ is assumed, yet a detailed discussion of β follows in Section 5.2 below. Thirdly, we assume that the utility function is both strictly increasing in each of these arguments (thus agents prefer more to less) and convex.

Equations (5) – (7) describe the individual student's budget constraints with respect to consumption in the two periods and the reputation of the attended university:

$$c_t = EN - TF + s \quad (5)$$

$$c_{t+1} = E[w] - r * s \quad (6)$$

$$Rep_t = \epsilon\, TF + E[IV] + \tau\, Feedback \quad (7)$$

$$E[w] = w_B + \{\epsilon\, TF + E[IV] + \tau\, Feedback\} \quad (8)$$

Again assuming $t = 1$, consumption in period one depends on the initial exogenous endowment *EN*, the amount of tuition fees which the university charges and the student has to pay, and on the lending and borrowing decision *s*. In period two, when the student has completed his higher education and has started working, he receives a wage *w*, which is composed of two variables, as can be seen in equation (8): Firstly, the base wage w_B, which everyone receives who is attending a university regardless of the

[14] Brewer, Eide, and Ehrenberg (1999, p. 104) conclude: "Even after controlling for selection effects, strong evidence emerges of a significant economic return to attending an elite private institution, and some evidence suggests this premium has increased over time". This implies that a university's reputation has some impact on the student's utility.

[15] The fact that a student may have to take up a loan in order to pay the high tuition fees makes it even more unlikely the he chooses to attend such a university.

quality of the respective institution, and secondly, the reputation of the chosen university. As one can see in equation (7), reputation in period one is again positively influenced by tuition fees, the intrinsic value (though for the student it is the expected intrinsic value rather than the actual intrinsic value of the university, since he is unaware of the true underlying quality a priori of attending a university) and feedback.[16] Feedback however is again assumed to be exogenously given in the student maximisation problem, for example via university rankings, thus the issue of students receiving feedback in one period and providing it in the next is not explicitly treated in the model, the main reason being that this is not central to the analysis of the sender-receiver game.

Obviously, for a student who decides not to attend university but to start working, equations (4) – (8) do not play a role, as this student receives w_0 in period one and two instead which is evidently not subject to a wage premium. Furthermore, this wage is assumed to remain constant over time.

The underlying reason for setting up the above mentioned utility function and constraints is that the student in general, when deciding which university to attend, does not only think about today, but also ahead and thus cares both about the level of consumption in period one as well as two. Moreover, the quality of the university in period one is of high importance since this affects the future wage and in turn consumption in period two. Therefore, the student can either decide to spend a higher amount of money on tuition fees in period one in expectation of attending a good university and in turn receiving a higher wage in period two, or he can spend less on tuition fees in expectation of attending a bad university. Additionally, the student has the ability to save or lend in period one, for which he receives or repays the amount of $r * s$ in period two, where r is defined as one plus the gross interest rate in period one.[17] We further assume that markets are competitive and that the student views prices as given, unaffected by his individual action. Therefore, one can interpret this setting as a two sided inter-temporal savings decision which the individual faces. On the one hand a student subject to this decision can decide to "save" either in education, which implies spending more money on tuition now, but receiving a higher wage later on or alternatively, he can save in the borrowing and lending market, for example by bringing money to a bank. Since each period a new generation of students starts attending university, this setting can be described to resemble an overlapping-generations model.

Thus, a student maximises his expected utility (4) subject to the above-mentioned constraints (5) – (7); the first-order conditions, with respect to tuition fees and savings, being:

$$\frac{\delta u}{\delta TF} = -\frac{1}{c_t} + \frac{\epsilon}{E[c_{t+1}]} + \frac{\epsilon}{E[Rep_t]} = 0 \tag{9}$$

$$\frac{\delta u}{\delta s} = \frac{1}{c_t} - \frac{r}{E[c_{t+1}]} = 0 \tag{10}$$

The student's optimal consumption level in period one is:

$$c_t = \frac{(r-\epsilon)}{\epsilon * r} * E[Rep_t] \;\leftrightarrow\; c_t = \left\{\frac{1}{\epsilon} - \frac{1}{r}\right\} * \{\epsilon\, TF + E[IV] + \tau\, Feedback\} \tag{11}$$

Therefore, the outcome of the student's optimisation problem can be interpreted as follows: the student's optimal level of consumption in period one depends on the reputation of the university with the

[16] The positive correlation between the quality of a university and the expected wage premium was examined by Chevalier and Conlon (2003), where a 6% wage premium for male graduates from the most prestigious universities (defined as those having the highest quality based on diverse quality measures) in the UK is found.

[17] As we assume the loan market to function perfectly, all students can borrow money and take up a loan without any severe disadvantage other than having less to consume in period two.

value $\frac{(r-\epsilon)}{\epsilon * r}$. This value is positive, since it was argued above that an increase in the tuition fees leads at maximum to a one-to-one increase in reputation, hence $r > \epsilon$. Thus, the amount of tuition fees charged, the expected intrinsic value of the university, and its feedback all positively influence the optimal consumption level of the student, since this positively influences the student's future wage. In case the student attends a good university, his optimal consumption in period one is higher than if a university with low quality is attended. Further, the importance of the tuition fees for the reputation of a university has an ambiguous effect on the optimal consumption of the student at point one, whereas the importance of feedback for the reputation of the university has a positive effect. However, as the intrinsic value of a university is unknown to the student in period one, he has to rely on the signals sent out by the university to determine his optimal consumption in period one and consequently to draw a conclusion about the university's intrinsic quality and its reputation.

4.5. THE GAME

Having individually described the two actors of the sender-receiver game, the possible solutions to the game are now explained in more detail. In general, such a game has four possible pure-strategy PBE: two pooling and two separating equilibria, which we consider in turn. Before conducting the analysis, two concepts deserve additional attention: the single-crossing condition and the Bayes' rule.

Firstly, before concluding that there exists a separating equilibrium in a sender-receiver game, one has to examine the single-crossing condition, as it underlies the existence of a separating equilibrium. The condition was developed by Milgrom and Shannon in 1994 and implies that "when choosing between a low action and a high action, if a low type of player I weakly (strictly) prefers the higher action, then all higher types of agent I weakly (strictly) prefer the action as well" (Athey, 2001, p. 862). This means that when a nondecreasing strategy is being used, the best response strategy is also nondecreasing. At the same time "it allows that some best response strategies might be decreasing over an interval of types where there are multiple optimal actions" (ibid., p. 866). The single-crossing condition can thus roughly be described as "whenever each opponent uses a nondecreasing strategy (in the sense that a higher types choose higher actions), a player's best-response strategy is also nondecreasing" (ibid., p. 861). Consequently, we assume this condition to hold.

Secondly, for all cases we have to determine the probability that a student considers the university to be of good quality given that he observes high (μ_H) or low (μ_L) tuition fees.

The student's beliefs must follow Bayes' rule (Meunier, 2006):

$$\mu^*(t_i|m_j) = \frac{p(t_i)\sigma(m_j|t_i)}{\sum_{t_i \in T} p(t_i)\sigma(m_j|t_i)} \tag{12}$$

$$\text{where } \sigma(m_j|t_i) = \begin{cases} 1 \; if \; m_j = m^*(t_i) \\ 0 \; if \; m_j \neq m^*(t_i) \end{cases} \tag{13}$$

In equations (12) and (13), t_i is the type of sender (either a good university or a bad one), m_j is the message or the signal (either high or low tuition fees) and μ represents the updated beliefs of the receiver upon observing the signal. Furthermore, $\sigma(m_j|t_i)$ is defined as the conditional probability of sending the message m_j, given that a sender is of type t_i.

For the four potential perfect Bayesian equilibria, the student's best response is examined first. Second, we analyse the student's best response in case either of the universities deviates and third we investigate if an incentive for the bad or the good university to deviate from the proposed strategy

actually exists. Furthermore, the analyses below are only used to illustrate whether a potential equilibrium exists, however, a sub-section within Section 5 below also determines its likelihood, and attempts to state more precisely under which conditions the equilibria hold.

As already mentioned above, the outcome of the model depends on the payoffs of the university, namely the relationship between the reputation of the bad university charging high tuition fees, Rep^{BH}, and the reputation of the bad university charging low tuition fees, Rep^{BL}. Whereas Rep^{BL} implies that the university is more concerned about the future discounted feedback, thus a large value of τ, Rep^{BH} implies that the tuition fees play a larger role, meaning a higher ϵ. Thus we will first examine what happens in case $Rep^{BH} > Rep^{BL}$ and thereafter the case where $Rep^{BH} < Rep^{BL}$.

4.5.1. Pooling Equilibrium in Low Tuition Fees: $m(t_G) = m(t_B) = Low$

In this pooling equilibrium both universities charge low tuition fees regardless of their intrinsic quality. The student's belief that a university is good when observing low fees is determined using the Bayes' rule as described in equation (12) and (13) and is equal to: $\mu_L = \frac{p(t_G)*1}{p(t_G)*1+(1-p(t_G))*1} = p(t_G)$. Receiving the signal high is the off the equilibrium path belief, thus the student's belief cannot be determined using the Bayes' rule, and consequently $\mu_H \in [0,1]$. Instead, these beliefs have to be consistent in order to be part of a sequential equilibrium.

- The student's best response in terms of his utility when observing low tuition fees is to accept the offer in case $u_S(Low,\ Accept,\ \mu_L) = p(t_G) * c_1^{GL} + \big(1 - p(t_G)\big) * c_1^{BL} > u_S(Low,\ Not\ Accept,\ \mu_L) = p(t_G) * w_0 + \big(1 - p(t_G)\big) * w_0$, where u_S depicts the student's utility. As the student derives a greater utility from attending a university in case of low tuition fees, it is hence better for him to accept the university's offer than to reject it. Thus, he chooses to attend the institution of higher education.
- In order to determine further whether it is an equilibrium strategy if both universities choose to pay low tuition fees and the student accepts these, it is examined what the student does in case one of the two universities decides to deviate and charges high fees. The student chooses to accept the offer of a university and pays high fees if: $u_S(High,\ Accept,\ \mu_H) = \mu_H * c_1^{GH} + (1 - \mu_H) * c_1^{BH} \geq u_S(High,\ Not\ Accept,\ \mu_H) = \mu_H * w_0 + (1 - \mu_H) * w_0$, which can be rewritten as $\mu_H \geq \frac{w_0 - c_1^{BH}}{c_1^{GH} - c_1^{BH}}$. Substituting w_0 with $\beta * c_1^{BH}$, it turns out that $\mu_H \geq \frac{\beta - 1}{c_1^{GH} - c_1^{BH}} * c_1^{BH}$. This implies that as long as this equation holds, the student accepts the offer of a university in case of a deviation from the proposed strategy.
- Next, one has to determine whether charging low tuition fees is a best response for the good university. By charging low tuition fees the university receives the utility $u_u^G(t_G,\ Low,\ Accept,\ \mu_L) = Rep^{GL}$. By deviating and charging high tuition fees instead the good university receives $u_u^G(t_G,\ High,\ Accept,\ \mu_H) = Rep^{GH}$ if $\mu_H \geq \frac{\beta - 1}{c_1^{GH} - c_1^{BH}} * c_1^{BH}$ or $u_U^G(t_G,\ High,\ Not\ Accept,\ \mu_H) = 0$ in case $\mu_H < \frac{\beta - 1}{c_1^{GH} - c_1^{BH}} * c_1^{BH}$. This implies that a university of excellent quality does not deviate from the proposed strategy as long as $\mu_H < \frac{\beta - 1}{c_1^{GH} - c_1^{BH}} * c_1^{BH}$, since it would then receive a lower payoff from deviating than from playing honestly.
- Last, the best-response for the bad type university has to be discussed. By playing honestly, its utility is $u_u^B(t_B,\ Low,\ Accept,\ \mu_L) = Rep^{BL}$. By deviating and charging high tuition fees instead the bad university receives a utility of $u_u^B(t_B,\ High,\ Accept,\ \mu_H) = Rep^{BH}$ if $\mu_H \geq \frac{\beta - 1}{c_1^{GH} - c_1^{BH}} *$

c_1^{BH} or $u_u^B(t_B,\ High,\ Not\ Accept,\ \mu_H) = 0$ if $\mu_H < \frac{\beta-1}{c_1^{GH}-c_1^{BH}} * c_1^{BH}$. Thus, just like the good university, the bad university does not deviate as long as $\mu_H < \frac{\beta-1}{c_1^{GH}-c_1^{BH}} * c_1^{BH}$.

Hence, the analysis above shows that a pooling equilibrium in which both universities charge low tuition fees exists if and only if $\mu_H < \frac{\beta-1}{c_1^{GH}-c_1^{BH}} * c_1^{BH}$ ($pooling_L^L$).[18] Alternatively, in case the updated beliefs of the receiver upon observing high tuition fees $\mu_H \geq \frac{\beta-1}{c_1^{GH}-c_1^{BH}} * c_1^{BH}$, the good as well as the bad university have an incentive to deviate and charge high tuition fees, resulting in a pooling equilibrium in high fees ($pooling_L^H$). However, the overall equilibrium further depends on the following specifications about actions of a bad university: Firstly, we examine the case of $Rep^{BH} > Rep^{BL}$: in this case the bad university has an incentive to deviate and receives Rep^{BH} and thus gets a higher utility than if it played honestly and charged low tuition fees. Consequently, the solution of the game depends on the updated beliefs of the student. Secondly, in case $Rep^{BH} < Rep^{BL}$ and in case all players know about this, independent from the value of μ_H, the bad university does not charge high tuition fees, as this leads to a lower reputation. If both the student and the bad university know about this, the good university can charge high tuition fees, and the student is guaranteed to receive a high quality education upon accepting the offer. Therefore, in this second case no pooling equilibrium exists in which both universities charge low fees.

4.5.2. Pooling Equilibrium in High Tuition Fees: $m(t_G) = m(t_B) = High$

The second possible pure-strategy equilibrium which is examined is the pooling equilibrium in which both types of universities charge high tuition fees. The student's updated beliefs that a university is good when observing high fees is equal to: $\mu_H = \frac{p(t_G)*1}{p(t_G)*1+(1-p(t_G))*1} = p(t_G)$ and receiving the signal low is the off the equilibrium path belief, thus $\mu_L \in [0,1]$.

- Again, the student accepts the offer if his utility $u_S(High,\ Accept,\ \mu_H) = p(t_G) * c_1^{GH} + (1-p(t_G)) * c_1^{BH} > u_S(High,\ Not\ Accept,\ \mu_H) = p(t_G) * w_0 + (1-p(t_G)) * w_0$.
  Substituting again $\beta * c_1^{BH}$ for w_0 means that $p(t_G) * c_1^{GH} \geq [\beta - (1-p(t_G))] * c_1^{BH}$, thus if $c_1^{GH} \geq \frac{\beta-1+p(t_G)}{p(t_G)} * c_1^{BH}$ then the student accepts the offer of an expensive university.
- Next, again the action of the student in case of a deviation of one of the university's has to be analysed. The student receives the payoff of $u_S(Low,\ Accept,\ \mu_L) = \mu_L * c_1^{GL} + (1-\mu_L) * c_1^{BL}$ when going to university in comparison to $u_S(Low,\ Not\ Accept,\ \mu_L) = \mu_L * w_0 + (1-\mu_L) * w_0$ when abstaining. Thus the student attends university in case $\mu_L * c_1^{GL} + (1-\mu_L) * c_1^{BL} \geq \mu_L * w_0 + (1-\mu_L) * w_0$. Thus, it has to hold that $\mu_L \geq \frac{w_0-c_1^{BL}}{c_1^{GL}-c_1^{BL}}$. As was argued before, the student always prefers to attend university when low tuition fees are charged. This is further verified since the numerator is negative, and the denominator positive; therefore, the decision of the student is independent of his updated beliefs, and μ_L can take any value.
- Furthermore, it has to be examined whether charging high tuition fees is a best response for both the good and the bad university, given the action the student takes thereafter. By charging high tuition fees, the good university receives $u_u^G(t_G,\ High,\ Accept,\ \mu_H) = Rep^{GH}$ if $c_1^{GH} \geq \frac{\beta-1+p(t_G)}{p(t_G)} * c_1^{BH}$ or $u_u^G(t_G,\ High,\ Accept,\ \mu_H) = 0$ if $c_1^{GH} < \frac{\beta-1+p(t_G)}{p(t_G)} * c_1^{BH}$. By deviating and

[18] The superscript refers to the actual equilibrium that is obtained, whereas the subscript refers to the equilibrium that is examined and tested.

charging lower tuition fees instead, the university gets $u_u^G(t_G,\ Low,\ Accept,\ \mu_L) = Rep^{GL}$ if $\mu_L \geq \frac{w_0 - c_1^{BL}}{c_1^{GL} - c_1^{BL}}$. Therefore it is optimal for the good university to charge high tuition fees and to signal good quality if $c_1^{GH} \geq \frac{\beta - 1 + p(t_G)}{p(t_G)} * c_1^{BH}$. In case $c_1^{GH} < \frac{\beta - 1 + p(t_G)}{p(t_G)} * c_1^{BH}$, the university sets low tuition fees.

- The bad university receives $u_u^B(t_B,\ High,\ Accept,\ \mu_H) = Rep^{BH}$ if $c_1^{GH} \geq \frac{\beta - 1 + p(t_G)}{p(t_G)} * c_1^{BH}$ and zero otherwise when charging high tuition fees whereas it receives $u_u^B(t_B, Low,\ Accept,\ \mu_L) = Rep^{BL}$ when charging low tuition fees if $\mu_L \geq \frac{w_0 - c_1^{BL}}{c_1^{GL} - c_1^{BL}}$. Once more, if $c_1^{GH} < \frac{\beta - 1 + p(t_G)}{p(t_G)} * c_1^{BH}$, the university charges low tuition fees.

Again, one has to discuss the cases when Rep^{BL} is either higher or lower than Rep^{BH}. In case the bad university prefers feedback over tuition fees it deviates implying that there can never exist a pooling equilibrium in high tuition fees. Thus, one can argue that a pooling equilibrium in which both universities charge high tuition fees can only exist if the bad university prefers the tuition fees over the feedback and even then only in case $c_1^{GH} \geq \frac{\beta - 1 + p(t_G)}{p(t_G)} * c_1^{BH}$ ($pooling_H^H$). If, however, $c_1^{GH} < \frac{\beta - 1 + p(t_G)}{p(t_G)} * c_1^{BH}$, the student does not accept the offer of any university charging high tuition fees, in which case both universities deviate and charge low tuition fees, resulting in the pooling equilibrium in low tuition fees similar to the one described above ($pooling_H^L$).

4.5.3. Separating Equilibrium with $m(t_G) = Low$ and $m(t_B) = High$

Under this equilibrium, it is optimal for the good university to charge low tuition fees whereas for the bad university to charge high tuition fees. At the point of the observation the student can thus be certain of the underlying quality of the university, as he has no difficulties in interpreting the signal. For the updated beliefs this implies that $\mu_H = \frac{p(t_G) * 0}{p(t_G) * 0 + (1 - p(t_G)) * 1} = 0$ and $\mu_L = \frac{p(t_G) * 1}{p(t_G) * 1 + (1 - p(t_G)) * 0} = 1$ and therefore both information sets lie on the equilibrium path.

- The student's best response in this proposed equilibrium with respect to the good university, and thus when observing low tuition fees is to accept the offer since $u_S(Low,\ Accept,\ \mu_L) = c_1^{GL} > u_S(Low,\ Not\ Accept,\ \mu_L) = w_0$. On the other hand, the best response strategy when it comes to the bad university is to reject the offer since $u_S(High,\ Accept,\ \mu_H) = c_1^{BH} < u_S(Low,\ Not\ Accept,\ \mu H = w0$.
- In case the good university sticks to the proposed strategy $u_u^G(t_G,\ Low,\ Accept,\ \mu_L)$ it receives a payoff of Rep^{GL}. In case it would deviate, the student, in the false belief that the university is bad, would reject the offer, which implies that the university would get a utility of $u_u^G(t_G,\ Low,\ Accept,\ \mu_H) = 0$. Therefore, the good university has no incentive to deviate from the proposed strategy.
- The bad university has a utility of $u_u^B(t_B,\ High,\ Not\ Accept,\ \mu_H) = 0$ if it plays according to the strategy. If it deviates, it is mistaken to be a good university and thus receives a utility $u_u^B(t_B,\ Low,\ Accept,\ \mu_L) = Rep^{BL}$. As the former is obviously smaller than the latter, the bad university deviates from the proposed strategy.

The analysis thus indicates that there does not exist a separating equilibrium in which the bad university charges high tuition fees and the good university charges low tuition fees, regardless of the relationship between Rep^{BL} and Rep^{BH}.

4.5.4. *Separating Equilibrium with* $m(t_G) = High$ *and* $m(t_B) = Low$

The last possible equilibrium assumes that the good university charges high tuition fees whereas the bad university charges low tuition fees. Again in this case, the student can assess the quality with certainty upon receiving the signal in form of tuition fees, implying $\mu_H = \frac{p(t_G)*1}{p(t_G)*1+(1-p(t_G))*0} = 1$ and $\mu_L = \frac{p(t_G)*0}{p(t_G)*0+(1-p(t_G))*1} = 0$.

- The best response for the student is to accept the offer in case he observes high tuition fees since $u_S(High,\ Accept,\ \mu_H) = c_1^{GH} > u_S(High,\ Not\ Accept,\ \mu_H) = w_0$, and also to accept the offer when receiving the signal of low tuition fees because $u_S(Low,\ Accept,\ \mu_L) = c_1^{BL} > u_S(Low,\ Not\ Accept,\ \mu_L) = w_0$.
- For the good university, pursuing this suggested strategy is optimal, because it does not gain anything from deviating since $u_u^G(t_G,\ High,\ Accept,\ \mu_H) = Rep^{GH} > u_u^G(t_G,\ Low,\ Accept,\ \mu L{=}RepGL$. Therefore, the good university will stick to the proposed strategy.
- The bad university receives a payoff of $u_u^B(t_B,\ Low,\ Accept,\ \mu_L) = Rep^{BL}$ upon behaving honestly, versus a payoff of $u_u^B(t_B,\ High,\ Accept,\ \mu_H) = Rep^{BH}$ in case of deviation from the strategy, charging high tuition fees and thus trying to mislead the students.

Consequently, the analysis yet again depends on the value of Rep^{BL} in relation to that of Rep^{BH}. If $Rep^{BH} > Rep^{BL}$, the bad university deviates and charges high tuition fees rather than low fees and thus this separating equilibrium does not exist. Alternatively, if $Rep^{BH} < Rep^{BL}$, the bad university behaves honestly and charges low tuition fees. In this case a separating equilibrium exists in which the bad university charges low tuition fees and the good university charges high tuition fees.

In sum, the examination of the four different possible equilibria is evidently depending on the assumption of whether the bad university is more interested about the feedback it receives or about the high tuition fees it can potentially receive by attempting to trick the student. As the analysis indicated in case the bad university cares more about the tuition fees it can receive, thus when $Rep^{BH} > Rep^{BL}$, there exists a pooling equilibrium in low tuition fees if $\mu_H < \frac{\beta-1}{c_1^{GH}-c_1^{BH}} * c_1^{BH}$, or if $c_1^{GH} < \frac{\beta-1+p(t_G)}{p(t_G)} * c_1^{BH}$. There also exists a pooling equilibrium in high tuition fees if $c_1^{GH} \geq \frac{\beta-1+p(t_G)}{p(t_G)} * c_1^{BH}$. Both types of separating equilibria are not possible in this case. If however, the university cares more about the feedback it receives in the future from all its students, thus if $Rep^{BH} < Rep^{BL}$, there exists only one equilibrium, which is the separating equilibrium in which the bad university charges low tuition fees and the good university charges high tuition fees. In this case the student knows, upon observing the tuition fees, what the university's intrinsic quality is prior to attending the higher education institution; on the other hand in case of either pooling equilibrium the student cannot deduce any information from the tuition fees observed and thus is not able to properly judge on the underlying quality of the university.

Until now, the discussion has focused on defining the possible equilibria in terms of the student's optimal consumption in period one, c_1. However, as was discussed in Section 4.4 above, in equilibrium this expression can also be rewritten as $\frac{(r-\epsilon)}{\epsilon*r} * E[Rep_1]$. Hence, the student's optimal consumption depends on his expectations concerning the reputation of the university a priori of attending it. Consequently, the above described equilibria can be rewritten as well, an example being the pooling equilibrium in high tuition fees ($pooling_H^H$) which holds in case $c_1^{GH} \geq \frac{\beta-1+p(t_G)}{p(t_G)} * c_1^{BH}$. Replacing

c_1^{GH} and c_1^{BH} with $\frac{(r-\epsilon)}{\epsilon * r} * E[Rep_1]$ leads to the following equation: $E\left[{Rep_1}^{GH}\right] \geq \frac{\beta-1+p(t_G)}{p(t_G)} * E\left[{Rep_1}^{BH}\right]$. Thus only in case the student believes that the reputation of a good university charging high tuition fees is bigger than $\frac{\beta-1+p(t_G)}{p(t_G)}$ times the expected reputation of a bad university charging high tuition fees, a pooling equilibrium in high tuition fees exists. A pooling equilibrium in high tuition fees ($pooling_L^H$) also exists in case the student's updated belief about a university being good in case he observes high tuition fees are bigger or equal to $\frac{\beta-1}{c_1^{GH}-c_1^{BH}} * c_1^{BH}$. Thus, $\mu_H \geq \frac{\beta-1}{E\left[{Rep_1}^{GH}\right]-E\left[{Rep_1}^{BH}\right]} * E\left[{Rep_1}^{BH}\right]$ again displays the importance of how the student views a university a priori of attending the higher education institution. Obviously, a similar paraphrase can be conducted for the pooling equilibria in low tuition fees. Nonetheless, in the remainder of the thesis we do not substitute the optimal consumption of the student with the equilibrium expression for simplicity reasons and reader-friendliness.

Concluding, Table 2 below recapitulates the equilibria found in the model and their main assumptions.

Type of Equilibrium	Details	Main Assumption	Details
Separating	$Good^{High};\ Bad^{Low}$	$Rep^{BH} < Rep^{BL}$	-
Pooling$_L^L$	$Good^{Low};\ Bad^{Low}$	$Rep^{BH} > Rep^{BL}$	$\mu_H < \frac{\beta-1}{c_1^{GH}-c_1^{BH}} * c_1^{BH}$
Pooling$_L^H$	$Good^{High};\ Bad^{High}$	$Rep^{BH} > Rep^{BL}$	$\mu_H \geq \frac{\beta-1}{c_1^{GH}-c_1^{BH}} * c_1^{BH}$
Pooling$_H^L$	$Good^{Low};\ Bad^{Low}$	$Rep^{BH} > Rep^{BL}$	$c_1^{GH} < \frac{\beta-1+p(t_G)}{p(t_G)} * c_1^{BH}$
Pooling$_H^H$	$Good^{High};\ Bad^{High}$	$Rep^{BH} > Rep^{BL}$	$c_1^{GH} \geq \frac{\beta-1+p(t_G)}{p(t_G)} * c_1^{BH}$

Table 2: Summary of the equilibria and their assumptions

Summarising, the application of a sender-receiver game to the industry of higher education has proven to be successful. The next section puts the findings into a wider context.

5. Analysis and Discussion

As a final step, the results obtained so far need to be discussed. This analysis firstly provides a general discussion of the model. Thereafter a sensitivity analysis determines whether the results also hold in case of changes in the parameters. Lastly, we discuss the validity of the results and determine if the equilibria can be sustained in the long-run.

5.1. General Discussion

The general aim of this thesis is to examine whether a university has the ability to use its insider perspective about its quality and consequently to signal some of the intrinsic value to the outside, that is the students. Our interest in this research question arose due to the ongoing discussion about the Bologna Process and the increasing competition between universities on a national and international

level as well as the public debates about the usefulness and rightfulness of charging students for higher education.

As was argued previously, the university suffers from informational asymmetries which may only be resolved through the transmission of some type of information. One way of doing so is through signalling with the help of tuition fees. This is particularly important since in case some sort of transmission of information is not possible at all, admittedly the extreme case as described by Akerlof (1970). This would result in all good universities being driven out of the market by the bad ones, as no student is able to observe the quality differences and thus no one is willing to pay a higher price for education than necessary. There are two main responses to the question as to why universities have more information about their own quality or alternatively why a student faces informational disadvantages. First of all, universities know best what they can truly offer, what their financial means are and in how far they can realistically improve their current service offerings. Although some of these issues may be laid down in official documents to be inspected by the public, it is still unlikely that any outsider can judge this official and unofficial information to the same extent as insiders can. Secondly, education as was argued before is viewed as an experience good; thus the qualitative aspects of attending universities can fully be grasped only after the actual completion of the studies occurred or even only after one has worked for some years. Though this does not explain the university's perception of its own quality, this point lays down the answer to the question as to why it may be difficult for university applicants to know the quality of a higher education institution. Yet again, the overall measure of quality is highly sensitive to the parameters one compares it with as well as to the subjectivity of the observer.

In general, one way to overcome the existing information asymmetries between a university and the (potential) student is to develop and apply a sender-receiver game. However, one may wonder about the appropriateness of this signalling game. Consequently, realistic alternatives need to be examined and one has to check if those are Pareto superior meaning that one player is better off while at the same time the other one is not worse off. As was stated in the literature review an alternative way to reduce information asymmetries is screening. This can be achieved for example by an extensive examination of prospective students by the university (with the help of various admission standards), or by visits and conversations to the potential university by the student. Yet despite the fact that students and universities screen each other and thereby attempt to gain as much information as possible about the opposite party, both players find it difficult to gain all necessary information to overcome the information asymmetries. Thus, the application of a sender-receiver game seems to be more appropriate and Pareto superior compared to screening. Further, since we are particularly interested in the signalling aspect of tuition fees and solely focus on this, any other model but a sender-receiver game would have failed to examine the actual research objective of this thesis.

In the theoretical model, the student's objective is depicted with the help of an inter-temporal utility function, in which consumption in two distinct periods (at the time of deciding which university to attend and at the time of commencing the professional life) and the reputation of a university at the time of application is taken into account. Furthermore, consumption in period two depends on the size of the expected wage premium which in turn depends on the quality of the attended university. The student thus faces the choice of either spending more on tuition fees in expectation of attending a good university (for which, however, he also receives a higher wage in the following period) or alternatively to save in tuition fees thereby having the expectation of attending a low cost university, which will though also diminish his future income. The outcome of the student's expected utility maximisation problem is that his optimal consumption in period one depends on the level of tuition fees, the expected intrinsic value of the attended university and the externally provided feedback. As

we decided to focus the on the university's perspective, any potential issues the student faces such as whether to accept an offer from one university or not is left aside, and it is simply assumed that the student receives a greater utility from attending university than from abstaining in case the university is of good quality or charges low tuition fees despite bad quality. This also underlines the incentive the student has to participate in this game, as he has the chance to filter out the 25% of going to the 'wrong' university. Further, the signal in form of tuition fees provides the student with at least some possibility of choosing the correct action independent of the unknown quality of the university. On the other hand, a university also has an incentive to participate in this game, since it can attempt to signal its quality to the student. Interestingly the university and the student have different opinions about the optimality of the outcome of the game. Independent of the quality of the university the student always prefers low tuition fees. The good university on the other hand prefers high tuition fees since this results in a higher income to be spent on facilities, research and salaries, and consequently on reputation. Furthermore, the optimal choice for the bad university depends on the assumption regarding the difference between the possible level of tuition fees and the feedback component, as was argued before.

In the model, the university's reputation is a static function of its intrinsic value, the tuition fees it receives, and the cumulative and discounted feedback it obtains in the future for its present actions. As the intrinsic value or quality is unknown to outsiders, a good university attempts to convince the applying student that it is of good quality, so that the student eventually attends. With the help of the peer-group effect the university ultimately also increases its quality, as more qualified students help raise the overall quality level of education. We found the following equilibria in this game, as was highlighted in the model section and summarised in Table 2: On the one hand, there exists a separating equilibrium in which the bad university charges low tuition fees and the good university charges high tuition fees. The good university has no incentive to deviate from this strategy, since it always prefers high tuition fees to low ones, whereas the bad university has no incentive to deviate either because it would gain in terms of money, but lose in terms of feedback for future periods, assuming the former to be larger and more important than the latter. On the other hand, the analysis also indicated the existence of a pooling equilibrium in which both types of universities charge low tuition fees, under the condition that $\mu_H < \frac{\beta-1}{c_1^{GH}-c_1^{BH}} * c_1^{BH}$ or that $c_1^{GH} < \frac{\beta-1+p(t_G)}{p(t_G)} * c_1^{BH}$. Moreover, we also found a pooling equilibrium in high tuition fees, whenever $c_1^{GH} \geq \frac{\beta-1+p(t_G)}{p(t_G)} * c_1^{BH}$ and as is expected from the equation above a further equilibrium whenever $\mu_H \geq \frac{\beta-1}{c_1^{GH}-c_1^{BH}} * c_1^{BH}$. Obviously, for the good university, these pooling equilibria are far from being optimal since it has no chance to signal its superior quality to the student, and is consequently less likely to attract superior students as well. The pooling equilibria however only hold in case the bad university cares more about the amount of tuition fees it can receive through misleadingly making the student believe that it is of high quality. Reasons for $Rep^{BL} < Rep^{BH}$ could be monetary aspects in that the university uses the income from tuition fees to invest in facilities such as the renovation of buildings. As the campus may be considered a signal in itself, the student may interpret this signal in a way that a university is good because it charges high fees and has a nice campus, hence the student's prior belief in the rightfulness of high tuition fees could be reinforced. An additional motive for why a university rather wants to charge high tuition fees despite the inevitable loss in reputation could be that this university consequently has more money available for teaching and research. On the one hand, the actual quality of the university could thus be improved, and on the other hand, more research could be published. Since publications play a large role in the outside perception of the university (though not explicitly treated in the

model), more money for research is likely lead to more publications and thus for example to a better position in rankings.

Nonetheless, trying to link these results back to the literature review, it can be estimated that both types of pooling equilibria are not observed in reality in most countries but rather constitute a phenomenon of theory. In nearly every country there are both expensive as well as inexpensive universities, a finding which in turn confirms the existence of the separating equilibrium we found. Furthermore, it is more likely that the university cares more about the feedback it can receive in the future than about the tuition fees it can obtain from charging the students for their education, especially since the negative feedback a university receives only depends on the actions taken at one point in time. This can be interpreted as follows: It is comparable to a grim-trigger strategy in a repeated prisoner's dilemma. One can argue that the game starts in a "cooperation phase" in which mutual trust between the student and the university exists which results in positive feedback, however in case the bad university cheats, the feedback it receives will be negative in the future. A supplementary reason why the separating equilibrium can be achieved, hence why $Rep^{BH} < Rep^{BL}$, is that a bad university might be risk-averse, in which case it may have an incentive to charge low tuition fees since it can subsequently be certain that the student accepts the offer, and is thus guaranteed a fixed income in the form of tuition fees. Hence the university is able to reduce any uncertainty with regards to its budget planning. Additionally, the likelihood of the existence of a pooling equilibrium in low tuition fees is further diminished through the above-made observation that tuition fees have risen to a large extent over the last years. Furthermore, most universities are expected to sharply raise their tuition fees in 2009, where this rise can be attributed to the current financial crisis. This is particularly applicable to the United States, where for instance the universities in Arizona are expected to increase their tuition fees by approximately 10% (Titz, 2008). Titz's main reason for this is that Ivy League universities, such as Harvard, in general rely to a large extent on endowments (money from these endowments can represent up to one-third of their yearly budget), which the universities consequently invest in different markets all around the world in order to diversify risk. Since the current financial crisis however does not only impact specific industries or countries but rather the global economy, it is not possible for these foundations to shift and diversify their funds. Thus, these universities are expected to lose up to 30% of the value of their foundations, which may represent up to 10 billion US dollars (ibid.). Consequently, in the (unlikely) case a pooling equilibrium is to be achieved, it is far more likely that this will be in high tuition fees, which implies that the bad universities have to sharply raise their tuition fees in order to reach a similar level as the good universities.

5.2. Sensitivity Analysis

The analysis so far has only focused on the general model and its equilibria as such – the following paragraphs discuss further their specific conditions: first $p(t_G)$, second the student's optimal consumption, and last β.

This part analyses the probabilities with which nature selects a university to be of good or bad quality. Until now, a specific number for these variables has not yet been assumed; the accuracy of these equilibria can however be further discussed under the condition that all other variables remain constant. Note that the separating equilibrium, in which the good university charges high tuition fees and the bad university charges low fees is independent of the choice of these probabilities. Though different numbers for the variables would evidently have lead to altered results for the updated beliefs μ_H and μ_L, they do not influence or change the overall result, since the bad university has no incentive to deviate from the proposed strategy of charging low tuition fees, and the student therefore always accepts the offer of the university. This fact also makes the model more realistic, since the starting prob-

abilities cannot be guaranteed to take a certain value in every case. The same holds for the pooling equilibrium in low tuition fees $\mu_H < \frac{\beta-1}{c_1^{GH}-c_1^{BH}} * c_1^{BH}$ ($pooling_L^L$), or alternatively in high fees when $\mu_H \geq \frac{\beta-1}{c_1^{GH}-c_1^{BH}} * c_1^{BH}$ ($pooling_L^H$), as these equilibria are also independent of the probability distribution of good and bad universities. However, the percentage of good and bad universities does have an impact on the pooling equilibrium in high tuition fees. To recall, this type of equilibrium exists under the condition that $c_1^{GH} \geq \frac{\beta-1+p(t_G)}{p(t_G)} * c_1^{BH}$ ($pooling_H^H$). On the contrary, should this equation not hold, implying that $c_1^{GH} < \frac{\beta-1+p(t_G)}{p(t_G)} * c_1^{BH}$ ($pooling_H^L$), a second possibility for a pooling equilibrium in low tuition fees is found. It can now easily be verified that a higher probability of nature selecting a university to be of good quality leads to a higher chance of observing a pooling equilibrium in high tuition fees, given a constant β. On the other hand, the higher the probability that nature chooses a university to be of bad quality the higher the chances that a pooling equilibrium in low tuition fees exists, ceteris paribus. This finding makes intuitively sense, since in case a lot of universities are of good quality for which the student is willing to pay high tuition fees, he should accept the offer and risk the small chance of having to go to a bad university. If, however, the student is aware of the fact that the probability of bad universities is higher than that of good universities, then it is saver for the student to reject the offer when he sees high tuition fees, which leads universities to charge low fees, and therefore results in a pooling equilibrium in low tuition fees.

Second, apart from the probabilities with which nature chooses the quality of the university, the decision of the student also depends to a large extent on the utility he personally derives from attending either a bad or a good university when paying high tuition fees. As was stated already before, rather than going to a bad university which charges high tuition fees the student prefers starting to work immediately and earn money. The precise action taken by the student thus also depends on the differences in his utilities derived from the optimal levels of consumption, either c_1^{BH} or c_1^{GH}. In case the utility of attending a good university is a lot higher than the utility of going to a bad school while paying high tuition fees, the likelihood of obtaining a pooling equilibrium in high tuition fees ($pooling_H^H$) increases. For instance assuming $\beta = 1.1$, if the probability of nature selecting a university to be good equals 10%, and the student receives double the utility from attending a good university compared to going to a bad one, he would take the obvious risk of ending up at a bad institution (since these are prevalent with 90%) and accept the offer. For the $pooling_L^L$ equilibrium, the difference between the two consumption levels is also important, but additionally the precise value for c_1^{BH} plays an important part. Nonetheless, a larger gap between c_1^{BH} and c_1^{GH} while keeping β constant reduces the likelihood of a pooling equilibrium in low tuition fees and thus increase the likelihood for one in high tuition fees. Again, in case a separating equilibrium exists, in which only the good university charges high tuition fees and the bad school charges low fees, the difference in the student's utility would also not influence the outcome.

The final component that needs to be discussed is the value, or the range of values, which β can assume, though this is only relevant for the scenario in which the bad university values feedback higher than tuition fees. We already indicated in the model section that we assume $\beta \geq 1$. The literature, both academic and non-academic, indicates that students can expect an up to 20% higher wage from continuing to attend a university for a Master degree upon the completion of the Bachelor degree. Since these figures assume the existence of an average university it may be even higher for a good university, but on the contrary it may also be a lot lower and even close to zero when it comes to a bad university. In order to pay the tuition fees the student either has to take out a loan for which he has to

pay interest or alternatively, even though he may have the necessary liquidity, this money cannot be invested for other purposes. Furthermore, the possible earnings, in addition to the advancement in the career, may make it more lucrative for a student to start working rather than completing a Master degree; this is why we assume the benefits of starting to work immediately and to progress in the career to be up to 10% higher than attending such a higher education institution. Consequently, the smaller β gets, the higher the likelihood for a pooling equilibrium in high tuition fees ($pooling_H^H$) since it is more likely that $c_1^{GH} \geq \frac{\beta-1+p(t_G)}{p(t_G)} * c_1^{BH}$ and thus also that the student accepts the offer of an expensive university. In turn, it obviously also shows that the pooling equilibrium in low tuition fees ($pooling_L^L$) becomes less likely since it only exists in case the upper equation does not hold (which was explained to be less likely in light of a decreasing beta) or alternatively when $\mu_H < \frac{\beta-1}{c_1^{GH}-c_1^{BH}} * c_1^{BH}$. Since a decreasing β reduces the value of the numerator, μ_H is likely to be larger, resulting in both universities deviating from the proposed low tuition fee strategy.

So far, the analysis for the more complicated pooling equilibrium in high tuition fees ($pooling_H^H$) has remained on a rather abstract level. To illustrate the issue further, Table 3 below shows parts of the calculations, namely $\frac{\beta-1+p(t_G)}{p(t_G)}$ in order to examine whether small variations in the variables lead to a large change in the results and in the implication for our model. We assume that the proportion of good universities can take any value – however, since we defined a good university to be of excellent quality, it is highly unlikely that more than 50% of all existing universities are of excellent quality.

		β										
		1.10	**1.09**	**1.08**	**1.07**	**1.06**	**1.05**	**1.04**	**1.03**	**1.02**	**1.01**	**1.00**
$p(t_G)$	**0.99**	1.101	1.091	1.081	1.071	1.061	1.051	1.040	1.030	1.020	1.010	1.00
	0.95	1.105	1.095	1.084	1.074	1.063	1.053	1.042	1.032	1.021	1.011	1.00
	0.90	1.111	1.100	1.089	1.078	1.067	1.056	1.044	1.033	1.022	1.011	1.00
	0.80	1.125	1.113	1.100	1.088	1.075	1.063	1.050	1.038	1.025	1.013	1.00
	0.70	1.143	1.129	1.114	1.100	1.086	1.071	1.057	1.043	1.029	1.014	1.00
	0.60	1.167	1.150	1.133	1.117	1.100	1.083	1.067	1.050	1.033	1.017	1.00
	0.50	1.200	1.180	1.160	1.140	1.120	1.100	1.080	1.060	1.040	1.020	1.00
	0.40	1.250	1.225	1.200	1.175	1.150	1.125	1.100	1.075	1.050	1.025	1.00
	0.30	1.333	1.300	1.267	1.233	1.200	1.167	1.133	1.100	1.067	1.033	1.00
	0.20	1.500	1.450	1.400	1.350	1.300	1.250	1.200	1.150	1.100	1.050	1.00
	0.10	2.000	1.900	1.800	1.700	1.600	1.500	1.400	1.300	1.200	1.100	1.00
	0.05	3.000	2.800	2.600	2.400	2.200	2.000	1.800	1.600	1.400	1.200	1.00
	0.01	11.00	10.00	9.00	8.00	7.00	6.00	5.00	4.00	3.00	2.00	1.00

Table 3: Sensitivity analysis for the pooling equilibrium in high tuition fees

The reader should recall again that the formula for a pooling equilibrium in high tuition fees ($pooling_H^H$) exists if $c_1^{GH} \geq \frac{\beta-1+p(t_G)}{p(t_G)} * c_1^{BH}$. Obviously, if the student's optimal consumption c_1^{GH} is smaller than c_1^{BH} times the fraction depicted in Table 3, a pooling equilibrium in low tuition fees ($pooling_H^L$) is reached, which is why we did not design a separate table for this. Since it is difficult to assume values for c_1^{GH} and c_1^{BH}, and since the discussion so far has only focused on values for β and $p(t_G)$, the table also only depicts a sensitivity analysis for the first part of the formula, namely $\frac{\beta-1+p(t_G)}{p(t_G)}$. Thus, for example assuming a wage premium of 10%, in case the probability of a university is good is 5%, the student's optimal consumption c_1^{GH} (or, replacing this with the student's optimal consumption in period one, $\frac{(r-\epsilon)}{\epsilon*r} * E[Rep_1]$, his expected reputation before studying about the

good university charging high tuition fees) needs to be at least 3.00 times bigger than his optimal consumption of c_1^{BH} (or again the expected reputation of a bad university charging high tuition fees) for a separating equilibrium in high tuition fees to exist. Two things are now easily verifiable from the table: firstly, the smaller the β, the more likely a pooling equilibrium in high tuition fees becomes. Secondly, the larger the percentage of good universities, again, the likelier a pooling equilibrium in high tuition fees becomes. 'The more likely' in this case means that the difference between a good and a bad university can be relatively small while still reaching a pooling equilibrium in high tuition fees.

5.3. VALIDITY AND PROSPECT

Having analysed and discussed the model and its main assumptions above, the general question about the validity of the model still remains unanswered. There exist two possible ways to resolve this issue: On the one hand one can start off by stating that the model was developed after having observed the pattern in the amount of tuition fees charged by the different universities in different countries, namely that universities which are ranked high in international rankings mostly tend to charge higher tuition fees compared to those that are ranked at a lower position. Therefore, as one of the equilibria of the model is a separating equilibrium in which a good/bad university charges high/low tuition fees, this observation can be regarded as an indirect and external validation of the model, also since, as discussed above, the pooling equilibria found are most likely to be a phenomenon of theory. However, one has to keep in mind that such a confirmation only regards the general and broad outcome of the model and not the individual aspects such as the student's maximisation problem or specific assumptions about variables. On the other hand, one can try to test this model empirically, an idea that is examined further in Section 6.

The analysis so far has focused on defining what constitutes the possible equilibria of the above described sender-receiver game. It was shown that a separating equilibrium can be achieved, in which the good university correctly signals its quality to the students by charging high tuition fees and correspondingly the bad university charges low fees, in case Rep^{BL} is bigger than Rep^{BH}. Despite this being a perfect Bayesian equilibrium, meaning that neither the sender, nor the receiver has an incentive to deviate and to behave differently, as the process of utility maximisation is completed, one may still speculate first about the general incentives a bad university could have to become 'good' and second how this would need to be done. Before analysing this, however, one has to acknowledge that changing the intrinsic value of a university is neither done easily nor quickly, since quality is defined rather broadly above, encompassing next to the quality of teaching also further aspects such as the offering of language-courses or the possibility for an exchange semester. Yet, in case the difference between the university's reputation Rep^{GH} and Rep^{BL} is big enough, a university might find it attractive to try to change its intrinsic quality in the medium-run to long-run. This difference might in fact be substantial, as next to the higher intrinsic value, higher tuition fees also add to the advantages of being a good university, and thus such a university can be expected to achieve huge gains in terms of reputation. Consequently, besides improving research and teaching, one way for a bad university to become better is to use the afore described peer-group effect. This means, that a university should attempt to have a variety of admission criteria so that it not only has to rely on the above described self-selection criteria. By doing so, the university is not only able to grasp the observed quality of the student, but also the underlying motivation and attitude with which he is expected to complete his degree. One way of doing so would be through interviews where each student is asked to give his motivation or through essays that have to be handed in prior to the start of the studies. There is however no absolute guarantee that unmotivated students can be excluded from actually attending the university. Additionally, as described above, these screening methods might not prove to be sufficient

to overcome all information asymmetries. Furthermore, one has to emphasise again that this does not constitute a direct incentive to change the separating equilibrium which was found in the model in the short run.

In summary, it can be said that a combination of a simple sender-receiver game with the discussion about the objectives and constraints of both the sender and the receiver is able to convincingly explain how universities are able to use the tuition fees charged to overcome information asymmetries from their point of view. The analysis has further narrowed the range of values that the variables can take in order for these equilibria to hold.

6. Limitations and Suggestions for Further Research

As any other academic article, this thesis suffers from certain limitations. We are well aware of the fact that the above developed sender-receiver game does not take all possible types of information asymmetries into account, such as the fact that the student may know certain aspects that the university cannot understand. However, as discussed above, there are indications that an unmotivated or alternatively bad student will either not attend a good university or alternatively will most likely be expelled after some time. A further limitation of applying a sender-receiver game results in the restriction of the types of universities to either good or bad, an aspect which definitely departs from reality, as well as the assumption concerning the university's objective function in that every university cares about reputation, ceteris paribus of other aspects such as the quality of research. However, as the model's focus lies on the signalling aspect of universities only, rather than developing an overall model of the university's and student's behaviour, these simplifications are put up with. Additionally, both the application of a static version of the university objective function and the usage of two discrete levels of tuition fees are further limitations to the paper. Nonetheless, an informal analysis indicated that a dynamic model with a continuous level of tuition fees would have resulted in more assumptions; yet the equilibria found in the model above would not have been altered.

Implications for further research would thus be to empirically test the model that we developed, for example with the help of data collection in order to examine whether its predictions concerning the university's behaviour correspond to the reality. It would also be interesting to see in how far the model changes if in addition to the direct costs the student incurs the indirect costs such as foregone earnings while studying were to be estimated and taken into account. Next, another of our assumptions was that the loan market functions perfectly, which is a rather unrealistic assumption. The model would surely change if the loan market suffered from frictions and thus not every student was able to obtain a loan or a scholarship from a university which is a problem observed in reality. The model could also be extended in a way that puts a closer focus on the actual quality of the students. In our model, the university accepts the student independent of the quality, as the university has no choice to influence the student other than through the signal of the high tuition fees. However, in reality most students apply for a university, whereupon the university decides whether to actually admit the student. An extension of the model should take this into account and thus put a stronger focus on other admission criteria.

7. Conclusion

Over the past years, due to international standards, universities and their quality have become more and more comparable which has resulted in an increase in the competition to attract the best students. In doing so, universities try to maximise their level of reputation, in the case at hand defined as a function of its intrinsic quality, feedback, and the level of tuition fees. In this thesis, a simple sender-

receiver game is used to analyse the interaction between universities and students and to examine the abilities universities might have to use tuition fees to signal their intrinsic quality to students. Students and their utility are depicted using an inter-temporal utility function and they are unable to observe the true intrinsic value of a university prior to attending the higher education institution. Furthermore, universities are assumed to be infinitely living, and a static university objective function is examined. The overall objective of this thesis is to analyse the mechanisms of signalling the intrinsic quality of a university with the help of setting tuition fees.

In conclusion, the application of a sender-receiver game to analyse the mechanisms of signalling the intrinsic quality of a university with the help of setting tuition fees works well, as both the student and the university have an incentive to participate in the game in order to overcome the existing informational asymmetries. The main results of this thesis, depending on the relationship between the reputation a bad university receives when charging either high or low tuition fees, can be summarised as follows. First, in case $Rep^{BL} > Rep^{BH}$, a separating equilibrium exists, in which each university has an incentive to correctly charge the tuition fees which resemble its intrinsic quality. Second, when $Rep^{BL} < Rep^{BH}$ it was shown that there does not exist a separating equilibrium, but rather universities will charge the same tuition fees, low in case either the updated beliefs of the student upon seeing the high tuition fees are smaller than $\frac{\beta-1}{c_1^{GH}-c_1^{BH}} * c_1^{BH}$, or if the student's optimal consumption when attending a good and expensive university is smaller than $\frac{\beta-1+p(t_G)}{p(t_G)} * c_1^{BH}$. Alternatively, if the two equations do not hold, both types of universities will deviate to charge high tuition fees in both cases, irrespective of quality.

The thesis adds to the general understanding of how tuition fees can be used by universities to overcome information asymmetries. The application of a sender-receiver game indicates that under the assumptions that the university is more concerned about the feedback it receives than about the tuition fees it can charge, it is optimal for the good university to charge high tuition fees and for the bad university to charge low tuition fees. This means that students are perfectly able to derive the quality of a university upon observing the signal, namely the tuition fees the university charges. At the same time this also implies that it is optimal for a university to charge the correct tuition fees, as it cannot gain anything from deviating. Hence, such an outcome can be regarded as the optimal solution for all players involved; it eliminates the existing uncertainty concerning the future, as the student knows his optimal consumption pattern and the university is sure which tuition fees lead to the desired maximisation of its utility. On the contrary, in case $Rep^{BL} < Rep^{BH}$, both universities charge the same amount of tuition fees, depending on the specific assumptions and variables, however, in this case it is much harder to define the precise benefits and actions for either player, as the university cannot be sure about the student's prior and updated beliefs about its own reputation. Consequently, the model indicates that it is more complicated to overcome the information asymmetries and for both types of universities to signal its intrinsic quality to the student. Thus, the application of a sender-receiver game adds a signalling aspect to the popular discussion both in academia and in the press regarding the advantages or disadvantages of charging tuition fees, an aspect which has not been examined previously.

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