Three Essays on Heterogeneous Workers in Imperfect Labour Markets

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

Introduction and Summary

This dissertation consists of three independent research papers that I wrote during my studies in the doctoral programme "Quantitative Economics and Finance" at the University of Konstanz.

All of these papers explore the effects of labour market frictions on heterogeneous workers. In contrast to goods markets, in labour markets no homogeneous product is traded, instead both supply and demand are highly heterogeneous: Workers differ in their individual professions, education, experience and non-cognitive skills such as industriousness, motivation, and persistency, but also in physical, not directly productivity-related attributes like gender, age and ethnic origin. Likewise, not only do job requirements differ between sectors or job divisions, but each particular firm requires workers to possess or obtain various general as well as job-specific skills. Even if a perfect match of a worker and a firm were to exist, they may never meet because they are located a long way from each other and the worker is making applications to less suitable firms. These kinds of coordination and information frictions prevent the "invisible hand" from perfectly bringing together labour supply and demand; instead firms and workers must spend time and resources in order to find a fitting counterpart. These *search frictions* can give rise to unemployment and related phenomena such as wage dispersion on the labour market. Standard models differ, for example, in the extent to which the searching process is explicitly modelled. Pissarides (2000) and Mortensen and Pissarides (1994) use a "black box" matching function and wages that are determined by Nash bargaining, while Burdett and Mortensen (1998) combine this idea of random search with profit-maximising wage posting of firms and on-the-job search to generate wage dispersion. In competitive search models like Moen (1997), workers direct their search towards specific advertised wages, while higher potential wages give rise to more competition among workers for these jobs. Other models describe the application process even more explicitly, for example Burdett et al. (2001) or Albrecht et al. (2006).

In addition, information asymmetries can hinder the efficient allocation of workers to vacancies. A worker who knows her own productivity, strengths and weaknesses better than anyone else can only communicate some of this information by means of certificates and references to her potential employer. The firm then relies on the

information provided and other observable characteristics such as age, education, gender, employment status, or ethnic origin to fill in missing information. During this process, individual reservations against applicants with certain characteristics can give rise to discrimination against these groups.
It is the purpose of this thesis to shed some light on selected issues of imperfect labour markets in terms of both efficiency and the distribution of labour market opportunities. The first paper uses a game-theoretical approach to show that coordination and informational frictions alone are sufficient to generate discrimination against old unemployed workers, even if the workers' productivities are independent of individual age. The second paper provides empirical evidence for discrimination against workers with a migration background from Turkey in the German labour market. The third paper focuses on the joint effect of imperfect labour and credit markets for student loans on unemployment and human capital. Additionally, it shows the effective distribution of the tuition burden between university graduates and blue collar workers.
This chapter serves as an introduction of the dissertation and summarises the main results.

Chapter 1 analyses why older workers face obstacles to finding a new job once they become unemployed: Firms retain older workers, but they do not hire them. Previous studies argue that, on average, a worker's productivity declines when he gets older[1], so firms have an incentive to *statistically discriminate* (Arrow, 1973; Phelps, 1972) against older workers, or they do not hire old workers because of high learning costs (Heywood et al., 1999). Alternatively, managers could have a *taste for discrimination* (Becker, 1957) and simply dislike personal interaction with older workers. However, chapter 1 develops a simple game-theoretical approach, based on the model by Blankenau and Camera (2006) to show that hiring discrimination against old workers can occur in imperfect labour markets even if individual productivity does not decrease with age and in absence of a taste for discrimination. In my model, workers are heterogeneous with respect to two characteristics: they differ in their innate and constant individual productivity, and they are ageing over time without affecting their productivity. In line with empirical observations, co-

[1]See Skirbekk (2004) for an excellent survey.

ordination and informational frictions generate unemployment with less productive workers facing higher unemployment risks. Firms can observe a potential employee's productivity only imperfectly and thus rely on the employment status as a signal for productivity. I show that the stigma of unemployment becomes stronger with individual age; the longer a worker is in the labour market, the higher is the probability that a productive worker is bound in a firm. This gives rise to a negative correlation between age and expected productivity of *unemployed* workers and reduces the hiring opportunities of older workers.
The decentralized equilibrium is not efficient as too few workers are hired. Moreover, I show that a reduction in dismissal protection can both reduce the relative hiring opportunities of old workers (that is, raise differential treatment) and at the same time increase older workers' absolute hiring opportunities. Unambiguously, employment and average income can only benefit from such a policy. In addition, I demonstrate that the introduction of an early retirement system can provide incentives for older, less productive workers to leave the market, raise the opportunities of remaining productive old workers and help to restore efficiency.

Chapter 2, which is the result of joint work with my advisor Leo Kaas, University of Konstanz[2], addresses the issue of discrimination against workers with a Turkish migration background in Germany. Most of these workers are the offspring of migrants who came to Germany in the 1960s as urgently required workers. Even though they were born in Germany, have a good command of the German language and are often German citizens, they are nevertheless on average less educated and more likely to be affected by unemployment.
Thus we conduct a correspondence test to provide evidence regarding the discrimination against workers with a Turkish migration background in the German labour market. To each of 528 vacancy postings for student internships we send two similar types of applications and randomly assign a Turkish-sounding name ("Fatih Yildiz" or "Serkan Sezer") and a German-sounding name ("Dennis Langer" or "Tobias Hartmann"). Students of both types are born and raised in Germany, native German speakers and have good grades at school and university. However, we vary the amount of information that is provided with each application in order to dis-

[2]Kaas and Manger (2010).

entangle statistical discrimination from taste-based discrimination. In particular, we supplement only one type of application with job references that emphasise the reliability and personality of that applicant. After we sent our applications via the internet, firms could answer by mail, e-mail or by phone. We consider any reaction that shows further interest in the candidate, such as invitations for a phone interview, direct job offers or contact information left on our voice mail, as callback.
We find that a German name raises the average probability of a callback by about 14%. This level of discrimination is significant but, compared to related studies of discrimination against Afro-Americans in the US (Bertrand and Mullainathan, 2004), Albanians in Greece (Drydakis and Vlassis, 2007) or Arabs in Sweden (Carlsson and Rooth, 2007) relatively moderate[3]. Differential treatment is particularly strong in firms with less than 50 employees, from which the applicant with the German name receives about 24% more callbacks. We find that mainly statistical discrimination accounts for the differential treatment: For applications without job references, 41.8% of the applications with a German name receive a callback, but only 32.5% of the applications with a Turkish name. This difference disappears if the students include the references that point out the personality of the applicant (37.4% with a German and 36.9% with a Turkish name). Moreover, we analyse the distribution of firms' reactions over time and find no evidence that applicants with a Turkish name have to wait significantly longer for any kind of reaction.

Chapter 3 shows how capital and labour market frictions amplify the costs of higher education and shift some of these costs from students to blue collar workers. Students who want to go to university often face obstacles in raising the necessary funds to cover their tuition fees, as they usually cannot provide any collateral. On the other hand, banks offer a variety of different student loans in terms of interest rates, payback rules and different prerequisites students must satisfy in order to be entitled to that loan. Therefore, I do not assume an exogenous borrowing constraint, but instead I adopt an approach by Wasmer and Weil (2004)[4]: Agents who want to go

[3]However, as the design of the different field studies varies significantly, especially regarding the qualifications of the applicants, one should not conclude that discrimination is less prominent in Germany than in other countries.

[4]Wasmer and Weil (2004) show how imperfections in the credit market for venture capital

to university must *search* for a bank that provides a student loan. This imperfect credit market is symmetric to the labour market, as both suffer from search frictions in the spirit of Pissarides (2000): It takes some time to obtain a loan (or respectively for banks to find a borrower), depending on the ratio between the credit supply of banks and the credit demand of the prospective students. Students have to pay an endogenous interest rate above the risk-free rate on their debt. Moreover, I assume that the student loan takes the form of a contingent loan, that is, workers pay back the credit only while they are employed. Moen (1998) shows that, assuming perfect credit markets, contingent loans can be used to overcome the inefficiencies caused by holdup frictions[5] in imperfect labour markets. However, I find that not only does this result no longer hold in imperfect credit markets, but that workers and banks strategically use the contingent loans to establish higher wages for well educated workers. This amplifies the adverse effects of tuition fees such as unemployment and declining investment in human capital, but it also reduces the wages of blue collar workers. Additionally, I provide a numerical example to illustrate the effect of increasing tuition fees on unemployment, wages, credit supply, welfare and education. I find substantial inefficiencies, even if the Hosios rule (Hosios, 1990) is satisfied and contingent loans are present.

I also compare my model to a benchmark economy with perfect credit markets and search frictions in the labour market, as well as an economy in which both labour and credit markets are perfect in order to isolate the effects of the different frictions. Even small credit market frictions significantly raise both unemployment and the skill premium and deter a sizable fraction of the workers from studying, which is amplified by the labour market imperfections and the strategic use of contingent loans.

amplify labour market frictions.

[5]When workers and firms negotiate the wage, the costs of education are already sunk and therefore not part of the wage bargaining. However, as firms have market power in imperfect labour markers, they retain a fraction of the productivity gains of education instead of fully compensating skilled workers in terms of higher wages. As workers pay all the costs but receive only a fraction of the benefits of education, investment in human capital is inefficiently low.

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CHAPTER 1

ENDOGENOUS AGE DISCRIMINATION

1.1 Introduction

While unemployment rates for older workers are not substantially higher than for younger ones, old workers nevertheless face strong entry barriers if they have to apply for new jobs. Several empirical studies show that firms retain older workers, but they do not hire them. Hirsch et al. (2000) provide an overview of employment and labour market access of older workers. Like Heywood et al. (1999), who focus on Hong Kong's labour market, they show that firms with high skill requirements and substantial on-the-job training hire disproportionally few old workers. Their results suggest that "the reduced hiring opportunities for older workers observed in many countries may be a natural response to specific training provision and to monitoring problems" (Heywood et al., 1999). As in Hutchens (1986), these studies state that fixed costs of further education combined with a short period of returns until workers retire and leave the firm reduce the hiring opportunities of old skilled workers. Thus, especially skill-intensive sectors should favour young employees.
Economic theory provides two standard approaches to explain discrimination against a group of workers in the labour market. First, individual productivity can decline with age, e.g. older workers may on average not be able to perform physically challenging tasks at the same speed as their younger colleagues or may not be familiar with new technologies. These differences in productivity give firms an incentive to *statistically discriminate* (Phelps, 1972; Arrow, 1973) against old workers once individual productivity cannot be observed perfectly: a firm that has several applicants with unknown productivity will select the youngest applicant, as he is on average the most productive. However, the experience of older workers can counteract their reduced physical capacity, especially in jobs that require highly specialized workers. Skirbekk (2004) provides a great survey, discussing whether and how fast individual productivity declines with age. He finds that "some abilities, such as perceptual speed, show relatively large decrements from a young age, while others, like verbal abilities, show only small changes throughout the working life" (Skirbekk, 2004).
Second, managers can have a *taste for discrimination* (Becker, 1957): managers derive disutility from employing old people simply because they do not like them. Such firms avoid hiring old workers or must be compensated by paying a lower wage. With perfect competition and mobility, old workers only apply at non-discriminating

firms. Then old and young workers with identical productivity earn the same wage, and discrimination disappears[1].

This paper uses a different approach: I do not assume that firms have an exogenous incentive to discriminate, but rather the cause for differential treatment is derived endogenously within the model. Individual productivity does not vary with age and employers do not have a taste for discrimination, but search frictions limit the number of available employment opportunities; additionally, the productivity of workers cannot be observed perfectly prior to employment. Firms do not hire workers that are obviously unproductive and they estimate the productivity of workers with unobservable skills. Unproductive agents who nevertheless found a job are fired as soon as dismissal protection ends, while productive agents receive a new contract. This combination of search and informational frictions sorts workers into two groups, employed and unemployed. Less productive workers face a higher risk of becoming unemployed, the two groups have different skill distributions, and the employment status can be used as signal for expected productivity.

In principle, this effect is well known: for instance, Kugler and Saint-Paul (2004) show that "as firing costs increase, firms increasingly prefer hiring employed workers, who are less likely to be lemons." (Kugler and Saint-Paul, 2004). However, I show that this stigma of unemployment becomes stronger with increasing individual age. The longer a worker is in the labour market, the higher is the probability that the imperfect matching progress has sorted him into the right employment status with respect to his productivity. This gives rise to a negative relationship between age and expected productivity of *unemployed* workers, even though every individual worker retains the productivity that he entered the market with. Firms favour young workers, and old workers face lower hiring opportunities.

There is some evidence that this *herding effect* plays a major role in labour markets. Oberholzer-Gee (2008) shows that managers can interpret longterm unemployment as a signal for low productivity: The longer a worker is already unemployed, the more other managers might have found that this worker is not sufficiently productive, so new potential employers become more and more suspicious. A theoretical analysis of herding behaviour in labour markets is conducted by Lockwood (1991).

[1] Nevertheless discrimination could persist in the presence of search frictions, see for example Lang et al. (2005).

However, these studies focus on long-term unemployment and do not cover the correlation between a worker's age and the stigma of unemployment.
I do not claim that individual productivity cannot change with age or that taste-based discrimination against older people does not occur. This paper shows that another effect, which is directly caused by the specific frictions of labour markets, gives rise to differential treatment. The herding effect differs from standard statistical discrimination as the low expected productivity of old *unemployed* workers is not assumed directly, but old and young workers are ex ante identical and only selection into employment through labour market frictions over time provides an incentive to treat old and young workers differently.
The paper is organised as follows. After introducing the economic environment and the equilibrium concept in Section 2, Section 3 analyses efficiency. Section 4 discusses the equilibrium hiring opportunities of old workers, and Section 5 extends the model by an early retirement system. Section 6 concludes.

1.2 The Model

I use a simple game theoretical approach, similar to the labour market described by Blankenau and Camera (2006): In an overlapping generation environment a continuum of 2-period lived young workers with mass 1 enters the labour market every period. The exogenous fraction P_y of these young workers has high productivity. At the same time some old unemployed workers are also searching for jobs. The number and the productivity distribution of these old workers depends on the labour market outcome in the previous period. All unemployed agents, young and old, are matched pairwisely by a random matching process (see Aliprantis et al. (2007)) and have to decide on jointly setting up a firm or producing separately. If at least one worker in a match declines, both earn their autarkic incomes: a productive worker earns $u > 0$ and an unproductive worker 0.
If both workers cooperate, total output of two unproductive workers is still 0, both neither gain nor lose. If two productive agents work together, they complement their skills and each of them earns in total $G + u$, with G as the individual profit of the successful cooperation. A mixed firm of a productive and an unproductive worker does not generate any additional output, but the unproductive worker acquires the

amount $L < u$ of his partner's higher income. Thereby the unproductive agent's income is L, while the productive agent earns $u - L$.[2]

Unproductive agents try to set up a firm with a productive partner and are indifferent when it comes to working with another unproductive worker, as they have nothing to lose. Productive agents want to cooperate with other productive workers to benefit from complemented skills and to try to avoid unproductive agents and the associated loss.

At the end of every period firms with two young productive workers continue to produce for a second period. These workers know that they are going to earn another G in the second period if they stay together and have no incentive to separate. This is a crucial difference to the model by Blankenau and Camera (2006) in which *all* firms are destroyed after every period and even two young productive workers separate. Any other firm is closed down, either because at least one agent is not productive and therefore fired, or because at least one of the workers retires. Hence the agents' behaviour in one period, in particular the extent of cooperation between young productive workers, affects the skill and age composition of the unemployed in the following period. The young workers who lost their jobs again search the labour market as old workers in the next period. In particular, $1 - P_y$ old unproductive and $O^s < P_y$ old productive workers who did not succeed in founding a firm with another young productive agent search for a job.

As in Blankenau and Camera (2006), it is assumed that skills can only be observed imperfectly when agents meet. In particular, an agent observes with probability γ whether or not his matching partner is productive. This implies that there is also no instrument to credibly signal that a worker has observed his partner's productivity (just stating it would be considered cheap talk). Therefore it is possible that two productive workers observe that their respective matching partner is also productive, but they nevertheless do not know that *also their partner* has observed productivity and they cannot signal credibly that they observed productivity themselves. Thus maybe both do not cooperate, even though both know that their matching partner is productive. Rubinstein (1989) shows in the *E-mail Game* that even a very small disturbance in the transmission of information regarding the state of the world can

[2]For example, the contract of cooperation between both workers could state that both receive one half of total output, that is, $L = u/2$.

invalidate the information and the cooperative outcome can no longer be reached. Next I derive what agents do if they are matched to a partner with unobservable productivity.

1.2.1 Strategies of Unproductive Workers

Cooperation with any partner with unobservable productivity is a *weakly* dominant strategy for unproductive workers: the worst possible outcome of cooperation is 0, and if the unproductive agent manages to set up a contract with a productive worker he can extract a positive rent. In contrast, if the unproductive worker does not cooperate he definitely earns 0. I focus on the equilibria in which unproductive agents accept any partner even though weak dominance is not sufficient to rule out Nash equilibria with non-cooperation of unproductive workers[3].

1.2.2 Strategies of Productive Workers

Productivity Distribution among Old Unemployed Workers

How will a productive worker deal with a matching partner who has unobservable skills? Cooperation with an unproductive partner would result in a loss of L, but if he refuses to cooperate with a feasible matching partner the potential additional income G is lost. Thus the worker estimates the productivity of the matching partner. Even if productivity itself is unknown, a worker's age can always be observed. Therefore, the optimal strategy can be conditioned on the age of the matching partner as well as on the worker's own age, which effects the other agent's behaviour. In the following I focus on symmetric Nash equilibria. Let ω_i^j denote the probability that a productive worker of age i cooperates with a worker of age j with unobservable skills (ages are labeled y for young and o for old). While the fraction P_y of all young agents who search for jobs is productive, the probability that an old *unemployed* worker is productive is lower and determined endogenously: all unproductive agents have to search for a new job in the second period of their lives, but some young productive agents have managed to start a business with another young skilled partner, so they

[3]Furthermore, more sophisticated equilibrium concepts could be used to remove equilibria in which weakly dominated strategies are played.

do not enter the labour market again when they are old. Hence the absolute number of unemployed old productive workers in the next period O^s_{t+1} depends on the extent of cooperation between young productive agents in this period $\omega^y_{y,t}$ and the number of old productive unemployed in this period O^s_t, who reduce the probability that two young agents meet and set up a 2-period firm:

$$O^s_{t+1} = P_y \left[1 - \frac{P_y}{2 - P_y + O^s_t}[\gamma + (1-\gamma)\omega^y_{y,t}]^2\right] < P_y. \tag{1.1}$$

Each of the P_y young productive agents is matched to another young productive partner with probability $P_y/[2 - P_y + O^s_t]$ as there are P_y young productive, $1 - P_y$ young unproductive, $1 - P_y$ old unproductive and O^s_t old productive workers (whose number depends on the previous periods) searching for a partner. This match results in a cooperation with probability $[\gamma + (1-\gamma)\omega^y_{y,t}]^2$, as each one observes the productivity of his respective partner and thus cooperates with probability γ, or does not observe it but decides to cooperate anyway with probability $(1-\gamma)\omega^y_{y,t}$. Only if both cooperate is the firm set up. In any other case the productive worker does not find employment in a firm with another young productive agent and must search again in the second period of his life.

I focus on long-run equilibria in which all endogenous variables such as cooperation decisions and the productivity distribution among the unemployed workers are constant over time, that is $\omega^y_{y,t} = \omega^y_{y,t+1} = \omega^y_y$ and $O^s_{t+1}(\omega^y_{y,t}, \omega^y_{y,t+1}, ...) = O^s(\omega^y_y)$. It can be shown that the economy converges to such an equilibrium independent of the initial conditions (see section 1.2.4).

As the total number of old unemployed workers is composed of $O^s(\omega^y_y)$ productive and $1 - P_y$ unproductive workers, an arbitrary unemployed old worker is productive with probability

$$P_o(\omega^y_y) = \frac{O^s(\omega^y_y)}{1 - P_y + O^s(\omega^y_y)} < P_y. \tag{1.2}$$

For any decision ω^y_y and nontrivial parameters, an unemployed old worker is on average less productive than a young one, that is $P_o(\omega^y_y) < P_y$. $P_o(\omega^y_y)$ is also decreasing in ω^y_y: more cooperation between young productive workers reduces the number of old productive unemployed workers in the next period, that is $\frac{\partial O^s(\omega^y_y)}{\partial \omega^y_y} < 0$, without affecting the number of unproductive ones. Therefore the probability that an arbitrary old unemployed worker is productive decreases.

Strategies of Old Productive Workers

A productive agent estimates the expected payoff of cooperation if he cannot observe the productivity of his partner. The optimal decision depends on the age of the matching partner as well as on his own age (which affects the strategy of the other agent). For the remainder of this paper I focus on the actions of productive agents who cannot observe productivity, as these are the non-trivial decisions, and denote the equilibrium strategy of such a worker $\boldsymbol{\omega} = (\omega_o^o, \omega_o^y, \omega_y^o, \omega_y^y)$. I consider four different cases, starting with an old productive worker who is matched to another old worker with unobservable productivity. He cooperates with the other old worker if this promises a positive payoff, that is,

$$P_o(\omega_y^y)[\gamma + (1-\gamma)\omega_o^o]G - [1 - P_o(\omega_y^y)]L \quad \geq \quad 0. \tag{1.3}$$

With probability $P_o(\omega_y^y)$ the old matching partner is productive and decides to cooperate himself with total probability $[\gamma+(1-\gamma)\omega_o^o]$. Cooperation with this worker then provides additional income G. With probability $(1 - P_o)$ the unknown agent is unproductive, thus setting up a firm with this worker will cost L. The additional income without cooperation is 0, so the worker cooperates if the expected gain is positive.

Then cooperation with unknown partners in a match of two old workers is part of a symmetric Nash equilibrium if, given that all workers are expected to play $\omega_o^o = 1$, no individual agent can increase his own expected payoff by deviating to non-cooperation. Therefore $\omega_o^o = 1$ is an equilibrium if

$$\overline{\Omega}_o^o(\omega_y^y) \equiv \frac{P_o(\omega_y^y)G}{1 - P_o(\omega_y^y)} \quad \geq L. \tag{1.4}$$

Respectively, $\omega_o^o = 0$ is an equilibrium if

$$\underline{\Omega}_o^o(\omega_y^y) \equiv \frac{\gamma P_o(\omega_y^y)G}{1 - P_o(\omega_y^y)} \quad \leq L. \tag{1.5}$$

Cooperation is optimal if the loss associated with cooperation with an unproductive agent L is below the threshold $\overline{\Omega}_o^o(\omega_y^y)$. Analogously, if L is above the threshold $\underline{\Omega}_o^o(\omega_y^y)$, non-cooperation is a Nash equilibrium. If ω_y^y is identical at both threshold levels (which is shown later on), $\underline{\Omega}_o^o < \overline{\Omega}_o^o$, that is, some levels of L exist such that both $\omega_o^o = 1$ and $\omega_o^o = 0$ can be sustained in equilibrium. Then for $L \in (\underline{\Omega}_o^o, \overline{\Omega}_o^o)$

there must also be an equilibrium in mixed strategies $\omega_o^o \in (0,1)$. These multiple equilibria can be explained by complementarities in the cooperation decision: if an old worker expects that he will be accepted by a productive matching partner even if he cannot signal his productivity, that is, ω_o^o is high, he has a good chance to set up a firm with a feasible partner and strong incentives to cooperate by himself. In contrast, if everybody expects that an old productive matching partner will deny cooperation if skills are not observed, the expected profit of cooperation is low.
Now assume that our old productive agent is not matched to another old, but to a young worker with unobservable productivity. Then it is optimal for him to cooperate if

$$P_y[\gamma + (1-\gamma)\omega_y^o]G - (1-P_y)L \quad \geq \quad 0. \tag{1.6}$$

The main difference to the previous case of two old agents is that an unknown young agent is more likely to be productive, $P_y > P_o(\omega_y^y)$. Thus $\omega_o^y = 1$ is an equilibrium if

$$\Omega_o^y(\omega_y^o) \equiv \frac{P_y[\gamma + (1-\gamma)\omega_y^o]G}{1-P_y} \quad \geq \quad L. \tag{1.7}$$

$\omega_o^y = 0$ is an equilibrium if

$$\Omega_o^y(\omega_y^o) \equiv \frac{P_y[\gamma + (1-\gamma)\omega_y^o]G}{1-P_y} \quad \leq \quad L. \tag{1.8}$$

Exactly one threshold Ω_o^y exists because two different types of workers are involved. Nevertheless the optimal decision of the old agent ω_o^y depends on the expected behaviour of the young one, ω_y^o. If $L < \Omega_o^y(\omega_y^o)$, old workers cooperate with young ones if they cannot observe productivity, if $L > \Omega_o^y(\omega_y^o)$ they do not. For $L = \Omega_o^y(\omega_y^o)$ they are indifferent.

Strategies of Young Productive Workers

Next consider the same match, old and young worker, from the young agent's point of view. If a young worker cannot observe his old partner's productivity he wants to set up a firm if

$$P_o(\omega_y^y)[\gamma + (1-\gamma)\omega_o^y]G - [1-P_o(\omega_y^y)]L \quad \geq \quad 0, \text{ thus} \tag{1.9}$$

$\omega_y^o = 1$ is an equilibrium if

$$\Omega_y^o \equiv \frac{P_o(\omega_y^y)[\gamma + (1-\gamma)\omega_o^y]G}{1 - P_o(\omega_y^y)} \quad \geq \quad L, \text{ and} \tag{1.10}$$

$\omega_y^o = 0$ is an equilibrium if

$$\Omega_y^o \equiv \frac{P_o(\omega_y^y)[\gamma + (1-\gamma)\omega_o^y]G}{1 - P_o(\omega_y^y)} \quad \leq \quad L. \tag{1.11}$$

Finally examine a match between two young workers. In such a match the incentives for cooperation are increased by an additional characteristic: a firm of two young productive agents can produce for two periods until both retire and workers do not have to search again once they are old. Let $U_o(\boldsymbol{\omega})$ denote the expected income of an old productive worker searching for a job. Cooperation of two young productive agents promises for each of them not only additional income G, but $2G - U_o(\boldsymbol{\omega})$, where $G - U_o$ can be interpreted as option value of joint production in the second period. Therefore, a young worker cooperates with another young worker with unobservable productivity if

$$P_y[\gamma + (1-\gamma)\omega_y^y][2G - U_o(\boldsymbol{\omega})] - (1 - P_y)L \geq 0, \text{ with} \tag{1.12}$$

$$\begin{aligned} U_o(\boldsymbol{\omega}) = \frac{1}{2 - P_y + O^s(\omega_y^y)} \Big[& P_y G[\gamma + (1-\gamma)\omega_y^o][\gamma + (1-\gamma)\omega_o^y] \\ + \quad & O^s(\omega_y^y)[\gamma + (1-\gamma)\omega_o^o]^2 G - (1 - P_y)(1-\gamma)(\omega_o^y + \omega_o^o)L \Big]. \end{aligned} \tag{1.13}$$

In every period 1 young and $1 - P_y + O^s$ old workers are searching for a partner. The three terms in brackets define the expected return of a match with a young productive, old productive, and unproductive agents, weighted by the number of such workers and the conditional acceptance probabilities. Then
$\omega_y^y = 1$ is an equilibrium if

$$\overline{\Omega}_y^y(\boldsymbol{\omega}) \equiv \frac{P_y[2G - U_o(\boldsymbol{\omega})]}{1 - P_y} \quad \geq \quad L \text{ and} \tag{1.14}$$

$\omega_y^y = 0$ is an equilibrium if

$$\underline{\Omega}_y^y(\boldsymbol{\omega}) \equiv \frac{\gamma P_y[2G - U_o(\boldsymbol{\omega})]}{1 - P_y} \quad \leq \quad L. \tag{1.15}$$

Again complementarities can give rise to levels of L with multiple equilibria: $\overline{\Omega}_y^y > \underline{\Omega}_y^y$ for given $\omega_o^o, \omega_o^y, \omega_y^o$, because $U_o(\boldsymbol{\omega}) \mid_{\omega_y^y=1} < U_o(\boldsymbol{\omega}) \mid_{\omega_y^y=0}$. The expected income of an old searching worker decreases with ω_y^y, as this reduces the number of productive matching partners.

Table 1 summarises the threshold levels for the different equilibrium decisions. Note that these thresholds still depend on the expected equilibrium strategies $\boldsymbol{\omega}$.

	lowest level of L for $\omega_i^j = 0$	**highest level of L for $\omega_i^j = 1$**
ω_o^o	$\underline{\Omega}_o^o(\omega_y^y) = \dfrac{\gamma P_o(\omega_y^y) G}{1 - P_o(\omega_y^y)}$	$\overline{\Omega}_o^o(\omega_y^y) = \dfrac{P_o(\omega_y^y) G}{1 - P_o(\omega_y^y)}$
ω_o^y	$\Omega_o^y(\omega_y^o) = \dfrac{P_y[\gamma + (1-\gamma)\omega_y^o] G}{1 - P_y}$	$\Omega_o^y(\omega_y^o) = \dfrac{P_y[\gamma + (1-\gamma)\omega_y^o] G}{1 - P_y}$
ω_y^o	$\Omega_y^o(\omega_o^y, \omega_y^y) = \dfrac{P_o(\omega_y^y)[\gamma + (1-\gamma)\omega_o^y] G}{1 - P_o(\omega_y^y)}$	$\Omega_y^o(\omega_o^y, \omega_y^y) = \dfrac{P_o(\omega_y^y)[\gamma + (1-\gamma)\omega_o^y] G}{1 - P_o(\omega_y^y)}$
ω_y^y	$\underline{\Omega}_y^y(\boldsymbol{\omega}) = \dfrac{\gamma P_y[2G - U_o(\boldsymbol{\omega})]}{1 - P_y}$	$\overline{\Omega}_y^y(\boldsymbol{\omega}) = \dfrac{P_y[2G - U_o(\boldsymbol{\omega})]}{1 - P_y}$

Table 1.1: List of Threshold Levels for Dismissal Protection

1.2.3 The Equilibrium

In order to explicitly determine the threshold levels for L I show that, if γ is sufficiently high, $\overline{\Omega}_y^y(\boldsymbol{\omega})$ and $\underline{\Omega}_y^y(\boldsymbol{\omega})$ are strictly larger than any other threshold.

Assumption 1: $\gamma > \dfrac{1}{2 - P_y}$.

Proposition 1: *Under assumption 1,* $\overline{\Omega}_y^y(\boldsymbol{\omega}) = \overline{\Omega}_y^y(0,0,0,1)$, $\underline{\Omega}_y^y(\boldsymbol{\omega}) = \underline{\Omega}_y^y(0,0,0,0)$, $\Omega_y^o(\omega_o^y, \omega_y^y) = \Omega_y^o(\omega_o^y, 1)$, $\overline{\Omega}_o^o(\omega_y^y) = \overline{\Omega}_o^o(1)$ *and* $\underline{\Omega}_o^o(\omega_y^y) = \underline{\Omega}_o^o(1)$.

Proof: see appendix.

The incentives to cooperate with an agent whose productivity cannot be observed are the highest if two young workers are matched. Young unemployed agents are on average more productive ($P_y > P_o(\omega_y^y)$), and such a match promises additional income $2G - U_o(\boldsymbol{\omega}) > G$. Therefore cooperation between two young workers ($\omega_y^y = 1$) can occur even if dismissal protection is too tough to allow for any other kind of

collaboration and $\overline{\Omega}_y^y(\boldsymbol{\omega})$ is strictly larger than any other threshold.
The lower bound for non-cooperation between two young agents $\underline{\Omega}_y^y(\boldsymbol{\omega})$ crucially depends on the observability of skills γ: For $\gamma \to 1$, expected behaviour of other productive agents *in case of uncertainty* ω_y^y becomes irrelevant for individual incentives, knowing that any matching partner will notice productivity and cooperate for sure. If other agents' decisions under uncertainty have no effect on individual incentives, complementarities disappear, and the thresholds for accepting and declining must coincide, i.e. $\underline{\Omega}_y^y \to \overline{\Omega}_y^y$.
This demonstrates that if γ is large enough, the high payoff $(2G - U_o)$ and the high average productivity P_y outweigh the negative effect of expected declining behaviour $\omega_y^y = 0$ in case of uncertainty, such that $\underline{\Omega}_y^y$, as $\overline{\Omega}_y^y$, is strictly larger than any threshold involving old agents (Ω_y^o, Ω_o^y, $\overline{\Omega}_o^o$ and $\underline{\Omega}_o^o$) for any other expected strategies $\boldsymbol{\omega}$.
Assumption 1 provides a *sufficient* condition for this kind of equilibrium and is satisfied if γ is large enough. Additionally, it prevents the complementarities from giving rise to "strange" equilibria in which two young workers decline, but two old workers who have worse circumstances cooperate.
Under assumption 1, at the thresholds for two young workers $\overline{\Omega}_y^y(\boldsymbol{\omega})$ and $\underline{\Omega}_y^y(\boldsymbol{\omega})$, L is so high that no cooperation involving at least one old worker and unobservable productivity is possible even for the most extreme expectations, so we know that $\overline{\Omega}_y^y(\boldsymbol{\omega}) = \overline{\Omega}_y^y(0,0,0,1)$ and $\underline{\Omega}_y^y(\boldsymbol{\omega}) = \underline{\Omega}_y^y(0,0,0,0)$. Inversely, at levels of dismissal protection if two old workers or workers in mixed matches are indifferent between cooperation and noncooperation, two young workers strictly must prefer to cooperate. That is, $\Omega_y^o(\omega_o^y, \omega_y^y) = \Omega_y^o(\omega_o^y, 1)$, $\overline{\Omega}_o^o(\omega_y^y) = \overline{\Omega}_o^o(1)$ and $\underline{\Omega}_o^o(\omega_y^y) = \underline{\Omega}_o^o(1)$.
Finally I determine the thresholds for matches involving agents of different ages. For γ sufficiently large, $\Omega_o^y > \Omega_y^o$, that is, some L exists such that old agents cooperate with young ones ($\omega_o^y = 1$), but not vice versa ($\omega_y^o = 0$).

Assumption 2: $\gamma > \dfrac{\sqrt{1 - P_y^2} - (1 - P_y)}{P_y}$.

Proposition 2: *Under assumption 2,* $\Omega_o^y = \Omega_o^y(0) > \Omega_y^o = \Omega_y^o(1) = \overline{\Omega}_o^o$.

Proof: see appendix.

Consider the incentives in a match of an old and a young worker: First, an old unemployed worker is on average less productive than a young one, so old workers

have stronger incentives to cooperate with young workers than vice versa. Second, in the proposed equilibrium old productive workers expect that a young productive agent will only cooperate with old workers who are able to communicate their skills ($\omega_y^o = 0$), whereas young productive workers expect that old agents will cooperate in any case ($\omega_o^y = 1$). This provides stronger incentives for young workers and weakens the previous effect.

If γ is sufficiently large the first effect dominates: a productive old worker knows that it is very likely that he can signal his skills, so the expected declining behaviour of the matching partner *in the case of observable skills* $\omega_y^o = 0$ has only a weak effect on the incentives of the old worker. Then old workers face lower hiring probabilities, $\omega_y^o = 0 < \omega_o^y = 1$ for $\Omega_y^o < L < \Omega_o^y$. This explicitly determines $\underline{\Omega}_o^o < \overline{\Omega}_o^o = \Omega_y^o < \Omega_o^y < \underline{\Omega}_y^y < \overline{\Omega}_y^y$ (see table 1.2 and figure 1.1).

	lowest level of L for $\omega_i^j = 0$	**highest level of L for $\omega_i^j = 1$**
ω_o^o	$\underline{\Omega}_o^o = \frac{\gamma P_o(1) G}{1 - P_o(1)}$	$\overline{\Omega}_o^o = \frac{P_o(1) G}{1 - P_o(1)}$
ω_o^y	$\Omega_o^y = \frac{P_y \gamma G}{1 - P_y}$	$\Omega_o^y = \frac{P_y \gamma G}{1 - P_y}$
ω_y^o	$\Omega_y^o = \frac{P_o(1) G}{1 - P_o(1)}$	$\Omega_y^o = \frac{P_o(1) G}{1 - P_o(1)}$
ω_y^y	$\underline{\Omega}_y^y = \frac{\gamma P_y [2G - U_o(0,0,0,0)]}{1 - P_y}$	$\overline{\Omega}_y^y = \frac{P_y [2G - U_o(0,0,0,1)]}{1 - P_y}$

Table 1.2: List of Threshold Levels Under Assumption 1 and 2

Differential Treatment

For $\overline{\Omega}_o^o < L < \Omega_o^y$ *all* productive young agents receive a job offer, whereas nobody wants to cooperate with an old worker whose productivity cannot be observed. Everyone knows that these old workers already had one opportunity to obtain a job, but they are still unemployed: some because they are not productive, others simply because they were unlucky and had the wrong partner. As long as the reason for unemployment cannot be signaled credibly, all old unemployed workers bear the stigma of missing one opportunity of employment, and the expected productivity

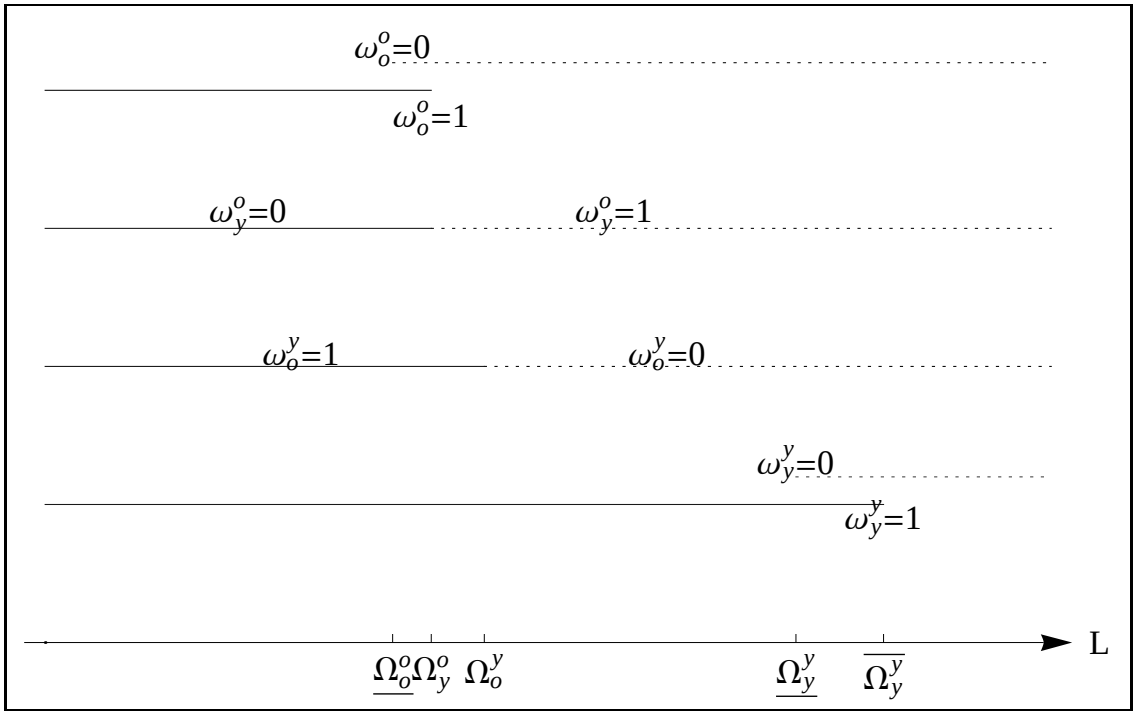


Figure 1.1: Equilibrium Strategies Conditional on Dismissal Protection

of old unemployed workers is lower than of young unemployed workers. If an agent could choose between an old and a young unemployed partner with unobservable skills, he would select the younger one, although individual productivity is independent of age. Note that even old workers discriminate against their contemporaries. This can only be driven by the lower expected productivity of old unemployed workers: every old worker knows that he is going to retire after this period, so he does not care whether a young agent *could* stay for two periods. Therefore any difference in treatment must be due to differences in expected productivity.

1.2.4 Convergence

So far I ignored the dynamic structure of this model: the number of old productive searching agents in period t, O_t^s, and thus the incentives for cooperation depend on the decisions in the *previous* periods $t-1$, $t-2$ and so on. However, the initial level O_0^s may well deviate from its long run equilibrium level.

Proposition 3:

The equilibrium will reach the long-run equilibrium proposed in section 1.2.3 independent of the initial conditions.

Consider the dynamic evolution of O^s_t,

$$O^s_{t+1}(\omega^y_y, O_t) \quad = \quad P_y \left[1 - \frac{P_y}{2 - P_y + O^s_t} [\gamma + (1-\gamma)\omega^y_{y,t}]^2 \right]. \tag{1.16}$$

For any fixed $\overline{\omega}^y_y$ the number of old skilled unemployed converges to a unique $O^s(\overline{\omega}^y_y)$ as $\frac{\partial O^s_{t+1}}{\partial O^s_t} > 0$, $\frac{\partial (O^s_{t+1})^2}{\partial^2 O^s_t} < 0$, $O^s_{t+1}(\overline{\omega}^y_y, 0) > 0$ and $O^s_{t+1}(\overline{\omega}^y_y, 1) < 1$ (see figure 1.2).

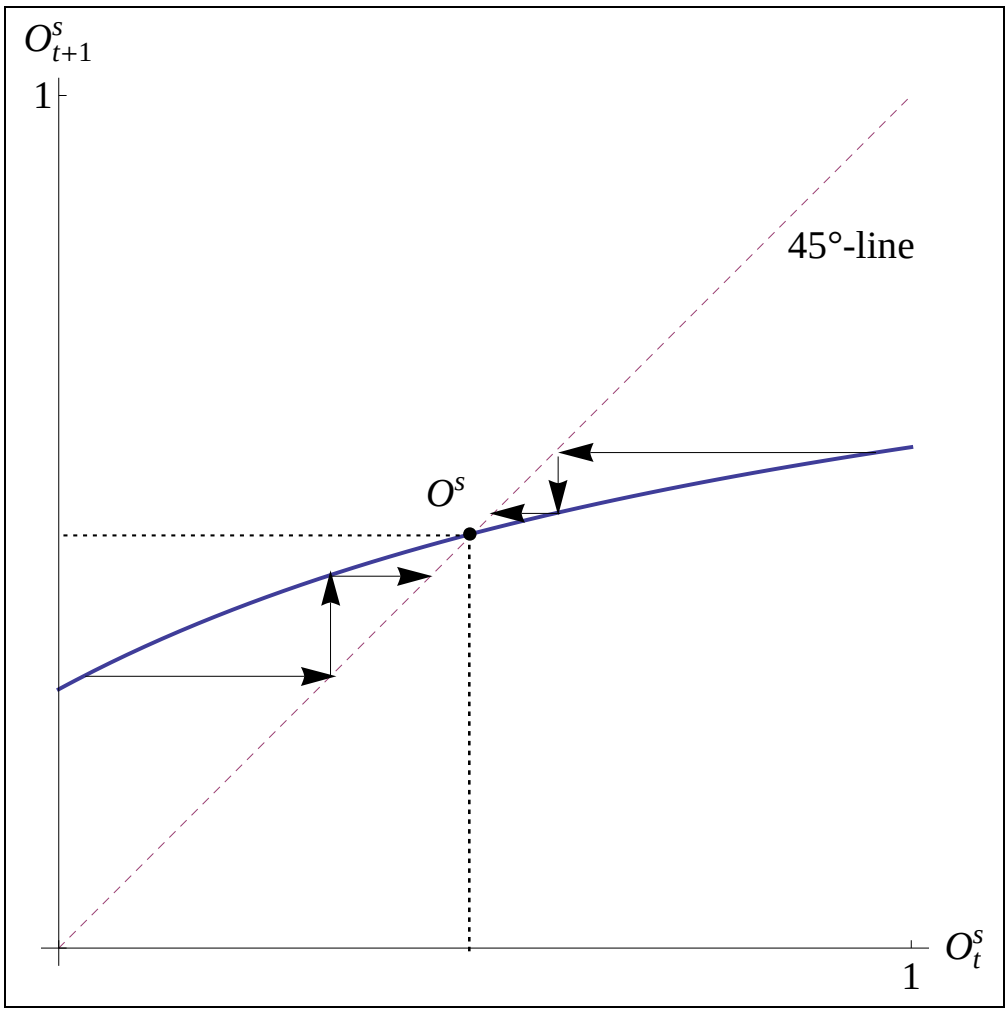


Figure 1.2: Convergence of the Productivity Distribution Among Old Unemployed

Next I show that, independent of the initial O_0^s, the cooperation between two young agents ω_y^y is at the proposed long run equilibrium level already in $t = 0$ and O_t^s will converge to its equilibrium:
Assumption 1 holds for any $\boldsymbol{\omega}$ and any O_t^s, so $\overline{\Omega}_{y,t}^y = \overline{\Omega}_{y,t}^y(0,0,0,1)$. Then a young productive agent accepts another young worker with unobservable skills if

$$P_y[\gamma + (1-\gamma)\omega_{y,t}^y][2G - U_{o,t+1}(\omega_{y,t}^y, 0, 0, 0)] - (1 - P_y)L \geq 0, \text{ with}$$
$$U_{o,t}(\omega_{y,t-1}^y, 0, 0, 0) = \frac{[P_y + O_t^s(\omega_{y,t-1}^y)]\gamma^2 G}{2 - P_y + O_t^s(\omega_{y,t-1}^y)}.$$

The expected income of an unemployed old productive worker is the higher, the more feasible matching partners he expects, that is $U_{o,t}$ is increasing in O_t^s. Thus, the (short-run) threshold levels $\overline{\Omega}_{y,t}^y$ and $\underline{\Omega}_{y,t}^y$ are the lower, the higher the expected level of O_{t+1}^s in the next period as the option value $G - U_o$ declines.
First focus on $\overline{\Omega}_y^y$, which considers as long-run outcome $\omega_y^y = 1$ and $O^s(1)$. This is the lowest O^s that can persist in the long run, as it incorporates the maximal cooperation between young productive agents, that is, in the long-run $O^s \geq O^s(1)$ must hold. Then in the long run $\omega_y^y = 1$ can never hold for any $L > \overline{\Omega}_y^y$ because this would mean $O^s < O^s(1)$ as $\dfrac{\partial \overline{\Omega}_{y,t}^y}{\partial O^s} < 0$.
Analogously, there can never be a long run equilibrium with $L < \underline{\Omega}_y^y$ and $\omega_y^y = 0$, because this necessitates $O^s > O^s(0)$, which can never hold in the long run.

1.3 Efficiency and the Commitment Problem

I have shown that old and young workers are treated differently, but this does not necessarily mean that differential treatment in the decentralised equilibrium is not efficient. In the following I focus on expected total income, as agents are risk neutral and do not discount the future.
Total income in the economy, that is the sum of productive and unproductive agents' income including L, is maximised if cooperation between productive agents is at its highest, that is $\boldsymbol{\omega} = (1,1,1,1)$. As the productive agents who decide on $\boldsymbol{\omega}$ treat L not as transfer but as loss, this high amount of cooperation can only be sustained if L is sufficiently low.
Do *productive* workers at least maximise their *own* expected income, or would a

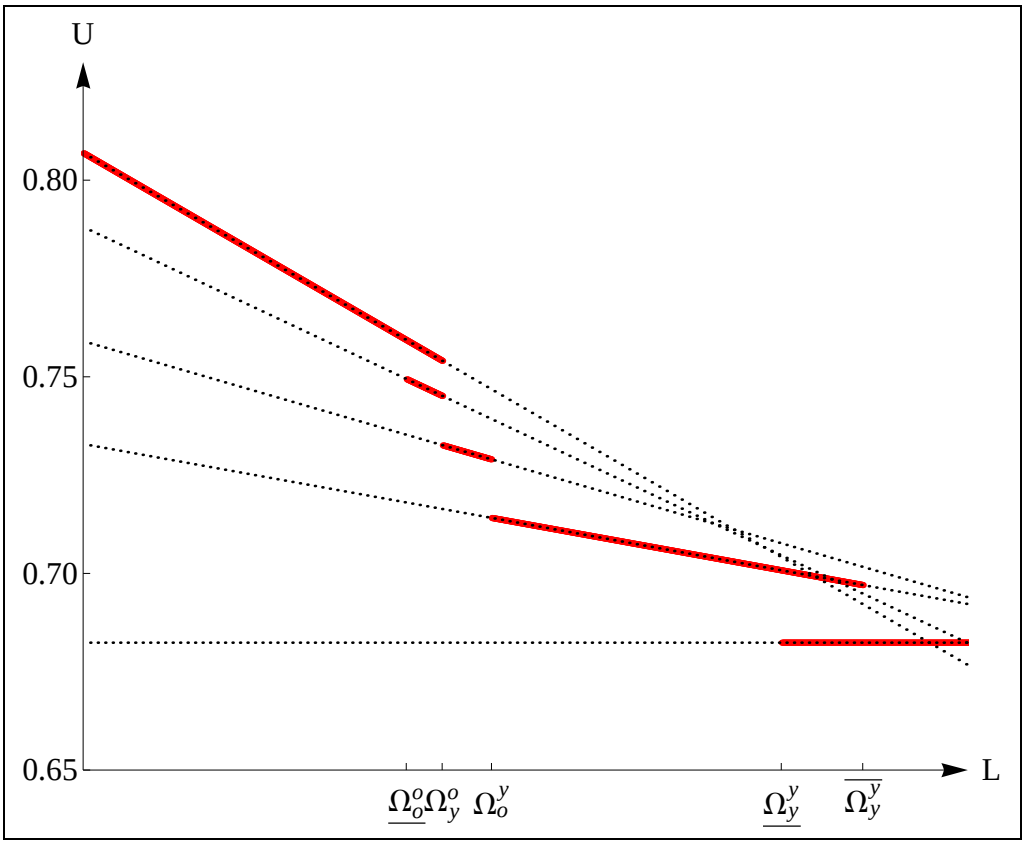
different strategy promise higher income for themselves? I compare the decentralised outcome with the decisions of a planner who maximises the expected income of productive agents U_g and takes market imperfections as given. This planner is not subject to individual incentives and can set $\boldsymbol{\omega}$ in order to maximise U_g, but he is still constrained by the search and informational frictions.

$$\begin{aligned}
\max_{\boldsymbol{\omega}} U_g &= U_y(\boldsymbol{\omega}) + U_o(\boldsymbol{\omega}) \qquad \text{with} \\
U_y(\boldsymbol{\omega}) &= \frac{1}{2 - P_y + O^s(\omega_y^y)} \Big[P_y[2G - U_o(\boldsymbol{\omega})](\gamma + (1-\gamma)\omega_y^y)^2 \\
&+ O^s(\omega_y^y)(\gamma + (1-\gamma)\omega_y^o)(\gamma + (1-\gamma)\omega_o^y)G - (1-P_y)(1-\gamma)(\omega_y^y + \omega_y^o)L \Big].
\end{aligned}$$

For given $\boldsymbol{\omega}$, total expected income U_g is linear and decreasing in L, that is a reduction of dismissal protection can only benefit productive workers (if there is at least some level of cooperation). Figure 1.3 depicts U_g for different strategies $\boldsymbol{\omega}$, market equilibria are marked as solid lines. The higher the level of cooperation, the stronger is the effect of L, that is, the more a reduction in L raises expected income and the steeper is the curve.

The decentralised equilibrium is not efficient in general: the planner would choose more cooperative strategies for many levels of L in order to reach the highest expected income for productive workers. But why can productive workers not reach the efficient outcome by themselves?

The explanation is, as usual, an externality: workers do not take into account that their individual behaviour has an effect on the income of a possibly productive matching partner. Examine, for example, a mixed match for L slightly above Ω_o^y. I have just shown that then $\boldsymbol{\omega} = (0, 0, 0, 1)$ is the only equilibrium, i.e. in this mixed match both agents only cooperate if they recognise that the other agent is productive. But if, for instance, the old worker deviated to cooperation ($\omega_o^y = 1$), in addition to the change in his individual income, he would also increase the expected income of a young productive matching partner: if the young worker could observe productivity and the old one could not, *both* would now cooperate. Total profit of the change in the old agent's behaviour is $2G$, but his individual profit is only G. Whereas a planner could internalise this effect, this behaviour is not necessarily an equilibrium. If for $L = \Omega_o^y + \varepsilon$ all productive workers could commit to cooperation



Notes: Expected income for different ω (dotted lines) and equilibrium strategies (solid lines).

Figure 1.3: Expected Total Income of a Productive Worker

with young workers *before* matching takes place, they would raise their expected income. Unfortunately, such contracts do not exist or would not be enforceable. Therefore *conditional* on being matched to a young agent with unobservable skills, old agents have an incentive to deviate from this commitment to noncooperation and maximise their *individual* expected profit.

The Unproductive Agents

As just shown, cooperation is for many L inefficiently low from the point of view of a productive agent. If such a productive agent were to gain by increasing cooperation, unproductive agents must also profit, as they are accepted more often and earn L. A slightly different question is: what is the effect of an increase in dismissal protection L on the expected income of an unproductive agent? This has two consequences: first, expected income rises as the amount that can be extracted if an unproductive agent is accepted as a partner increases. On the other hand, the increase in L might induce a less cooperative strategy $\boldsymbol{\omega}$, reducing the probability of being accepted and earning L. Thus, both very strong dismissal protection $L \geq \overline{\Omega}_y^y$ and $L = 0$ yield zero income for unproductive agents, and their income will be maximised by some L in between. Hence, even if unproductive agents are able to implement their favourite L (for example because the majority of the population is unproductive), they would not decide to maximise exploitation by maximising L.

1.4 Hiring Opportunities for Old Workers

I examine whether old productive workers in fact face lower probabilities of finding a new job, and what affects these hiring opportunities. The absolute probability that such a worker finds a new job is[4]

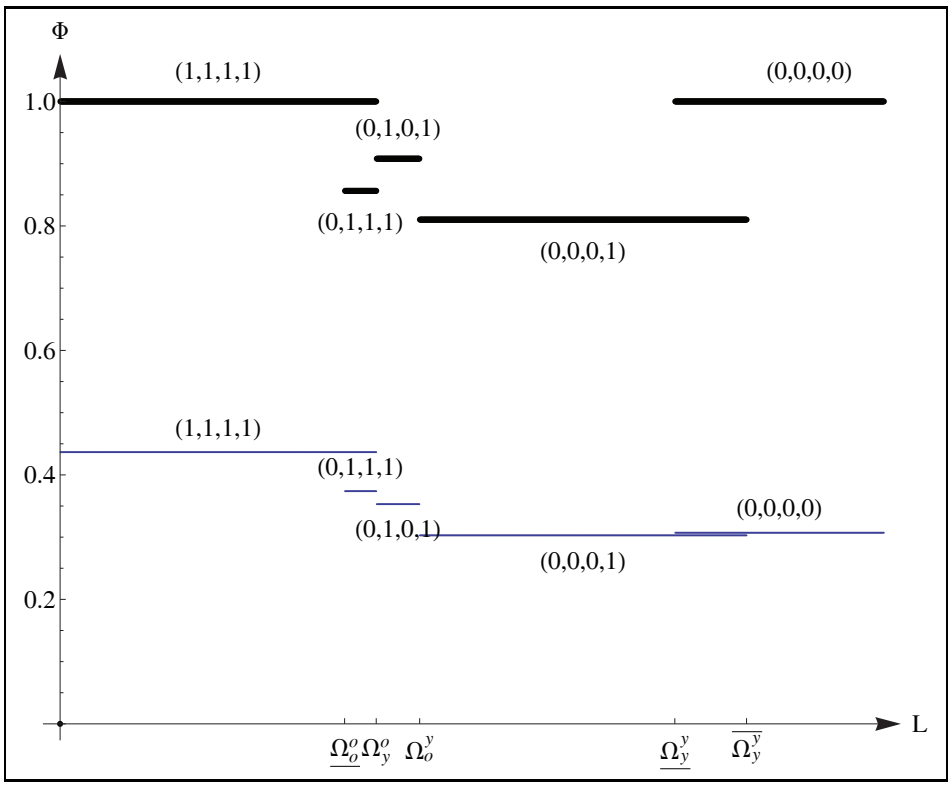
$$\begin{aligned}\Phi_o &= \frac{1}{2 - P_y + O^s(\omega_y^y)}\Big[P_y(\gamma + (1-\gamma)\omega_y^o)(\gamma + (1-\gamma)\omega_o^y) \\ &+ O^s(\omega_y^y)(\gamma + (1-\gamma)\omega_o^o)^2 + (1 - P_y)(1-\gamma)(\omega_o^o + \omega_o^y)\Big]. \qquad (1.17)\end{aligned}$$

[4]This is the probability that cooperation with any agent takes place, so a firm with an unproductive agent is treated as employment. The results do not change qualitatively if I only consider firms with productive workers.

The employment prospects for old productive agents are increasing in ω_o^o, ω_o^y and ω_y^o, but their hiring opportunities decrease in ω_y^y, which reduces the number of productive matching partners for old workers. In contrast, the probability that a young worker is employed is

$$\begin{aligned}\Phi_y &= \frac{1}{2 - P_y + O^s(\omega_y^y)}\Big[P_y(\gamma + (1-\gamma)\omega_y^y)^2 \\ &+ O^s(\omega_y^y)(\gamma + (1-\gamma)\omega_o^y)(\gamma + (1-\gamma)\omega_y^o) + (1-P_y)(1-\gamma)(\omega_y^o + \omega_y^y)\Big].\end{aligned}$$

In any equilibrium, the probabilities that an old worker is accepted, ω_o^o and ω_y^o, are never larger than the acceptance probabilities for young workers, ω_y^y and ω_o^y. Thus the absolute hiring probabilities for an old worker are always equal to or smaller than those of young workers. Figure 1.4 illustrates the absolute and the relative hiring probability for old workers, Φ_o and Φ_o/Φ_y.



Notes: Absolute hiring probabilities are depicted as solid, relative probabilities as bold lines.

Figure 1.4: Relative and Absolute Hiring Probability of a Productive Old Worker

The Effect of Job Protection

A reduction of job protection L increases the *absolute* hiring opportunities of old skilled workers if the reduction is strong enough to trigger a change in $\boldsymbol{\omega}$, *except* for a transition from $\boldsymbol{\omega} = (0,0,0,0)$ to $\boldsymbol{\omega} = (0,0,0,1)$: this transition has no direct effect on matches that involve old workers, but through the increase in ω_y^y more young productive workers are retained in good firms. There are fewer productive old matching partners left, $O^s(\omega_y^y)$ decreases and the employment opportunities for old workers decline. For young workers, the direct effect of the increase in ω_y^y dominates the drop in $O^s(\omega_y^y)$. Hence, such a transition will, in terms of absolute hiring probabilities, benefit young and impair old productive workers. In any other transition, a reduction of dismissal protection can only improve absolute hiring opportunities for both groups: if $P_o(\omega_y^y)$ does not change but the risk of cooperation L is reduced, $\boldsymbol{\omega}$ can change toward more cooperative behaviour.

Differential treatment is usually measured in relative terms, and politicians *compare* the hiring opportunities of old and young workers. If old workers perform significantly worse than younger ones, politicians might start to act in order to provide equal opportunities for both groups. This is quite a questionable strategy, as relative and absolute hiring opportunities of old workers can move in opposite directions. Focus, for example, on such an equilibrium with strong discrimination, $\boldsymbol{\omega} = (0,1,0,1)$, that is all young agents with unobservable skills receive a job offer, while the old ones do not. The government increases dismissal protection beyond $\overline{\Omega}_y^y$, that is $\boldsymbol{\omega} = (0,0,0,0)$. In the new equilibrium, old and young productive workers both face identical hiring opportunities and the relative opportunities for old workers have risen to 1. Politicians were successful in fighting discrimination. But in absolute terms, hiring opportunities for both are extremely low and expected income for both young and old has decreased.

This demonstrates that we should not focus only on *relative* performance of a group of people. A policy that benefits these people might well reduce its relative performance, that is increase inequality or discrimination against this group. In this light, relative measures of hiring opportunities, as in Hutchens (1986), might not be adequate as a sole indicator for the performance of older people searching for jobs.

1.5 Early Retirement

Consider an equilibrium with low hiring opportunities for old workers. All agents are afraid of cooperation with an old unproductive worker. The government might then consider offering old unproductive workers an incentive to leave the market and introduce an early retirement system: every old worker has the option to retire and receive retirement income R instead of again searching for a new partner. I assume that workers must take this decision *before* matching takes place. In particular, the sequence of decisions works as follows: nature selects future matching partners without revealing results to the agents. Then old agents decide whether to search for and meet their partner or to leave the market. An agent whose designated old matching partner decided to leave the market is not matched to another "new" agent but *must* produce in autarky.

If R is sufficiently large, old unproductive workers prefer to sort themselves out of the market. Productive workers anticipate this behaviour and expect that all old workers who are still searching for jobs must be productive, thus every old matching partner should be accepted, that is, $\omega_y^o = \omega_o^o = 1$. In such an equilibrium the expected income of an old unproductive worker who were to *deviate* and stay in the labour market is

$$U_o^u = \frac{[P_y + O^s(\omega_y^y)](1-\gamma)L}{2 - P_y + O^s(\omega_y^y)}. \tag{1.18}$$

$2 - P_y + O^s(\omega_y^y)$ workers search for jobs, $P_y + O^s(\omega_y^y)$ are productive and cooperate with the unproductive worker if they do not notice that he is not productive, that is, with probability $1 - \gamma$. Then the unproductive agent extracts L.

Unproductive workers accept early retirement only if their pension is not smaller than the expected income of searching again for a job, that is if $R \geq U_o^u$. The sufficient pension is decreasing in γ (reducing the number of old productive matching partners and increasing the risk of being discovered as an unproductive worker), ω_y^y (also reducing old productive matching partners) and increasing in L (higher payoff if accepted by a productive worker).

The pension reform determines $\omega_o^o = \omega_y^o = 1$, but it also effects the thresholds for ω_o^y and ω_y^y:

Whereas $\Omega_o^y < \underline{\Omega}_y^y < \overline{\Omega}_y^y$ still holds under assumption 1, now $\Omega_o^y = \Omega_o^y(1) > \Omega_o^y(0)$,

that is, productive old workers are more willing to accept unknown young workers because they expect that all young matching partners cooperate. The new thresholds for matches of two young workers $\underline{\Omega}_y^y = \underline{\Omega}_y^y(1,0,1,0)$ and $\overline{\Omega}_y^y = \overline{\Omega}_y^y(1,0,1,1)$ are lower because the expected income of old searching productive workers U_o has risen and the option value of 2-period-production decreases.

Given that skills cannot be observed perfectly, it is reasonable that every agent, productive and unproductive, old and young, has to pay a lump sum tax τ to finance the pension system. The population of size 2 has to pay transfers to $1 - P_y$ old unproductive workers, so every agent in the economy must contribute

$$\tau = \frac{(1-P_y)R}{2} = \frac{(1-P_y)[P_y + O^s(\omega_y^y)](1-\gamma)L}{2[2 - P_y + O^s(\omega_y^y)]}. \tag{1.19}$$

Now compare the expected total income of a productive worker U_g with and without a pension system. If the pension system does not trigger a change in ω_y^y and ω_o^y the change in expected income is

$$\begin{aligned}\Delta U_g &= \frac{1}{2 - P_y + O^s(\omega_y^y)}\Big[(O^s(\omega_y^y) + P_y)[\gamma + (1-\gamma)\omega_o^y]G[1 - [\gamma + (1-\gamma)\omega_y^o]] \\ &+ (1-P_y)(\omega_y^o + \omega_o^o - P_y - O^s(\omega_y^y))(1-\gamma)L + O^s(\omega_y^y)G[1 - [\gamma + (1-\gamma)\omega_o^o]^2]\Big].\end{aligned}$$

with $\boldsymbol{\omega}$ as the strategy of the equilibrium without early retirement. Consider first as a benchmark the implementation of a pension system in a labour market with $\boldsymbol{\omega} = (1,1,1,1)$. The pension payments R are identical to the amount productive workers would lose in the "old" system anyway in terms of L. But now *all* agents pay this transfer to the old unproductive, not only the productive workers. Therefore net income of unproductive workers decreases and net income of productive workers would increase. Such a pension system is simply a transfer system from unskilled to skilled. Of course the government could also increase R beyond U_o^u in such a way that both incomes remain constant.

In contrast, consider now the effect of the pension system in a highly discriminating labour market in which all young agents receive a job offer, whereas old workers with unobservable productivity do not, that is $\boldsymbol{\omega} = (0,1,0,1)$. The government recognises that there is lack of cooperation, so they decide to implement the pension system, such that unproductive old workers sort themselves into retirement and

$\omega_o^o = \omega_y^o = 1$. Then the change in expected income of a skilled worker is

$$\Delta U_g = \frac{[O^s(1)+P_y]G(1-\gamma)+(1-P_y)(-P_y-O^s(1))(1-\gamma)L+O^s(1)G(1-\gamma^2)}{2-P_y+O^s(1)}.$$

The highest level of L that supports an equilibrium with $\boldsymbol{\omega} = (0,1,0,1)$ is $L = \Omega_o^y = \frac{P_y G\gamma}{1-P_y}$. Thus I substitute $L = \Omega_o^y$ to show that productive workers benefit if

$$[O^s(1)+P_y]G(1-\gamma)(1-P_y\gamma)+O^s(1)G(1-\gamma^2) > 0, \tag{1.20}$$

which is always satisfied.

Proposition 4:
In any equilibrium with maximal discrimination, that is $\boldsymbol{\omega} = (0,1,0,1)$*, the implementation of an early retirement system will raise the expected income of productive agents.*

Note that the effect of the retirement system depends crucially on the basic equilibrium: while with $\boldsymbol{\omega} = (0,1,0,1)$ productive agents gain, with $\boldsymbol{\omega} = (1,1,1,1)$ it is solely a redistribution system. In contrast, if $L > \overline{\Omega}_y^y$ and $\boldsymbol{\omega} = (0,0,0,0)$, it can be shown that productive agents will lose if they try to compensate old unproductive workers for leaving the market.

1.6 Conclusions

I have shown that hiring discrimination against old workers can be directly caused by labour market frictions, such as search frictions and asymmetric information. Firms do not have a taste for discrimination, but hiring young unemployed workers maximises their expected real profit. Even though young workers are not more productive in principle, being unemployed is a stronger signal of low productivity if a worker is old, because old workers have been subject to more skill-conditional "sorting". To deal with this kind of discrimination and raise the low hiring opportunities of older workers, politicians can directly reduce market frictions, such as dismissal protection.
There are several promising potential modifications: Currently, young and old workers face the same probability of being recognised as productive workers. Moreover,

dismissal protection is independent of age. Allowing for more heterogeneity among agents of different ages could give rise to new insights.
One could also draw up a different design for the early retirement system: Instead of financing the transfers by a lump-sum tax, politicians could also introduce a proportional income tax. Income, in contrast to productivity, should be observable. This would make the system less beneficial for productive agents, as they would have to pay a larger share of the transfers.
However, these extensions are left to future research.

1.7 Appendix

1.7.1 Proof of Proposition 1

I derive a sufficient condition such that both $\underline{\Omega}_y^y$ and $\overline{\Omega}_y^y$ are strictly larger than all other thresholds for any $\boldsymbol{\omega}$. While this is easy to check for $\overline{\Omega}_y^y$, it holds for $\underline{\Omega}_y^y$ only if

$$\gamma[2G - U_o(\boldsymbol{\omega})] > G \qquad \forall\, \boldsymbol{\omega}. \tag{1.21}$$

Since $U_o(\boldsymbol{\omega})$ is strictly decreasing in L and ω_y^y and I am only interested in a sufficient condition, I can assume $L = 0$ and $\omega_y^y = 0$. For $L = 0$, $U_o(\boldsymbol{\omega})$ is strictly increasing in ω_o^o, ω_y^o and ω_o^y, so I use $U(1, 1, 1, 0)$. Now I can rewrite (1.21) as

$$\gamma > \frac{2 - P_y + O^s(0)}{4 - 3P_y + O^s(0)}. \tag{1.22}$$

The right-hand-side of (1.22) is increasing in $O^s(0)$ so I substitute P_y for $O^s(0)$ as $P_y > O^s(0)$ to obtain the sufficient condition

$$\gamma > \frac{1}{2 - P_y}. \tag{1.23}$$

This inequality is satisfied if γ is sufficiently large and P_y sufficiently small. Figure 1.23 shows the combinations of P_y and γ that satisfy A1.

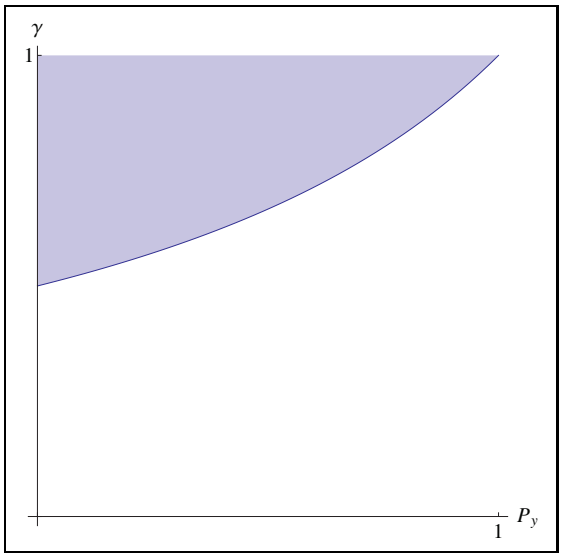


Figure 1.5: Illustration of Assumption 1

This sufficient condition is very loose (assuming $L = 0$ etc.) and even a higher fraction of productive workers should support this equilibrium once I impose restrictions on G/L.

1.7.2 Proof of Proposition 2

To determine $\Omega_y^o(\omega_o^y)$ and $\Omega_o^y(\omega_y^o)$, first note that $\underline{\Omega}_o^o \leq \Omega_y^o(\omega_o^y) \leq \overline{\Omega}_o^o$ (because $\Omega_y^o(0) = \underline{\Omega}_o^o$ and $\Omega_y^o(1) = \overline{\Omega}_o^o$) and $\Omega_o^y(\omega_y^o) > \underline{\Omega}_o^o$. The threshold for cooperation with a young agent, being an old one, depends on the expected behaviour of that young agent (and vice versa). That is, the position of one threshold has an impact on the position of the other one. There could be three different cases:

I) First consider $\Omega_o^y(\omega_y^o) < \Omega_y^o(\omega_o^y)$. This implies $\Omega_o^y = \Omega_o^y(1)$ and $\Omega_y^o = \Omega_y^o(0)$, so

$$\begin{aligned} \Omega_o^y(1) &= \frac{P_y G}{1 - P_y} \text{ and} \\ \Omega_y^o(0) &= \frac{P_o(1)\gamma G}{1 - P_o(1)}. \end{aligned}$$

It is easy to check that then $\Omega_o^y(1) > \Omega_y^o(0)$, which contradicts the assumption $\Omega_o^y(\omega_y^o) < \Omega_y^o(\omega_o^y)$.

II) Now consider the case $\Omega_o^y = \Omega_y^o$:

$$\frac{P_y(\gamma + (1-\gamma)\omega_y^o)G}{1 - P_y} = \frac{P_o(1)(\gamma + (1-\gamma)\omega_o^y)G}{1 - P_o(1)}$$

This can only be satisfied if ω_o^y on the right-hand-side is sufficiently larger than ω_y^o on the left-hand-side to outweigh $P_o(1) < P_y$. When does a combination of strategies ω_y^o and ω_o^y exist such that $\Omega_o^y = \Omega_y^o$ can hold? I substitute $P_o(1) = 1 - \frac{\sqrt{1-P_y}}{\sqrt{1+P_y}}$ and obtain

$$P_y[\gamma + (1-\gamma)\omega_y^o] = \left[\sqrt{1 - P_y^2} - (1 - P_y)\right][\gamma + (1-\gamma)\omega_o^y].$$

This can only hold if $\omega_o^y > \omega_y^o$. If even for $\omega_o^y = 1$ and $\omega_y^o = 0$ the left hand side is larger than the right hand side, **no** combination of ω_o^y and ω_y^o exists such that the two thresholds can coincide.

Result:
For $\gamma \leq \dfrac{\sqrt{1-P_y^2}-(1-P_y)}{P_y}$ some combinations of ω_o^y and ω_y^o exist with $\omega_o^y > \omega_y^o$ such that $\underline{\Omega}_o^o < \Omega_o^y(\omega_y^o) = \Omega_y^o(\omega_o^y) \leq \overline{\Omega}_o^o$. There can be different thresholds with $\Omega_y^o = \Omega_o^y \in]\underline{\Omega}_o^o, \overline{\Omega}_o^o]$ because there are different combinations of ω_o^y and ω_y^o that support this condition.

III) Assume $\Omega_o^y(\omega_y^o) > \Omega_y^o(\omega_o^y)$. This implies $\Omega_o^y = \Omega_o^y(0)$ and $\Omega_y^o = \Omega_y^o(1)$. Then

$$\begin{aligned} \Omega_o^y(0) &= \frac{P_y \gamma G}{1-P_y} \text{ and} \\ \Omega_y^o(1) &= \frac{P_o(1) G}{1-P_o(1)}. \end{aligned}$$

So in fact $\Omega_o^y > \Omega_y^o$ is an equilibrium if

$$\begin{aligned} \frac{P_y \gamma G}{1-P_y} &> \frac{P_o(1) G}{1-P_o(1)}, \\ \gamma &> \frac{\sqrt{1-P_y^2}-(1-P_y)}{P_y}. \end{aligned}$$

Result:
For $\gamma > \dfrac{\sqrt{1-P_y^2}-(1-P_y)}{P_y}$, $\Omega_o^y = \Omega_o^y(0) > \Omega_y^o = \Omega_y^o(1) = \overline{\Omega}_o^o$ is the only equilibrium.

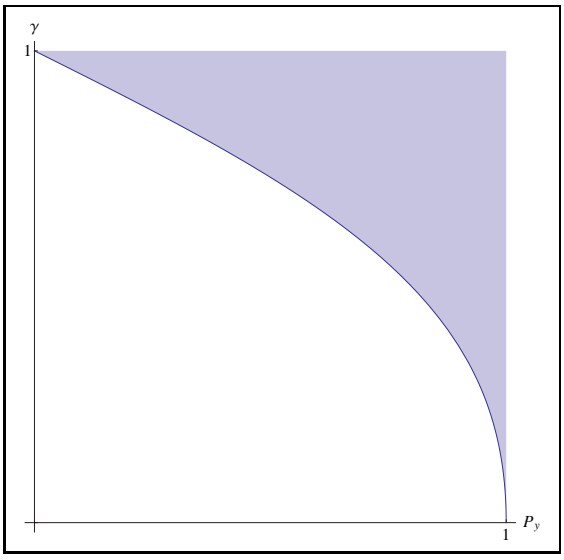


Figure 1.6: Illustration of Assumption 2

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CHAPTER 2

ETHNIC DISCRIMINATION IN GERMANY'S LABOUR MARKET: A FIELD EXPERIMENT

2.1 Introduction

Discrimination against individuals with respect to ethnicity, gender, or religion has a wide impact on labour market outcomes, including job opportunities, promotions and earnings. The extent to which a society is plagued by discrimination is hard to measure, however. On the one hand, empirical studies based on field data can deliver measures for earnings inequality but they cannot unveil discriminatory practices in the hiring process, for example. Moreover, field data are not collected in a controlled environment, so that the researcher has typically much less information about worker characteristics than is available to the employing firm. Hence it is difficult to disentangle the effects of actual productivity differences from employer discrimination. On the other hand, laboratory experiments on discrimination can be conducted in fully controlled settings. What is measured there, however, is the behaviour of subjects in a sterile environment; how far the findings of such experiments extend to employer–worker interactions in real–world labour markets is unclear. Field experiments are a compromise between these approaches, combining the advantages of controlled experiments with a field context.[1] With regard to measuring hiring discrimination, the correspondence test method is a sensible way to measure the initial response of employers to varying characteristics of artificial applicants.

This paper describes a correspondence test conducted in the German labour market for student internships. We examine the hiring opportunities of individuals with a Turkish migration background. Germany has about 2.4 million persons with a Turkish ethnic background (2.9 percent of its population). Predominantly in the 1960s, migrants from Turkey came to Germany to enlarge its labour force. About forty years later, the children and grand–children of these workers, born and raised in Germany, represent a significant share of Germany's workforce. Among other things, a full integration of these young women and men into the German labour market necessitates equal employment opportunities.

Our experiment generates a snapshot of ethnic discrimination in one particular subsection of the labour market. In particular, we send more than one thousand applications to firms that offer internships for students of economics and management

[1] See Harrison and List (2004) for a survey on field experiments.

science. In practice such internships serve as an important prerequisites for access into regular jobs. Although they are not well paid, a student who has successfully completed an internship gains job experience and significantly improves his employment opportunities after graduation. Today, the completion of at least one internship is commonly expected and is often considered as a "foot in the door".

To each of 528 job advertisements, we send two similar applications, one with a Turkish sounding name ("Fatih Yildiz" or "Serkan Sezer") and one with a typical German name ("Dennis Langer" or "Tobias Hartmann"). Importantly, the name is the only distinguishing characteristic of the applicant with Turkish ethnical background. That is, all applicants have German citizenship and they were born and educated in Germany, and all of them specify "German" as their mother tongue. With that design, we are able to isolate the effect of ethnicity from possible language effects. We create two slightly different types of applications with similar grades, soft skills, and photographs. For every job vancancy, applicant names are randomly assigned to the two different applications. Furthermore, the amount of information provided by the students varies between the two different applications. In particular, one application type contains reference letters stating favourable information about the candidate's personality traits such as conscientiousness and agreeableness. We use this variation to explore the effect of statistical discrimination versus taste–based discrimination.

The field experiment shows that an application with a German–sounding name is on average 14% more likely to receive a callback. Discrimination is more pronounced among smaller firms: firms with less than 50 employees give "Dennis" and "Tobias" about 24% more callbacks than "Fatih" and "Serkan". We also find evidence that a reasonable fraction of the differential treatment can be attributed to statistical discrimination: while there is almost no difference in callback probabilities for the application that is equipped with personality information (37.4% with a German name vs. 36.9% with a Turkish name), the absence of such information in the other application gives rise to significant differences in callback probabilities (41.8% with a German and 32.5% with a Turkish name).

Our results can be compared with those from other field studies that explore ethnic discrimination in other countries.[2] Across these studies, the measured degree

[2]There are several field studies that test discrimination against other characteristics, e.g. Neu-

of differential treatment varies remarkably with the respective context. In the U.S. labour market, Bertrand and Mullainathan (2004) show that applications with White–sounding names receive 50% more callbacks for interviews than those with African–American–sounding names. They find that the racial gap is uniform across occupation, industry, and employer size. A similarly huge difference in callback rates is documented by Drydakis and Vlassis (2007) who analyze the labour market opportunities of Albanians in Greece. They find that Albanians not only face a 43% smaller chance of access to occupations, but they are also significantly less likely to be registered with insurance coverage. For Arabs in Sweden, Carlsson and Rooth (2007) find that every fourth employer discriminates against the minority. Wood et al. (2009) conduct a correspondence test in Britain, finding that there are considerable gaps in callbacks between whites and several different ethnical groups. For the German labour market, Goldberg et al. (1996) conducted various field experiments to analyze ethnic discrimination of migrants, also finding substantial differences in callback rates. However, the legal framework has changed since 1994 when their experiments were conducted. Further, Goldberg et al. analyze the situation of migrants, that is, workers that were born in Turkey and with Turkish mother tongue, whereas we focus on German citizens with a Turkish migrational background.

Compared to these other studies, the extent of discrimination in our experiment is comparatively small. There are at least two explanations for this phenomenon. First, our applications contain much more information than those in the studies cited above. In particular, in Germany it is common practice to submit not only a resume, but also copies of all school and university certificates; these certificates provide detailed hard–evidence information about various skills. Second, we focus on a high–skill segment of the labour market; it is unclear whether ethnic discrimination in Germany is stronger in other segments of the labour market.[3] The rest of this

mark (1996), Goldin and Rouse (2000)) and Petit (2007) for gender, Banerjee et al. (2009) for caste and religious groups in India, Rooth (2007) for obesity and Weichselbaumer (2003) for sexual orientation.

[3]Carlsson and Rooth (2007) find large differences across occupations, with differences in callback rates varying from 10 percent (computer professionals) to over 100 percent (shop sales and cleaning). But even in their study, there are several high–skill segments of the labour market with much higher discrimination rates than in our study. Large callback differences across occupations are also observed by Wood et al. (2009).

paper is structured as follows. Section 2 describes the experimental design and Section 3 presents and discusses the results. Section 4 concludes.

2.2 Experimental Design

The Vacancies

The experiment focuses on a specific segment of the labour market, in particular the market for internships for students in economics and business. This restriction allows us to completely automate the application process by sending serial letters and to eliminate potential bias caused by individually written and adjusted applications. We also restrict our study to internships within Germany.

We only apply for internships with a duration ranging from 6 weeks to 6 months and consider all reasonable vacancies posted at large internet job sites (such as *monster.de* and *jobscout24.de*). The field experiment was conducted in two waves, the first one covering vacancies posted in December 2007 and January 2008, the second one considering positions posted in December 2008. Although all firms explicitly search for students in economics or business programmes, the internships are quite heterogeneous. This concerns employer characteristics (size, sector, location), the division within the firm (typically human resources, marketing, finance or controlling). Most of the vacancies are at firms with 500 or more employees. Large firms and banks are the most relevant employers for graduates of economics and business, and they are more likely to post their vacancies on large internet job sites. Further, there are only few vacancies from East Germany since most large corporations have their headquarters in West Germany.

The Applications

All applicants are second–year students of age 21 or 22. Our applications are quite comprehensive compared to other field studies on hiring discrimination. In particular, each application contains a cover letter, a curriculum vitae, a high–school certificate and a certificate documenting university grades in the first year. In the German labour market, this amount of information is necessary to achieve a reasonable callback rate. In fact, most employers explicitly request copies of all these

certificates. Omitting them would bias our results significantly since only quite unattractive employers would respond to an application that contains only a resume.

We create two slightly different types of resumes, labeled type A and type B, such that we can send two application to each firm.[4] Students of both types were born, raised and educated in West Germany, but in different regions, one in the state of North Rhine–Westphalia, the other one in Baden–Wuerttemberg. After graduating from school, both skip military service, work at a summer job and then attend different universities. Both aim at a bachelor's degree in business economics. At the time of the application they are in their third semester and they are applying for an internship during their fourth semester. The school and university certificates document grades between "good" and "very good", so that the students range in the top 25 percent of their peer groups.

Both types are fluent in English and they have basic knowledge of one further foreign language. Since applications are identical for applicants with a Turkish and a German name, the applicant with the Turkish name is a native German speaker and he also does not report any command of Turkish in his CV. Both types have reasonably developed computer skills. Moreover, both applicants state in there CV that they had two minor part–time jobs, but while type B provides two letters of reference from previous employers, type A does not add any related documents. The two reference letters contain positive statements about the student's personality (affability, commitment, capacity for teamwork, conscientiousness). This variation in information is used to analyze the effects of statistical discrimination. In all other dimensions, applications of types A and B are rather similar; particularly, there are only minor deviations in individual school and university grades. Hence, the variation in information about personality is the decisive informational difference between these types.

Finally, all applications are completed by a type–specific photograph. While in many countries firms do not request or even oppose photographs in applications, they are still very common (and sometimes requested) in Germany. Omitting them would again bias the results. We select photographs that fit both a native German student as well as one with a Turkish migration background. Each resume type has

[4]Detailed CVs of both types are available upon request.

its own unique photograph, while names are randomly assigned to the types. This guarantees that the choice of the photograph has no overall effect on the callback rates of an individual name.

We systematically adjust certain details in the cover letter of every single application to match job–specific features relating to the sector of the firm or the division of the internship. This adjustment is performed automatically using serial letters. That is, we design for each type and each division a specific paragraph matching the basic requirements and interest for that division. For example, when applying for an internship in the human resource division, an applicant of type A would explain why he is interested in human resource management and he also states that he intends to pursue a master's degree in human resource management after finishing his bachelor degree. Our approach to standardize serial letters reflects the trade–off between maximizing the callback rate by adjusting the application to the specific requirements of each post and generating unbiased letters (and also reducing our workload).

The Names

The first application that is supposed to be sent to each individual firm is randomly assigned a type (A or B) and a name (German or Turkish), while the second application then is assigned the complementary type and name.[5] We choose "Dennis Langer" (first wave) and "Tobias Hartmann" (second wave) as names for the native German candidate. The first names as well as the surnames belong to the 30 most common ones for the birth years 1986 to 1988 in Germany. The name of the applicant from the ethnic minority is "Fatih Yildiz" in the first wave and "Serkan Sezer" in the second one. Both, first names and surnames, are common for male descendants of Turkish immigrants in Germany. It is also evident for every human resource manager to deduce the ethnic background from these names. We did not explicitly check for connotations of names regarding their social background, but we assured that the names do not contradict common sense, are very stereotype or exhibit other peculiarities (e.g. ruling out combinations between an Anatolian

[5]In particular, we simulate an urn model to determine the type and name of the application that is sent first. All four possible combinations of types and names are used equally often.

first name and a Kurdish surname). We also made sure that none of these names corresponds to a real person in Germany's student web network (*studivz.de*).

The Application Process

We create an individual e-mail address for each name and prepare mobile phones with name–specific numbers. However, we do not answer incoming calls directly, but firms are redirected to the voice mail where they are politely asked to leave their names and contact information. Additionally, we made arrangements such that answers by regular mail to both candidates and addresses were redirected to us. Thus firms could contact the applicants via mail, e-mail and phone.
When applying, all documents (cover letters, CVs, additional documents such as certificates) are automatically merged to one single pdf file and are e-mailed to the firm. After sending the first application we waited two days before sending the second one. A reasonable fraction of firms (especially larger ones that expect to receive many applications) do not accept applications by e-mail, but instead require the applicants to complete several pre–defined online forms. In these cases, the forms are filled out with the respective applicant's information and our documents were attached as pdf files whenever possible.
After applying for the vacancy we registered callbacks in the subsequent four months. A callback is defined as any action of a firm that signals interest in the respective resume, including offers for interviews, direct job offers and leaving contact information on the voice mail. In contrast, automatic responses confirming the receipt of our applications are not considered as callbacks, as well as written requests for additional information which were answered whenever possible. For every reaction of a firm, be it a callback, rejecting the applicant, or a request for more information, we collect the date and the type of reaction. Within 24 hours of that reaction, we politely withdraw the candidate's further interest in the position.

2.3 Results

The application process at each of the 528 firms can have several outcomes, summarized in Table 2.1. Either the firm shows no positive reaction towards any of the

candidates (column 1), or at least one applicant receives a callback (column 2). In the latter case, either both receive a callback (column 3), or the firm prefers one of the students, either the one with the German (column 4) or with the Turkish name (column 5). Column (6) calculates net discrimination as the difference in callbacks between applications with a German and with a Turkish name, expressed as a percentage of those observations where at least one candidate received a callback. This definition of net discrimination treats those cases where no candidate receives a callback as a non–observation. Riach and Rich (2002) discuss whether a negative answer (or no answer at all) for both candidates should be considered as equal treatment or as a non–observation. On the one hand, if a firm rejects both applicants (or does not even send an answer) this could be considered equal treatment; that is, somebody reviewed both applications and found them not suitable for the job. On the other hand, it is also conceivable that the firm was not even considering the applications, for instance because the vacancy has already been filled.

We conduct a standard χ^2 test of the hypothesis that the two possible outcomes of unequal treatment (that is, columns (4) and (5)) are equally likely.[6] If the application with the German name is preferred significantly more often than the Turkish one, the H_0 of equal treatment is rejected. As this test considers only observations with differential treatment, observations of firms that either decline both applicants or callback both applicants are irrelevant.

The first row shows the aggregate results of the field study. Out of the 258 firms that accepted at least one application, 29.1% contacted only the German, and 19.0% only the Turkish candidate, while 51.9% contacted both. This corresponds to a callback rate of 34.7% for the Turkish student and of 39.6% for the German student. In other words, while the German candidate has to write 15 applications to obtain 6 callbacks, the Turkish candidate must send 17 applications for the same number of callbacks. This difference is significant at the 5%-level, but it is remarkably small compared to studies on employment discrimination of ethnic minorities in other countries, such as Albanians in Greece (Drydakis and Vlassis, 2007), Arabs in Sweden (Carlsson and Rooth, 2007) or Afro–Americans in the U.S. (Bertrand and Mullainathan, 2004);

[6] The result is the same as the χ^2 of a McNemar test which considers the null hypothesis that a dichotomous and paired outcome variable (i.e. the reaction dummies to German and Turkish candidates) have the same distributions.

	(1) no callback	(2) at least one	(3) both	(4) only G	(5) only T	(6) net discr.	(7) χ^2 test
all firms (528)	51.14 (270)	48.86 (258)	51.94 (134)	29.07 (75)	18.99 (49)	10.08 (26)	5.45**
Firm Size							
large (> 500) (379)	51.19 (194)	48.81 (185)	49.19 (91)	29.73 (55)	21.08 (39)	8.65 (16)	2.72*
medium (59)	52.54 (31)	47.46 (28)	50.00 (14)	28.57 (8)	21.43 (6)	7.14 (2)	0.29
small (< 50) (90)	50.00 (45)	50.00 (45)	64.44 (29)	26.67 (12)	8.89 (4)	17.78 (8)	4.00**
Location							
South (292)	48.29 (141)	51.71 (151)	52.32 (79)	29.14 (44)	18.54 (28)	10.60 (16)	3.56*
East (40)	62.50 (25)	37.50 (15)	40.00 (6)	40.00 (6)	20.00 (3)	20.00 (3)	1.00
other (196)	53.06 (104)	46.94 (92)	53.26 (49)	27.17 (25)	19.57 (18)	7.60 (7)	1.14
Division							
Marketing (173)	43.35 (75)	56.65 (98)	54.08 (53)	29.59 (29)	16.33 (16)	13.26 (13)	3.76*
Controlling (91)	52.75 (48)	47.25 (43)	46.51 (20)	25.58 (11)	27.91 (12)	−2.33 (−1)	0.04
Finance (84)	48.81 (41)	51.19 (43)	46.51 (20)	32.56 (14)	20.93 (9)	11.63 (5)	1.09
Human Res. (122)	59.84 (73)	40.16 (49)	51.02 (25)	32.65 (16)	16.33 (8)	16.33 (8)	2.67
Consulting (32)	65.63 (21)	34.37 (11)	72.73 (8)	9.09 (1)	18.18 (2)	9.09 (−1)	0.33
other (26)	46.15 (12)	53.85 (14)	57.14 (8)	28.57 (4)	14.29 (2)	14.29 (2)	0.67
Industry							
Fin. Services (105)	41.90 (44)	58.10 (61)	40.98 (25)	34.43 (21)	24.59 (15)	14.75 (6)	1.00
Consulting (98)	56.12 (55)	43.88 (43)	69.77 (30)	16.28 (7)	13.95 (6)	2.33 (1)	0.08
Manufacturing (150)	55.33 (83)	44.67 (67)	56.72 (38)	26.87 (18)	16.42 (11)	10.45 (7)	1.69
IT & Telecom (31)	58.06 (18)	41.94 (13)	69.23 (9)	23.08 (3)	7.69 (1)	15.38 (2)	1.00
Public Services (11)	63.64 (7)	36.36 (4)	25.00 (1)	50.00 (2)	25.00 (1)	25.00 (1)	0.33
other (133)	47.37 (63)	52.63 (70)	44.29 (31)	34.29 (24)	21.43 (15)	12.86 (9)	2.08

Notes: This table shows the distribution of the firm responses, absolute numbers are in parentheses. Column (1) reports the fraction of firms that gave none of the candidates a callback, so the remainder in column (2) contacted at least one applicant. Firms that gave both candidates a positive reaction, column (3), are considered as equal treatment, while the rest preferred either the candidate with the German or the one with the Turkish name, columns (4) and (5). Net discrimination is calculated as (6)=(4)-(5). Column (7) contains the χ^2 for equality between (4) and (5) (H_0: Turkish and German candidates are equally likely to receive a callback at any of the paired observations). * denotes significance at the 10%-level, ** significance at the 5%-level.

Table 2.1: Callbacks Conditional on Names and Firm Characteristics.

see Section 4 for further discussion.

Regarding the effect of firm characteristics on discrimination, we note that only four (8.9%) out of the 45 firms with less than 50 employees made an offer only to the Turkish candidate, while 12 (26.7%) preferred the German over the Turkish applicant. We would assume that smaller firms with fewer vacancies have a less standardized recruitment process. This leaves more scope for individual preferences of the human resource manager to influence hiring decisions. Indeed, discrimination is less prominent in larger firms, presumably since their recruitment processes follow pre–defined rules.

However, differences with respect to other firm characteristics are rather limited. We note that there are twice as many firms in East Germany[7] that favour the candidate with the German name; however, there are both too few vacancies as well as too low callback rates to give rise to significant results. If we consider jobs in different divisions, differential treatment is weakly significant for jobs in the marketing department. But discrimination is not particularly strong in this division; instead there are simply many internships in marketing divisions, which implies that only the large sample is responsible for significant discrimination here. On the other hand, differences in callback probabilities are remarkably strong for internships in human resource departments, where the number of employers which favour the German candidate is twice as large as the number of employers preferring the Turkish one. Strong discrimination in human resource departments could be considered to support taste–basted discrimination according to Becker (1957): managers refuse to hire minority workers either because they do not wish to work with them personally (due to their own discriminatory taste), or because they fear that discriminatory tastes among co–workers or outsiders impairs productive efficiency in a division with high exposures to outsiders and intense team interactions. However, there are too few callbacks to provide statistically significant evidence for this hypothesis.

Table 2.2 shows the callback rates for the different names conditional on the resume type. For applications of type B which include reference letters containing information regarding the candidate's personality, Turkish and German applicants achieve

[7]"East Germany" is defined as the states Berlin, Brandenburg, Mecklenburg–Western Pomerania, Saxony, Saxony–Anhalt and Thuringia. "South Germany" includes the states Baden–Wuerttemberg, Bavaria, Hesse, Rhineland–Palatinate, and Saarland.

almost identical callback rates. However, for applications of type A (without personality information), the minority student receives only for 32.5% of his applications a callback, while the German student is successful in 41.8% of his applications. The difference in the number of callbacks between German and Turkish students of type A is significant at the 5%-level, while it is not significant for students of type B. We cautiously interpret this as evidence for statistical discrimination (Arrow, 1973): the difference in callbacks decreases with the provision of information about the applicant's character. Note however that "information" and any other type characteristics are perfectly correlated. Hence the observation that callback differences are smaller at applications of type B could, in principle, also be due to other characteristics of a type B application. However, it is not true that type B is generally more attractive: in contrast, German applicants of type B receive *fewer* callbacks than German applicants of type A. More importantly, as we have argued above, the other differences between type A and type B applicants are rather minor and they should not be expected to generate the large observed difference in discrimination rates.[8] It is worth to note that there is no evidence that firms from different regions favour a certain type, although both types come from different regions within Germany.

callback rate	type A	type B
German name	41.8% (110 out of 263 applications)	37.4% (99 out of 265 applications)
Turkish name	32.5% (86 out of 265 applications)	36.9% (97 out of 263 applications)

Notes: Applications of type B contain two reference letters with information about the applicant's personality, those of type A do not.

Table 2.2: Callback Rates for Different Types.

[8]Although the universities of both types are comparable in their academic standards within Germany, the university of type A offers a more business–oriented program which could explain why such a candidate is a bit more attractive for most employers. Nonetheless, it is rather implausible that this feature explains the strong difference in callback rates between ethnical types.

Probit Estimation

In order to disentangle the effects of different employer and worker characteristics, we conduct several probit estimations with the callback dummy as the dependent variable. Table 2.3 summarizes the various configurations. Columns (1) to (5) show regression outputs using the full sample. In the basic model (1) we regress the callback only on a constant and a dummy for the Turkish name and find a weakly significant (at the 10 percent level) negative effect of the Turkish name on the callback probability. The interpretation of the result is that a Turkish name reduces the probability of a callback on average by about 14%. This effect is robust to adding a dummy for the location of the firm and the workers's type in (2), a dummy for firms with less than 50 employees in (3) and dummies for the sector of the firm as well as for the division of the internship in (4).[9] The coefficient of the dummy for South Germany is (weakly) significantly positive, suggesting that it is easier to find an internship in regions with less unemployment and more job openings. There is no evidence that one of the two application types is more successful than the other in general. That is, the type dummy is always small and insignificant. However, once we add an interaction term between the name (ethnicity) and the type dummies in (5), this term catches all the disadvantage of the Turkish name, and the coefficient of the name dummy becomes small and insignificant. Again this confirms the conclusion from Table 2.2 that the difference in callbacks occurs predominantly at applicants of type A where personality information is not provided. The reduction in information seems to hurt applicants with a Turkish name. Again we cautiously interpret this finding as evidence in support of statistical discrimination.

Other Means of Discrimination

Discrimination can manifest itself in several ways, not only in different callback rates. If a firm has no interest in any of the applicants, but the applicant with the German name receives a polite message declining him, while an applicant with a Turkish name is just ignored, we would consider this as discriminatory treatment,

[9] We tested several other variables but found all of them (and their interactions with the ethnicity dummy) insignificant. This includes a "first application" dummy, a dummy on "top employers" (obtained from a student survey), and a dummy for employers located in a large city region.

Callback	(1)	(2)	(3)	(4)	(5)
constant	-0.26^{***} (0.06)	-0.34^{***} (0.08)	-0.36^{***} (0.08)	-0.04 (0.22)	-0.1 (0.22)
Turkish name	-0.13^{*} (0.08)	-0.13^{*} (0.08)	-0.13^{*} (0.08)	-0.13^{*} (0.08)	0.003 (0.11)
Southern Germany		0.13^{*} (0.08)	0.14^{*} (0.08)	0.14^{*} (0.08)	0.13 (0.08)
type A		-0.0001 (0.08)	-0.0001 (0.08)	0.002 (0.08)	0.14 (0.11)
small firm			0.13 (0.10)	0.14 (0.12)	0.14 (0.12)
sector dummies				yes	yes
division dummies				yes	yes
Turk*Type A					-0.27^{*} (0.16)
Observations	1056	1056	1056	1056	1056

Notes: Each column represents a probit regression with the callback dummy as dependent variable. Robust standard errors are in parentheses. * denotes significance at the 10%-level, ** significance at the 5%-level, and *** at the 1%-level. Several other interactions have been tested and not found significant.

Table 2.3: Probit Regression with Callback Dummy as Dependent Variable.

even though it takes no direct impact on the job search outcome.
Table 2.4 provides a first snapshot. The most noticeable difference in treatment of the two applicants takes place at firms that callback one candidate and do not respond to the second one; indeed, 28 firms showed interest in the applicant with the German name and ignored the Turkish applicant, while only 12 firms contacted the Turkish and ignored the German one. We would consider this as the strongest form of discrimination: the firm has a vacant post, it shows interest in the German candidate and does not even answer the Turkish one. The difference in politeness can also be illustrated by the following comparison: 74.3% of the employers that show no interest in the German applicant nevertheless send him a polite rejection message, while an applicant with a Turkish name receives such a message only from 71.3% of the firms. However, this difference is not statistically significant.

As another type of discrimination, we check how long applicants with different names have to wait for the firm's decision, and what determines that waiting period. Most firms react only a few workdays after we sent the application (see Table 2.5). A callback is, on average, received after 11 workdays, while a rejection takes on average

German / Turkish	callback	rejection	no reaction	$\sum$
callback	134	47	28	209
rejection	37	179	21	237
no reaction	12	20	50	82
$\sum$	183	246	99	528

Table 2.4: Differential Treatment in Answers.

17 workdays. An applicant with a Turkish name has to wait slightly longer for a callback (11.3 workdays with a Turkish and 10.7 workdays with a German name), but this difference is not statistically significant. For rejections, the difference is even smaller (17.39 workdays with a Turkish and 17.36 workdays with a German name). There are two peculiarities, however. First, small firms react faster in general. Second, the difference in reaction times between German and Turkish applicants is larger at smaller firms. For example, to decline a Turkish applicant, a small firm needs 2.3 workdays more than to decline a German applicant. We would assume that small firms are faster in general because there is often just one decision maker, whereas larger firms are more likely to have standardized recruitment processes where applications have to go through many hands.

	callback			rejection		
	German name	Turkish name	average	German name	Turkish name	average
small	6.1	7.0	6.5	9.9	12.2	11.0
medium	7.8	7.5	7.7	19.6	19.0	19.3
large	12.4	13.0	12.7	18.1	17.8	17.9

Table 2.5: Average Reaction Time in Workdays.

We also conduct a multinomial logit with the outcomes 1 (callback), 2 (applicant receives a rejection) versus 0 (no reaction) for every application and every workday, beginning at the application day until the workday of the firm's reaction. We complemented the controls of the previous probit estimation by the number of workdays that have passed without a reaction (t and t^2) and by an interaction term between t and the firm–size dummy (see Table 2.6). The main results of the probit estimate can also be observed in the multinomial logit: applicants with a Turkish name are

less likely to receive a callback, and firms in South Germany are more likely to give a positive response. In contrast, there are no such effects for rejections. That is, applications from the Turkish applicant do not receive significantly less (or more) rejections than candidates with a German name. Table 2.6 also confirms that large firms take more time to answer an application. We also checked other interaction terms (in particular those involving the name dummy), but found all of them to be insignificant.

reaction	1	2
constant	-2.59^{***} (0.16)	-3.48^{***} (0.17)
t	-0.11^{***} (0.14)	-0.03^{***} (0.008)
t^2	-0.00008 (0.0001)	-0.00025^{***} (0.00008)
Turkish name	-0.187^{*} (0.103)	-0.03 (0.09)
largefirm	-0.76^{***} (0.16)	0.036 (0.156)
$t\cdot$ largefirm	0.068^{***} (0.015)	0.019^{***} (0.007)
typeA	-0.018 (0.102)	0.022 (0.092)
South	0.187^{*} (0.104)	0.038 (0.093)
Sample	full	full
Observations	1056	1056

Notes: Multinomial logit with the outcomes 1: callback, 2: rejection (vs 0: no reaction at workday t). Standard errors are in parentheses. * denotes significance at the 10%-level, ** significance at the 5%-level, and *** at the 1%-level. Several other interactions have been tested and not found significant.

Table 2.6: Multinomial Logit.

To complement this survival analysis, we show in Figure 2.1 the distribution and survival functions for our total sample. We do not show the differences between German and Turkish candidates since they are rather tiny, especially for the callback distribution. The figure shows that the probability to receive an answer (callback or rejection) is significantly declining over time and is nearly zero after about 30–40 workdays. Before that, the probability declines about linearly for callbacks, but non–linearly for rejections. This pattern explains why the coefficient for t^2 in column 2 of Table 2.6 is significantly negative.

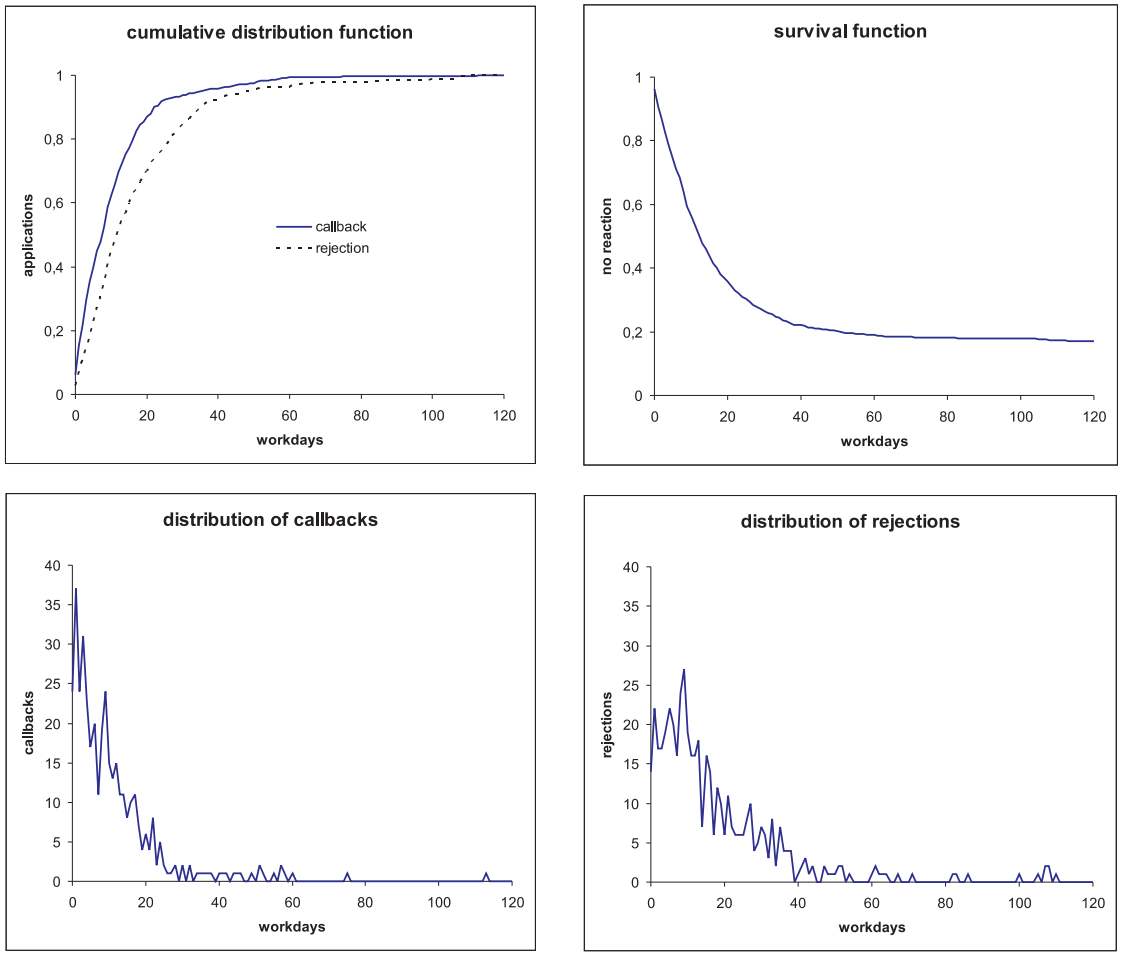

Figure 2.1: Response Time of Firms for Callbacks and Rejections.

The Role of the Business Cycle

Our field study also permits to explore the impact of the business cycle. We conducted the study in two waves, the first one in Winter 2007/08 and the second one in Winter 2008/09. The macroeconomic situation changed substantially between these two dates. In particular, the accelerating financial crisis strongly affected the real economy in late 2008. By then, most research institutes published forecasts for Germany's GDP growth in 2009 at -3 percent or less. Although the German labour market remained remarkably robust during the course of 2009, we would expect that firms adjusted their hiring behaviour in January 2009 relative to the year before. However, the aggregate callback rates (as well as the name–specific ones) were rela-

tively stable over time (38.8% in 2007/08 versus 35.4% in 2009). It seems that two effects offset each other: as global demand decreases, firms should be expected to hire fewer workers, but they could also try to replace regular employees with cheaper interns.

2.4 Conclusions

We conducted a correspondence test, sending more than a thousand applications with randomly assigned German and Turkish names to firms advertising student internships. The difference in callbacks is significant but, compared to similar studies for other countries, relatively small. Several explanations can account for this result. First, we focus on a specific high–skill segment of the labour market. If competition for qualified students is intense, discriminating firms cannot survive the "war for talents" and are driven out of the market. On the other hand, in labour market segments with an excess supply of qualified workers, discrimination should be stronger as firms can choose their favourite candidate among a large number of applicants. Moreover, in our experiment the student with the Turkish name is a German citizen with a migration background. He was born and raised in Germany, went to school in Germany and is now studying in Germany. We focus on these second and third generations of immigrants as they represent the largest ethnic minority in the German labour market. The fact that all applicants are observationally equivalent (except their name) permits us to isolate the name effect from any language effects. Conducting a similar study with non–German citizens with a mother tongue other than German should be expected to produce a larger difference in callback rates.
Both applications were endowed with very good grades and interesting enough CVs so as to guarantee a reasonably high callback rate. It is conceivable that net discrimination is substantially larger for candidates with mediocre grades; for such applications negative stereotypes of human resource managers (such as "students with Turkish migration background are under–performing") become potentially more important. On the other hand, the rather good grades can be inconsistent with employers' expectations about a Turkish applicant. Hence such an observation is more salient and takes a stronger impact on impression formation than it would do for a German candidate (see e.g. Sherman et al. (1997)). We would further expect that

most firms with a standardized recruitment procedure use a threshold strategy. Any candidate that fulfills certain minimal criteria receives a callback, and these criteria apply equally for all candidates. Since larger firms have more often a standardized recruitment process, they also discriminate less than smaller firms.

This study gives only a first insight into the extent of ethnical discrimination in Germany's labour market. There are several further questions that should be explored in further research. First, measuring hiring discrimination in different segments of the labour market would provide more information on the effects of sector and firm characteristics. Second, varying the quality of the applications would also permit to measure group–specific returns to skills, as in Bertrand and Mullainathan (2004). Third, our experiment shows that provision of information about personality reduces the extent of discrimination. In many countries it is uncommon to use references at early stages of the recruitment process.[10] Our result suggests that such conventions can potentially backfire on minority employees. Future experiments, also those conducted in the laboratory, should further illuminate the role of information about personality on recruitment decisions.

[10]In the UK, the "Employment Practices Data Protection Code" states that employers should only carry out pre–employment vetting (e.g. reference letters) on an applicant at a late stage in the recruitment process.

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CHAPTER 3

HOW JOE THE PLUMBER PAYS THE TUITION OF FUTURE WHITE COLLARS – HUMAN CAPITAL IN IMPERFECT LABOUR AND CREDIT MARKETS

3.1 Introduction

Investment in human capital is crucial for the long-term well-being of an economy. According to Becker (1964) investments in human capital can be analysed with similar instruments to those in physical capital. But there are several peculiarities of human capital, e.g. it is not transferable and cannot serve as collateral. In order to collect the benefits of education, human capital has to be applied on the job. Therefore not only the conditions on the credit market, but also on the labour market effect the incentives to invest in human capital.

However, labour markets are not perfect. Unemployed workers and free vacancies coexist, as informational and coordination frictions prevent the invisible hand from clearing the market. A large amount of literature considers human capital in imperfect labour markets, see for example Acemoglu (1997), Albrecht and Vroman (2002) or Sato and Sugiura (2003). Acemoglu and Shimer (1999) show how labour market imperfections can create holdup problems that distort the incentives to invest in capital: the costs of capital are already sunk when firms and workers decide how to split the surplus of a worker-firm match. Therefore these costs are not considered during the wage-bargaining process. Individual agents pay all of the costs but only receive a fraction of the benefits due to market power their counter part, and investment is inefficiently low. Acemoglu and Shimer (1999) focus on physical capital, but the same mechanism works for human capital: the worker pays for her education, but when firms and workers bargain on the wage these costs are sunk.

Moen (1998) suggests to use contingent loans that shift the costs of education back into the wage-bargaining process and solve the holdup problem: workers pay the credit rates for their student loan only while they are employed at a firm, but the payment is interrupted if a worker becomes unemployed. This way the credit rates are considered as opportunity costs of working (as unemployment benefits), so they become part of the surplus splitting and efficiency is restored. However, Moen (1998) considers perfect capital markets such that students can borrow any necessary amount of money and banks do not extract any rent from the students.

But the credit market for human capital in particular suffers from imperfections. Human capital cannot be collaterised, so students can be constrained with respect to the amount they can borrow. In imperfect capital markets, banks also have some

bargaining power and are able to extract rents by charging interest rates above the risk-free rate. There is much literature on the effect of capital market frictions on human capital (e.g. Galor and Zeira (1993)), but only a few studies consider these imperfections together with labour market frictions. Wasmer and Weil (2004) illustrate how imperfect markets for venture capital amplify the adverse effects of labour market imperfections, and how even small frictions on both markets are sufficient to generate substantial unemployment.

This paper shows how imperfect credit- and labour markets amplify the costs of higher education, and how these imperfections shift some of the costs from students to unskilled workers. I do not assume an exogenous borrowing constraint, but agents who want to go to university must first *search* for a bank that provides a student loan. This imperfect credit market is symmetric to the labour market, both with search frictions à la Pissarides (2000). It takes some time to obtain a loan (or respectively for banks to find a borrower), depending on the ratio of the credit supply of banks to the credit demand of prospective students. Students pay an endogenous interest rate above the risk free rate on their debt. Moreover, I assume that the student loan takes the form of a contingent loan. I find that not only does the efficiency result of Moen (1998) no longer hold in imperfect credit markets, but that workers and banks strategically use contingent loans to establish higher wages for well educated workers. This amplifies unemployment and makes unskilled agents worse off.[1]

The main mechanism works as follows: the imperfections in both markets give all agents some bargaining power when they decide how to split the surplus of a bank-worker match (the bargain on the credit contract) and a firm-worker match (the wage bargaining). The credit contract is already fixed when workers and firms negotiate wages, so both treat the repayments as exogenous. As workers must only pay back the credit during employment, the repayments are considered as part of the opportunity costs of working. Therefore, the wages of skilled workers compensate them for a share of their credit costs. Banks and workers internalise this effect when they bargain on the credit contract, giving rise to higher credit rates and a further increase in wages for skilled workers.

[1] Kaas and Zink (2008) use a model with directed search to show that contingent loans provide incentives to search for jobs that offer higher wages, giving rise to higher unemployment.

If higher tuition fees for students raise the wages of skilled workers for a given productivity, firms' profits decline and some firms leave the market, raising unemployment. Unemployment, on the other hand, increases the time between the costs and the benefits of education; workers and banks react by further raising the repayments to share the costs, which again raises wages and unemployment etc. However, the higher repayments are not sufficient to fully compensate banks for their lower profits, so some banks leave the credit market, reducing the credit supply for prospective students.

These effects do not only apply to students who are directly affected by the tuition fees and credits, but also harm unskilled agents who do not want to study: first, unskilled workers suffer from rising unemployment caused by the high wages of skilled workers. Second, unemployment worsens the unskilled agents' bargaining position and reduces their wages. Third, a lower fraction of workers acquires an education, reducing the marginal productivity of unskilled workers and thus putting even more downward pressure on their wages. These adverse effects are amplified by the credit market imperfections and the strategic use of the contingent loans.

The paper is organised as follows. Section 2 introduces the economic environment, Section 3 derives the equilibrium. Section 4 discusses the effect of higher tuition fees, while Section 5 provides a numerical example. Section 6 analyses the role of credit market imperfections and efficiency, and Section 7 concludes.

3.2 The Model

Consider an economy that is populated by three types of risk-neutral agents: workers, banks and firms. Workers enter the model after having finished their secondary education and they must decide whether or not they want to go to university. Studying raises productivity, but it is costly: universities charge tuition fees and prospective students are not endowed with sufficient funds to finance their studies on their own. Therefore they have to find a bank that will give them a loan to cover their expenses. After finishing their university degrees they enter the labour market as skilled workers and try to find a job. Those who do not go to university search directly for a job as unskilled workers without entering the credit market.

3.2.1 The Labour Market

I follow Pissarides (2000) and assume that searching for a job or a worker is costly and takes time. In particular, if there are $\mathcal{U}$ unemployed workers and $\mathcal{V}$ vacancies in the labour market, the total number of matches can be described by the function $m(\mathcal{U}, \mathcal{V})$. This matching function is homogeneous of degree one. Therefore I can determine the flow probability that an individual firm with a vacancy meets a worker $q(\theta)$:

$$\frac{m(\mathcal{U}, \mathcal{V})}{\mathcal{V}} = m\left(\frac{1}{\theta}, 1\right) = q(\theta).$$

This probability depends only on the ratio of vacancies to unemployed workers, the *labour market tightness* $\theta = \mathcal{V}/\mathcal{U}$ (from a firm's perspective). I can also determine the probability that an unemployed worker finds a job vacancy,

$$\frac{m(\mathcal{U}, \mathcal{V})}{\mathcal{U}} = \frac{m(\mathcal{U}, \mathcal{V})}{\mathcal{V}} \cdot \theta = m\left(\frac{1}{\theta}, 1\right) \cdot \theta = \theta q(\theta).$$

The higher the ratio of unfilled vacancies to unemployed workers, that is, the higher the labour market tightness θ, the longer it takes for an individual firm to fill a vacancy and the easier it becomes for a worker to find a job, so

$$\frac{\partial q(\theta)}{\partial \theta} < 0 \text{ and } \frac{\partial \theta q(\theta)}{\partial \theta} > 0.$$

3.2.2 The Credit Market

I use a similar approach as Wasmer and Weil (2004) and model credit market imperfections as search frictions, symmetric to the labour market[2]: let $\mathcal{B}$ be the number of banks searching for a debtor on the credit market[3], and $\mathcal{S}$ the number of students searching for a loan. Then the total number of matches between prospective students and banks is determined by the function $h(\mathcal{B}, \mathcal{S})$, again homogeneous of

[2]This approach not only keeps the model tractable, but also accommodates the findings of Carneiro and Heckman (2002) that direct credit constraints prevent only a small fraction of young women and men from acquiring higher education. Thus, "softer" credit constraints, such as search frictions, could be more suitable to model the credit market for student loans.

[3]We can also interpret $\mathcal{B}$ as a measure for the credit supply of banks, determined by the funds reserved for student loans, the labour costs for bank employees who acquire students etc.

degree one. Thus the flow probability that a student finds a bank at every instant can be written as function of the *credit market tightness* $\phi = \frac{\mathcal{S}}{\mathcal{B}}$ (from a student's perspective), the ratio of students to banks:

$$\frac{h(\mathcal{B},\mathcal{S})}{\mathcal{S}} = h\left(\frac{1}{\phi}, 1\right) = p(\phi).$$

On the other hand, the probability that a bank finds a matching partner is

$$\frac{h(\mathcal{B},\mathcal{S})}{\mathcal{B}} = \frac{h(\mathcal{B},\mathcal{S})}{\mathcal{S}} \cdot \phi = h\left(\frac{1}{\phi}, 1\right) \cdot \phi = \phi p(\phi).$$

The higher the number of students per bank ϕ the harder it is for workers to find a matching partner and the easier it becomes for banks to find a debtor:

$$\frac{\partial p(\phi)}{\partial \phi} < 0 \text{ and } \frac{\partial \phi p(\phi)}{\partial \phi} > 0.$$

3.2.3 Unskilled Workers

Workers who decide on their education compare the present value of a career as a skilled worker to the present value of the earnings as an unskilled one. First consider an agent who decides against going to university but directly searches for a job as an unskilled worker. The present value of all cash flows of an unemployed unskilled worker W_0^u and an employed unskilled worker W_1^u can be described by the following Bellman equations:

$$rW_0^u = b + \theta q(\theta)[W_1^u - W_0^u], \tag{3.1}$$

$$rW_1^u = w^u + s[W_0^u - W_1^u]. \tag{3.2}$$

The agent enters the labour market in phase 0 as an unemployed unskilled worker and earns flow income b (domestic work, social benefits for people without income, value of leisure). He is matched to a firm with probability $\theta q(\theta)$. In this case he bargains for his wage w^u and starts to work for the firm (phase I). With the exogenous probability s a shock hits the firm, the match is destroyed and the worker is unemployed again. By solving these equations for W_0^u I find the net present value of a career as an unskilled worker:

$$W_0^u(\theta) = bd(\theta)/r + w^u[1 - d(\theta)]/r \text{ with} \tag{3.3}$$

$$d(\theta) = \frac{r+s}{r+s+\theta q(\theta)}, \frac{\partial d(\theta)}{\partial \theta} < 0.$$

The total income of this worker consists of unemployment benefits b during spells of unemployment and wage income w^u while the worker is employed. The term $d(\theta)$ helps to determine the present value of all cash flows that an agent expects to receive in all unemployment periods[4]. The worker receives unemployment benefits b in phase 0 until he leaves unemployment, which happens with probability $\theta q(\theta)$, and also discounts cash flows with rate r. However, with probability s the worker loses his job and is unemployed again. On the other hand, the unskilled worker can also expect some wage income. The present value of all wage earnings consists of all potential earnings minus the earnings that are forgone because the worker is unemployed every now and then, thus $w^u - w^u d(\theta)$.

3.2.4 Skilled Workers

Now consider a worker who has decided to go to university and the corresponding Bellman equations:

$$rW_0^s = b + p(\phi)[W_1^s - W_0^s] \tag{3.4}$$

$$rW_1^s = b + \theta q(\theta)[W_2^s - W_1^s] \tag{3.5}$$

$$rW_2^s = w^s - \rho + s[W_1^s - W_2^s]. \tag{3.6}$$

First, the worker has to search for a bank in order to obtain financial support for his studies (phase 0). In this state he earns flow income b. With probability $p(\phi)$ he finds a bank and bargains for the conditions of the credit contract, in particular the size of the repayment rate ρ, studies[5], and enters the labour market. As an unemployed worker (phase I) he receives unemployment benefits b and is matched to a firm with probability $\theta q(\theta)$. In this case he bargains for his wage and starts working, earns the wage w^s and starts paying back his loan until the match is destroyed exogenously. Then the worker becomes unemployed again.

I derive the value of a skilled worker who has just studied and now starts to search for a job W_1^s in two different ways: first, I compute the expected costs to get funding, that is solving (3.4) w.r.t. W_1^s to obtain (3.7). On the other hand, I compute the

[4]It is also possible to interpret $d(\theta)$ as the fraction of cashflows that is generated in periods of unemployment. However, note that $d(\theta)$ also considers discounting.

[5]Note that studying does not take time in this model.

net present value of all future incomes this worker can expect, that is, using (3.5) and (3.6) to obtain (3.8).

$$W_1^s = W_0^s + \frac{rW_0^s - b}{p(\phi)} \tag{3.7}$$

$$W_1^s = bd(\theta)/r + (w^s - \rho)[1 - d(\theta)]/r. \tag{3.8}$$

The value of a worker who has found a bank (3.7) is identical to a worker who just entered the credit market W_0^s plus the expected costs of finding the bank. The present value of all following cashflows (3.8) is similar to the one of unskilled workers, but the skilled worker receives the wage w^s and has to pay credit rates ρ while he is employed.

3.2.5 Banks

Next consider the value of a bank in the different states:

$$rB_0 = -k + \phi p(\phi)[B_1 - B_0 - A] \tag{3.9}$$

$$rB_1 = \theta q(\theta)[B_2 - B_1] \tag{3.10}$$

$$rB_2 = \rho + s[B_1 - B_2]. \tag{3.11}$$

(3.9) determines the value of a bank that has just entered the credit market B_0 and starts to search for a debtor. The bank has to pay flow searching costs k, e.g. for its employees and for holding the money for the loans in short term investments with low returns. As soon as the bank meets a prospective student it bargains for the credit contract and pays the tuition fees A. Then the bank has to wait until the worker finds a job. While the worker is unemployed the bank does not experience any direct cash flows. However, the longer the worker stays unemployed, the longer the bank has to wait for the repayment of its loan. Once the worker finds a job the bank receives the flow repayment ρ. Whenever the worker goes through a spell of unemployment the credit rates are stopped until the worker finds a new job.
I use these Bellman equations to compute the value of a loan B_1 by using (3.9) and free entry of banks, that is $B_0 = 0$. On the other hand, a bank that has just paid for the education of a student can estimate the present value of all cash flows that

it can expect from this worker.

$$B_1 = \frac{k}{\phi p(\phi)} + A \tag{3.12}$$

$$B_1 = \rho[1/r - d(\theta)] \tag{3.13}$$

The free entry condition for banks (3.12) shows that the expected costs to deal in a loan are composed of the searching costs on the credit market and the students' tuition fees covered by the bank. The profits (3.13) correspond to the net present value of the expected repayments. For a fixed repayment size ρ the present value of these profits is increasing in θ, that is, decreasing in unemployment: higher unemployment extends the time until the worker finds his first job as well as all future unemployment spells. In both situations the worker interrupts his repayments.

3.2.6 Firms

Firms can enter the labour market and open a vacancy to search for a worker whenever they want. They can either have an open vacancy, employ one worker with higher education or employ one unskilled worker. Each 1-worker-firm with a filled vacancy produces one unit of an intermediate good, either with high (skilled worker) or low (unskilled worker) quality. The competitive final goods sector uses both intermediate goods as inputs to produce a homogeneous final good, following the CES production function $Y(q^s, q^u) = [a_1 q_s^\sigma + a_2 q_u^\sigma]^{1/\sigma}$ where q^s (q^u) denotes the amount of high (low) quality intermediate goods used. Competition between all of the small intermediate goods-producing firms drives prices of these goods down to their marginal productivity. The production function has constant returns to scale, so the marginal productivity of an intermediate good depends only on the relative amount of high and low quality inputs, and thus on the fraction of workers with higher education α. Therefore a firm with a skilled (unskilled) worker can sell its output for $p^s(\alpha) = \frac{\partial Y}{\partial q_s}$ ($p^u(\alpha) = \frac{\partial Y}{\partial q_u}$).
Consider the following Bellman equations that determine the value of a firm with a free vacancy V and the value of a position that is filled with a worker of productivity i, S^i:

$$rV = -f + q(\theta)[\alpha(S^s - V) + (1-\alpha)(S^u - V)] \tag{3.14}$$

$$rS^i = p^i(\alpha) - w^i + s(V - S^i). \tag{3.15}$$

Firms pay flow costs f while they search, e.g. for capital costs or their human resources department and they cannot direct their search towards a special type of worker. Once matched to a worker, which happens with flow probability $q(\theta)$, the firm observes the productivity of this worker: with probability α he is skilled, and with the counter probability he is not. The firm and the worker bargain on the wage, they start producing, the firm sells the output for $p^i(\alpha)$ and pays the wage w^i until the match is destroyed exogenously with flow-probability s.
Free market entry drives the value of opening a vacancy V down to 0. I substitute S^s and S^u from (3.15) into (3.14) and obtain the job-creation condition (conditional on the wages)

$$\frac{f}{q(\theta)} = \frac{1}{r+s}[\alpha(p^s(\alpha)-w^s)+(1-\alpha)(p^u(\alpha)-w^u)]. \tag{3.16}$$

The left-hand-side of (3.16) shows the expected costs to fill a vacancy, while the right-hand-side illustrates the expected profits of a filled vacancy: with probability α the firm hires a skilled applicant, who produces $p^s(\alpha)$ and earns the wage w^s, with the counter probability the employee is unskilled, produces $p^u(\alpha)$ and earns w^u. The firm can earn this cash-flow until the match is exogenously destroyed with probability s and discounts profits with r.

3.2.7 Wage Bargaining

A skilled worker is involved in two negotiations that are separated in time: first when he is matched to a bank he has to bargain for the credit rate ρ. Later, after he is matched to a firm, he bargains for his wage w^s. The credit contract determines the cash flows from workers to banks and therefore has an effect on the surplus of a worker-firm match later: the more money flows from workers to banks as repayment ρ, the less is left for workers and firms to split. It is crucial that these two negotiations are separated by a time interval and that the credit contract is fixed when workers and firms bargain on the wage. Therefore, workers and firms treat the credit rates ρ as given. The wage maximises the generalised Nash Product with $0<\gamma<1$ as bargaining power of a firm, so

$$\begin{aligned} w^s &= \arg\max(W_2^s - W_1^s)^{1-\gamma}(V-S^s)^\gamma \text{ and} \\ w^u &= \arg\max(W_1^u - W_0^u)^{1-\gamma}(V-S^u)^\gamma. \end{aligned}$$

This gives rise to the standard surplus-splitting first order conditions

$$\begin{aligned} \gamma[W_2^s - W_1^s] &= (1-\gamma)[S^s - V] \text{ and} \\ \gamma[W_1^u - W_0^u] &= (1-\gamma)[S^u - V]. \end{aligned}$$

After substitution from the Bellman equations I obtain the wages of unskilled and skilled workers, the latter conditional on the credit contract ρ:

$$w^u(\theta,\alpha) = \overline{\gamma}(\theta)b + (1-\overline{\gamma}(\theta))p^u(\alpha) \text{ and} \tag{3.17}$$

$$w^s(\rho,\theta,\alpha) = \overline{\gamma}(\theta)(b+\rho) + (1-\overline{\gamma}(\theta))p^s(\alpha) \quad \text{with} \tag{3.18}$$

$$\overline{\gamma}(\theta) = \frac{\gamma d(\theta)}{\gamma d(\theta) + 1 - \gamma}, \frac{\partial \overline{\gamma}}{\partial \theta} < 0.$$

The wage is a weighted average of the worker's productivity and the worker's opportunity cost of working, including the repayment ρ for skilled workers. However, the extent to which the firm can push wages towards the worker's opportunity costs is not identical to the firm's bargaining power γ, but the effective bargaining power $\overline{\gamma}(\theta)$, with $0 < \overline{\gamma}(\theta) < \gamma$. This effective bargaining power of firms converges to γ if unemployment becomes extremely large (θ goes to 0) and decreases with θ until it reaches 0 when θ goes to infinity, that is, the worker could find another firm in no time and is therefore able to capture all of the surplus[6].

Proposition 1: A unit increase in the repayment rates ρ raises the wage by $\overline{\gamma}$.

Proof: $\dfrac{\partial w^s}{\partial \rho} = \overline{\gamma}$.

It is easy to show that unemployment puts downward pressure on the unskilled wages, that is, $\dfrac{\partial w^u}{\partial \theta} > 0$ given that $p^u > b$ (note that $d'(\theta) < 0$). The positive effect of θ on wages is well known and is caused by the improvement of the worker's outside option as the unemployment rate decreases with θ: the higher θ, the easier it becomes for a worker to find a job. Therefore the worker's threat point improves and the worker can sustain a larger share of the matching surplus, that is, drive up the wage.

However, the effect on skilled wages $\dfrac{\partial w^s}{\partial \theta}$ is not obvious. While unemployment reduces the skilled worker's bargaining position c.p., it also has an effect on the surplus

[6] A similar effect can be found in Wasmer and Weil (2004).

of a bank-worker match and thus on the installment ρ. Thus, I next take a look at the credit contract between students and banks.

3.2.8 Credit Bargaining

Banks and workers know that firms compensate workers for the fraction $\overline{\gamma}(\theta)$ of the credit repayments. Thus banks and workers internalize this effect when they bargain on the credit contract: in contrast to standard Nash-Bargaining, the surplus of a bank-worker match is increasing in the bargained credit rate ρ as a third party, the firms, pays $\overline{\gamma}(\theta)$ of the credit rate to workers, while the credit rate itself is only a transfer from workers to banks. The credit contract ρ is the result of Nash-Bargaining, satisfying

$$\rho = \arg\max(B_1 - B_0 - A)^{\beta}(W_1^s - W_0^s)^{1-\beta} \tag{3.19}$$

where $0 < \beta < 1$ represents the bargaining power of the bank. I substitute B_1 from (3.13), W_1^s from (3.8) and the free entry condition $B_0 = 0$. These values do not directly depend on ϕ, but contain all cashflows workers and banks can expect once they already have matched and enter the labour market. In an inner equilibrium, workers are indifferent between studying and following a career as unskilled worker, thus $W_0^s = W_0^u$, which can be substituted from (3.3). I take the derivative with respect to ρ (internalising the effect on wages from Proposition 1) and obtain the first order condition

$$\beta[(w^s(\rho,\theta,\alpha) - \rho - w^u(\theta,\alpha))(1-d(\theta))/r] = (1-\beta)[\rho(1-d(\theta))/r - A](1-\overline{\gamma}(\theta)) \tag{3.20}$$

The multiplier $(1-\overline{\gamma}(\theta))$ on the right-hand-side captures the effect of ρ on w^s. Solving (3.20) for ρ yields

$$\begin{aligned} \rho &= (1-\overline{\beta})Ar/[1-d(\theta)] + \overline{\beta}[w^s(\rho,\theta,\alpha) - w^u(\theta,\alpha)] \text{ with} \\ \overline{\beta} &= \frac{\beta}{\beta + (1-\beta)(1-\overline{\gamma})}. \end{aligned} \tag{3.21}$$

The credit rate is a weighted average of the costs of education A (translated into cash flows during the employment-periods) and the benefits of education, that is, the skill premium. The effective bargaining power of the banks $\overline{\beta}$ decreases in θ

from $\beta/(\beta + (1-\beta)(1-\gamma)) < 1$ to β as θ goes from 0 to infinity. However, this is only due to the connection of θ, ρ, and w^s: for high unemployment the effective bargaining power of firms $\overline{\gamma}$ is high, so the opportunity costs of working $b + \rho$ have a strong weight in wage setting and the worker is well compensated for higher ρ by higher wages. Therefore workers and banks have an incentive to set higher ρ.

Proposition 2: *The credit contract ρ is a convex combination of the productivity gain of education and the costs of education,*

$$\rho(\theta, \alpha) \quad = \quad \beta[p^s(\alpha) - p^u(\alpha)] + (1-\beta)Ar/[1-d(\theta)], \;\; \frac{\partial \rho}{\partial \theta} < 0, \; \frac{\partial \rho}{\partial \alpha} < 0. \; (3.22)$$

Proof: *Substitute* (3.17) *and* (3.18) *into* (3.21).

After considering the effect of ρ on w^s, the credit rates are just a convex combination of the increase in productivity that is made possible through the bank's credit, and the costs of education. They do not (directly) depend on the bargaining power of firms. The reasoning is as follows: on the one hand, higher effective bargaining power of firms shifts the wage further towards the opportunity costs of working that include the credit rates, giving workers and banks incentives for higher credit rates. On the other hand, a higher bargaining power of firms reduces the overall surplus of a bank-worker match, as the firms capture a larger share of the workers' productivity, making workers and banks worse off and reducing the absolute size of ρ. These two effects offset each other, giving rise to (3.22).
Moreover, the credit rates decrease in θ and in α: lower unemployment reduces the time between investments and returns to education, and the skill premium decreases in the share of skilled workers α.

3.2.9 The Incentives to Accept a Job

So far I have implicitly assumed that agents always prefer to proceed to the next phase. However, if the costs of education are very high it could be optimal for skilled workers to stay unemployed instead of accepting a job offer, that is, they prefer to receive b instead of earning w^s and paying ρ. Banks will only offer credits to prospective students if skilled workers will accept job offers and repay the loan, that is, if $W_2^s \geq W_1^s$. Using the skilled worker's Bellman equations it is easy to check that this is the case if $w^s \geq \rho - b$. By substituting w^s from (3.18) we see that the worker

has an incentive to accept a job if $p^s - \rho - b \geq 0$, that is, if after giving the bank its money and compensating the worker for forgoing his unemployment benefits there is still something left to be distributed between the firm and the worker. However, workers always have the option to abstain from studying and follow a career as an unskilled worker. Thus, instead of becoming skilled, declining all job offers, and receiving b forever he could also refrain from education, save the costs of searching for a bank, earn the same b while unemployed and have the opportunity to find a job as an unskilled worker (given that $p^u > b$). Of course, the latter is a strictly dominant strategy. So in any inner equilibrium where some workers are unskilled, the workers who opt for education always have an incentive to repay their loans.
A similar argument holds for the incentives of firms to accept skilled workers: a situation where firms decline skilled workers can never be a long run equilibrium, as then no worker would acquire an education. Also note that surplus splitting guarantees that a match is either beneficial for all involved agents or for none.

3.3 The Equilibrium

I substitute the banks' and the workers' costs of finding a matching partner on the credit market (3.12) and (3.7) into the surplus splitting rule (3.20) to obtain the credit market tightness, conditional on W_0^s

$$\phi^* = \frac{(1-\overline{\beta})}{\overline{\beta}} \frac{k}{rW_0^s - b}. \tag{3.23}$$

Workers are indifferent with respect to their education, so $W_0^s = W_0^u$ must hold. I substitute (3.3) with the wages from (3.17) into (3.23) and obtain as equilibrium credit market tightness

$$\phi^*(\theta, \alpha) = \frac{1-\beta}{\beta} \frac{k}{[p^u(\alpha) - b](1/r - d(\theta))}, \frac{\partial \phi^*}{\partial \alpha} < 0, \frac{\partial \phi^*}{\partial \theta} < 0. \tag{3.24}$$

ϕ^* is decreasing in α because the higher the fraction of skilled workers workers, the higher are the wages of the unskilled, so the opportunity costs of searching on the credit market rW_0^u are larger. Higher θ, that is lower unemployment, also increases the opportunity costs of searching on the credit market: workers could instead search for an unskilled job, which is relatively promising due to low unemployment, and

then earn money. This gives rise to positive relationship between unemployment and credit market tightness.

Next I express the banks' free entry condition conditional on θ and α. There are two ways to obtain B_1, the value of a bank that just has paid for a student's education: We can either consider the expected costs to reach this stage (3.12) or the present value of cash flows that a bank can expect from the student (3.13). I combine both and substitute ρ from (3.22) to obtain

$$\frac{k}{\phi^* p(\phi^*)} + \beta A = \beta[[p^s(\alpha) - p^u(\alpha)][1 - d(\theta)]/r]. \tag{3.25}$$

On the left-hand-side we find the banks' costs of finding a worker plus the fraction of the education costs that are effectively paid by the bank. On the right-hand-side we see that the bank is able to capture the fraction β of the productivity improvement generated by the workers' education.

In a similar way I determine the workers' indifference condition as a function of θ and α. The costs of finding a bank, that is, reaching W_1^s via (3.7), must be identical to the present value of all cash flows the worker can expect from this point in time onwards, that is computing W_1^s via (3.8). Indifference of workers implies that the costs of searching the credit market for a bank also incorporate the opportunity costs of not being able to search the labour market as an unskilled worker rW_0^u. After substitution of ρ from (3.22) I obtain

$$\frac{rW_0^s - b}{p(\phi^*)} + (1 - \overline{\gamma})(1 - \beta)A = (1 - \overline{\gamma})(1 - \beta)[[p^s(\alpha) - p^u(\alpha)][1 - d(\theta)]/r]. \tag{3.26}$$

On the left-hand-side of (3.26) we see the workers' costs of reaching W_1, that is the opportunity costs of searching the credit market plus the fraction of the tuition fees that the worker effectively has to pay: banks pay the fraction β, and out of the remaining costs $(1 - \beta)A$ the firms pay the fraction $\overline{\gamma}(\theta)$ by means of higher wages. On the right-hand-side we see that the worker is able to capture the same fraction of the increase in productivity; the remainder goes to banks and firms[7].

Proposition 3: (3.25) *and* (3.26) *are identical.*

[7]Note that if the frictions on both markets are infinitely small, that is $p(\phi) \to \infty$ and $q(\theta) \to \infty$, the indifference condition (3.26) converges to the indifference condition with perfect markets (see appendix).

Proof: *Substitute* (3.23) *into* (3.25).

If a bank and a worker have met, they split the surplus of this match, that is, the bank receives a fraction of the worker's future cash flows. Therefore the effects of θ and α on workers' and banks' incentives are identical. Both act as a unit in the labour market. If unemployment is higher, then both wait longer for their share, and if more workers are skilled, they both suffer in the same way from lower marginal productivity. Thus (3.25) describes all combinations of θ and α that satisfy the banks free-entry condition *and* the workers' indifference condition.

Now I substitute w^s and w^u into (3.16) to obtain the firms' job creation condition

$$\frac{f}{q(\theta)} = \frac{\overline{\gamma}(\theta)}{r+s}\left[\alpha(1-\beta)[p^s(\alpha) - A/[1/r - d(\theta)]] + (1-\alpha+\alpha\beta)p^u(\alpha) - b\right]. \quad (3.27)$$

The expected costs of finding a worker must be equal to the expected profits of having a filled vacancy. A reduction in unemployment (higher θ) tightens the labour market for firms and raises the costs of finding a worker. Additionally, the workers' bargaining position improves, so firms must raise wages, and profits decrease. On the other hand, less unemployment also reduces the effective costs of education $Ar/[1-d(\theta)]$. As the wages of skilled workers include some of these costs, the lower costs counteract decreasing profits.

Different Equilibria

An equilibrium is a combination of θ and α that solves (3.25) and (3.27) and thereby also determines $\phi^*(\theta^*, \alpha^*)$ via (3.24). Moreover, for reasonable calibrations both curves describe a positive relation between θ and α: If unemployment raises (θ decreases), skilled workers must get compensated by a higher skill premium, that is, lower α. On the other hand, if firms face a tighter labour market and θ rises, the average profit of a match must also rise, that is the skill level on the labour market α must increase.[8] In principle, there could be three types of equilibria: if the costs of education are extremely high (low) compared to the productivity of skilled workers,

[8]The shape of the curves depends on the CRS production function and the size of A. For very high levels of α, a further increase of α can make firms worse off as they prefer a mix of skilled and unskilled workers, thus they must be compensated by higher unemployment. However, this does not occur in equilibrium for any reasonable calibration, see also section 3.5.

there might only be equilibria in which none (all) of the workers study. However, assuming a neoclassical production function that satisfies the Inada conditions, that is, the marginal productivity of the first worker who acquires higher education is very high, some of the workers always study. With endogenous education decisions we also cannot run into a situation where everyone studies, as then an unskilled worker's productivity (and wage) would be higher and it would be worthwhile to deviate to no education.

3.4 The Effect of Tuition Fees

What happens if universities raise their tuition fees A? The consideration of (3.25) shows that the expected surplus of a worker-bank match declines ceteris paribus, so the combinations of θ and α that satisfy the worker's indifference curve and the bank's free-entry condition must change in such a way that both are compensated for the higher costs. This is the case if for every given level of unemployment θ the fraction of skilled workers α decreases, raising both the skill premium and the number of workers per bank, which reduces banks' searching costs in (3.25). Thus the banks' free entry curve (identical to the households indifference curve) (3.25) must shift downwards.

A similar approach shows the effect on the firms' free entry condition (3.27): for any given combination of θ and α, firms now make lower expected profits as they pay a share of the increase in A through higher wages. Fix for a moment the skill composition of the labour force α. Then for any α unemployment must change in a way that compensates firms for the higher wages. Unemployment reduces the searching costs of firms and raises the firm's effective bargaining power $\overline{\gamma}(\theta)$. However, unemployment also raises the effective costs of education by extending the time between the costs and the returns to education. This weakens the positive effect of unemployment on firms' profits and unemployment has to increase even more until the firms' free entry condition is satisfied. Therefore, as long as tuition fees are not to large compared to p^s, the increase in A shifts the firms' job creation curve to the left[9].

In the new equilibrium unemployment has risen, and the share of workers who

[9] see also 3.5.

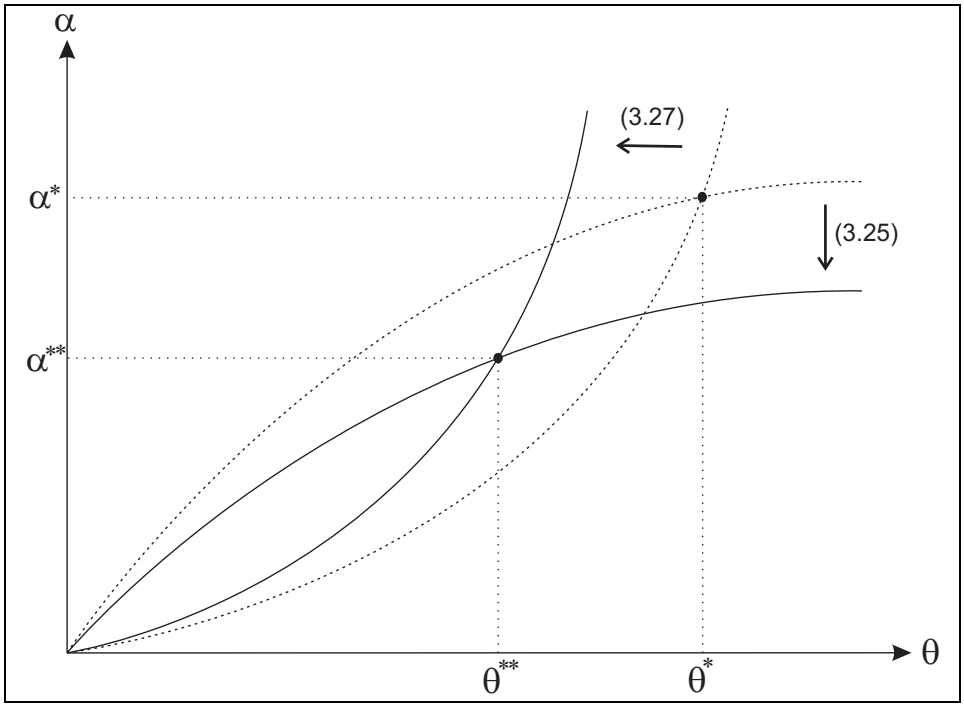

Figure 3.1: An Increase in Tuition Fees

acquire tertiary education has declined (see figure 3.1). This gives rise to lower wages for unskilled workers (3.17) as both their productivity and their threat point have declined. In addition, following (3.3), the present value of income for both types of workers W_0^i has declined. Then (3.23) shows that the credit market tightness has increased, that is, there are fewer banks per student in the credit market.

3.5 A Numerical Example

I illustrate the effect of tuition fees on the skill composition of the labour force, unemployment, wages and welfare with a numerical example. Table 3.1 shows the details: I follow the calibration of Wasmer and Weil (2004) whenever this makes sense (such as for the risk-free interest rate, job destruction rate, and agents' bargaining power). However, I take into account that in our model workers search for student loans (instead of entrepreneurs searching for venture capital). I nevertheless

adopt the elasticity of their matching functions[10], but I adjust the parameter of the credit market matching function such that prospective students only search the credit market for a few months. Banks' flow costs of searching for a debtor involve at least indirect access to the necessary funds as well as some personnel costs. I assume $k = 0.7$, such that banks spend on average 4% of the credit amount to find a debtor. The flow income of non-employed workers b, regardless of whether they search the credit or the labour market, is set to $b = 0.3$[11]. Finally, the CRS production function has an elasticity of substitution (with respect to skilled and unskilled workers) of .7 (Das, 2003), while the remaining productivity parameters a_1 and a_2 are chosen such that the model predicts a reasonable skill premium[12].

I analyse an increase of the tuition fees[13] from $A = 5$ to $A = 8$. Table 3.2 shows the

b	flow income of workers who are not employed	0.3
k	searching costs of banks on the credit market	0.7
f	searching costs of firms on the labour market	1.5
$p(\phi)$	matching function capital market	$3\phi^{-0.5}$
$q(\theta)$	matching function labour market	$1.5\theta^{-0.5}$
γ	bargaining power of firms	0.5
β	bargaining power of banks	0.5
σ	production function parameter	-0.4
a_1	production function parameter	0.6
a_2	production function parameter	0.4
r	interest rate	0.05
s	job destruction rate	0.15

Table 3.1: List of Parameters

[10]The elasticity of the matching functions in Wasmer and Weil (2004) is equal to the bargaining power of the banks or the firms, implying that the Hosios rule is satisfied and the market outcome might be efficient. However, I show in section 3.6 that this is not the case here.

[11]The average wage income in equilibrium is .095, thus $b = 0.3$ gives rise to an average replacement rate of 32%, in line with the standard literature such as Shimer (2005).

[12]Ingram and Neumann (2006) show that the skill premium averages about 80% in the past 40 years, and it has recently risen to about 100%. This trend fits the prediction of our model that increasing tuition fees will give rise to higher wages for skilled and lower wages for unskilled workers.

prediction of the model: the initial unemployment rate[14] is about 9.7%, and 52% of the workers acquire tertiary education. Skilled workers earn 1.09 and pay about 0.3 for their credit, while unskilled workers earn 0.79.

When tuition fees rise to $A = 8$, the fraction of skilled workers drops to 48%. The skill premium rises significantly, as skilled workers now earn 1.19 while the wages for unskilled workers decline to .70. Despite the declining number of students, the credit market tightens and welfare decreases. Note that the effects on welfare were even stronger if I would consider that the increasing unemployment benefits must be financed, for example by taxes. Both skilled and unskilled workers suffer, skilled workers directly, but by less that ΔA, and unskilled workers suffer from higher unemployment and lower wages.

		$A = 5$	$A = 8$
α	fraction of skilled	0.517	0.484
θ	labour market tightness	0.858	0.704
ϕ	credit market tightness	1.464	1.768
u	unemployment rate	0.097	0.107
$1/[\theta q(\theta)]$	average unemployment spell	0.720	0.795
$1/[p(\phi)]$	average searching time credit market	0.403	0.443
ρ	credit rate	0.297	0.474
w^s	wage of skilled workers	1.092	1.186
w^u	wage of unskilled workers	0.786	0.704
$w^s/w^u - 1$	skill premium	.39	.68
W_0	net present value of total income	14.50	12.97

Table 3.2: The Effect of Increasing Tuition Fees

[13]Note that the wage of skilled workers is slightly above 1 and studying does not take any time, thus the proposed tuition fees are rising from moderate levels to significant costs.

[14]The stationary unemployment rate must satisfy $s(1-u) = \theta q(\theta) u$ and gives rise to the Beveridge curve $u = s/[s + \theta q(\theta)]$.

3.6 Efficiency and the Effect of Credit Market Imperfections

Markets with random search suffer from externalities: if firms, banks and workers decide to enter a particular market they do not consider that they tighten this market for agents of the same type and loosen it for the type that they try to match with. Hosios (1990) shows that the efficiency of the decentralised market crucially depends on the agents' bargaining power. The higher the relative bargaining power of firms (banks), the more rent can they extract from a match, thus free entry gives rise to a high firm-worker-ratio (low ratio of students to banks) and thus relatively high search costs for firms (banks) and lower costs for workers.

I consider a social planner who maximises average consumption in the economy U. The planner can decide upon the number of vacancies per unemployed θ, the number of banks per prospective student $1/\phi$ and the skill composition of the labour force α, but he cannot overcome the search frictions.[15]

$$U = \alpha U^s + (1-\alpha)U^u \text{ with} \tag{3.28}$$

$$U^s = \frac{b - k/\phi + p(\phi)[(b - f\theta)d(\theta)/r + p^s(\alpha)[1 - d(\theta)]/r - A]}{r + p(\phi)} \text{ and} \tag{3.29}$$

$$U^u = (b - f\theta)d(\theta)/r + p^u(\alpha)[1 - d(\theta)]/r. \tag{3.30}$$

For every unemployed worker there are θ vacancies in the labour market, thus the present value of all cash flows a worker generates during all of his unemployment spells is $(b - f\theta)d(\theta)/r$. The worker produces p^i while he is employed, and workers who acquire skills cost A before they enter the labour market. These workers also search for a bank before they enter the labour market and contribute $b - k/\phi$ (for each worker there are $1/\phi$ banks in the credit market). Finally, the skilled workers returns are discounted because searching for a bank takes time.

Again I use the numerical example from section 3.5 to get a feel for the size of the distortions. Table 3.3 compares the decentralised outcome with the planner's solution, first under the assumption that the planner wants to replicate the α of the decentralised market, and of a planner who also sets the optimal α. As expected,

[15]Note that this does not necessarily imply that skilled and unskilled workers have the same utility. However, the planner can always redistribute wealth among workers.

the education decision is not efficient, as costs and benefits of human capital are split between skilled workers, banks and firms, but the costs of credit market imperfections are not. I find that, given the level of α, the market outcome is not efficient, but the planner would open more vacancies and reduce credit supply. This would give rise to an increase in welfare of about 1%, which also becomes larger if the planner were allowed to set α. Of course, efficiency in the decentralised market heavily depends on agents' bargaining power, and welfare losses drastically increase once β and γ differ from the level that is implied by the Hosios rule.

	$\beta=\gamma=0.5$				$\beta=\gamma=0.2$			
	α	θ	ϕ	U	α	θ	ϕ	U
decentralised market	0.517	0.858	1.464	14.496	0.51	0.194	6.917	13.652
planner (α fixed)	0.517	1.126	1.635	14.514	0.51	1.121	1.576	14.507
planner (α optimal)	0.523	1.129	1.688	14.516	0.523	1.129	1.688	14.516

Table 3.3: Decentralised Equilibrium versus Social Planner

In order to illustrate the source of the inefficiencies it the decentralised market, I compare this model (M) to a benchmark (B1) in which only the labour market suffers from search frictions, but the credit market is perfect in the sense that students can get contingent loans for the unemployment adjusted risk-free rate as in Moen (1998). A model in which both markets are perfect serves as second benchmark (B2). First consider the workers' indifference condition in the three models[16]:

$$(B2) \qquad [p^s(\alpha^*) - p^u(\alpha^*)]/r = A \tag{3.31}$$

$$(B1) \qquad [p^s(\alpha) - p^u(\alpha)]\,[1 - d(\theta)]/r = A \tag{3.32}$$

$$(M) \qquad [p^s(\alpha) - p^u(\alpha)][1 - d(\theta)]\,/r = A + \frac{rW_0^s - b}{p(\phi)} \cdot \frac{1}{[(1-\overline{\gamma})(1-\beta)]} \tag{3.33}$$

Proposition 4: *Investment in human capital is not (constraint) efficient if both labour and credit markets are not perfect, even if contingent loans are available.*

Proof:

$$\begin{aligned} 1/[(1-\overline{\gamma})(1-\beta)] &> 1 \quad \text{as } 0 < \overline{\gamma} < \gamma < 1 \text{ and } 0 < \beta < 1 \\ \frac{\partial[1/[(1-\overline{\gamma})(1-\beta)]]}{\partial\theta} &> 0 \quad \text{as } \frac{\partial\overline{\gamma}(\theta)}{\partial\theta} < 0. \end{aligned}$$

[16]Both benchmark models can be found in the appendix.

The benefits of tertiary education, the increase in productivity, is on the left-hand-side of (3.31) to (3.33). While with perfect markets (3.31) the worker will benefit in all periods, in the models with imperfect labour markets (3.32) and (3.33) he can use this productivity only while he is employed. The right-hand-side shows the costs this worker considers: with perfect credit markets he has to pay A for his education, regardless of whether he pays it directly (3.31) or takes a contingent loan (3.32). If credit markets are imperfect, in addition to the tuition fees A he has to consider the searching costs $\frac{rW_0^s - b}{p(\phi)}$. But these searching costs are amplified by $1/[(1-\overline{\gamma})(1-\beta)] > 1$ with regard to investment in human capital: While the worker effectively pays only the $(1-\overline{\gamma})(1-\beta)$ of the tuition fees and receives the same fraction of the increase in productivity, he pays all of the searching costs on the credit market. Thus, when he decides upon investment in human capital, the relative weight of these searching costs is $1/[(1-\overline{\gamma})(1-\beta)]$. The less that is left for the worker after banks and firms take their share of the productivity increase, the higher the weight of the costs of obtaining the loan. The searching costs on the credit market have a stronger weight than tuition fees and the skill premium, so investment is not efficient. This amplification of the credit market imperfections becomes stronger with unemployment and the bargaining power of firms and banks. Next I take a look at the job creation condition of firms (of course in B2 there is no unemployment and no explicit job creation condition):

$$(B1): \frac{f}{q(\theta)} = \frac{\overline{\gamma}(\theta)}{r+s}\left[\alpha(p^s(\alpha) - Ar/[1-d(\theta)]) + (1-\alpha)p^u(\alpha) - b\right]$$

$$(M): \frac{f}{q(\theta)} = \frac{\overline{\gamma}(\theta)}{r+s}\left[\alpha(1-\beta)[p^s(\alpha) - Ar/[1-d(\theta)]] + (1-\alpha)(1-\beta)p^u - \beta p^u - b\right]$$

There are two main differences between M and B1: first, with credit market imperfections firms receive a smaller fraction of the worker's productivity as banks capture the share β. Second, $-\beta p^u$ is an additional effect that carries over from the credit contract.

Table 3.4 shows the equilibria of the different models with the calibration from section 3.5. The introduction of credit market frictions reduces the number of students by a similar amount as the introduction of search frictions on the labour market, and it reduces welfare by 1.5%. It is important to remember that the only credit market friction is that workers who want to study lose about 2-3 months in which

	M	B1	B2
α	0.517	0.522	0.528
θ	0.8582	0.8682	/
u	0.0974	0.0969	/
w^s	1.092	1.0795	1.1271
w^u	0.785	0.799	0.877
$w^s/w^u - 1$	.391	.351	.285
W_0	14.50	14.72	17.54
$W_0 + \alpha A$	17.08	17.33	20.18

Table 3.4: The Outcome in the Three Different Models

they could *search* for a job as an unskilled worker. Also note that the welfare loss hits all workers, but only some of them benefit from tertiary education, thus the loss per student is about twice as high. The credit market imperfections also raise the skill premium by more than 10%.

3.7 Conclusions

This paper has shown that tuition fees in the presence of credit and labour market imperfections have a severe impact on the welfare of unskilled workers who suffer from increasing unemployment and lower wages. Even in the presence of contingent loans the investment in human capital is distorted: banks, firms, and workers share costs and benefits of education, but not the costs of obtaining the credit. The effect of credit market frictions on average welfare is substantial, and moderate changes in tuition fees are sufficient to generate large skill premia, as skilled workers are compensated for their expenditures at the expense of unskilled workers.

This result shows that tuition fees are not ex ante more suitable for shifting the costs of higher education to the agents who enjoy the benefits of education, but workers without education pay, as in a tax-financed education system, a fraction of these costs.

The model can be extended in several ways. If we add a proportional income tax as

a second instrument to finance tertiary education we can determine the optimal mix of private and public funding. Note that also the income tax distorts the incentives to invest in human capital as it reduces the skill premium as well as the costs of education from the students' point of view.

Another extension would be to integrate a link between the costs and the quality of education, that is, higher tuition fees increase skilled workers' productivity. However, these extensions would go beyond the scope of this paper and are left to future research.

3.8 Appendix

3.8.1 Benchmark I: The Frictionless Model

Consider an economy with ex ante homogeneous workers who decide upon their education. Workers can borrow at the risk-free rate r any necessary amount and work in perfect competitive labour markets. An agent who acquires a higher education is more productive and earns a high wage w^s, but he has to pay university tuition fees A. If he refrains from going to university and directly enters the labour market he only earns w^u.

In a frictionless world with free entry for firms and perfect competition workers are paid their marginal product. With constant returns to scale the productivity of a worker p^i depends only on the relative composition of the labour force, that is, the fraction of skilled α among all workers, but not on absolute numbers, so

$$w^i(\alpha) = p^i(\alpha) \text{ with } \frac{\partial p^s}{\partial \alpha} < 0 \text{ and } \frac{\partial p^u}{\partial \alpha} > 0, \quad i = s, u.$$

Workers are risk neutral and maximise the net present value of their income stream. In an inner equilibrium, any worker is indifferent with respect to his education. The total income of a skilled worker net of the costs of acquiring skills must be equal to the present value of all earnings of an unskilled worker,

$$\frac{p^s(\alpha^*)}{r} - A = \frac{p^u(\alpha^*)}{r} \tag{3.34}$$

and the share of skilled agents α in the economy satisfies

$$\frac{p^s(\alpha^*) - p^u(\alpha^*)}{r} = A. \tag{3.35}$$

3.8.2 Benchmark II: Perfect Credit Market, Imperfect Labour Market

Consider a standard Mortensen-Pissarides model with search frictions only on the labour market. Young workers decide whether or not they want to study. Agents who acquire a higher education can obtain a contingent loan on a perfect credit market, that is, they now receive A to cover there expenditures and repay credit rates ρ while they have a job. In contrast to the imperfect capital market, the implicit interest rate on the credit equals the risk free rate, adjusted for the expected unemployment spells. Thus a worker who wants to study follows the Bellman equations

$$\begin{aligned} rW_0^s &= b + \theta q(\theta)[W_1 - W_0] \text{ and} \\ rW_1^s &= w^s - \rho + s[W_0 - W_1] \end{aligned}$$

giving rise to

$$W_0^s = bd(\theta)/r + (w^s - \rho)[1 - d(\theta)]/r. \tag{3.36}$$

A worker who does not acquire higher education searches for an unskilled job, but he does not repay any credit while employed,

$$W_0^u = bd(\theta)/r + w^u[1 - d(\theta)]/r. \tag{3.37}$$

In the perfect credit market, the present value of all credit rates ρ equals the cost of education A, that is,

$$\rho = A/[1/r - d(\theta)]. \tag{3.38}$$

In an inner equilibrium, workers are indifferent with respect to their education decision, thus $W_0^s = W_0^u$ and

$$(w^s - w^u)[1 - d(\theta)]/r = A. \tag{3.39}$$

The benefits of human capital, the present value of the skill premium, must be equal to the cost of obtaining this skill premium.
The Bellman equations for firms do not change as, they still search the imperfect

labour market and are randomly matched to skilled or unskilled workers. Free entry gives rise to the same job creation condition (conditional on wages) as in the main model (3.16),

$$\frac{f}{q(\theta)} = \frac{1}{r+s}\left[\alpha(p^s(\alpha) - w^s(\theta,\alpha)) + (1-\alpha)(p^u(\alpha) - w^u(\theta,\alpha))\right]. \quad (3.40)$$

When firms and workers meet, they bargain on the wage as usual. As we deal with contingent loans, the credit costs are part of the opportunity costs of working, and workers are compensated for the share β of it. However, with perfect credit markets the credit rate ρ is defined by (3.38) and banks cannot charge implicit interest rates above the risk-free rate. Thus, the wage is determined by the generalised Nash product

$$w^i = \arg\max(W_1^i - W_0^i)^{1-\gamma}(V - S^i)^{\gamma}, \quad (3.41)$$

giving rise to the surplus-splitting condition

$$\gamma[W_1^i - W_0^i] = (1-\gamma)[S^i - V]. \quad (3.42)$$

After substituting the Bellman equations and the credit rate I obtain the wages of unskilled and skilled workers

$$\begin{aligned} w^u(\theta,\alpha) &= \overline{\gamma}(\theta)b + (1-\overline{\gamma}(\theta))p^u(\alpha) \text{ and} \\ w^s(\theta,\alpha) &= \overline{\gamma}(\theta)(b + Ar/[1-d(\theta)]) + (1-\overline{\gamma}(\theta))p^s(\alpha) \quad \text{with} \\ \overline{\gamma}(\theta) &= \frac{\gamma d(\theta)}{\gamma d(\theta) + 1 - \gamma}, \quad \frac{\partial \overline{\gamma}}{\partial \theta} < 0. \end{aligned}$$

The Equilibrium

I substitute w^s and w^u into (3.39) and (3.40) to obtain the two equilibrium conditions for θ and α,

$$[p^s(\alpha) - p^u(\alpha)] = Ar/[1-d(\theta)] \text{ and} \quad (3.43)$$

$$\frac{f}{q(\theta)} = \frac{\overline{\gamma}(\theta)}{r+s}\left[\alpha(p^s(\alpha) - Ar/[1-d(\theta)]) + (1-\alpha)p^u(\alpha) - b\right]. \quad (3.44)$$

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Zusammenfassung

Diese Dissertation besteht aus drei eigenständigen Arbeiten, die ich während meiner Forschung im Rahmen des Doktorandenprogramms „Quantitative Economics and Finance“ an der Universität Konstanz angefertigt habe.
Alle drei Arbeiten diskutieren die Auswirkungen von Arbeitsmarktunvollkommenheiten auf heterogene Arbeitskräfte. Im Gegensatz zu Gütermärkten wird auf dem Arbeitsmarkt nicht ein homogenes Gut gehandelt, sondern sowohl Arbeitsangebot als auch Arbeitsnachfrage sind hochgradig heterogen: Arbeiter unterscheiden sich hinsichtlich Schulbildung, Berufswahl und Berufserfahrung, nicht-kognitiven Fähigkeiten wie Fleiß, Motivation und Frusttoleranz, aber auch in äußerlichen, nicht unmittelbar produktivitätsbestimmenden Merkmalen wie Geschlecht, Alter oder ethnischer Herkunft. Ebenso variieren die Anforderungen an Arbeitnehmer nicht nur zwischen einzelnen Sektoren oder Abteilungen, sondern jedes einzelne Unternehmen fordert von seinen Angestellten sowohl allgemeine als auch branchen- und unternehmensspezifische Kenntnisse. Selbst wenn es dennoch den perfekten Arbeitnehmer für eine eine freie Stelle gäbe muss dies nicht zwangsläufig dazu führen, dass die Vakanz auch tatsächlich mit diesem Arbeiter besetzt werden kann; möglicherweise sind beide räumlich weit von einander getrennt und wissen nicht von der Existenz des entsprechenden Gegenparts, weshalb sich der Arbeiter bei anderen, weniger passenden Unternehmen bewirbt. Diese Koordinations- und Informationsfriktionen können verhindern, dass die „unsichtbare Hand“ unmittelbar Angebot und Nachfrage zusammenbringt; stattdessen müssen Unternehmen wie auch Arbeiter Zeit und Ressourcen aufwenden, um den passenden Gegenpart zu finden. Diese *Suchfriktionen* können Arbeitslosigkeit und andere Phänomene wie Lohndispersion auf dem Arbeitsmarkt hervorrufen. Die Standardliteratur, die sich mit dieser Problematik auseinandersetzt, unterscheidet sich unter anderem darin, wie explizit der Such- bzw. Bewerbungsprozess modelliert wird. Pissarides (2000) und Mortensen and Pissarides (1994) verwenden eine „black box“ Matching-Funktion sowie Löhne, die im Rahmen einer Nash-Verhandlung bestimmt werden, während Burdett and Mortensen (1998) diese Idee der ungerichteten Suche mit Lohnposting durch die Unternehmen sowie on-the-job search kombinieren, um Lohndispersion zu generieren. In competitive search models wie Moen (1997) entscheiden Arbeiter bewusst,

für welche in Aussicht gestellten Löhne sie sich bewerben, wobei bei Arbeitsplätzen mit höheren Löhnen auch die Konkurrenz unter den Bewerbern größer ist, während andere Ansätze wie von Burdett et al. (2001) oder von Albrecht et al. (2006) den Bewerbungsprozess noch detaillierter betrachten.
Zudem kann die asymmetrische Verteilung von Informationen eine effiziente Allokation von Arbeitnehmern auf freie Stellen erschweren. Eine Arbeitnehmerin, die naturgemäß ihre eigene Produktivität, die eigenen Stärken und Schwächen besser als ein potentieller Arbeitgeber kennt, kann nur einen Teil dieser Informationen glaubwürdig mittels Zeugnissen und Referenzen an ein interessiertes Unternehmen übermitteln. Das Unternehmen muss dann anhand dieser Unterlagen sowie anderer beobachtbarer Charakteristika wie Alter, Ausbildung, Geschlecht, Beschäftigungsstatus oder ethnischer Herkunft Rückschlüsse auf die Produktivität dieser Arbeiterin ziehen. Dabei können im Rahmen des Bewerbungsprozesses persönliche Vorbehalte gegen Bewerber mit bestimmten Merkmalen auch zu Diskriminierung gegen diese Gruppierung führen.
Es ist Ziel dieser Dissertation, einige ausgewählte Auswirkungen von Arbeitsmarktunvollkommenheiten auf sowohl Markteffizienz als auch hinsichtlich ihrer Verteilungseffekte zu analysieren. Die erste Arbeit zeigt anhand eines spieltheoretischen Modells, dass lediglich Koordinations- und Informationsfriktionen ausreichen, um Diskriminierung gegen ältere arbeitslose Arbeitnehmer hervorzurufen, selbst wenn die Produktivität der Arbeiter unabhängig von deren Alter ist. Die zweite Arbeit umfasst eine empirische Studie zur Diskriminierung gegen Arbeiter mit türkischem Migrationshintergrund auf dem deutschen Arbeitsmarkt. Die dritte Arbeit diskutiert den Effekt von Studiengebühren auf Arbeitslosigkeit und Humankapital für den Fall, dass sowohl Arbeitsmärkte als auch Kreditmärkte zur Finanzierung der Studiengebühren von Friktionen betroffen sind. Zudem wird die tatsächliche Verteilung der Studiengebührenlast zwischen Akademikern und Arbeitern ohne Studium betrachtet.
Dieses Kapitel fasst die wichtigsten Ergebnisse zusammen.

Kapitel 1 analysiert, weshalb es älteren Arbeitnehmern besonders schwer fällt eine neue Arbeitsstelle zu finden, sobald sie arbeitslos werden: Unternehmen beschäftigen sehr wohl auch ältere Arbeitnehmer, aber sie stellen kaum ältere Arbeits-

suchende ein. Bisherige Studien argumentieren meist, dass die Produktivität eines durchschnittlichen Arbeitnehmers mit dessen Alter abnimmt[17]. In diesem Fall haben Unternehmen einen Anreiz zu *statistischer Diskriminierung* (Arrow, 1973; Phelps, 1972) gegen ältere Arbeiter, oder Unternehmen stellen auf Grund hoher Kosten zum Einarbeiten o.ä. (Heywood et al., 1999) keine älteren Arbeiter mehr ein. Ebenso wäre denkbar, dass Unternehmen im Sinne eines *taste for discrimination* (Becker, 1957) den Kontakt mit älteren Arbeitnehmern schlicht wegen persönlicher Antipathie meiden wollen. Kapitel 1 zeigt jedoch anhand eines einfachen spieltheoretischen Ansatzes auf der Basis eines Modells von Blankenau and Camera (2006), dass es in unvollkommenen Arbeitsmärkten auch dann zur Diskriminierung gegen ältere Arbeitnehmer kommen kann, falls die individuelle Produktivität nicht mit dem Alter abnimmt und es keinen taste for discrimination gibt. In meinem Modell besteht Heterogenität der Arbeiter hinsichtlich zweier Dimensionen: Die Arbeiter unterscheiden sich in ihrer konstanten, angeborenen Produktivität, und Arbeiter werden älter, ohne dass dies einen Einfluss auf deren Produktivität nimmt. Koordinations- und Informationsfriktionen führen zu Arbeitslosigkeit, wobei den empirischen Beobachtungen entsprechend weniger produktive Arbeitnehmer verstärkt von Arbeitslosigkeit betroffen sind. Da Unternehmen die Fähigkeiten von potentiellen Arbeitnehmern nur eingeschränkt beobachten können, nutzen Arbeitgeber auch den Beschäftigungsstatus von Bewerbern als Signal für deren erwartete Produktivität. Dabei lässt sich zeigen, dass die Stigmatisierung durch Arbeitslosigkeit umso stärker wirkt, je älter ein Arbeitnehmer ist: Je länger ein Arbeiter auf dem Arbeitsmarkt aktiv ist, desto höher ist die Wahrscheinlichkeit, dass ein produktiver Arbeiter in einem Unternehmen gebunden ist. Dies führt zu einem negativen Zusammenhang zwischen individuellem Alter und der erwarteten Produktivität von *arbeitslosen* Arbeitern und reduziert Anstellungschancen von älteren Arbeitslosen.

Das dezentrale Marktgleichgewicht ist nicht effizient, da im Allgemeinen zu wenige (ältere und junge) Arbeiter eingestellt werden. Zudem lässt sich zeigen, dass eine Einschränkung des Kündigungsschutzes zwar die relativen Anstellungschancen von älteren Arbeitnehmern reduzieren (d.h. „Diskriminierung“ verstärken), aber zugleich deren absolute Beschäftigungschancen verbessern kann. Außerdem kann eine solche Politik zu einem Anstieg von Beschäftigung und Durchschnittseinkommen führen.

[17] Für eine Übersicht siehe Skirbekk (2004).

Zudem kann die Einführung eines Frühverrentungssystems älteren, wenig produktiven Arbeitnehmern einen Anreiz bieten, den Markt zu verlassen und somit die Anstellungschancen für die verbliebenen, produktiven älteren Arbeitnehmer erhöhen.

Das zweite Kapitel umfasst eine gemeinsame Forschungsarbeit mit Leo Kaas[18] (Universität Konstanz) zur Diskriminierung gegen Arbeiter mit türkischem Migrationshintergrund in Deutschland. Die meisten dieser Arbeiter sind Nachkommen in der zweiten oder dritten Generation von Migranten, die in den 1960er Jahren als dringend benötigte Arbeitskräfte nach Deutschland kamen. Obwohl sie in Deutschland geboren wurden, über hervorragende Deutschkenntnisse verfügen und häufig die deutsche Staatsbürgerschaft besitzen, verfügen Menschen mit Migrationshintergrund im Schnitt über eine schlechtere Schulbildung und sind überproportional von Armutsrisiken betroffen.
Wir überprüfen daher anhand eines Korrespondenztests, in wiefern Arbeiter mit türkischem Migrationshintergrund auf dem deutschen Arbeitsmarkt systematisch diskriminiert werden. Im Rahmen unserer Feldstudie bewarben wir uns auf 528 ausgeschriebene Praktikaplätze für Studenten. Dabei erhielt jedes Unternehmen zwei ähnliche Bewerbungen, jeweils mit einem *zufällig* zugewiesenen markant türkischen Namen („Fatih Yildiz“ oder „Serkan Sezer“) oder mit einem klassisch deutschen Namen („Dennis Langer“ oder „Tobias Hartmann“). Die Studenten in beiden Bewerbungen leben seit ihrer Geburt in Deutschland, geben „Deutsch“ als Muttersprache an, haben mit gutem Erfolg in Deutschland ihr Abitur erworben und befinden sich zum Zeitpunkt der Bewerbung im dritten Semester eines wirtschaftswissenschaftlichen Studiengangs. Die beiden Bewerbungen unterscheiden sich jedoch im Umfang der Informationen, die der Arbeitgeber vom jeweiligen Bewerber erhält, um bei der Auswertung der Studie zwischen statistischer und taste-based Diskriminierung unterscheiden zu können. Konkret sind immer nur einer Bewerbung Arbeitszeugnisse beigefügt, welche die Zuverlässigkeit und Persönlichkeit des Bewerbers betonen. Nachdem wir die Bewerbungen per Internet verschickt hatten, registrierten wir sämtliche Reaktionen der Unternehmen per E-Mail, Post wie auch telefonische Rückmeldungen.

[18]Kaas and Manger (2010).

Die Studie zeigt, dass ein deutscher Name die Wahrscheinlichkeit, eine positive Rückmeldung zu erhalten, um etwa 14% erhöht. Diese Diskriminierung von Bewerbern mit türkischem Namen ist signifikant, scheint aber verhältnismäßig moderat, wenn man unser Ergebnis mit ähnlichen Studien zur Diskriminierung von Afroamerikanern in den USA (Bertrand and Mullainathan, 2004), Albanern in Griechenland (Drydakis and Vlassis, 2007) oder Arabern in Schweden (Carlsson and Rooth, 2007) vergleicht[19]. Die Benachteiligung des Bewerbers mit dem türkischen Namen ist besonders bei kleinen Firmen mit weniger als 50 Mitarbeitern auffällig, bei denen ein deutscher Name die Wahrscheinlichkeit einer positiven Reaktion um 24% steigert. Unsere Ergebnisse legen nahe, dass die unterschiedliche Behandlung der beiden Bewerber hauptsächlich auf statistischer Diskriminierung beruht: Bei Bewerbungen, die keine Arbeitszeugnisse enthalten, erhalten 41.8% der Kandidaten mit deutschem Namen eine positive Rückmeldung, aber lediglich 32.5% der Bewerber mit türkischem Namen. Sobald wir unsere Sample auf Bewerbungen mit Arbeitszeugnissen beschränken, ist kein signifikanter Unterschied zwischen beiden Kandidaten mehr festzustellen (37.4% positive Rückmeldungen mit einem deutschen und 36.9% mit einem türkischen Namen). Zudem analysieren wir, wie zügig die Unternehmen den Kandidaten antworten und finden keine Anzeichen, dass Bewerber mit Migrationshintergrund signifikant länger auf eine Zu- oder Absage warten müssen.

Kapitel 3 zeigt, wie die Auswirkungen von Studiengebühren durch Kapital- und Arbeitsmarktunvollkommenheiten verstärkt werden und dass durch diese Friktionen ein Teil dieser Kosten auf Nicht-Akademiker abgewälzt wird. Junge Menschen sind bei der Finanzierung ihres Studiums in zunehmendem Maße auf Kredite durch Banken angewiesen. Studenten verfügen allerdings nur selten über nennenswerte Sicherheiten, während Banken Studienkredite mit den verschiedensten Konditionen hinsichtlich Zinssätzen und Zugang zum jeweiligen Kreditangebot anbieten. Anstatt von einer fixen, exogenen Begrenzung der Kreditwürdigkeit auszugehen, folge ich daher in Kapitel 3 einem Ansatz von Wasmer and Weil (2004)[20]: Schulabsolventen, die

[19] Aufgrund des unterschiedlichen Designs der einzelnen Studien sollte daraus allerdings nicht der Schluss gezogen werden, dass in Deutschland per se weniger diskriminiert wird.

[20] Wasmer and Weil (2004) untersuchen die Effekte von Unvollkommenheiten auf dem Markt für Venture-Capital bei gleichzeitigem Auftreten von Arbeitsmarktfriktionen.

studieren möchten, müssen zuvor nach einer Bank *suchen*, die den benötigten Studienkredit zur Verfügung stellt. Diese Kreditmarktunvollkommenheiten sind analog zu den Friktionen am Arbeitsmarkt, beide mit Suchfriktionen à la Pissarides (2000): Es dauert eine gewisse Zeit, bis ein zukünftiger Student Zugang zu einem Kredit hat (bzw. bis eine Bank einen interessierten Studenten gefunden hat), wobei dieser Zeitaufwand vom Kreditangebot der Banken und der Kreditnachfrage der Studenten abhängt. Der Zinssatz, der für Studienkredite gezahlt werden muss, ist endogen und liegt über dem risikofreien Zinssatz. Zudem wird angenommen, dass der Studienkredit in der Form eines *contingent loans* vergeben wird, d.h. die Kreditraten werden nur gezahlt, wenn der Kreditnehmer nach seinem Studium eine Anstellung gefunden hat, nicht aber während er arbeitslos ist. Moen (1998) demonstriert, dass unter der Annahme von perfekten Kreditmärkten contingent loans helfen können, die durch holdups hervorgerufene Ineffizienzen[21] zu bekämpfen. Kapitel 3 zeigt jedoch, dass dieses Ergebnis nicht mehr zutrifft, sobald nicht nur der Arbeitsmarkt, sondern auch der Kreditmarkt von Friktionen betroffen ist. Im Gegenteil, Arbeiter und Banken können contingent loans strategisch nutzen, um höhere Löhne für Akademiker durchzusetzen. Dies verstärkt nicht nur die Folgen von Studiengebühren wie Arbeitslosigkeit und zurückgehenden Investitionen in Humankapital, sondern führt auch zu niedrigeren Löhnen für Nichtakademiker. Zudem werden anhand eines numerischen Beispiels die Auswirkungen von steigenden Studiengebühren auf Arbeitslosigkeit, Löhne, Zugang zu Krediten, Wohlfahrt und Studierendenquote aufgezeigt. Selbst wenn die Hosios-Regel (Hosios, 1990) erfüllt ist und contingent loans verfügbar sind, ist das Marktergebnis nicht effizient.

Um die Interaktion der Kreditmarktfriktionen mit dem unvollkommenen Arbeitsmarkt zu verdeutlichen, werden die Resultate mit einer Volkswirtschaft, in der nur der Arbeitsmarkt von Friktionen betroffen ist, sowie mit einer vollkommen friktionslosen Volkswirtschaft verglichen. Im Ergebnis lässt sich zeigen, dass bereits schwache

[21] Wenn Arbeiter und Unternehmen in Lohnverhandlungen eintreten, sind Kosten für die Ausbildung des Arbeiters bereits versunken. Da jedoch Unternehmen in unvollkommenen Arbeitsmärkten über Marktmacht verfügen, bleibt ein Teil des durch das Studium ermöglichten Produktivitätsanstiegs bei den Unternehmen und wird nicht in Form von höheren Löhnen an den Arbeitnehmer weitergegeben. Da der Arbeiter alle Kosten seiner Ausbildung zahlen muss, aber nur einen Teil der Erträge aus einem Studium erhält, sind die privaten Investitionen in Humankapital ineffizient gering.

Kreditmarktfriktionen sowohl Arbeitslosigkeit als auch Lohnunterschiede signifikant erhöhen und eine beträchtliche Anzahl potentieller Studenten von der Aufnahme einer Hochschulausbildung abhalten. Diese Effekte werden sowohl durch Arbeitsmarktunvollkommenheiten wie auch von der strategischen Nutzung der contingent loans durch Banken verstärkt.

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Erklärung

Ich versichere hiermit, dass ich die vorliegende Arbeit mit dem Thema

Three Essays on Heterogeneous Workers in Imperfect Labour Markets

ohne unzulässige Hilfe Dritter und ohne Benutzung anderer als der angegebenen Hilfsmittel angefertigt habe. Die aus anderen Quellen direkt oder indirekt übernommenen Daten und Konzepte sind unter Angabe der Quelle gekennzeichnet. Weitere Personen, insbesondere Promotionsberater, waren an der inhaltlich materiellen Erstellung dieser Arbeit nicht beteiligt[22]. Die Arbeit wurde bisher weder im In- noch im Ausland in gleicher oder ähnlicher Form einer anderen Prüfungsbehörde vorgelegt.

Konstanz, den 19. März 2010

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(Christian Manger)

[22]Siehe hierzu die Abgrenzung auf der folgenden Seite.

Abgrenzung

Ich versichere hiermit, dass ich Kapitel 1, und 3 der vorliegenden Arbeit ohne Hilfe Dritter und ohne Benutzung anderer als der angegebenen Hilfsmittel angefertigt habe.

Kapitel 2 entstammt einer gemeinsamen Arbeit mit Prof. Dr. Leo Kaas (Universität Konstanz). Die individuelle Leistung im Rahmen dieser Arbeit gliedert sich wie folgt:

1. Introduction/Conclusions: 30% Manger, 70% Kaas
2. Durchführung des Experiments: 50% Manger, 50% Kaas
3. Datenauswertung: 70% Manger, 30% Kaas

Konstanz, den 19. März 2010 _____

(Christian Manger)