Hochschule Amberg-Weiden
für angewandte Wissenschaften
University of Applied Sciences (FH)

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Weidener Diskussionspapiere

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Diskussionspapier No. 27
März 2011

ISBN 978-3-937804-29-3

Sorting on the Labour Market: A Literature Overview and Theoretical Framework*

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March 2011

Zusammenfassung

In der Literatur sind zwei Theorien zur Erklärung des positiven Zusammenhangs zwischen dem Bildungsniveau und dem Lohn vorherrschend: die Human Kapital-Theorie und die Signaltheorie. Wir beschreiben die Gemeinsamkeiten und Unterschiede beider Theorien und präsentieren ein allgemeines theoretisches Signal-Modell mit produktivitätserhöhenden Effekten der Bildung. Anhand diesem Modell entwickeln wir vier Hypothesen, die empirisch getestet werden können.

Abstract

In the literature there are basically two main approaches that explain the positive link between the level of education and wages: the human-capital theory and the signalling/screening (collectively known as sorting) theory. We highlight the similarity and differences between these theories and present a general theoretical model of screening with productivity-enhancing effects of education from which we derive four empirically testable hypothesis.

JEL Code: J24, J31

Keywords: human-capital theory, signalling, screening.

* Financial support from Tiroler Wissenschaftsfonds is gratefully acknowledged.
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1 Introduction

The aim of this paper is to present a survey of the literature on the effects of education both between high- and low-skilled within a group as well as between different groups. More precisely, our interest is in the value of educational signals if the signals come from different countries. In this case, it is likely that employers have more information about degrees from the home country than they have about – formally equivalent – foreign degrees.

Generally, there are two main explanations in the economics of education literature for the positive link between the level of education and wages: the human capital theory based on Becker (1975) and the signalling/screening (collectively known as sorting) theory which was originally developed by Spence (1973, 1974). In our view and as originally expressed in Weiss (1995), sorting theory extends but in no way contradicts human-capital theory. Therefore, we present a general theoretical model of screening with productivity-enhancing effects of education which we use to derive four testable hypotheses.

Our paper is structured as follows: The Chapter 2 discusses the main theoretical approaches and surveys the existing literature. Based on this discussion, in Chapter 3 we present a general theoretical model of screening with productivity-enhancing effects of education. Chapter 4 concludes.

2 Survey of Theoretical Literature and Empirical Conclusions

In the following we provide an overview of the effects of education signals for different groups on the labour market. Especially, we are interested in the signalling effects for groups with and without a migration background. Intuitively, one might expect that, after controlling for other personal as well as occupational characteristics, the wage paid to people with the same (formal) education level but different migration backgrounds should be the same. As we show below, however, this is not the case.

2.1 Main Theoretical Approaches

Generally, there are two main explanations in the economics of education literature for the positive link between the level of education and wages: the human-capital theory based on Becker (1975) and the signalling/screening (collectively known as sorting) theory which was originally developed by Spence (1973, 1974). Human-capital theory focuses on the productivity-augmenting effects associated with education. Sorting theory assumes that the educational level signals certain characteristics that a person has. For example, besides the expected productivity of people with different education levels, if an employer knows from past experience that highly educated individuals have more innate ability, then this is a characteristic that he or she cannot directly observe when hiring the employee but is willing to reward if he or she is able to obtain the information indirectly. This information is inferred from educational signals which hence act as a proxy for expected productivity.

2.2 Literature Overview

It is often argued that sorting theories assume no productivity-enhancing effects of education. To this extent there is a huge amount of literature which tries to test which of the two theories is correct by trying to separate empirically the purely productivity-enhancing effects of education (which are then assumed to support the human-capital theory) from the purely sorting effects of education in which education is assumed to leave productivity unaltered but is associated with other positive characteristics. For example:

- There are studies based on comparisons between workers in dependent employment and self-employed people in terms of years of schooling have been published by Wolpin (1977), Riley (1979), Katz and Ziderman (1980), Fredland and Little (1981), Tucker (1985), Cohn et al. (1987), Grubb (1993), Alba-Ramirez and Segundo (1995), Brown and Sessions (1999, 1998), Lofstrom (2000), van der Sluis and van Praag (2004), Castagnetti et al. (2005) and Garcia-Mainar and Montuenga-Gómez (2005).

- Psacharopoulos (1979, 1983), Lee (1980), Tucker (1986) and Cohn et al. (1987) compare the rates of return to schooling between the competitive and the non-competitive sectors of an economy.

- Liu and Wong (1982) measure the effect of tenure.

- Alba-Ramirez and Segundo (1995), Arabsheibani and Rees (1998) and Brown and Sessions (1999) ground their research on comparisons between public and private sector workers.

- The decomposition of earnings is studied by Tucker (1985).

- Albrecht (1981) and Albrecht and van Ours (2006) analyse the relationship between the returns to schooling and job information.

- Studies using data of identical twins have been published by Miller et al. (1995, 2004).

- Wiles (1974), Miller and Volker (1984) and Arabsheibani (1989) base their analysis on comparisons between the salaries of workers in occupations relevant to their educational qualification to those with the same qualification working in jobs not directly related to their qualifications.

- An experimental study concerning signalling and screening has been published by Kübler et al. (2005).

- Frazis (2002) and Landeras and de Villareal (2005) present a signalling model with initial uncertainty about ability.

- Hogan and Walker (2007) develop a model in which the education choice varies with the risk associated with uncertainty. They find that educational attainment is higher the more uncertain the outcome is. This issue is also recently addressed by Cunha and Heckman (2007) and Jacobs (2007).

2.3 Empirical Conclusions

We want to stress the point that there is no reason to assume that there are no productivity-enhancing effects of education in sorting models. Both the sorting model and the human-capital approach imply that wages increase with the level of education. Therefore, as both human-capital models and sorting models predict the same empirical result Brown and Sessions (1999) argue convincingly that it is – especially for empirical purposes – quite redundant whether education augments skills or signals innate abilities. Along similar lines, Lang (1994, p. 353) states, "the distinguishing characteristic of a sorting model is that knowing an individual's education provides employers with information about that individual's productivity which would be unknown otherwise."

Often the speed of employer learning is also used to test differences between the two theories. Here it is argued that when a firm first hires an individual, easily observable variables such as the education level are important. However, over time and depending on how fast employers learn about the true productivity of their employees, their importance (and hence the signalling value of education) diminishes. The faster they learn the less important are signalling considerations. Evidence confirming this hypothesis is provided by Altonji and Pierret (1998, 2001), Farber and Gibbons (1996) and most recently by Lange (2007). For Germany, Bauer and Haisken-DeNew (2001) find no evidence in support of this assumption. In addition, Habermalz (2006) doubts whether information about the speed of employer learning can be used to differentiate between human-capital and sorting theory at all. He argues that the signalling hypothesis implies that firms associate expected productivities with different education levels. In equilibrium, these hypothesis need to be confirmed as otherwise the firm would not be maximising its profits and needs to adapt its expectations. Hence, a fast speed of learning simply means that firms are quick in adjusting their expectations.

A slightly different approach is tested by Albrecht and van Ours (2006) who compare formal with informal hiring methods. Their hypothesis is that firms will know more about workers when they use informal recruiting methods. In this case, the signalling value of education will be less important than when formal hiring methods are used. Their empirical estimations confirm that education is more important in formal hiring channels.

In our view and as originally expressed in Weiss (1995), sorting theory in no way contradicts human-capital theory. On the contrary, there are numerous similarities between the two: In both theories wages are paid according to marginal productivity, firms maximise their profits and individuals their utility, the marginal benefit of education equals the marginal costs and, as can be seen from the model in Section 3, in both cases more education is associated with higher productivity. Sorting theory simply extends human-capital theory in that it firstly assumes that the decision to invest in a certain amount of education is positively related to innate abilities which also positively influence productivity on the job and secondly, as Fang (2006, 1154) puts it:

> *"...if workers' productivities are in fact not perfectly observed (which is particularly true for newly hired workers), then the firms would have to infer the productivities [...] from noisy signals such as interviews, tryouts, and reference letters together with their education levels."*

I.e. as already mentioned above, firms need to form expectations about productivities based solely upon observable characteristics. This in turn has important implications for an empirical analysis as what one is wanting to estimate is not the rate of return on education. Instead, it is the *ex ante* employer beliefs about how innate abilities are related to education and hence productivity. Thus, sorting theory implies that:

> *"The coefficient on education is fully capturing the effects of that inference process and would not be affected by the inclusion of additional explanatory variables that are not observed by the firm. Even if the researcher knows the results of accurate tests of attributes like perseverance or a taste for additional learning, if the firm does not have that direct information available, then the sorting model predicts that including these variables in the wage equation will not affect the coefficient on schooling"* (Weiss 1995, p. 135f.).

This theoretical implication is also in line with the huge body of evidence on the rates of return to education (see Card 2001 for a comprehensive survey). Table II in his article shows that the difference in the coefficients on education between OLS estimates (which do not take unobservable innate abilities into account) and IV estimates (which do try to take them into account) can be small and not significant. In general, the coefficients obtained from the IV estimates are higher. However, as pointed out in the article this may be because the IV estimator depends crucially on the assumption that the instruments are uncorrelated with other latent characteristics of individuals that may affect their earnings. In addition, measurement error in the schooling variable causes a downward bias in OLS estimates (see Griliches 1977 or Angrist and Krueger 1991) but not in IV estimates. Recently, Gebel and Pfeiffer (2010) have also estimated returns to education and compared OLS with the conditional mean independence approach developed by Wooldridge (2004). Again, although there are some differences in the two results, the general picture between the two is very similar.

In the next section we present a general theoretical model of screening with productivity-enhancing effects of education which defines a good starting point for empirical research related to labour markets that are characterized by different groups and education levels.

3 Screening with Productivity-Enhancing Effects of Education

Starting point of the analysis is a general theoretical model of screening with productivity-enhancing effects of education (cf. Hirshleifer and Riley 1992, ch. 11). We assume that there are two types of individuals which differ with respect to their innate abilities θ_p, where $p = H$ denotes high and $p = L$ denotes low ability, i.e. $\theta_H > \theta_L$. Net utility of an individual is

$$U(w, s, \theta) = w - C(s, \theta) \tag{1}$$

For simplicity, net utility U is assumed to increase linearly in the wage w and decrease in the perceived cost of education C. As usual, this perceived cost increases convexly with the signalled level of education s and decreases with innate ability θ. Hence, individuals with a higher innate ability require a smaller increment in income to be willing to increase their education level. This also implies that high ability individuals have flatter indifference curves in the (s, w)-space.

It is often assumed in sorting models that education only has a signalling value and no direct effect on productivity. However, there is no reason and no need for this assumption (see, for example, Spence 1974, Weiss 1983, Lang 1994). With such productivity-enhancing effects of education, the net value of production π of a firm also depends on both s and θ. Hence, the net value of production can be written as

$$\pi (w, s, \theta) = P (s, \theta) - w \tag{2}$$

where $P (s, \theta)$ denotes the marginal product of a worker with an education signal s and an innate ability θ.

In the following, we first analyse the outcome based on of a full information scenario as our benchmark. Subsequently, we address the more realistic case of imperfect information contracts.

3.1 Full Information Contract

To illustrate our argument, we first assume a perfectly observable ability level θ. If there is perfect competition among firms, the wage of an individual of type θ is bid up until the net production value is zero. The equilibrium is reached where the zero profit curve given by $w = P (s, \theta)$ is tangential to the indifference curve $U (w, s, \theta)$ of a type θ individual (cf. Figure 1). Any point which is not tangential is not an equilibrium because one party could improve its position without deteriorating the other party's position.

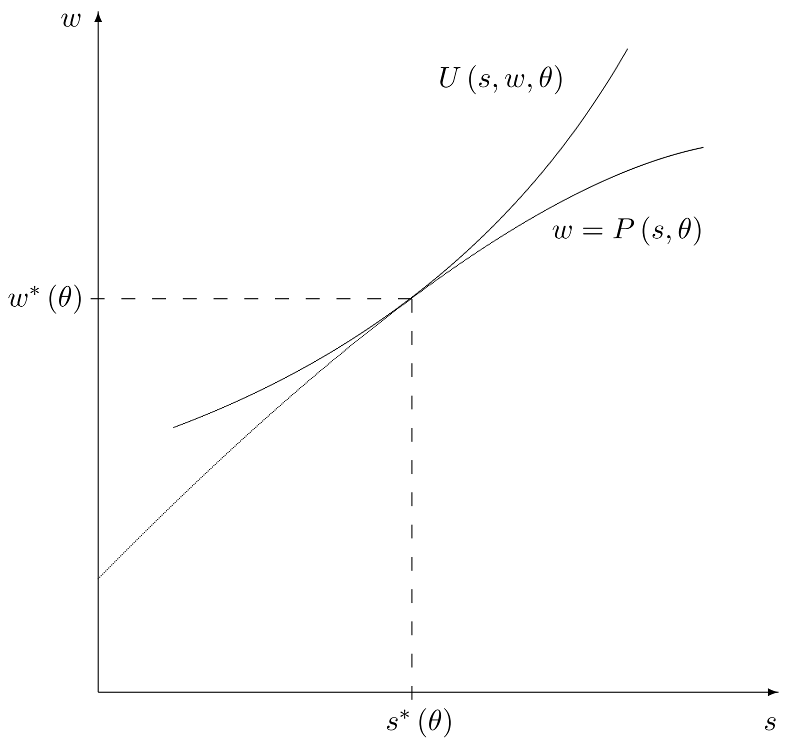

Figure 1: Perfect Information Contract with One Type of Workers

Figure 2 shows the equilibria when there are two types of workers who differ in their innate abilities. If the types are observably distinct, i.e. we have perfect information, their equilibrium contracts are

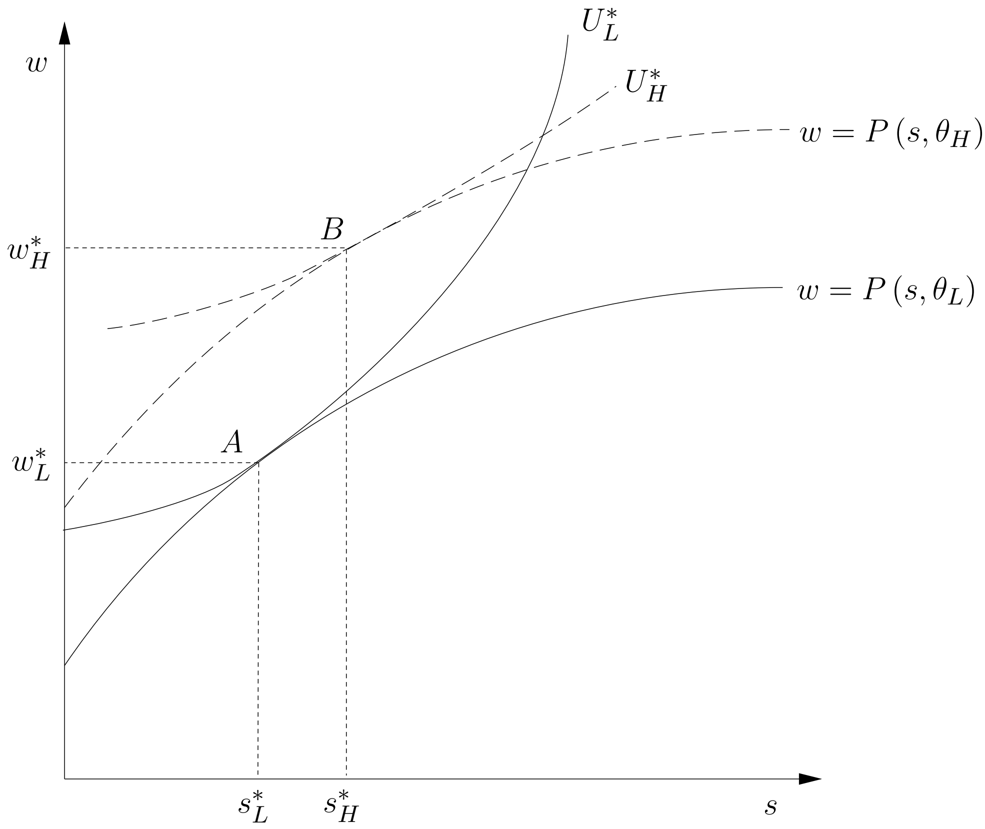

Figure 2: Perfect Information Contracts with Two Types of Workers

(s_L^*, w_L^*) and (s_H^*, w_H^*) shown by points A and B, respectively. In these points, the respective zero-profit (as there is as usual assumed perfect competition) and indifference curves are tangential. In this case, because of the perfect-information situation there is no signalling-effect, i.e. the signal s is just showing the productivity level of an applicant. Hence, no party could improve its position without either a decrease in utility or losses by the firms. On the other hand, independent of the (im)perfectness of information high (low) productivity the utility-maximizing workers will never signal an education level below s_H^* (s_L^*).

3.2 Imperfect Information Contracts

If the two types cannot be distinguished by the employer, i.e. we have imperfect information, type L workers would prefer a type H contract in which their indifference curve would then go through point B which is associated with a higher net utility level. However, firms would make a loss if they paid both type L and H workers the high productivity wage w_H^*. Therefore, firms have an interest in separating the two types and will hence not offer the contract (s_H^*, w_H^*).

Figure 3 shows the case of a separating equilibrium with imperfect information. In order to prevent type L-workers from mimicking the workers with a high innate ability, firms will now continue to offer type L workers the contract (s_L^*, w_L^*). However, the contract for type H workers is now (s_H^s, w_H^s), i.e. in going from an equilibrium with perfect to one with imperfect information, high-ability workers have to invest more in education to separate themselves and move from point B to point C in Figure

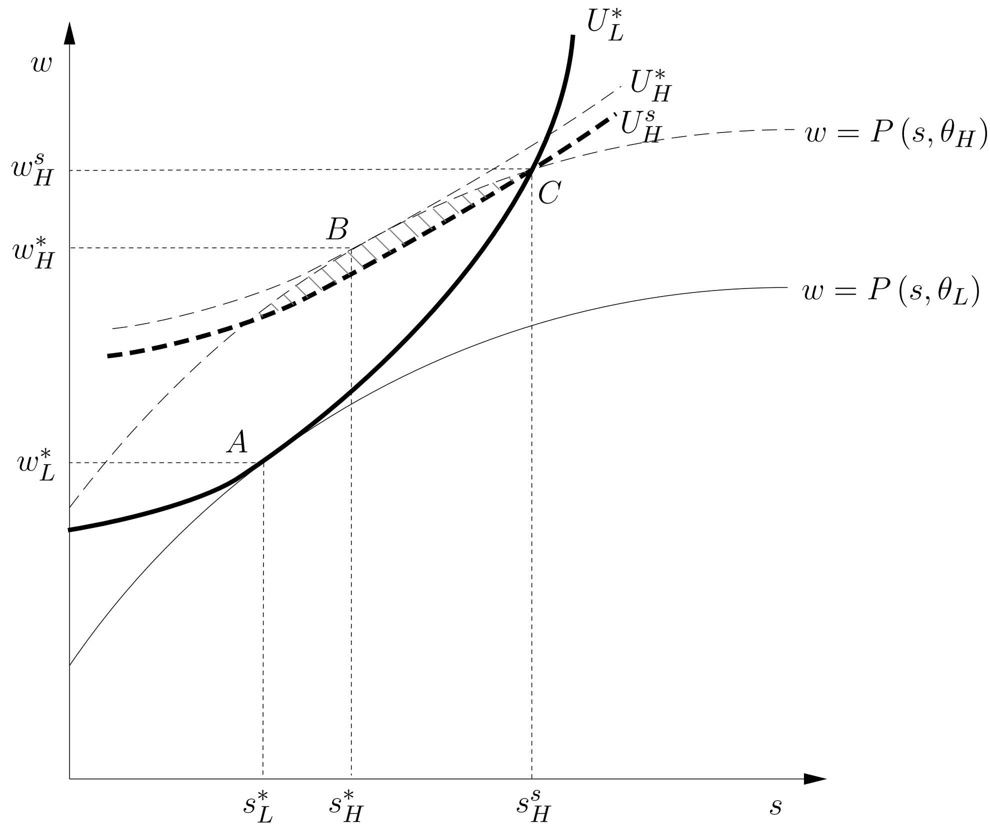

Figure 3: Imperfect Information Separating Contracts for Two Types of Workers

3. With such a contract pair, type L workers are just indifferent between contracts A and C.[1] The type H workers incur a negative externality, as they need to invest in a higher signal level than is the case under perfect information. Hence, their utility decreases from U_H^* to U_H^s.

However, as shown in Figure 4, depending on the relative productivities (and shares of the two types of workers), a separating solution may not represent an equilibrium. For example, both types of workers prefer a pooling contract with wages of or above $\tilde{w}_{HL}$. If the average productivity of the two types of workers is higher than this wage, then the scope of possible pooling contracts is given by the shaded area BCD in Figure 4. As an educational level of at least s_H^* is required to reach the productivity level at which firms can pay $\tilde{w}_{HL}$ without making a loss, this signalling level marks the lower bound of the shaded area. The upper bound is again the signal s_H^s as this is the level after which type L workers would then prefer a separating contract.

However, Rothschild and Stiglitz (1976) show that with competition amongst firms it is no longer possible to determine a unique pooling equilibrium which is stable. This can be seen from Figure 5 which is an enlargement of the relevant area in Figure 4. For example, if one firm were to offer a contract as shown by point D, then another firm could offer a contract to the north-east of D such as the wage-signal combination shown by point Q, in which both type H and L workers reach a higher utility. But the range for such pooling equilibria is limited to the right by U_L', i.e. the indifference curve of the type L-workers which goes through D, the lowest possible wage-signal-combination in which there would be a pooling equilibrium.

[1] Strictly speaking, high-ability workers have to signal marginally above the s_H^s level in order to really separate themselves from the low-ability workers.

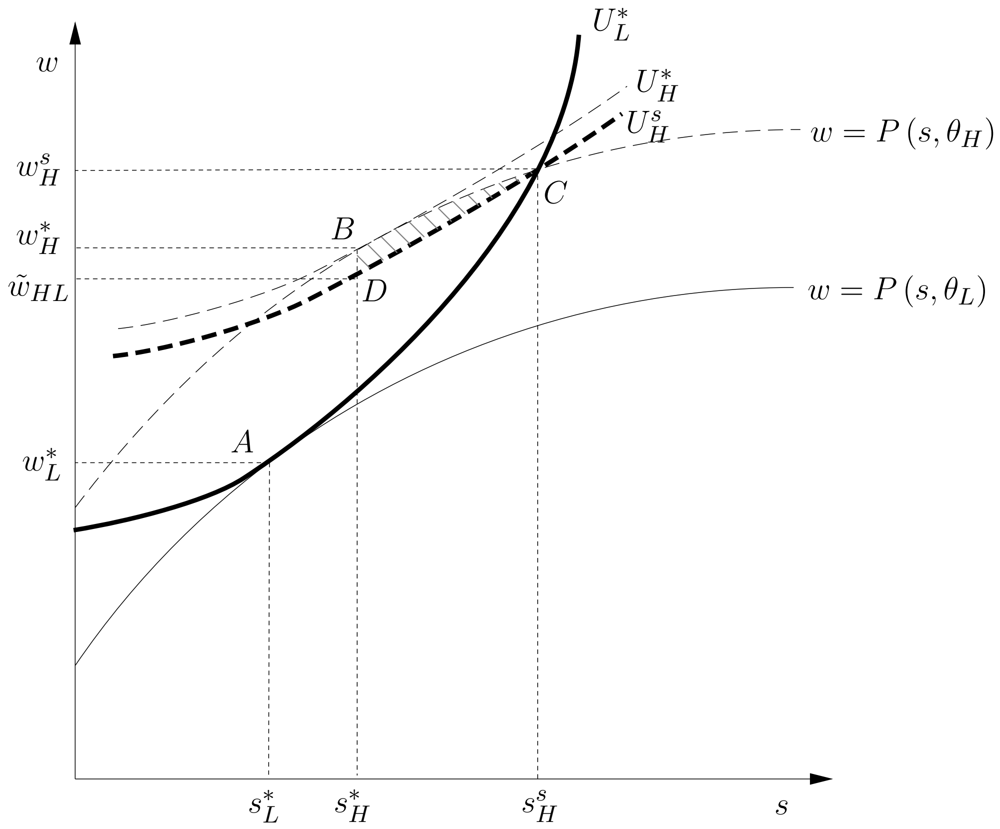

Figure 4: Imperfect Information with Pooling Contract for Two Types of Workers

However, point Q cannot be a stable pooling equilibrium, as firms could react and offer a contract-point R. As compared to D, type H workers would increase but type L workers decrease their utility level. Therefore, only the high-ability workers would prefer this contract. In this case, the competitor originally offering the contract point Q would now make a loss as only the low-ability individuals would stay in the firm with productivities below the wage associated with Q. At the same time, firms offering R would make positive profits as they only employ high-ability workers with productivities higher than the wage associated with R. Even if then another firm were to offer a higher wage than the reactive firm, the firm paying R would "only" lose its workers and end up making zero profits but would not incur any losses. Therefore, in the potential pooling equilibria range BDU_L', there is always the possibility for competitors to react by offering new contracts which make the original offers unprofitable. Engers and Fernandez (1987) show that in such a case there will only be one unique "reactive equilibrium" and that in this equilibrium there will be offered two separate contracts for the two types of workers. Hence, no pooling equilibria can exist and there is only the separating equilibrium as originally shown by points A and C in Figure 3.

3.3 Hypothesis for Empirical Research

From the above it is possible to derive the following four hypothesis which can be tested empirically:

1. There is always either a separating or reactive equilibrium, i.e. there will always be different contracts for people with different signal levels. Hence, we expect that the coefficients for the

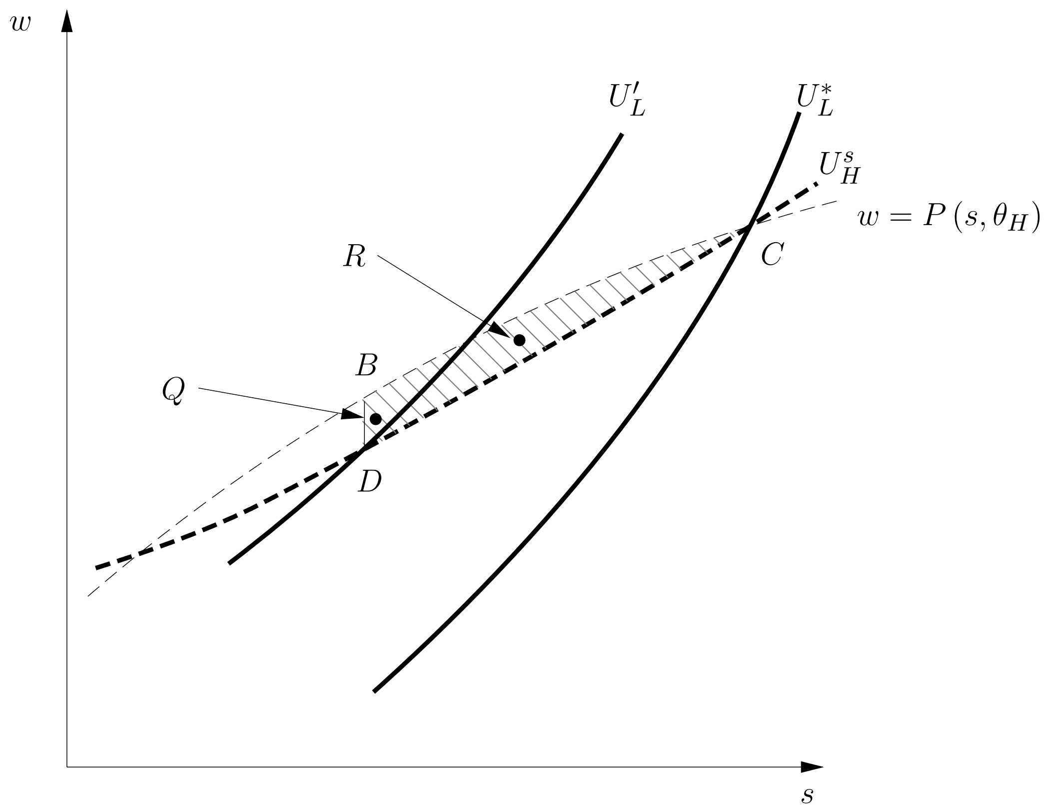

Figure 5: Imperfect Information with Pooling Contract and Reactive Equilibrium for Two Types of Workers

various education levels differ significantly. This should hold both for all labour-market groups under consideration.

2. If employers associate a lower productivity with the degrees of one labour-market group (for example foreigners) than for degrees of another labour-market group (for example degrees obtained in the home country), then their zero-profit curves will be lower for foreign education signals.[2] In this case, a person with a degree from abroad will receive a lower wage than a person with the same formal degree stemming from the home country. Even if their expectations about productivity are the same, if employers have less information – i.e. a higher variance – about foreign relative to home degrees, then they will also pay lower wages: see below.

3. If it is true that low-skilled occupations do not require formal qualifications, we expect that the wages associated with the low-ability individuals (i.e. people who invest in the lowest education signal which in the empirical research below is equivalent to "no vocational training") be the same. Hence, one could test whether the coefficient of the low-education signal is the same across the two groups.

4. If both hypothesis 2. and 3. hold, then the difference in the coefficients between low- and high-skilled home country people should be higher than the corresponding difference for the foreigners.

[2] This attitude could be caused for example by risk-averse employers or by experience from past hirings.

If employers have less accurate information about the value of foreign than home degrees, then this could lead to screening discrimination and hypothesis 2 also holds. As shown for example in Pinkston (2006, p. 271), in this case, even if the average productivities are the same for both groups, the higher variance of foreign degrees will lead to lower wage offers.

To see this, assume that firms observe a signal S_i when worker i belonging to group j applies.[3] Let μ_{ij} denote the log of the worker's actual productivity and assume that productivity has the same distribution across groups: $\mu \sim N(m, \sigma_\mu^2)$. Further, assume that the signal of initial productivity that is observed by the market is:

$$s_{ij} = \mu_{ij} + \epsilon_{ij}, \tag{3}$$

where $\epsilon_{ij} \sim N(0, \sigma_j^2)$ and is independent of μ_i for each group j. Groups are distinguished by the variance of this initial signal σ_j^2.

If the log of the worker's starting wage equals the expected log of initial productivity, then this wage w_i will be equal to:

$$w_{ij} = \mathrm{E}(\mu|s_{ij}) = \frac{\sigma_{sj}^2}{\sigma_{sj}^2 + \sigma_\mu^2} m + \frac{\sigma_\mu^2}{\sigma_{sj}^2 + \sigma_\mu^2} s_{ij} \tag{4}$$

From this it can be derived that even if the signal for the group with foreign degrees is the same as that of the natives but there is a higher variance associated with the signal from abroad, then workers with equivalent foreign signals will receive lower wages than those with native signals if $m < s_{ij}$. In addition, as Lundberg and Startz (1983, 2007) have shown, if workers invest in unobservable human capital or have degrees with less informational content for employers, wages will be lower for the group with the higher variance even if the productivities of the two groups are the same.

4 Conclusion and Outlook for Further Research

This paper provides an overview of the literature on the role of educational signals in determining wages. In our opinion, the presented theoretical framework together with the derived hypothesis are especially suitable for labour-market analysis when the signalling effects of education for groups with and without a migration background are to be be analysed. We perform such a test in Hornig et al. (2011). Intuitively, one might expect that, after controlling for other personal as well as occupational characteristics, the wage paid to people with the same (formal) education level but different migration backgrounds should be the same. However, as we show in our companion paper, this is clearly not the case.

[3] See DeGroot (1970).

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