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Alessandro Tampieri

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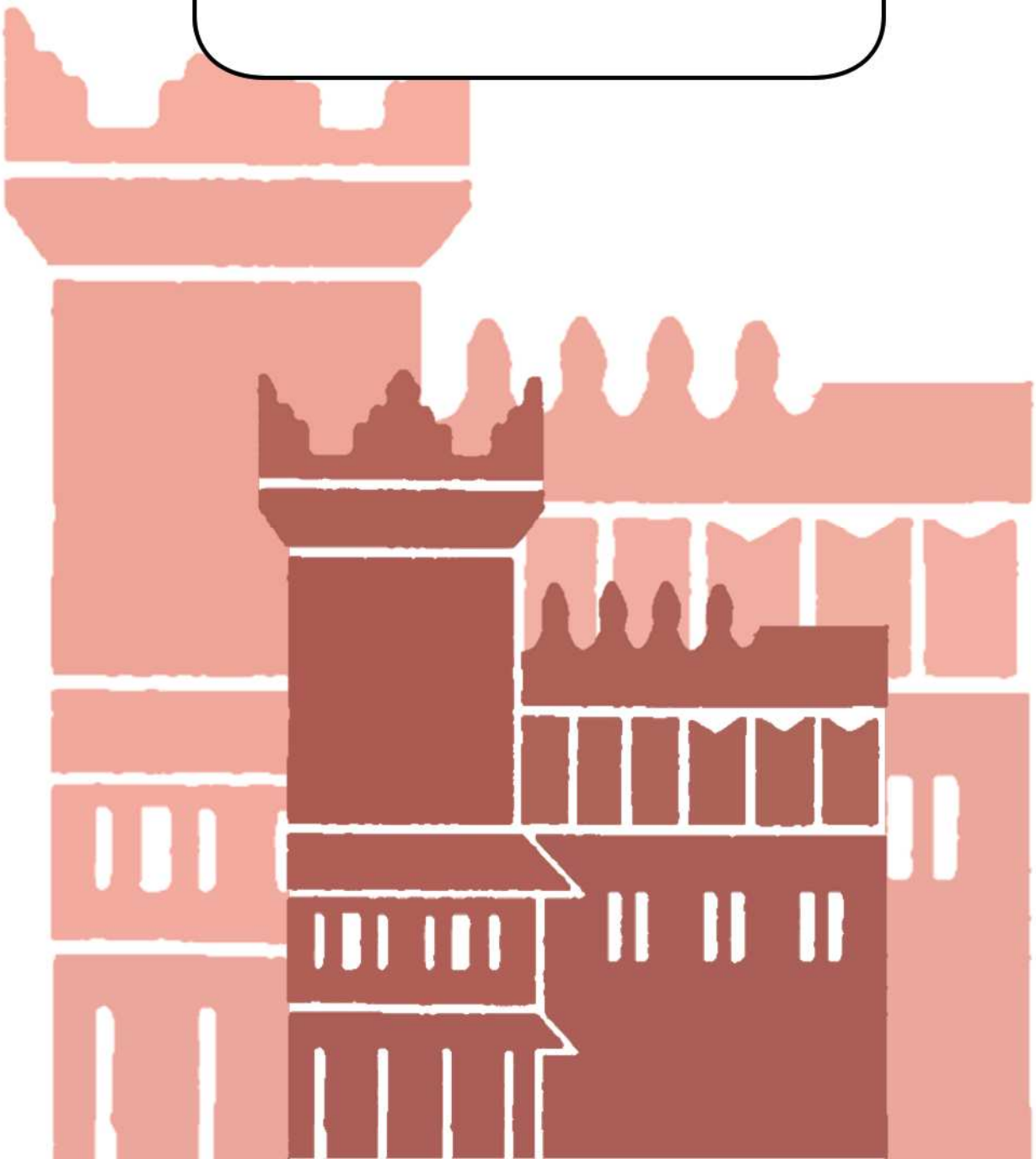

Meeting at School. Assortative Matching in Partnerships and Over-Education*

Alessandro Tampieri†
University of Bologna

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Abstract

This paper argues that assortative matching may explain over-education. Education determines individuals' income and, due to the presence of assortative matching, the quality of the partner, who can be a colleague or a spouse. Thus an individual acquires some education to improve the expected partner's quality. But since everybody does that, the partner's quality does not increase and over-education emerges. Tax progression to correct over-education has ambiguous effects on the educational incentives according to the individuals' ability. We test the model using the British Household Panel Survey. The empirical results support our theoretical findings.

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†University of Bologna, Department of Economics, Strada Maggiore 45, 40125, Bologna, ITALY; email: alessandro.tampieri@unibo.it.

1 Introduction

In recent decades, the level of educational attainment in developed countries has surpassed the skill requirements of available jobs[1]. This phenomenon is known as "over-education". There is a large empirical literature measuring over-education, while this paper aims to contribute to a theoretical understanding of it.

We propose a possible explanation for the existence of over-education based on the idea that acquiring education has two main effects. First, it improves job conditions: income, job quality, and so on. Second, it may influence the quality of future colleagues and spouses.

Schools and universities are among the places where people create their own social networks, make friends and spend a considerable part of their youth. At school, individuals can meet their future colleagues. For instance, school or university mates can apply to the same company, decide to work in partnership or find themselves working in the same firm. Also, many people meet their spouse at school[2]. Colleagues and spouses who met at school share similar levels of education[3]. We refer to this positive correlation as "assortative matching"[4]. Assortative matching reflects similarities in innate ability,

[1]Vaisey (2006) shows evidence that a substantial and growing number of American workers are over-qualified for their jobs along the period 1972-2002. The principal time-trend is positive and linear, and appears to be the result of the widening gap between a large expansion in educational attainment and only modest increases in job educational requirements over the past three decades. Budria and Moro-Egido (2007) find same evidence in European countries and a negative differential in salary between over-qualified individuals and their well-matched counterparts.

[2]Stevens (1991) analysed the reasons of why spouses tend to have similar educational levels. In the sample considered, more than 50% of spouses attended the same school, college or university.

[3]Some evidence of the positive relation in the education of colleagues can be found in Barth, (2002) and Barth and Dale-Olsen (2003). There is a large empirical evidence on the positive relationship in spouses' education. Some important contributions are Kalmijn (1991a, 1991b), Mare (1991), Pencavel (1998), Quian (1998), Qian and Preston (1993); Smits *et al.* (2000), Schwartz and Mare (2005).

[4]The expression "assortative matching" has been coined by Gary Becker (1973), and it alludes to a relationship (either positive or negative) between characteristics of spouses. We

since this is similar in individuals who share the same school experience. Our idea is that the presence of assortative matching may cause over-education.

We build up a model where individuals differ in ability. They study and are matched in the working period with a partner, who can be a colleague or a spouse. The partner's ability positively affects the individual's utility. This may be due to a variety of reasons. An individual can benefit from a colleague by informal apprenticeship, appraising or good influence, and from a spouse by sharing interests and income. Individuals maximise their expected utility by choosing their education levels and taking into account their matching.

This can be random or assortative. Random matching takes place when partners meet each other by chance. Assortative matching occurs if an individual meets the partner at school or university, or in any situation where the educational level influences the chance of a meeting. Whether matching is assortative depends on the institutions and tradition of a society: for example, the more the educational system requires that students spend time together, the more likely the matching will be assortative.

Our results suggest that assortative matching makes the education acquired inefficient from a social point of view. In particular, individuals would reach a lower level of education in a socially optimal solution. Thus we define over-education as the difference between the actual level of education and the socially optimal level of education.

What determines these results? Assortative matching gives an incentive to study more in order to increase the partner's quality. However, every individual with the same level of ability acquires the same quantity of education and hence is matched with a partner of the same type. This approach is in the spirit of Akerlof (1976), where workers signal their ability through their work speed. In order to look more able, workers of a given ability work faster

refer to the similarities in the levels of education specifically, and we apply the relationship not only to spouses, but also to colleagues.

than they would if they were not observed. In our model, individuals observe the partner's education level as a signal of ability, and in order to look more able they acquire more education than they would if assortative matching were not present.

The paper considers next how the introduction of a progressive income tax aiming to correct over-education may influence the incentives to acquire education. Interestingly, tax progression blunts the educational incentive for high-ability individuals but improves it for individuals with lower ability.

To test the theoretical model, we use the British Household Panel Survey (BHPS) for years 1991-2006. Because of the lack of information on the educational levels of colleagues, we analyse assortative matching only for couples and we consider a sample of spouses or long-term partners. We define as over-educated individuals whose educational qualification exceeds the required qualification in their occupation. Then, we test for a relationship between over-education and assortative matching, determined by a positive correlation in partners' levels of education. Our empirical findings support the theoretical results.

To our knowledge, over-education has not been largely developed from a theoretical perspective, with few notable exceptions. Frank (1978) investigates the differentials in wages between men and women as a consequence of female over-qualification. This is caused by family location decisions, since a family is more likely to move if it is the husband that acquires a better job, sacrificing the wife's opportunities. Hence the role differences between men and women are essential for his results, and over-education is generated by a job search process. Compared to this work, we do not consider differences in wages among sexes, job search nor the different role in society between men and women.

Our results are also linked to Lommerud (1989), where over-education occurs as individuals care about social status, determined by the relative income. As in our paper, he corrects over-education through a progressive

income taxation. This can weaken the incentive to study, since acquiring education becomes more costly. Subsidies might be necessary to restore this incentive.

Konrad and Lommerud (2000) explain over-education through a household bargaining model where young individuals separately choose their level of education and, once married, they sacrifice their returns to education in favour of an optimal level of family public goods (i.e., to spend time with children, partner, and so on). Over-education emerges because the educational decisions affect the threat point (i.e., the reservation utility given by being single) of spouses. To over-invest in education is inefficient in order to optimise the quantity of the family public good, but leads to an increase in the threat point so as to be in an advantaged position in the household bargaining.

As with studies by Peters and Siow (2001), Baker and Jacobsen (2005), Iyigun and Walsh (2005), Chiappori *et al.*(2006) and Nosaka (2007), our paper shares the link between education and assortative matching, whilst they consider assortative matching only between spouses. Our theoretical contribution is to address this link as an explanation for over-education.

Finally, the paper is related to the empirical literature of over-education (for discussions, see Hartog, 2000 and McGuinness, 2006). In particular, Lindley and McIntosh (2009) have studied over-education using the BHPS but identify over-education as the distance between the individual's job and the mode highest qualification in each occupation. Unlike them, we classify jobs as "graduate", "non-graduate" and "no qualification" jobs and to see whether a match exists with the educational qualification acquired. As far as we know, our empirical analysis is the first that examines assortative matching as a possible cause of over-education.

The remainder of the paper is organized as follows: Section 2 describes the model. Section 3 shows the results. Section 2.4 analyses the educational incentives given by progressive taxation on income. Section 5 presents the

empirical analysis. Section 6 concludes.

2 Theoretical Model

There is a continuum of individuals[5] normalised to 1. Individuals differ in ability, denoted by $\theta \in [\underline{\theta}, \overline{\theta}]$ and distributed according to density $f(\theta)$ with cumulative distribution function $F(\theta)$. We refer to ability as every innate characteristic that contributes to income potential. Individuals choose their level of education. We denote as $e \geq 0$ the quantity of education acquired by an individual. Education is costly for individuals. We denote the utility cost of education as $\frac{c}{2}e^2$, with $c > 0$.

After deciding their education, individuals work and are matched with a partner. We denote as $e\theta$ the income of an individual with education e and ability θ. The partner can be seen as a colleague or a spouse. An individual benefits from the partner's quality[6]. This is represented by $\alpha\theta_p$, where $\alpha \in [0, 1]$ is the relative importance of the partner's quality in determining the individual's utility, while $\theta_p \in [\underline{\theta}, \overline{\theta}]$ denote the partner's ability. Thus an individual's utility is determined by[7]:

$$U(e, \theta, \theta_p) = e\theta + \alpha\theta_p - \frac{c}{2}e^2. \tag{1}$$

We analyse the matching technology and then the educational problem.

[5]We do not consider differences in sex. This implies that men and women behave symmetrically, and excludes the case (more credible in reality) that educational decisions change according to sex (due to a different role in society and household, childbearing and so forth). However, the message of the paper does not change by considering differences in sex and these would only complicate the analysis.

[6]In teamwork, individuals find the performance of their duties easier if those they co-operate with are able, competent and dedicated. In individual jobs, a good environment improves job performance through suggestions or discussions. In love life, individuals share the advantages of a more able spouse: a better income, work flexibility (which reflects more availability in the spare time), a more interesting conversation and more open mindedness.

[7]We assume a linear additive utility in order to keep the analysis tractable. Different formulations would complicate the algebra without adding much insight.

2.1 Matching

Matching can be of two types: *random* or *assortative*. A random matching occurs when partners meet each other by chance. Within this framework, random matching happens anytime a meeting takes place in situations that are unrelated to the acquired education. For example, a match between a lawyer and a labourer sharing the passion for football and playing in the same team is totally casual. Two individuals meeting at the supermarket can have completely different educational backgrounds.

Assortative matching occurs when an individual meets their partner at school, university or in any situation where the educational level influences the chance of a meeting. For example when individuals attend the same social environment given by previous school friendships, or when a certain activity is related to the studies attended, like individuals with a degree in arts meeting in a museum or in an exhibition, and so on. In all these cases, partners' education is positively related. For the sake of simplicity, we assume that with assortative matching, a perfect positive correlation exists in partners' levels of education. In other words, the partner of an individual who acquires education e has the same level of education e. Considering an imperfect correlation would not alter our results.

Let $\beta \in [0, 1]$ denote the exogenous probability that the matching is assortative. This is independent of the individual's ability θ. The value of β depends on the customs and the educational system of the society we are considering. For instance, the more an educational system requires that students spend years at school for obtaining a certain qualification, the greater the probability of assortative matching[8]. Another example is the role of school tracking, that is the separation of pupils by academic ability into groups for all subjects within a school (Gamoran, 1992). An educational system

[8]Blossfeld and Timm (2003) analyse the relationship between educational system and marital assortative matching in many western countries. Their results show that the more time individuals spend at school, the greater the chance of marrying a partner with similar education (i.e., the higher β).

that postpones school tracking keeps a more heterogeneous group of pupils together for a long time, decreasing the probability of assortative matching[9].

2.2 Educational choice

When individuals decide the quantity of education to acquire, the future matching affects their decisions. According to equation (1), they prefer to be matched with a high-quality partner, as this increases their benefit. With random matching, since there is no correlation in partners' education, individuals have no information about partners' characteristics during the educational decisions. Thus partners' expected quality is determined by the average individual type, $\theta_p = \int_{\underline{\theta}}^{\overline{\theta}} \theta_p f(\theta_p) d\theta_p$, and hence random matching does not influence the educational choice.

With assortative matching instead, individuals can observe the education of some of their potential partners (for example, their school friends) during their educational period. Thus they may want to acquire more education in order to improve the probability of being matched with a better partner. Consequently, it is possible to influence the expected partner's type through the educational decisions.

In particular, individuals can correctly infer a partner's ability through their education. This is shown by supposing $E(\theta_p)$ being the education of a partner with ability θ_p, and also that[10] $E'(\theta_p) > 0$. The fact that

[9]Holmlund (2006) studies the effects of a school reform on marital assortative matching. She examines an educational reform, implemented in Sweden in the 1950s and 60s, which postponed tracking and extended compulsory education from seven to nine years. Her results show that this might have resulted in a reduction in assortative matching.

[10]In practice, we are arguing that the belief in equilibrium is that education is an increasing and monotonic function of ability. In other words, individuals believe that the abler ones study more. The equilibrium that emerges is "separating" (i.e., the level of education will be different for each level of ability). This does not exclude the existence of other equilibria that are determined by different beliefs. For instance, if the belief is that the level of education is constant irrespective of the individuals' ability, then a pooling equilibrium must emerge. However, the belief we focus on looks more consistent to what happens in reality.

in equilibrium, education is a strictly increasing function of ability allows the individual to recognise their partner's ability through his/her education. From a technical perspective, this happens because an increasing function can be inverted[11]. Given the assumption that in assortative matching partners have the same level of education, then an individual with ability θ acquiring an amount of education e will be matched with a partner whose education is $e = E(\theta_p)$. Hence the individual can infer the partner's ability θ_p as the inverse image of $E(\theta_p)$, so $\theta_p = E^{-1}(e)$. If this holds, we can rewrite equation (1) as:

$$e\theta + \alpha \left((1-\beta) \int_{\underline{\theta}}^{\overline{\theta}} \theta_p f(\theta_p) d\theta_p + \beta E^{-1}(e) \right) - \frac{c}{2} e^2. \tag{2}$$

In equilibrium we consider, all type e individuals make identical choices, and so (2) is the expected utility in each individual type e. The first part of (2) is the total benefit given by the individual's income, the second part is the total benefit given by the partner's quality, and the third part is the total cost of education. The second part of (2) can be in turn decomposed into two parts: (i) $\alpha(1-\beta) \int_{\underline{\theta}}^{\overline{\theta}} \theta_p f(\theta_p) d\theta_p$, and (ii) $\alpha\beta E^{-1}(e)$, which represent the expected benefit given by the partner with random and assortative matching, respectively.

Equation (2) shows that, in the presence of assortative matching, the educational choice e influences not only the future income ($e\theta$) but also the partner's expected quality ($\beta E^{-1}(e)$). In particular, an individual tries to manipulate the education signal by acquiring more education than others of similar ability, in order to obtain, in the future, a partner with higher ability than his/her. But in equilibrium, every individual takes into account assortative matching and tries to do precisely this, hence with probability β everyone is matched with a partner of the same ability.

[11] Clearly we need to verify that in equilibrium this condition holds.

The first order condition for the maximisation of equation (2) is:

$$\theta + \alpha\beta \frac{d}{de} E^{-1}(e) - ce = 0. \tag{3}$$

The following lemma shows the solution of equation (3).

Lemma 1 *The level of education chosen by type θ in equilibrium is $e_{ov} = \alpha\beta + \frac{\theta}{c}$.*

Proof. Since an individual with ability θ acquires a level of education e and with assortative matching a partner with ability $\theta_p = E^{-1}(e)$ acquires an amount of education e too, then necessarily $\theta_p = \theta$. Hence we can substitute[12] $\theta = E^{-1}(e)$ in equation (3). This is a differential equation which has solution:

$$\frac{d}{de} E^{-1}(e) = \frac{ce - E^{-1}(e)}{\alpha\beta}. \tag{4}$$

We consider a linear solution $E^{-1}(e) = Ae + B$. By substituting this in (4) we obtain $A = c$ and $B = -\alpha\beta c$. Hence $E^{-1}(e) = ce - \alpha\beta c$. By explicating e, noting that $E^{-1}(e) = \theta$, so we can rewrite $e = \alpha\beta + \frac{\theta}{c}$. In order e_{ov} to be invertible, it needs to be a strictly increasing function. Differentiating e_{ov} with respect to θ yields $\frac{\partial}{\partial\theta}(\alpha\beta + \frac{\theta}{c}) = \frac{1}{c} > 0$. ■

3 Theoretical results

In the equilibrium presented in the previous section, a part of the education acquired by individuals is to improve the quality of the potential partner. But since everyone does this, the expected quality of partners does not improve. Thus although individuals choose their optimal amount of education,

[12]Note that we can substitute $E^{-1}(e) = \theta$ only once that e has been maximised. If we do it before the maximisation is like to keep as fixed the partner's education. But this is a simultaneous game where every individual is also a partner, so the result would not be a Nash equilibrium.

the overall education is not socially efficient. Indeed the part acquired for increasing the chance of a better potential partner is not helpful in it, and is therefore wasted.

In this section we investigate the equilibrium where individuals exploit the socially optimal educational resources. We assume that education is determined by a planner aiming to maximise social welfare. This is given by the unweighted sum of the individual utilities when $\beta = 0$:

$$W = \int_{\underline{\theta}}^{\overline{\theta}} \left(\theta + \alpha \int_{\underline{\theta}}^{\overline{\theta}} \theta_p f(\theta_p) d\theta_p - \frac{c}{2} e^2 \right) d\theta.$$

In other words, the social welfare function considered does not take into account assortative matching, in order to rule out the cause of inefficiency from the problem. For every θ, the social planner's problem is the maximisation of equation (2) when $\beta = 0$.

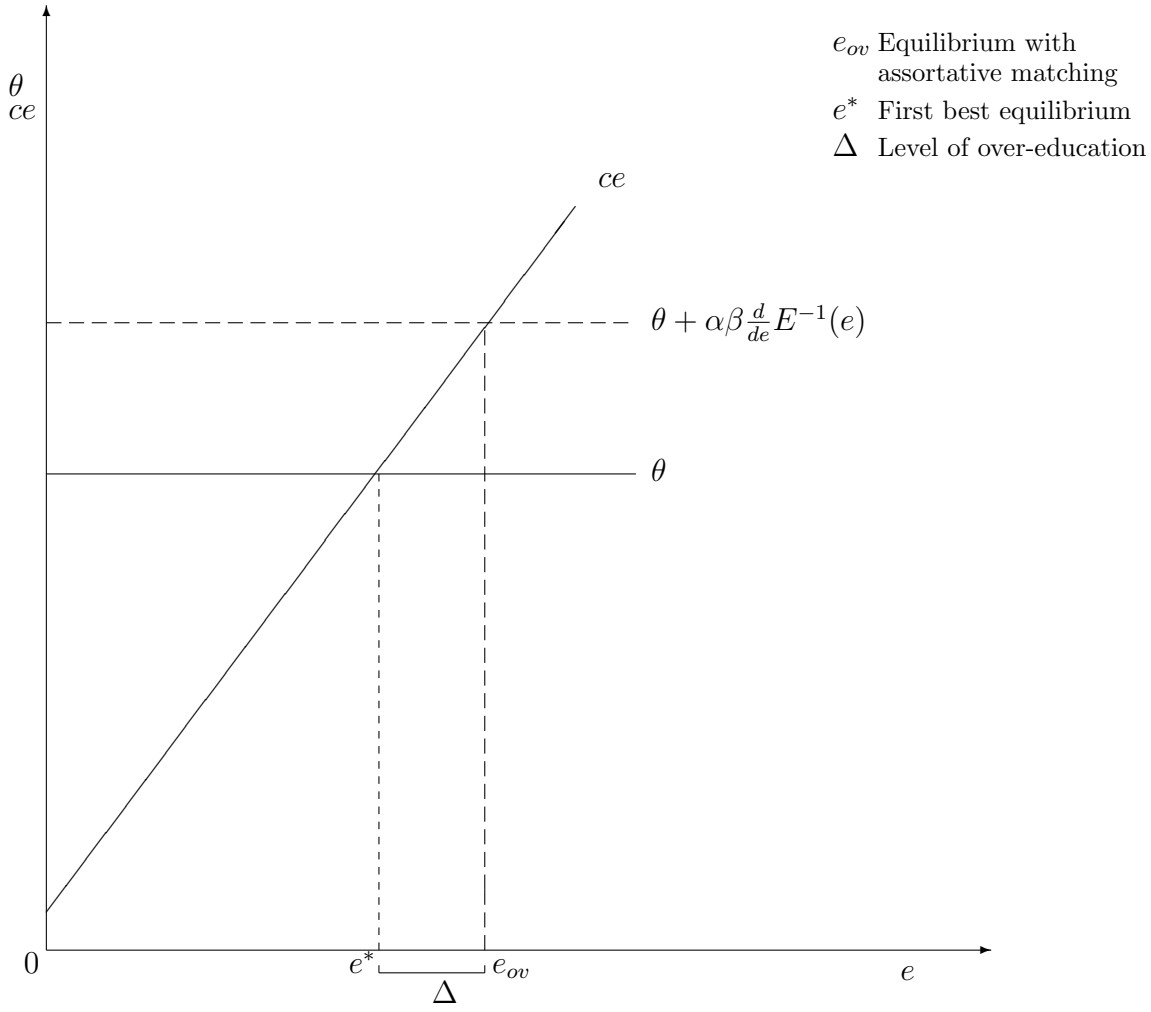
The solution of Lemma 1 becomes $e^* = \frac{\theta}{c}$. In order to have over-education, it is necessary that $e_{ov} > e^*$, $\alpha\beta + \frac{\theta}{c} > \frac{\theta}{c}$, which is always verified since $\alpha\beta > 0$. This is intuitive. In the presence of assortative matching, individuals observe the potential partners' education and try to look more able. This extra amount of education is not considered by the social planner. Individuals obtain the same result in terms of optimal choice (i.e., same income and partner), but employing less educational resources than in the presence of assortative matching and thus optimising social welfare (Figure 1). Hence we refer to e^* as the *first best equilibrium*. Over-education is defined as the difference between e_{ov} and e^*.

Definition 1 *$\Delta e = \alpha\beta$ is the level of over-education.*

By looking at Δe, we can observe that an increase either in β or in the relative importance of the partner's quality α leads to an increase in over-education. Clearly the more education individuals acquire, the more likely they are to meet their partner among their school friends (β high). Also, they

invest more in education if α is high, since having a high-quality partner is more valuable. This leads to more over-education.

Figure 1. Over-education.



4 Educational Incentives

In this section, we examine how a public intervention aiming to erase over-education can influence educational incentives. We assume that there is a government that fights over-education through a progressive taxation on

income. We strongly assume that the government is able to perfectly discriminate taxation according to the individual type. This indeed implies that the government can observe individuals' ability, which is clearly not possible in reality. Although this analysis does not yield normative implications, nevertheless it allows us to highlight some properties of progressive taxation on education incentives in the presence of assortative matching.

With progressive taxation, the tax rate increases the higher the income. We denote it as $\tau = \gamma^2 \left(1 - \frac{e\theta_L}{e\theta}\right) \in [0,1]$, where $\gamma \neq 1$ represents the tax progression and $e\theta_L$ is the lowest income in the population considered (the income of the least able individuals). For every θ, equation (2) becomes:

$$e\theta \left(1 - \gamma^2 \left(1 - \frac{e\theta_L}{e\theta}\right)\right) + \alpha \left((1-\beta) \int_{\underline{\theta}}^{\overline{\theta}} \theta_p f(\theta_p) d\theta_p + \beta \left(\alpha E^{-1}(e)\right)\right) - \frac{c}{2} e^2. \tag{5}$$

The first order condition for the maximisation of (5) is:

$$\theta + \beta\alpha \frac{d}{de} E^{-1}(e) = ce + \gamma^2 \theta, \tag{6}$$

and the level of education is determined by the following lemma.

Lemma 2 *With a progressive tax on income, the education in equilibrium is* $e^{\tau} = \frac{\theta\left(1-\gamma^2\right)}{c} + \frac{\alpha\beta}{(1-\gamma^2)}$.

Proof. We substitute $\theta = E^{-1}(e)$ in equation (6). This is a differential equation which has solution:

$$\frac{d}{de} E^{-1}(e) = \frac{ce + (\gamma^2 - 1) E^{-1}(e)}{\alpha\beta}. \tag{7}$$

We consider a linear solutions $E^{-1}(e) = Ae + B$. By substituting this in (7) we obtain $A = \frac{c}{1-\gamma^2}$ and $B = \frac{\alpha\beta c}{(1-\gamma^2)^2}$. Hence $E^{-1}(e) = \frac{ce}{1-\gamma^2} - \frac{\alpha\beta c}{(1-\gamma^2)^2}$. By explicating e and noting that $E^{-1}(e) = \theta$, we can rewrite $e = \frac{\theta\left(1-\gamma^2\right)}{c} + \frac{\alpha\beta}{(1-\gamma^2)}$. Note that γ cannot be 1, in order to have determinate solutions. ■

To reach the first best level of education, e^{τ} needs to be equal to e^{*}, thus: $\frac{\theta\left(1-\gamma^{2}\right)}{c}+\frac{\alpha\beta}{(1-\gamma^{2})}=\frac{\theta}{c}$. By explicating γ we find two positive solutions $\gamma_1 = \left(\frac{1}{2}+\frac{\left(\theta^{2}-4\alpha\beta c\theta\right)^{\frac{1}{2}}}{2\theta}\right)^{\frac{1}{2}}$ and $\gamma_2 = \left(\frac{1}{2}-\frac{\left(\theta^{2}-4\alpha\beta c\theta\right)^{\frac{1}{2}}}{2\theta}\right)^{\frac{1}{2}}$. The necessary condition to define the solutions as real numbers is that $c<\frac{\theta}{4\alpha\beta}$. We keep γ_2 because it is the lowest solution, in order to have less distortion.

Lemma 3 *For* $c<\frac{\theta}{4\alpha\beta}$, *The optimal progressive income tax is* $\tau^{*}=\left(\gamma^{*}\right)^{2}\left(1-\frac{e\theta_{L}}{e\theta}\right)$, *where* $\gamma^{*}=\left(\frac{1}{2}-\frac{\left(\theta^{2}-4\alpha\beta c\theta\right)^{\frac{1}{2}}}{2\theta}\right)^{\frac{1}{2}}$.

Figure 2 shows the equilibrium where the progressive income tax is levied. At a first glance, these results may justify the introduction of income progressive taxation on efficiency grounds, with no appeal to equity or redistributive reasons. Most interesting, through this result we can study the effects of income tax progression γ on the educational incentives. This is shown by the following proposition.

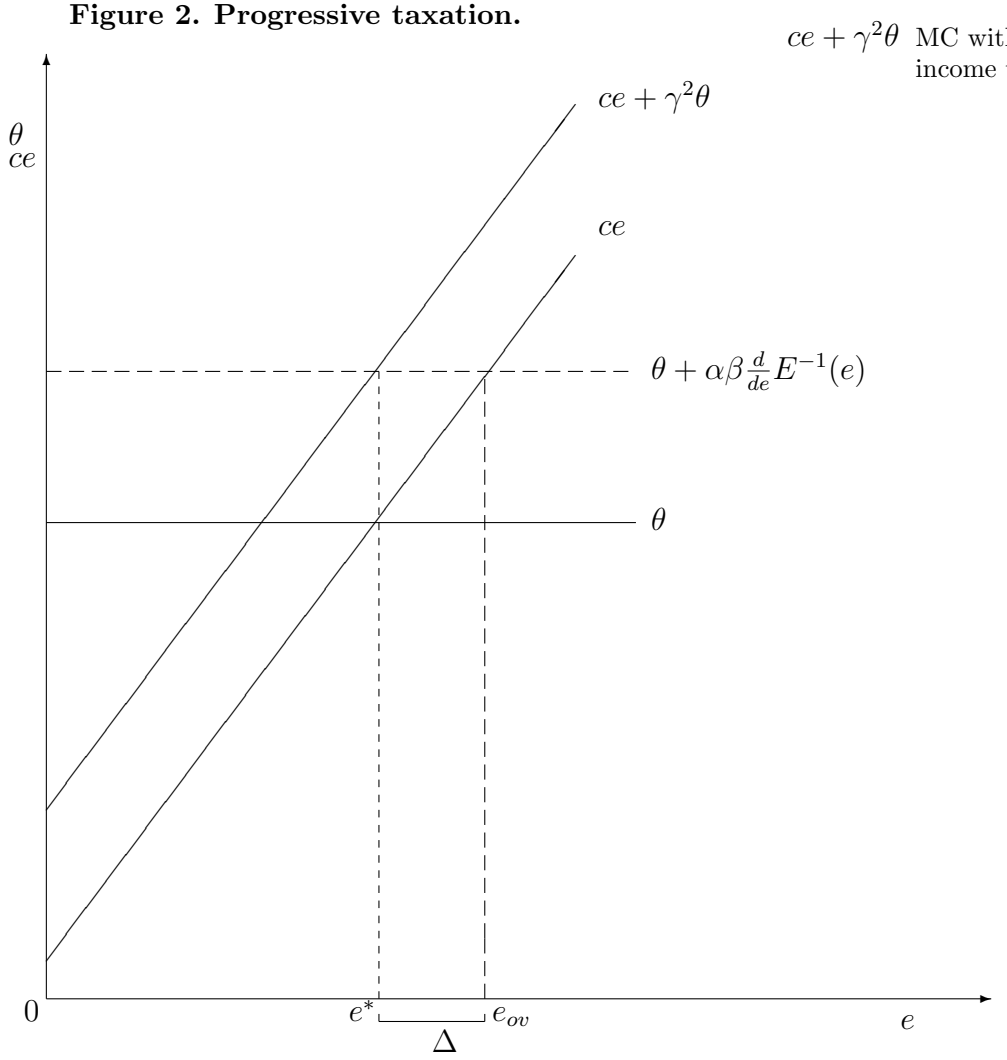
Proposition 1 *For individuals with ability higher than* $\frac{\alpha\beta c}{(\gamma^{2}-1)^{2}}$, *a more progressive income taxation makes the incentive to acquire education diminish. For individuals with ability lower or equal to* $\frac{\alpha\beta c}{(\gamma^{2}-1)^{2}}$, *a more progressive income taxation makes the incentive to acquire education increase.*

Proof. Differentiation of e^{τ} with respect to γ yields $\frac{\partial e^{\tau}}{\partial\gamma}=2\alpha\beta\frac{\gamma}{(\gamma^{2}-1)^{2}}-\frac{2}{c}\theta\gamma$. This is positive if $\theta<\frac{\alpha\beta c}{(\gamma^{2}-1)^{2}}$ and negative otherwise. ■

An increase in tax progression has ambiguous effects on the incentives of acquiring education, according to the individual's ability. As tax progression increases, individuals with higher ability have less incentives in acquiring education while individuals with lower ability have more incentives.

The reason is the following. An increase in progressive taxation lowers the incentive in acquiring education for the purpose of increasing income, but gives more incentive in acquiring education to improve the partner's quality.

Figure 2. Progressive taxation.



This second effect occurs since tax progression makes every individual have a relative advantage in acquiring education for improving the partner's quality compared to other individuals with higher ability. In other words, given the fact that the benefit obtained by the partner is the same for every individual (since it does not depend on the ability), to acquire education for improving this benefit is less costly the lower the individual's ability because taxation increases with ability.

The first effect is stronger the higher the individual's ability, while the

second effect is identical for each individual. Consequently, when ability is high, the first effect more than offsets the second effect, and vice versa when ability is low.

This result can be compared with Lommerud (1989), where over-education is caused by social status (represented by the relative income). In Lommerud, progressive income taxation corrects over-education but blunts the incentive to undertake education irrespective of the ability level.

5 Empirical analysis

In this section we test the implications of the theoretical model by examining empirically whether assortative matching may cause over-education.

5.1 Data

The dataset used in our analysis is the British Household Panel Survey (BHPS). This is a nationally representative random sample survey of households in Britain, which started in 1991. The BHPS was designed as an annual survey of each adult (16+) member of a sample of more than 5,000 households, making a total of approximately 10,000 individual interviews. The same individuals are interviewed in successive waves and, if they leave their original households, all adult members of their new households will also be interviewed.

Within the BHPS there is no information about the relationship between the level of education of colleagues. This does not allow us to consider assortative matching at work. Thus our empirical analysis focuses on assortative matching between couples.

We study a sample for years 1991-2006, including 20784 couples (41568 individuals) of men and women aged[13] between 21 and 65 years who pro-

[13]We do not take into account individuals aged below 21 because, according to the British university system, they might not have had the opportunity to complete their

vided complete information at the interview dates, who are married or in a relationship and live in the same household[14].

5.2 Dependent variable: over-education

An individual is over-educated if his or her educational qualification exceeds the required qualification in her occupation.

Empirical work has relied on four approaches of measuring over-education. In one approach, education is compared to the self-assessed qualification required to perform one's job (Duncan and Hoffman, 1981, Hartog and Tsang, 1987, Sicherman, 1991, Alba-Ramirez, 1993, Green *et al.*, 2000). Another way is to calculate the distribution of education for each occupation; employees who exceed the mean, median or mode by more than some *ad hoc* value (generally one standard deviation) are classified as over-educated (Vedugo and Verdugo, 1989, Groot and Massen van den Brink, 1995, Lindley and McIntosh, 2009). A third strategy is to consider a measure of over-education based on whether the graduate is satisfied with the match between her education and her occupation. Graduates in a sub-graduate occupation who are satisfied are defined as "apparently" over-educated, whereas those who are dissatisfied are called genuinely over-educated (Chevalier, 2000). In a fourth approach, the educational requirement is a systematic evaluation who specifies the required level of education for any occupational qualification based on the the American classification "Dictionary of Titles" (Thurow and Lucas, 1972, Hatrog, 1980, Rumberger, 1987, Kiker and Santos, 1991, Oosterbeek and Webbink, 1996).

All these strategies are not fully satisfying in our analysis, for a variety of reasons. The BHPS does not have any worker self-assessment about the education required for the job. Moreover, such a definition of over-education

higher education.

[14]In order to build up a sample of only couples, we keep individuals who live with the partner. In the case that the partner is not participating to the interview, the observation is dropped.

relies on employees accurately reporting the skills required for their job. Also and more importantly, this measure is based on the ability of an employee to match a specific level of skills with a qualification level. Finally, employees might report the current hiring standards, which in the presence of qualification inflation or grade drift will bias the over-education measure upward. The distribution of education in each occupation does not seem a good measure, since it is based on the observed distribution of education for a given occupation, it is sensitive to cohort effects, especially in the case of a rapid change in the educational level required to perform in a given occupation. The definition of over-education based on the subjective individual's job satisfaction excludes objectivity to the measure.

Occupations in the BHPS are not classified with a Dictionary of Titles, however jobs are sorted through the Standard Occupational Classification (SOC). By considering it, it seems consistent to evaluate in a clear way which educational qualification is required by any job. In particular, all the professions between 100 and 299 are managerial, professional (sollicitors, chartered accountants, engineers...) or academic jobs (physicists, psychologists,...). It is straightforward to think that to do these profession a university degree is required. Therefore we denote those as "graduate" jobs. All the occupations between 300 and 499 are technical or clerical jobs, that is occupations requiring a secondary school degree. We denote those activities as "non-graduate" jobs. Finally, all the occupations equal or above 500 are manual jobs that generally do not require any educational qualification. We refer to those as "non qualified" jobs.

We then rearrange educational qualifications with the same measurement scale and examining when a match occurs. We refer to every academic qualification as "graduate" , to the CSE, GCE, GCSE, A level[15] and every Scottish

[15]The "Certificate of Secondary Education"and the "General Certificate of Education"are secondary education degrees replaced in the late 1980s by the GCSE in England, Wales and Northern Ireland. The "General Certificate of Secondary Education"is the educational qualification for students aged 14-16 in England,Wales and Northern Ireland.

equivalent[16] as "non-graduate" . Finally, we refer to apprentice qualification or no qualification whatsoever as "non-qualified" .

Over-education occurs when an individual has a graduate qualification and a non-graduate/non-qualified job, or a non-graduate qualification and a non-qualified job.

5.3 Explanatory variables

The key explanatory variable is assortative matching. We proxy assortative matching through the positive relationship in the partners' education. In particular, we consider the rearrangement of the educational classification as "graduate", "non-graduate"and "non qualified" already adopted to identify over-education. Hence, in our identification assortative matching occurs when two partners' have the same level of education according to this scale.

The control variables are sex, age, age squared, regions, years of work, job satisfaction by type of work and number of workers in the firm. The variable sex takes values of zero for men and one for women.

As for regions we consider five macro areas: Northern England, Middle England, Southern England, Scotland and Wales. We exclude from the analysis individuals from Northern Ireland, for the strong segregation in marriages between Catholics and between Protestants in this area (Jerkins, 1997), which may cause distortions in the analysis of assortative matching.

The years of work represent the work experience of an individual, and measure whether over-education can be a long run phenomenon, as might be in the case that an experienced worker is also over-educated.

The "Advanced Level General Certificate of Education"is the educational qualification for students aged 16-18 and is the standard entry qualification for assessing the suitability for applicants for academic courses in English, Welsh and Northern Irish universities.

[16]In terms of educational system, the UK Government is responsible for England, and the Scottish Government, the Welsh Assembly Government and the Northern Ireland Executive are responsible for Scotland, Wales and Northern Ireland, respectively. While the systems in England, Wales and Northern Ireland are more similar, the Scottish system is quite different.

The BHPS asks to rate the satisfaction by "job type". The worker gives a number from 1 to 7, where 1 corresponds to "not satisfied at all" and 7 is "completely satisfied". Finally, the variable "number of workers" can take the value 1 if in the firm there are less than 100 employees, 2 if there are from 100 to 999 employees and 3 if there are 1000 or more employees.

We could have included more control variables[17]. Nonetheless, this would have greatly reduced the number of observations. Another drawback in our identification strategy is given to the lack of information in the BHPS on individuals' ability. Finally, the BHPS does not give information on whether partners meet at or attended the same school. These limitations do not offset the great advantages in using the BHPS for our analysis, given by the large number of observations, and by the partner's information which allow us to control for assortative matching.

5.4 Descriptive analysis

Table 1 shows the descriptive statistics of men and women.

The mean of over-education is 0.561 for men and 0.516 for women. Assortative matching occurs for the 53% of couples of our sample. The average age is around 40 years for men and 38 for women.

The majority of couples (about 31%) are from Southern England and the minority are from Wales (about 11%). Job satisfaction is slightly higher for women (5.537 out of 7) than for men (5.381). Men have on average more than five years of work experience while women have more than four years. Finally, the average number of employees in a firm is less than 100.

[17]Lindley and McIntosh (2009) use the BHPS and, unlike our approach, they include also single individuals, which allows them to use more control variables and keep a higher number of observations. In particular, they consider the presence of children in the household, whether the spouse is employed, if the individual is a union member, if his or her job is permanent or part-time, the promotion prospects, if the individual had a training period in the last year, the commute time and the reason for moving.

Table 1. Descriptive analysis.

Variable	Men				Women			
	Mean	Std Dev	Min	Max	Mean	Std Dev	Min	Max
Over-education (No=0; Yes=1)	0.561	0.496	0	1	0.516	0.499	0	1
Assortative matching (No=0; Yes=1)	0.536	0.498	0	1	0.536	0.498	0	1
Age	40.554	9.983	21	65	38.845	9.844	21	65
Regions								
Wales	0.113	0.316	0	1	-	-	-	-
Scotland	0.162	0.368	0	1	-	-	-	-
Southern England	0.315	0.464	0	1	-	-	-	-
Middle England	0.151	0.358	0	1	-	-	-	-
Northern England	0.248	0.431	0	1	-	-	-	-
Job information								
Satisfaction by job type (Not at all=1; Complete=7)	5.381	1.342	1	7	5.537	1.302	1	7
Years of work	5.522	6.548	0	50	4.555	5.200	0	37
Number at workplace (1-99=1; 100-999=2; 1000 or more=3)	1.572	0.678	1	3	1.481	0.677	1	3
Observations	**20400**				**20400**			

5.5 Empirical Model

Following the existing literature on mismatch between education and job, we estimate the following equation:

$$O_{it} = \beta \mathbf{x}_{it} + \gamma assortative_{it} + \varepsilon_{it},$$

where the discrete variable O_{it} measures the presence of over-education, the vector $\mathbf{x}_{it}$ contains the control variables for individual i at time t. The variable $assortative_{it}$ identifies assortative matching for individual i at time t.

What we expect is that over-education increases with assortative matching.

We compare the random with the fixed effects logit[18] model by performing a Hausman test. We develop the analysis separately for men and women, in order to control for differences by gender.

5.6 Empirical results

Table 2 shows the empirical results. The Hausman test tells us that the fixed effects is the most appropriate model for our analysis. Thus in this paragraph we will discuss those results only. This comes at a cost, since the fixed effects model drops all the observations with no variation along the years. As a consequence, the number of men and women is asymmetric and much lower than the original sample considered.

The coefficient on age is negative for both groups at an increasing rate. This can be interpreted in different ways. First, over-education falls as job experience increases. Second, over-education is a recent issue and it did not involve older generations. Our results below on the positive correlation between over-education and job experience suggest that the second interpretation fits better with our results.

Regions are generally not significant in explaining over-education. Exceptions are a positive correlation between Scotland and male over-education and between Midlands and female over-education. As expected, job satisfaction by work type looks to be negatively correlated to over-education, although it is not significant.

[18]Note that it is not possible to perform a fixed-effects probit model. Indeed, there does not exist a sufficient statistic allowing the fixed effects to be conditioned out of the likelihood. Possible alternatives, such as the unconditional fixed-effects probit models, are biased. Lindley and McIntosh (2009) consider a vector of individual-level mean variables for all the socio-economics characteristics contained in their control variables to proxy the fixed effects contained in the error term.

Table 2. Over-education.

Variable	RE				FE			
	Men		**Women**		**Men**		**Women**	
Age	- 0.241	***	- 0.101	***	- 0.278	***	- 0.119	***
	(0.031)		(0.032)		(0.036)		(0.037)	
Age squared	0.002	***	0.001	***	0.003	***	0.002	***
	(0.000)		(0.000)		(0.000)		(0.000)	
Regions (dummy variable omitted: Southern England)								
Wales	0.497	**	0.974	***	- 0.426		0.635	
	(0.214)		(0.242)		(0.407)		(0.571)	
Scotland	0.467	**	0.702	***	1.243	***	- 0.400	
	(0.196)		(0.215)		(0.452)		(0.483)	
Middle England	0.233		0.819	***	0.033		0.842	**
	(0.197)		(0.207)		(0.317)		(0.321)	
Northern England	0.043		0.370	**	0.066		0.347	
	(0.172)		(0.183)		(0.286)		(0.298)	
Job Information								
Satisfaction by job type	- 0.052	**	- 0.050	**	- 0.025		- 0.024	
(Not at all=1; Complete=7)	(0.023)		(0.023)		(0.024)		(0.024)	
Years of work	0.015	**	- 0.031	***	0.020	***	- 0.008	
	(0.006)		(0.007)		(0.007)		(0.008)	
Number at workplace	- 0.011		- 0.089		0.065		- 0.136	**
(1-99=1; 100-999=2; more=3)	(0.052)		(0.054)		(0.056)		(0.058)	
Assortative matching	0.127		0.260	***	0.274	***	0.248	***
(No=0; Yes=1)	(0.084)		(0.083)		(0.093)		(0.088)	
Log likelihood	- 8840.7775		- 8878.5679		- 3265.3057		- 3125.76	
LR chi2	-		-		94.25		253.90	
Wald chi2	169.87		68.94		-		-	
(Prob>chi2)	(0.000)		(0.000)		(0.000)		(0.000)	
Hausman	-		-		253.94	***	410.74	***
Observations	**20400**		**20400**		**8206**		**8181**	

Notes: the dependent variable is over-education.Values of standard errors are presented in parenthesis. Significance at the 1%, 5% and 10% levels is indicated by ***, ** and * respectively.

In contrast to other results in the same dataset (Lindley and McIntosh, 2009), we found a positive correlation between the likelihood of male over-

education and job experience[19]. According to this, over-education may not be a temporary phenomenon whilst individuals acquire the necessary experience to obtain a job commensurate with their qualification. However, this correlation is negative for women, although not significant. The number of employees seems negatively related to female over-education.

Finally, over-education appears to be positively correlated to assortative matching. This is strongly significant both for men and women. Thus the empirical results might confirm that assortative matching may cause over-education.

6 Concluding remarks

In the presence of assortative matching, individuals increase their education to improve the quality of colleagues or spouses. But as everyone is more educated, the extra education acquired does not improve the chance of a good match. Hence over-education emerges, since individuals can obtain the same result in terms of optimal choice but exploiting less educational resources. We test the model using the British Household Panel Survey for years 1991-2006. Our empirical results support the theoretical finding that assortative matching may cause over-education.

An interesting extension of the paper may be to consider assortative matching in terms of social class. Although educational and social class assortative matching are positively correlated, individuals with different social backgrounds may acquire the same level of education. Introducing assortative matching by social class may have different effects according to the social group we regard. On the one hand, the opportunity cost to acquire more education is generally higher for advantaged individuals since, for instance, they may have better job opportunities through the parental network. On the other hand, this can strengthen the effect on over-education for dis-

[19]The difference in our results lies in the different approach in measuring over-education.

advantaged people, as assortative matching by class is a further barrier in the attempt to improve the matching through education. The introduction of assortative matching by social class is left for future work.

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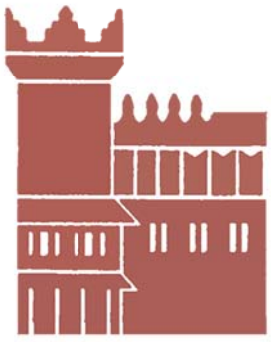

Alma Mater Studiorum - Università di Bologna
DEPARTMENT OF ECONOMICS

Strada Maggiore 45
40125 Bologna - Italy
Tel. +39 051 2092604
Fax +39 051 2092664
http://www.dse.unibo.it