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A PECKING ORDER ANALYSIS OF GRADUATE OVEREDUCATION AND EDUCATIONAL INVESTMENT IN CHINA+

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ABSTRACT

Against the background of the recent rate of expansion of China's higher education system that has outstripped even China's own high rate of economic growth, the paper examines evidence of the emerging problem of graduate overeducation within China. Based upon a pecking-order model of employment offers and associated ordered probit model, it analyses the empirical factors which determine the incidence of graduate overeducation across China. The extent to which individual students have an incentive to become overeducated compared to a socially optimal level of their education is also examined in the context of a supporting economic model that compares individual and socially optimal levels of investment in education, in the face of labour market demands. The extent of the divergence between individual and socially optimal levels of investment in education, and of the associated levels of graduate overeducation, is found to depend upon how recent major increases in the supply of graduates within China will interact with the future growth rates in job specifications, in demand variables and in resultant graduate wages within China.

KEYWORDS: Graduate overeducation, higher education policy, optimal educational investment, economic growth in China.

1. Introduction

In this paper, we present evidence of an emerging problem of overeducation in China's graduate population, and of the factors which determine the incidence of overeducation. The importance of China as a major player in world markets, and a dominant emergent economy of the twenty-first century, is now widely acknowledged. However, while China has indeed experienced an impressive rate of economic growth, this has been outstripped in several recent years by the expansion rate of its higher education system, as we illustrate in Table 1 below. Given the magnitude of China's current production of graduates, of some 3.1 million per annum in 2005, the extent of its current overeducation problem is clearly important from the viewpoint of the economics of the graduate labour market within China itself.

Table 1: The growth rates of higher education and GDP in China

Year	Total Number of Under-Graduates (thousands)	Total Number of Post-Graduates (thousands)	New entrants of Under-Graduates (thousands)	New entrants of Post-Graduates (thousands)	Growth Rate of Total New Entrants (per cent)	Growth Rate of GDP in constant prices (per cent)
1990	1970	93	579	30	-8.8*	-8.9
1995	1956	145	875	51	11.5*	14.4
1996	2858	163	907	59	4.3	7.2
1997	2998	176	1064	64	3.5	6.7
1998	3211	199	1011	73	8.4	6.1
1999	3901	234	1505	92	47.3	6.2
2000	5260	301	2078	128	38.1	8.6
2001	6797	393	2518	165	21.6	8.0
2002	8533	501	3002	203	19.5	9.0
2003	10435	651	3553	269	19.3	10.2
2004	13335	820	4473	326	16.7	12.4
2005	15618	979	5044	365	12.7	14.5
2006	17388	1105	5460	398	8.3	14.7

Sources: Ministry of Education and Ministry of Labor and Social Security, China (1998-2006)
* average growth rate over 5 years.

With the increasingly international nature of the higher education market for students, the magnitude of China's overeducation problem may also, however, have important consequences for the economics of the higher education systems of other major economies. Table 2 shows the growth in recent years in the numbers of students from China studying abroad. Whilst this has been substantial in the US, it has been even greater in percentage terms in the UK, Canada and Australia. Since students from China typically pay overseas tuition fees which are several times higher than those paid by UK (and EU) students, they have also become an important source of income for UK universities, where in 2005-6 they accounted for 16.8 per cent of all overseas students, compared to 11.1 per cent of overseas students studying at higher education institutions in the US.

Table 2: The number of students from China studying abroad

Year	US	Canada	Australia	UK
1998-99	51001	1791	3220	4445
1999-2000	54466	3837	4291	7160
2000-01	59939	6055	5679	12095
2001-02	63211	13435	9079	20710
2002-03	64757	11159	22154	35160
2003-04	61765	9822	30086	47735
2004-05	62523	10032	30203	52675
2005-06	62582	N/A	37441	55504

Sources: US National Centre for Education Statistics, and Institute of International Education, Statistics Canada, Australian Department of Education, Science and Training, UK Higher Education Statistics Agency.

As a labour-intensive service industry with a growing export component, higher education within the UK and other developed economies offers many attractions as a target for expansion and a means of economic adjustment to the decline in their manufacturing sectors in recent decades. The rise of China's own economy and the liberalisation of international trade are themselves indeed helping to accelerate the decline in their manufacturing sectors. Overeducation amongst China's own graduate population, however, poses a potential threat to the level of international student demand from China, if students from China risk being unable to recoup their associated investment in human capital through securing graduate-level employment on their return to China.

2. Pecking Order Analysis

In view of the substantial changes which are occurring in both the higher education sector and the wider economy and employment market in China, we need a framework of analysis that can take on board changes in the rate of graduate overeducation in response to changes in the demand for, and supply of, graduates over time. Human capital theory, as developed by Becker (1993) and Mincer (1974), however, concentrates on the supply side of the labour market, with wages determined by the assumption that a constant rate of return on investment in years of education will be earned with certainty. We therefore examine an alternative *pecking order* theory for the incidence of overeducation. The pecking order theory we analyse below specifically addresses the assignment problem discussed by Sattinger (1993) and enables considerations of the determinants of the demand for different levels of labour skills to be incorporated within the analysis.

Within this framework, the demand for graduates is a derived demand. It is derived from the demand by employers for individuals whose skills and other characteristics can complement the specifications of the jobs they are seeking to fill. Each job $j \in \Omega_t$ within the set Ω_t of all available jobs at time t is assumed to have a list of job specifications at time t given by the vector $Z_{jt}=(Z_{j1t},....,Z_{jmt})$, which specifies the work which the job entails. How well that job is carried out depends upon the skills and other characteristics of the individual who occupies the post associated with the job. Each individual i is assumed to possess a vector of characteristics $X_{it}=(X_{i1t},....,X_{int})$ at time t that includes n-1 objective characteristics, such as their educational qualifications or functions of them, as its first n - 1 elements. Its last element is a stochastic term $X_{int} \equiv u_{it}$ that reflects other less objective characteristics of the individual, such as their enthusiasm, which the employer can assess by less formal means, such as interviews, and which also contribute to the individual's ability to make an enhanced contribution.

The value of the output from the job will depend also upon the demand in the product market for the output of goods or services which the job produces. The main drivers of the level of demand at time t for such output across all jobs for whom graduates may be candidates include economy-wide factors $Y_t=(Y_{t1},....,Y_{ts})$, such as the country's level of GDP, its growth rate, its foreign exchange rates with its major trading partners, and its rate of population growth.

More specifically, we will assume that if individual i occupies job j at time t the value of their output is given by the Cobb-Douglas function:

$$V_{ijt} = \omega_t \gamma_j \prod_{\tau=1}^{s} Y_{\tau t}^{\alpha_\tau} \prod_{h=1}^{n} X_{iht}^{a_h} \prod_{k=1}^{m} Z_{jkt}^{b_k} \tag{2.1}$$

where the α_τ, a_h and b_k are positive constants, with $a_n=1$, and the ω_t and γ_j are positive stochastic terms that vary across each t and j respectively according to independent standardised lognormal distributions. In addition, we will assume that each employer faces a wage function of the form:

$$w_{it} = w_{it}(X_{i1t},....,X_{int}) \tag{2.2}$$

that specifies the wage that must be paid at time t to recruit individual i with characteristics $X_{it}=(X_{i1t},....,X_{int})$. The employer for job j is assumed to select the individual i who will occupy the post according to the individual's characteristics X_{it} in order to maximise the net value V_{ijt} - w_{it} to the employer of having such an individual perform job j. Since for each $j \in \Omega_t$, the individual characteristics X_{iht} influence V_{ijt} in (2.1) via the index

$$C_{it} \equiv \prod_{h=1}^{n} X_{iht}^{a_h} \quad with \;\; \partial V_{ijt} / \partial C_{it} > 0 \qquad (2.3)$$

employers will evaluate each individual according to their overall value of C_{it}, and are willing to offer a higher wage to individuals whose overall value of C_{it} is greater. For each small increase in C_{it}, the employer for job j would be willing to pay an additional wage premium up to an amount equal to $\partial V_{ijt} / \partial C_{it}$. In a competitive labour market, the wage w_{it} will be bid up to be an increasing function of C_{it}, with

$$(\partial w_{it} / \partial C_{it}) = (\partial V_{ijt} / \partial C_{it}) = v_t J_{jt} \;\; where \; v_t \equiv \; \omega_t \prod_{\tau=1}^{s} Y_{\tau t}^{\alpha_\tau}, \; J_{jt} \equiv \; \gamma_j \prod_{k=1}^{m} Z_{jkt}^{b_k} \qquad (2.4)$$

for the job j which individual i performs. Moreover, since $(\partial^2 V_{ijt} / \partial C_{it} \partial J_{jt}) > 0$ employers with jobs whose specification level is higher according to the index J_{jt} will be willing to offer a greater additional premium to individuals who possess superior characteristics according to the index C_{it} than employers with jobs whose specification level is lower according to the index J_{jt}. In a competitive labour market, employers with jobs whose specification level is higher according to the index J_{jt} will succeed in recruiting individuals with superior characteristics according to the index C_{it}. The top z individuals according to the index of individual characteristics C_{it} are then recruited to the top z jobs according to the index J_{jt} of job specifications for all $0< z \leq \eta_t$, where η_t is the total number of jobs in the economy at time t. We will assume for simplicity that the total number of jobs, including those in subsistence agriculture, at each time t is equal to the number of individuals of working age, with all individuals assumed to have access to at least a subsistence job. We then have

$$\phi_t(C_{it}) = \varphi_t(J_{jt}(C_{it}))\; for \; all \; C_{it} > 0 \;\; and \; hence \; J_{jt}(C_{it}) = \varphi_t^{-1}\phi_t(C_{it}) \qquad (2.5)$$

where $J_{jt}(C_{it})$ is the level of specification for the job to which an individual with a level of characteristics C_{it} is recruited, ϕ_t is the distribution function at time t for C_{it} across the population of individuals of working age, and φ_t is the distribution function at time t for J_{jt} across jobs in the economy. We will assume that ϕ_t and φ_t are both cumulative lognormal distribution functions, so that (2.5) implies:

$$J_{jt}(C_{it}) = C_{it}^{\sigma_{Jt}/\sigma_{Ct}} A_t \ \ where\ A_t \equiv \exp(\theta_{Jt} - \theta_{Ct}(\sigma_{Jt}/\sigma_{Ct})) \qquad (2.6)$$

where θ_{Jt} and θ_{Ct} are the mean values of ln J_{jt} and ln C_{it}, and σ_{Jt} and σ_{Ct} are their respective standard deviations, at time t.

(2.3), (2.4) and (2.6) imply a wage function of the form:

$$w_{it}(X_{it}) = B_t \prod_{h=1}^{n} X_{iht}^{\beta_{ht}} + \zeta \ \ where\ \beta_{ht} \equiv a_h \varpi_t,\ \varpi_t \equiv 1 + (\sigma_{Jt}/\sigma_{Ct}), B_t \equiv v_t A_t / \varpi_t \qquad (2.7)$$

where ζ is a constant of integration, which equals zero if the reservation wage given by the employment benefit rate is zero and jobs in agriculture offering a subsistence wage are available to all (see Sattinger, 1993). With unemployment benefits in China less than one per cent of the wage level of many new graduates, we will assume that these conditions hold, and hence set $\zeta = 0$. Equations (2.1), (2.3), (2.4), (2.6) and (2.7) then imply:

$$V_{ijt} = v_t A_t C_{it}^{\varpi_t} \ \ \&\ \ V_{ijt} - w_{it} = \sigma_{J_t} v_t A_t C_{it}^{\varpi_t} /(\sigma_{C_t} + \sigma_{J_t}) > 0 \ \ for\ all\ C_{it} > 0 \qquad (2.8)$$

so that wage levels still enable employers to make a net surplus from the jobs they offer.

In a pecking order model, individual characteristics $X_{it}=(X_{i1t},....,X_{int})$ play an important part in wage determination, as in equation (2.7). However, so too do the parameters, θ_{Jt} and σ_{Jt}, of the distribution of job characteristics, alongside the parameters, θ_{Ct} and σ_{Ct}, of the overall distribution of individual characteristics in the population at large, as in equations (2.6) and (2.7). Pecking order theory here differs from Thurow (1975)'s job competition model where wages are only "based on the characteristics of the job in question" (op. cit p. 76) and "not directly on ... personal characteristics" (ibid, p. 77). In Thurow's model, marginal productivity is taken as a fixed characteristic of the job, but wages do not necessarily equal marginal productivity, with Hartog and Oosterbeek (1988) concluding that in Thurow's model "in fact, it is not at all clear how exactly earnings are determined".

In pecking order theory, wages are those which induce those workers highest in the pecking order of desirable characteristics into the jobs whose specifications will ensure that these individual characteristics result in the highest value of output across the range of available jobs. While the parameters of the distributions of job specifications and individual characteristics both enter into the wage equation (2.7), they remain constant across the same labour market at any given point in time. The parameters of the distributions of job specifications and individual characteristics therefore do not appear explicitly as variables in the associated cross-section wage equation for a given labour market. However, they remain of considerable potential importance in examining the impact on wages of changes in these underlying parameters over time.

Pecking order theory also has an important role to play in the analysis of the incidence of overeducation and undereducation across different individuals. In analysing the incidence of overeducation and undereducation of graduates with different levels of degree qualifications, we will assume that jobs can be categorised into one of five levels. Level $\ell = 4$ corresponds to those requiring PhD-level skills, $\ell = 3$ to those requiring Masters-level skills, $\ell = 2$ to those requiring undergraduate degree-level skills, $\ell = 1$ to those requiring college-level skills, and $\ell = 0$ to those requiring none of these skills. Higher level jobs at time t will be assumed to involve higher levels of specification according to the index J_{jt}. $J_t^{o\ell}$ will denote the minimum level of the job specifications index J_{jt} for which skills of level ℓ >0 are required, and below which only a lower level of skills is required.

Since from (2.4), (2.5) and (2.7) for any job j for which individual i is selected:

$$(dC_{it} / dJ_{jt}) = (\partial^2 V_{ijt} / \partial C_{it} \partial J_{jt}) / (\partial^2 w_{it} / \partial C_{it}^2) > 0 \tag{2.8}$$

a pecking-order process will apply to the selection of individuals according to their overall quality given by the linear function:

$$q_{it} = \ln C_{it} = x_{it}\, a + \varepsilon_{it} \tag{2.9}$$

where $x_{it} \equiv (x_{i1t},....,x_{in-1t}) \equiv (\ln X_{i1t},....,\ln X_{in-1t})$, $a \equiv (a_1,...,a_{n-1})$, $\varepsilon_{it} \equiv \ln u_{it}$.. Individuals with a higher quality according to their q_{it} rating in the pecking order of individuals in the population will attain a higher value to their C_{it} index of individual characteristics that enhance their employability, and hence secure a higher specification job according to the index J_{jt} in (2.8). In particular, in order to secure a job of level $\ell > 0$ or above, individual i must have a quality level

$$q_{it} > q_t^{o\ell} \equiv (\sigma_{Ct} / \sigma_{Jt})(\ln J_t^{o\ell} - \theta_{Jt}) + \theta_{Ct} \tag{2.10}$$

Employers thus set a 'hurdle' level $q_t^{o\ell}$ at time t for the minimum quality q_{it} of individual i to whom an offer is made of a level $\ell > 0$ job. This hurdle level, moreover, depends upon the parameters of the distribution of job specifications in the economy and the distribution of individual characteristics in the population, both of which may change over time with growth in the economy at large and changes in the supply of graduates.

We will assume that ln μ_{it} , and hence ε_{it} , is a stochastic variable that is normally distributed with a mean of zero and a standard deviation of one across the population, independently of x_{it}. The probability of any individual i with objective characteristics given by x_{it} being offered employment at time t at level $\ell > 0$ or above is then given by:

$$\begin{aligned} p_{\ell t}(x_{it}) &\equiv \Pr(q_{it} > q_t^{o\ell} \,|\, x_{it}) = \Pr(x_{it}a + \varepsilon_{it} > q_t^{o\ell}) \\ &= 1 - \Pr(\varepsilon_{it} \leq -x_{it}a + q_t^{o\ell}) = 1 - N(-x_{it}a + q_t^{o\ell}) = N(x_{it}a - q_t^{o\ell}) \end{aligned} \tag{2.11}$$

where N is the cumulative standardised normal distribution function. Using (2.11), we can estimate the coefficient vector a and the intercept term $q_t^{o\ell}$ using an ordered probit analysis, as in Table 5 below.

From (2.5), (2.6) and (2.9), the total supply of individuals who satisfy a minimum level of quality of q_t is given by:

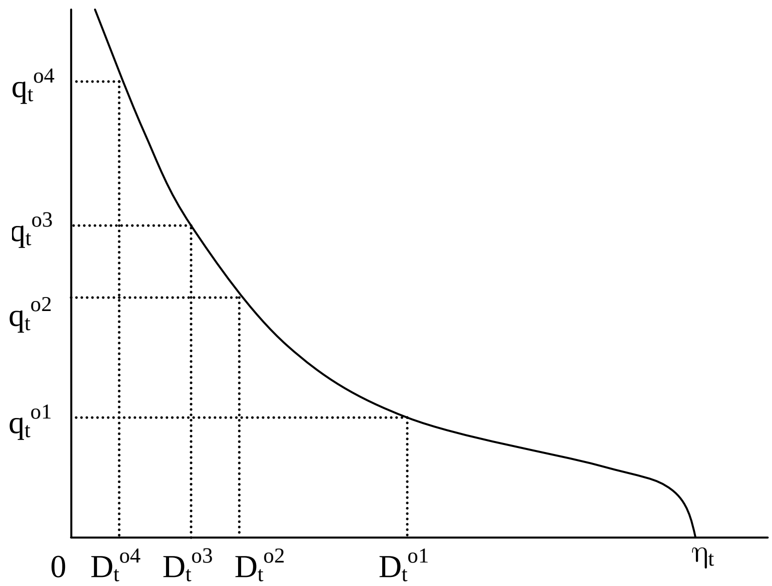
$$S_t(q_t) = \eta_t(1 - N((q_t - \theta_{Ct}) / \sigma_{Ct})) \;\; with\; \partial S_t / \partial q_t < 0 \tag{2.12}$$

From (2.5), the total demand, $D_t^{o\ell}$, by employers at time t for individuals to fill jobs of level $\ell > 0$ or above is given by:

$$D_{\ell t} = \eta_t(1 - \varphi_t(J_t^{o\ell})) \tag{2.13}$$

The minimum quality hurdle $q_t^{o\ell}$ that employers set at each time t for making a job offer of level ℓ in (2.10) is set to equate the supply, $S_t(q_t^{o\ell})$, of individuals with at least the quality level $q_t^{o\ell}$ to the demand, $D_{\ell t}$, by employers for individuals to fill jobs of level $\ell > 0$ or above.

Figure 1: The minimum quality hurdles and the demand for graduates



In Figure 1, the minimum quality hurdle $q_t^{o\ell}$ for an individual to be offered a job at level $\ell > 0$ is thus determined as that value of q_t where $S_t(q_t^{o\ell})$ is equal to the demand $D_{\ell t}$, with a higher level of such demand from employers implying a lower quality hurdle $q_t^{o\ell}$ in order for the available supply of individuals to be sufficient to meet the demand . Such equality implies also that:

$$S''_{\ell t} \equiv S_t(q_t^{o\ell}) - S_t(q_t^{o\ell+1}) = D_{\ell t} - D_{\ell+1,t} \equiv D''_{\ell t} \text{ for } \ell = 1,2,3 \text{ and } S''_{4t} \equiv S_t(q_t^{o4}) = D_{4t} \equiv D''_{4t} \qquad (2.14)$$

i.e. an equality between the number of individuals, $S''_{\ell t}$, who are available within each quality range and the number of jobs, $D''_{\ell t}$, employers are seeking to fill at each level of employment.

Overeducation can arise in the above pecking order analysis from the possibility that an individual will have graduated with a qualification of level $\ell > 0$ (which we will denote by $\delta_{it\ell} = 1$) but still have an overall level of quality q_{it} that falls short of the minimum hurdle level, $q_t^{o\ell}$, for being offered a job of level ℓ . The associated probability of overeducation is given by:

$$p_{\ell t}^{o}(x_{it}^{\ell}) \equiv \Pr(q_{it} < q_t^{o\ell} \left| x_{it} \,\&\, \delta_{it\ell} = 1) = \Pr(x_{it}^{\ell} a + \varepsilon_{it} < q_t^{o\ell}) = N(q_t^{o\ell} - x_{it}^{\ell} a) \right. \qquad (2.15)$$

where x_{it}^{ℓ} is a vector of individual characteristics x_{it} that includes the individual having graduated with a qualification of level $\ell > 0$. Similarly undereducation can arise in the above pecking order analysis if an individual has an overall level of quality, q_{it}, that exceeds the minimum hurdle level, $q_t^{o\ell}$, for being offered a job of level ℓ, even though they have not graduated with a qualification of level $\ell > 0$ (which we will denote by $\delta_{it\ell} = 0$). The associated probability of undereducation is given by:

$$p_{\ell t}^{u}(x_{it}^{o\ell}) \equiv \Pr(q_{it} > q_t^{o\ell} \,|\, x_{it} \;\&\; \delta_{it\ell} = 0) = \Pr(x_{it}^{o\ell}a + \varepsilon_{it} > q_t^{o\ell}) = N(x_{it}^{o\ell}a - q_t^{o\ell}) \qquad (2.16)$$

where $x_{it}^{o\ell}$ is a vector of individual characteristics x_{it} that includes the individual having graduated without a qualification of level ℓ.

3. The Empirical Determinants of the Incidence of Overeducation and Undereducation

In this section, we analyse the empirical determinants of over- and undereducation across individuals, against the background of the above theoretical analysis. Our empirical analysis is based upon data from a survey that was carried out amongst 18722 graduating students, from 45 universities and colleges in seven provinces spread geographically across China, including 5 higher education institutions in Beijing, 6 in Shangdong, 6 in Guangdong, 6 in Hunan, 4 in Shannxi, 17 in Yunnan and 1 in Guangxi, under the supervision of the Research Centre for the Economics of Education at Peking University. Within the sample, 39.3 per cent of graduating students had graduated with college diploma qualifications, 57.1 per cent with bachelor degrees, 3.0 per cent with Masters degrees and 0.6 per cent with Doctorates. At the time that the survey took place, in June 2003, 40.7 per cent of respondents had found a job, 4.0 per cent individuals planned to be self-employed, 15.1 per cent planned to continue studying, 20.0 per cent had other plans and 20.2 per cent had not yet found a job. Since those who had found a job by the time that they were graduating may not have exactly the same characteristics to the population of graduates at large, we will correct for such selection bias in our analysis.

There are three main ways in which overeducation has been measured in the literature to date. The first depends on a systematic external evaluation by an expert job analyst who defines the education requirements of a particular type of job by reference to a standard manual, such as *U.S.*

Dictionary of Occupational Titles (e.g. Rumberger, 1987) or the ARBI code developed by the Dutch Department of Social Affairs (see Hartog and Oosterbeek, 1988). While this approach seeks to be objective, occupational titles may span different detailed job requirements that can change with technology and economic growth. A second external method is the statistical method developed by Verdugo and Verdugo (1989) who define overeducation as existing if an individual has an education level more than one standard deviation above the mean education level for their occupation. However, the mean educational level of those in the occupation will itself depend upon the supply of graduates over time, so that the benchmark for defining overeducation in a particular job is itself endogenous to this process. The third approach, which we deploy here, and which has been widely used elsewhere is that of self-assessment. This method can take account of heterogeneity of individuals and skills needed for each job at the time of the self-assessment. In the survey questionnaire used in our study, students who had found a job were asked: "What is your current qualification?" (with four possible choices from college diploma to university doctorate) and "What is the minimum formal qualification required in your contracted job?" (with six possible choices from a junior school education to a PhD). Matching the two groups of answers resulted in the distribution for implied rates of over- and undereducation shown in Table 3.

Table 3: The incidence of over- and undereducation across educational levels and subjects

Education Level / Subject	Males & Females		Males & Females		Males		Females	
	Per Cent Under-educated	Per Cent Over-educated	Per Cent Male	Per Cent Female	Per Cent Under-educated	Per Cent Over-educated	Per Cent Under-educated	Per Cent Over-educated
Diploma	41.1	12.9	52.7	47.3	41.4	13.5	40.8	12.3
Bachelor	12.4	21.1	65.4	34.6	13.3	21.9	10.7	19.7
Master	7.3	35.8	59.1	41.0	6.4	36.9	8.5	34.1
PhD	0.0	42.0	73.9	26.1	0.0	41.1	0.0	44.4
Total	17.4	20.5	62.8	37.2	17.2	21.5	17.7	18.8
Economics	18.9	22.2	56.4	43.6	18.3	20.6	19.7	24.3
Law	22.0	19.6	49.8	49.8	11.0	6.6	6.2	8.2
Art	18.6	17.1	40.9	59.0	16.9	22.0	19.8	13.7
Medicine	17.2	17.2	44.8	55.1	17.0	12.3	17.4	21.2
Science	12.2	18.3	59.1	41.0	14.4	21.7	9.0	13.4
Engineering	16.8	18.5	78.0	22.1	16.8	19.1	16.7	16.7
Agriculture	8.3	28.1	73.0	26.9	10.0	30.0	3.7	23.0

Table 3 shows that overall 20.5 per cent of graduates across China who had jobs reported themselves as being overeducated. This is a higher than the 12 per cent rate of overeducation found by Bauer (2002) in Germany and the 17 per cent rate found in Holland by Hartog and Oosterbeek (1988) and by Alba-Ramirez (1993) in Spain. However, it is considerably lower than the 42 per cent rate found in the UK by Battu *et al* (1999), the 30-38 percentage rate found in another study in the UK by Dolton and Vignoles (2000), the 30 per cent rate found in Canada by Frenette (2004), and the rates of 42 per cent and 41 per cent in the US found by Duncan and Hoffman (1981) and Sicherman (1991) respectively, with all of these studies using the self-reporting method. The percentage in China, however, varies in Table 3 from 12.9 per cent in the case of college graduates to 42.0 per cent in the case of PhDs, with overeducation more frequent among those studying for higher degrees than among those studying for lower degrees. This is consistent with the findings of Groot (1996) in the UK, although differs from those of Frenette (2004) in Canada, where graduates with Master's degrees were the most likely to be overeducated, followed by college graduates.

The overall rate of overeducation for females in Table 3 in China is 18.8 per cent, rather less than the overall 21.5 percentage rate for males. The overall rates of undereducation in China for females and males were similar at 17.7 per cent and 17.2 per cent respectively. In comparison, Groot (1996) in the UK, and Duncan and Hoffman (1981) in the US, found the overall rates of both overeducation and undereducation to be less for females than males. Our findings across fields of study differ from those in developed countries, where there tends to be a high variation in overeducation rates across fields of study (see Frenette 2004). In China, the overeducated rate is similar across major subjects, with the exception of Agriculture, which has the highest overeducation rate and the lowest undereducation rate. Outside of Agriculture, Economics graduates have the highest overeducation rate and Law graduates the highest undereducation rate. The overall rate of undereducation was 17.4 per cent, and monotonically increased from 0.0 per cent for PhDs up to 41.1 per cent for college Diploma graduates, with a similar trend for both males and females.

The survey also recorded information on each individual's personal characters, academic achievement and choice of geographical location and employment sector, that allows us to examine the factors which are statistically related to over-education and under-education. These variables are shown in Table 4 below.

Table 4: Definitions of variables

Variable	Description
Educational Qualification:	Base case is a 2-year college degree
Schooling	Total years spent in higher education in excess of 2 years for a college Diploma
Bachelor	Two additional years spent completing a Bachelor’s degree compared to the base case of 2 years for a college Diploma.
Masters	Three additional years spent completing a Master’s degree in addition to a Bachelor’s degree.
PhD	Three additional years spent completing a PhD degree in addition to a Master’s degree
Cadre	Position of responsibility held in university (1 = not a student representative, 2 = student representative at class level, 3 = student representative at Departmental or Institute level, 4 = student representative at University level)
Parentalcareer	1 = Father is a manager, officer or government official, 2 = Father is a professional technician or clerk, 3 = Father is a manual worker, retailer or a shop assistant, 4 = Father is unemployed, retired or a peasant
Parentalqualif	Parental Qualification (1 = Father's highest qualification is a Master’s degree or above, 2 = Father's highest qualification is a Bachelor’s degree, 3 = Father's highest qualification is as a college graduate, 4 = Father's highest qualification is as a senior school graduate, 5 = Father's highest qualification is as a junior school graduate, 6 = Father’s highest qualification is below junior school level)
Registration	1 = Registered as born in a large city, 2 = Registered as born in a small city, 3 = Registered as born in a small town, 4 = Registered as born in a village
Partymember	1 = Is a member of the Chinese Communist Party
English	1 = Has no English Language qualification, 2 = Has acquired the College English Test Level 4 qualification, 3 = Has acquired the College English Test Level 6 qualification

Degree Classification	1 = Degree is in the top quartile of marks, 2 = Degree is in the second quartile of marks from the top, 3 = Degree is in the third quartile of marks from the top, 4 = Degree is in the lowest quartile of marks.
workplace	1= The job chosen is in a village, 2 = The job chosen is in a small town, 3 = The job chosen is in a small city, 4 = The job chosen is in a large city.
stateown	1 = The job chosen is in a State-Owned Enterprise
govern	1 = The job chosen is in a Government or related bureau
jointven	1 = The job chosen is in a Joint Venture Company
institute	1 = The job chosen is in an educational institute
workprovince	The rank from 1 to 31 of the province within China in which the job chosen is located in decreasing order of its GDP per capita, as an indicator of its current state of economic development
Job Level Thresholds:	
Level 1	The threshold score to secure a college-graduate level job.
Level 2	The threshold score to secure a Bachelor's-level job.
Level 3	The threshold score to secure a Master's-level job.
Level 4	The threshold score to secure a PhD-level job.

In line with our pecking-order analysis, the determinants of the rates of overeducation and undereducation were estimated by an ordered probit model conditioning on these individual characteristics. As our sample is selected from graduates who had already signed their employment contract, who may systematically differ in their individual characteristics to the wider population of graduates, the Heckman (1979) two-step method was used to adjust for sample selection. In the first step, a probit model was used to estimate the parameters of the selection equation for those graduates who had been successful in obtaining an employment contract by the time that they were graduating. These parameter estimates were then used to obtain the inverse Mills ratio (Davidson and McKinnon, 2004) that was used to correct for selection bias in the second step, where an ordered probit model was used to analyse the determinants of the overeducation and undereducation rates amongst those who did have employment contracts on graduation. Three sets of coefficients for these determinants are reported in Table 5 below, namely those for males, females, and both combined. In Table 5, * denotes that the relevant coefficient is significant at the 90 percent level, ** that it is significant at 95 per cent level, and *** that it is significant at the 99 per cent level.

In the first version of the ordered probit model, labelled Ordered Probit Model I, in Table 5, the Schooling variable was used to estimate the length of higher education, with the base case of a two-year college degree as the minimum for students within our sample of graduates. The coefficient on this variable proved to be highly significant for both genders combined and for males and females separately. In the second version of the ordered probit model, labelled Ordered Probit Model II, the Schooling variable was replaced by three separate variables. These were firstly the Bachelor variable for all those that had completed at least a Bachelor level degree, and which corresponds to two more years study in higher education than the base case of 2 years for a college Diploma. Secondly, the Masters variable for all those who had completed at least a Master's degree corresponds to three more years' study compared to achieving a Bachelor's degree. Thirdly, the PhD variable, for all those graduating students who had completed a PhD degree corresponds to three more years' study compared to achieving a Master's degree. The coefficients in the pecking-order model on each of the three variables Bachelor, Masters and PhD proved to be highly significant for both genders combined, and for males and females separately.

Model I is a nested case of Model II, with the additional restriction of the same coefficient on each year of higher education in the Schooling variable, compared to different possible coefficients on each year spent in Bachelor's, Master's and PhD study in Model II. A Likelihood Ratio (LR) test for whether Model II is a significant improvement upon Model I yielded a chi-squared statistic of 9.86 for the case of both genders combined, which with two degrees of freedom is significant at the 1 per cent level. Similarly for males, the LR test, involving twice the difference between the unrestricted maximum of the loglikelihood function and its restricted maximum, yields a chi-squared statistic of 11.78, which with two degrees of freedom is also significant at the 1 per cent level. However, for females, the corresponding chi-squared statistic of 2.74 is not significant, implying that there is no strong evidence of a differential effect of additional years higher education at different degree levels for females in China.

The inverse Mills ratio proved to be very significantly positive for females in both Models I and II, but otherwise not significant. This suggests sample selection was not significant except for females. As Vella (1998, p. 129) notes: "The possibility of sample selection arises whenever one examines a subsample and the unobservable factors determining inclusion in the subsample are correlated with the unobservables influencing the variable of primary interest". The significant positive coefficients for the inverse Mills ratio in the case of females suggests that the unobservables in determining whether the student has any job offer on graduation, such as being more proactive in searching for a job before graduation, are indeed positively correlated (see Davidson and MacKinnon, 2004, pp. 486-9) with the unobservable individual characteristics in the ordered probit model, such as enthusiasm and a positive personality, which increase the student's chances of securing a higher level job within the sample of students who do have a job offer on graduation.

A variable which is indeed significantly positive across both males and females, and for both genders combined, in the Ordered Probit Models I and II is membership of the Chinese Communist Party. The Cadre variable, that reflects having a position of responsibility within the student body, is also significantly positive, except for males in Model I. Since both these attributes involve a process of selection according to how well regarded the student's ability and character are amongst their peers or superiors, they are likely to reflect personal characteristics which are considered important within China. In contrast, degree classification was not significant in Models I and II, except for females. The lack of a significant effect of degree classification parallels the conclusion of Battu *et al* (1999), who found that degree class played no part in explaining overeducation in UK. In contrast to the conclusion of Dolton and Silles (2001) that students graduating with first class honours in the UK are more likely to find a job requiring a degree, there was no evidence in our analysis of data from across China that a superior degree classification was a positive factor influencing employers' job offers to graduates within China. This may be reflect the fact that degree programmes in China still contain compulsory courses in Marxism, Chinese History and other subjects which count towards the final degree classification, but which employers do not value highly.

The subject of the degree (with History as the base case) was similarly insignificant for both genders separately and combined. This contrasts with the findings of Groot (1996), Battu *et al* (1997), Dolton and Stilles (2001), and Frenette (2004), that being a graduate in Arts or Languages in the US, UK or Canada increases the chances of failing to find a graduate-level job. In contrast to the findings of Dolton and Vignoles (2002) that there is a significant wage premium on mathematical ability in the UK, being a graduate in Science (a category which includes Mathematics in Table 5 below) or Engineering in China does not have a significantly positive effect on the chances of securing a graduate-level job. In contrast to the UK, where students may give up studying Mathematics at the age of 16 (or even 14), Mathematics is a compulsory subject for students in China in the entrance examination to higher education at the age of 18, which they must pass at a high level to gain a university place, so that proficiency in Mathematics carries less of a scarcity value in China than in the UK.

Table 5: Determinants of the Attractiveness of Graduates for Securing Graduate-Level Jobs

Variable	Ordered Probit Model I			Ordered Probit Model II		
	Combined	Male	Female	Combined	Male	Female
Female	0.029 0.039			0.028 0.039		
schooling	0.379*** 0.032	0.386*** 0.039	0.307*** 0.057			
Bachelor				0.414*** 0.043	0.461*** 0.053	0.234*** 0.078
Master				0.656*** 0.047	0.629*** 0.059	0.628*** 0.083
PhD				0.882*** 0.065	0.832*** 0.077	1.003*** 0.129
Cadre	0.092* 0.027	0.071 0.046	0.162*** 0.063	0.096*** 0.037	0.077* 0.046	0.152** 0.064
Parentalcareer	-0.009 0.019	-0.035 0.024	0.054* 0.030	-0.007 0.019	-0.031 0.024	0.047 0.033
Parentalqualif	-0.003 0.016	0.006 0.020	-0.010 0.028	-0.002 0.016	0.009 0.020	-0.014 0.028
Registration	-0.005 0.016	-0.004 0.019	-0.023 0.029	-0.010 0.016	-0.011 0.019	-0.020 0.029
Partymember	0.254*** 0.041	0.237*** 0.052	0.280*** 0.067	0.254*** 0.041	0.239*** 0.052	0.273*** 0.067
English	0.103*** 0.025	0.141*** 0.030	-0.028 0.044	0.086*** 0.023	0.099*** 0.028	0.025 0.040
Degree classification	0.023 0.019	0.006 0.023	0.074** 0.037	0.019 0.020	-0.005 0.024	0.087** 0.037
Philosophy major	-0.132 0.237	-0.342 0.301	0.381 0.403	-0.127 0.235	-0.251 0.299	0.141 0.404
Economics major	0.050 0.131	-0.008 0.183	0.066 0.194	0.027 0.131	-0.043 0.183	0.056 0.195
Law major	-0.013 0.133	-0.175 0.191	0.289 0.192	-0.037 0.133	-0.212 0.191	0.277 0.193
Education major	-0.128 0.253	-0.297 0.516	0.048 0.305	-0.148 0.253	-0.273 0.516	-0.035 0.306
Art major	-0.027 0.114	-0.227 0.168	0.112 0.159	-0.045 0.114	-0.246 0.168	0.095 0.160
Science major	-0.086 0.114	-0.200 0.162	-0.005 0.167	-0.124 0.115	-0.264 0.163	-0.005 0.168
Engineering major	0.039 0.115	0.016 0.161	-0.158 0.175	0.004 0.114	-0.057 0.161	-0.136 0.171
Agriculture	-0.011	-0.083	0.057	-0.057	-0.172	0.099

major	0.163	0.207	0.309	0.164	0.208	0.312
Medicine major	0.216 0.146	0.245 0.210	0.127 0.209	0.179 0.146	0.164 0.211	0.195 0.208
Management major	0.016 0.116	-0.024 0.164	-0.072 0.170	-0.010 0.115	-0.072 0.164	-0.070 0.169
workplace	0.151*** 0.028	0.163*** 0.035	0.098** 0.049	0.147*** 0.028	0.161*** 0.035	0.101** 0.049
stateown	0.459*** 0.046	0.520*** 0.055	0.306*** 0.084	0.447*** 0.046	0.498*** 0.055	0.308*** 0.085
govern	0.501*** 0.060	0.512*** 0.074	0.511*** 0.108	0.491*** 0.060	0.497*** 0.074	0.512*** 0.108
jointven	0.582*** 0.067	0.674*** 0.084	0.381*** 0.112	0.574*** 0.067	0.662*** 0.084	0.385*** 0.112
institute	0.789*** 0.052	0.895*** 0.069	0.638*** 0.082	0.783*** 0.052	0.888*** 0.069	0.644*** 0.083
workprovince	-0.002 0.002	-0.009*** 0.003	0.016*** 0.004	-0.002 0.002	-0.009*** 0.003	0.016*** 0.004
Inverse Mills ratio	0.005 0.085	-0.125 0.104	0.521*** 0.156	0.017 0.080	-0.081 0.098	0.479*** 0.147
Level 1	5.257 0.335	5.046 0.421	5.122 0.587	0.067 0.227	0.193 0.288	-0.959 0.403
Level 2	6.575 0.338	6.278 0.424	6.6702 0.591	1.396 0.227	1.444 0.289	0.584 0.402
Level 3	8.495 0.343	8.117 0.430	8.806 0.602	3.321 0.230	3.285 0.292	2.73 0.405
Level 4	9.750 0.351	9.303 0.438	10.355 0.626	4.557 0.235	4.448 0.297	4.288 0.420
Loglikelihood	-4962.174	-3315.348	-1590.688	-4957.245	-3309.458	-1589.320
Observations	5018	3217	1801	5018	3217	1801

However, for males and for both genders combined, English language ability was a very significantly positive factor in securing a higher level job amongst graduates in China. Willingness to work in a larger city rather than a small town or village, in a State-owned enterprise, in a government or related bureau, in a joint venture company or in an educational institute, rather than elsewhere, was similarly a very significant positive factor in securing a higher level job for both genders separately and combined in Models I and II. For males, willingness to work in a province with a higher degree of economic development, according to the province’s comparative ranking of its GDP per capita, increased the chances of securing a higher level job. However, the converse was true for females, with an insignificant overall coefficient on this variable for both genders combined, in Models I and II. Father’s career was only significant in the case of females in Model I. Father’s qualifications and the residential background of the student were insignificant in all cases.

In both Models I and II, we are able to test whether or not all the other coefficients which affect the probability of an offer of a better job are equal across males and females. Since the Combined case can be treated as a restricted version of the unrestricted case where these coefficients are free to vary between males and females, we can deploy a Likelihood Ratio test on the null hypothesis that these coefficients are all equal. When we compute twice the difference between the unrestricted maximum of the loglikelihood function and its restricted maximum, in Model I we obtain a value of 112.28, and in Model II a value of 116.94. Using the corresponding asymptotic chi-squared distributions with 29 and 31 degrees of freedom respectively, these values are highly significantly different from zero. The null hypothesis that the above coefficients are all equal can be rejected for both Models I and II. Significantly different weights on the relevant variables thus appear to be applied in job offers between male and female graduates in China.

The significant positive weight placed upon English language abilities suggests that students who have studied abroad in an English-speaking country will, other things being equal, have an advantage over students studying within China who have not developed such abilities. Other advantages that students studying outside China may acquire, and which may help them to avoid the average 20.5 per cent risk within China of failing to find a job matching their graduate qualifications, are more links and contacts within Western countries, including in some cases access to jobs outside China.

4. The Determinants of A Job Offer Before Graduation

Since only 40.7 per cent of the respondents surveyed had a job offer before graduation, we examine in this section the determinants of having any such job offer before graduation. As discussed above, this involves an initial probit analysis that generates the inverse Mills ratio in the above second step ordered probit analysis. The coefficients in the initial probit analyses for the variables which affect the probability of having a job offer on graduation are shown in Table 6 below. In order to aid the identifiability of the ordered probit model in the second step of the analysis (see Vella, 1998, p. 135), additional variables are included in the initial probit analysis for the probability of having a job offer in the first step. These include Univ.location and born.location, which correspond to the rank from 1 to 31 of the GDP per capita within China of the province in which, respectively, the current University of the student, and their birthplace, are located. They also include English2, which corresponds to the square of the English variable in Table 4 above, and which adds to the degree of non-linearity involved that can further aid identifiability (ibid, p. 135).

Table 6: Probit analysis for the probability of having any job offer before graduation

Variable	Probit Model I			Probit Model II		
	combined	male	female	combined	male	female
Female	-0.193*** 0.028			-0.190*** 0.028		
schooling	0.197*** 0.028	0.298*** 0.018	0.301*** 0.022			
Bachelor				0.449*** 0.017	0.437*** 0.022	0.449*** 0.027
Master				0.411*** 0.033	0.398*** 0.043	0.406*** 0.053
PhD				0.242*** 0.054	0.299*** 0.067	0.160* 0.094
Cadre	-0.151*** 0.027	-0.147*** 0.036	-0.141*** 0.043	-0.150*** 0.027	-0.152*** 0.036	-0.134*** 0.043
Univ. location	-0.034*** 0.002	-0.028*** 0.003	-0.044*** 0.004	-0.037*** 0.002	-0.031*** 0.003	-0.047*** 0.004
Born location	0.007*** 0.002	0.006** 0.003	0.012*** 0.004	0.008*** 0.002	0.007*** 0.003	0.013*** 0.004
Parentalcareer	-0.040* 0.016	-0.037* 0.021	-0.040 0.025	-0.033** 0.016	-0.033 0.021	-0.030 0.025
Parentalqualif	-0.016 0.013	-0.026 0.017	-0.008 0.021	-0.011 0.013	-0.020 0.017	-0.004 0.021
Registration	0.017 0.013	0.040 0.017	-0.016 0.021	0.012 0.013	0.033** 0.017	-0.019 0.021
Partymember	0.103*** 0.035	0.109** 0.047	0.109** 0.052	0.115*** 0.035	0.118*** 0.047	0.128** 0.053
English	0.312* 0.164	0.096 0.223	0.589** 0.243	0.355** 0.165	0.192 0.225	0.580** 0.244
English2	-0.122*** 0.041	-0.074 0.056	-0.184*** 0.061	-0.119*** 0.042	-0.085 0.057	-0.167*** 0.062
Degree classification	-0.045*** 0.016	-0.043** 0.020	-0.050* 0.028	-0.066*** 0.016	-0.068*** 0.020	-0.061** 0.028
Philosophy major	-0.386* 0.220	-0.341 0.279	-0.365 0.353	-0.179 0.211	-0.113 0.266	-0.216 0.347
Economics major	0.136 0.105	0.259 0.142	-0.051 0.157	0.104 0.105	0.219 0.141	-0.067 0.158
Law major	-0.353*** 0.103	-0.265* 0.141	-0.519* 0.153	-0.396*** 0.103	-0.327** 0.141	-0.531*** 0.153
Education major	-0.140 0.144	-0.321 0.213	-0.036 0.201	-0.110 0.144	-0.303 0.213	0.009 0.202
Art major	0.120 0.092	0.165 0.128	-0.000 0.136	0.117 0.092	0.161 0.127	0.007 0.137

Science major	0.106 0.093	0.182 0.125	0.015 0.141	0.070 0.093	0.140 0.124	-0.012 0.142
Engineering major	0.537*** 0.089	0.690*** 0.119	0.292** 0.137	0.492*** 0.089	0.630*** 0.118	0.276** 0.138
Agriculture major	0.110 0.132	0.182 0.162	0.125 0.247	0.009 0.132	0.062 0.162	0.073 0.248
Medicine major	0.267** 0.117	0.549*** 0.164	-0.027 0.168	0.167 0.117	0.434*** 0.164	-0.105 0.169
Management major	0.273*** 0.092	0.427*** 0.124	0.056 0.138	0.238*** 0.092	0.375*** 0.123	0.047 0.139
Constant	-11.241*** 0.875	-11.804*** 1.145	-10.172*** 1.373	1.564*** 0.534	0.900 0.724	2.267*** 0.794
Loglikelihood	-6327.327	-3744.945	-2553.834	-6245.202	-3703.263	-2517.232
Observations	11508	6767	4741	11508	6767	4741

The findings in Table 6 are consistent with the probability of having a job on graduation being the result of conflicting pressures to secure a job before graduation if the individual can find a job which meets the individual student's expectations, without engaging in excessive search time that may detract from the student's remaining university work. If this condition does not hold, the student may decide not to accept a job before graduation that does not meet their longer-term expectation, but instead decide to search harder after graduation when they have more time available to search for a job which does meet their longer-term expectation. The significant negative coefficients on being female in Table 6 suggest that females have more difficulty in China in securing a job before graduation that meets their longer-term expectation. The negative coefficients on English2 but positive coefficients on the English variable suggest that there may indeed be a non-linear inverted U-shaped relationship between English ability (which we confirm below is an important determinant of the level of the job which the student can expect) and the probability of their having a job offer before graduation. Students whose English scores are currently low may decide not to take a lower-level job before graduation, but instead devote their time to improving their academic performance before graduation and more time to searching for a better job after graduation. Those students whose current English scores are reasonably good are more able to secure a good job offer before graduation, and more likely to accept it. Those students whose English abilities are high may be more confident of being able to secure a very good offer after graduation and are less willing to spend time searching for a job offer before graduation.

The significant positive coefficients on the educational qualification variables and on party membership in Table 6, alongside their positive role in boosting the level of job the individual is likely to be offered in Table 5 above, indicate that these variables raise the chances of the individual securing a good job that meets their longer-term expectations before graduation. Since the Univ.location variable involves the ranking of the province in which the University is located according to its GDP per capita from the top of the associated distribution within China, the significant negative coefficients on Univ.location in Table A indicate that a higher GDP per capita for the province of the University tends to boost their chances of receiving an acceptable job offer. Conversely, the significantly positive coefficients on born.location are consistent with higher expectations for those students who originate from more affluent provinces, and a lower willingness to accept a job offer before graduation that does not meet their higher expectation.

The significant negative coefficients on the Cadre variable in Table 6 suggest that individuals with greater responsibilities within the University may be less willing to spend time searching for a job before graduation, but alongside the results of Table 5 above are confident that their current responsibilities will boost their chances of securing a higher level job. The significant negative coefficients on the degree classification variable that indicates the quartile from the top in which the individual's marks fall is consistent with a greater willingness of students with good marks to look for a job before graduation. There are also several significant coefficients on degree subject in Table 6, in contrast to their absence in Table 5 above. Majoring in Engineering, Medicine and management can significantly increase the chances of a job offer before graduation, whereas majoring in Law tends to reduce it.

5. Overeducation and Socially Optimal Investment in Education

A central question for educational policy in China is the extent to which the emerging problem of graduate overeducation in China casts doubt upon the economic desirability of China's policy of rapid expansion of higher education, and instead suggests that its supply of graduates now exceeds a socially optimal level. The possibility of graduate supply exceeding a socially optimal level can itself arise from the economic logic of the pecking order model. Individuals making decisions on their desired length of schooling, H_i, may seek to maximise their life-time utility U_i (using a subjective time preference rate ρ_i), subject to an inter-temporal budget constraint that the present value of their life-time consumption is equal to the present value of their wage income less the present value of their tuition fees, i.e.

$$\max_{H_i} U_i = \int_0^{L_i} U_i(c_{it}) e^{-\rho_i t} dt \quad s.t. \int_0^{L_i} c_{it} e^{-rt} dt = -\int_0^{H_i} \psi_{it} e^{-rt} dt + \int_{H_i}^{R_i} w_{it} e^{-rt} dt \tag{5.1}$$

where c_{it} is individual i's consumption level at time t, L_i is their life-span, r is the prevailing interest rate, ψ_{it} is the level of their tuition fees at time t, and R_i is their retirement age. Wage income w_{it} earned during the individual's working life after leaving full-time education at time $t = H_i$ up until retirement at time $t = R_i$ must here provide a return on the individual's investment in education that is sufficient to finance their life-time consumption. This includes their consumption in retirement that is funded through their savings and pension contributions out of their wage income whilst working. In view of recent policy concerns over the need to adjust retirement ages to improve the funding of pension schemes (e.g. Pensions Commission, 2006), we will consider a number of possibilities for the extent to which the retirement age R_i is responsive to H_i, through the relationship:

$$R_i = T + \kappa H_i \quad where \ 1 \geq \kappa \geq 0 \ and \ R_i - H_i > 0 \tag{5.2}$$

The case $\kappa = 0$ corresponds to the case where there is a fixed retirement age T irrespective of how long the individual has spent in full-time education. The case $\kappa = 1$ in contrast corresponds to the case where the individual works T years to finance their retirement, irrespective of how long they have spent in full-time education.

For analytical simplicity, we will assume in this section that the wages w_{it} of each individual during their working life are influenced by their length of schooling, H_i, by their length of working experience $t - H_i$ at time t, and by n - 2 other individual characteristics that do not change over time, with:

$$X_{i1t} = H_i \quad and \quad X_{i2t} = \exp(t - H_i) \quad for \ \ t \geq H_i \tag{5.3}$$

in the wage function (2.7). Over time, the index v_t of macroeconomic variables is assumed grow at the rate g_v, whilst the mean level θ_{Jt} of the log of the job specifications index J_{jt} across the available jobs j in the economy is assumed to increase by g_J per unit of time. The expansion rate in education is characterised here by the parameter g_1, that corresponds to the increase per unit time in the mean level of $\ln H_i$ across individuals. While the mean levels of these variables are increasing over time, for the sake of simplicity we will assume that the variances of $\ln J_{jt}$ and $\ln C_{it}$ remain constant, with:

$$\sigma_{Jt} = \sigma_J, \sigma_{Ct} = \sigma_C, \sigma \equiv \sigma_J / \sigma_C \quad \textit{for all } t \geq 0 \tag{5.4}$$

Equations (2.7), (5.3) and (5.4) then imply:

$$w_{it} = w_{iH_i} \exp(g_w(t - H_i)) \quad \textit{for } t \geq H_i \tag{5.5}$$

$$\textit{where} \;\; g_w = g_v + g_J + \beta_2 - (a_1 g_1 + a_2)\sigma = g_v + g_J + a_2 - a_1 g_1 \sigma \tag{5.6}$$

so that whilst the growth rate g_w in wages over time is boosted by the growth rate g_v in the macroeconomic index v_t, by the growth rate g_J in job specifications and by the coefficient a_2 on the gain from working experience, it is depressed by a higher rate of supply of more educated individuals, to an extent that depends upon the parameter σ that reflects the relative dispersion of job specifications and individual characteristics in the economy.

When (5.5) is inserted into (5.1), the first-order conditions for (5.1) may readily be shown to imply that individual i's desired length of education is given by:

$$H_i^* = a_1 / [a_2 + ((1 + \xi_i - \kappa P_i)(r - g_w) / (1 - P_i)(1 + \sigma))] \tag{5.7}$$

$$\text{where } \xi_i = \psi_{iH_i} / w_{iH_i}, \; P_i \equiv \exp((g_w - r)(R_i - H_i)) \tag{5.8}$$

Differentiation of (5.7) in turn implies that:

$$\partial H_i^* / \partial a_1 > 0, \; \partial H_i^* / \partial g_w > 0, \; \partial H_i^* / \partial \sigma > 0, \; \partial H_i^* / \partial \kappa > 0 \tag{5.9}$$

$$\partial H_i^* / \partial a_2 < 0, \; \partial H_i^* / \partial \xi_i < 0, \; \partial H_i^* / \partial g_1 < 0 \tag{5.10}$$

so that individual i's desired length of education is an increasing function of its coefficient a_1 in the production function (2.1), the growth rate g_w in wages, the coefficient σ of relative dispersion in job specifications and individual characteristics, and of κ, reflecting the extent to which their working life is not reduced by additional years of education. At the same time, individual i's desired length of education is a decreasing function of the coefficient a_2 in the production function on years of working experience, rather than additional education, of the overall rate of expansion g_1 of education in the population at large, and of the ratio ξ_i between the tuition fees which individual i pays for additional education and the wage they forego in undertaking such additional full-time education. A variation in ξ_i across individuals will itself produce variations in the desired length of education across different individuals. *Ceteris paribus*, high ability individuals who face low tuition fees, net of scholarships, compared to their foregone wage will have a higher desired length of education compared to those of lower ability individuals, whose opportunity costs of wages foregone are low compared to the wages of their teachers and their associated tuition fees.

Each individual's desired length of education can then be compared to the length of education H_i^{**} which maximises the value V_{ij} of their production over their working life, net of the full cost $\chi_i(H_i)$ of their education. Using equations (2.1), (5.2) and (5.3), when the coefficients g_v, g_J, and a_2 are held constant, the first order conditions for the associated optimisation:

$$\max_{H_i} V_{ij}^{'} = V_{ij} - \chi_i(H_i) \;\; where \;\; V_{ij} \equiv \int_{H_i}^{R_i} V_{ijt} e^{-rt} dt \qquad (5.11)$$

can be shown to imply:

$$H_i^{**} = a_1 / [a_2 + ((1 + \chi_i^o - \kappa Q_i)(r - g) / (1 - Q_i))] \qquad (5.12)$$

$$\text{where } g \equiv g_v + g_J + a_2, \; Q_i \equiv \exp((g - r)(R_i - H_i)), \; \chi_i^o \equiv (\partial \chi_i / \partial H_i)(e^{H_i r} / V_{ijH_i}) \qquad (5.13)$$

An advantage of assuming a finite life-span L_i and finite retirement age R_i, in contrast to an infinite life-span with no retirement, is that we do not need to impose here the restriction that $r > g$ or $r > g_w$ in (5.7) - (5.12), so long as $\kappa P_i < 1 + \xi_i$.

For the case $g_1 = 0$ and $\xi_i \leq \chi_i^o$, (5.6) - (5.8), (5.12) - (5.13) imply:

$$H_i^* > H_i^{**} \qquad (5.14)$$

so that under the above assumptions individuals' desired levels of education exceed those that maximise the value of their own production, net of the full costs of their tuition. More individuals may then willingly undertake higher education than can be justified on the basis of the net value of their own resultant increased production, and in this sense are willingly overeducated.

Such an incentive for willing overeducation arises here because each individual has an incentive in the pecking order model to seek to improve their own personal characteristics *relative to* those of other individuals, and thereby inflict a *negative externality* upon the relative position of the other individuals with whom they are competing for graduate-level jobs. This is true even though greater education does contribute directly to increased production in the production function (2.1). The pecking order model differs in several respects from signalling theory (e.g. Spence, 1973), where individuals have an incentive to invest, and over-invest, in education when their educational level is used as a *signal* to convey information to their potential employers about their future productivity, even though the education may not itself directly raise their productivity. As Spence (1973) noted, ‘Systematic overinvestment in education is a distinct possibility because of the element of arbitrariness in the equilibrium configuration of the market’, with education potentially an arbitrary choice as the signal for higher productivity within signalling theory. However, within our above pecking order model, increased education does raise each individual’s output, but with a limited number of graduate-level jobs available in the economy at any given time.

Moreover, within our pecking order model, the incentive for each individual to seek to be overeducated is potentially reduced by the expansion of higher education, as reflected in the coefficient g_1. With a positive increase of g_1 each period in the mean value of the log of the length of education in the population, the scarcity value of more education declines and the associated rate of growth of wages is reduced in equation (5.6), if we hold constant the coefficients g_v, g_J, and a_2. The incentive for each individual to seek to be overeducated is thereby reduced in equation (5.7), with

$$[(1-Q_i)/(r-g)] = \int_0^{R_i-H_i} (\exp(g-r)t)\, dt > \int_0^{R_i-H_i} (\exp(g_w-r)t)\, dt = [(1-P_i)/(r-g_w)] > 0 \qquad (5.15)$$

whenever $g_1 > 0$ and hence $g > g_w$ in equation (5.6), so that the inequality (5.14) no longer necessarily holding once $g_1 > 0$ in equations (5.7) and (5.12). In particular, a growth rate of higher education that is persistently higher than the growth rate of GDP may substantially depress the anticipated growth rate of graduate wages in (5.6), so that any tendency for individuals to seek to be overeducated from (5.7) is significantly reduced.

Further important considerations arise when we relax our earlier assumption that the growth rates g_v and g_J, and the coefficient a_2, are constant over time. In order to examine the impact of possible changes in these growth rates, we may first note that the mean value of production *per* *capita* in the economy at each time t under the pecking order model is given from equations (2.1) – (2.6) by:

$$V_t \equiv E(V_{ijt}) = v_t \exp(\theta_{Jt} + \theta_{Ct} + 0.5(\sigma_J^2 + \sigma_C^2 + 2\sigma_{JC})) \quad where\ \sigma_{JC} = \sigma_J \sigma_C \qquad (5.16)$$

using Aitchison and Brown (1963 , pp.8, 12) and (5.4). It can be seen from (5.16) that V_t depends in general on the covariance σ_{JC} within the economy between the index of job specifications for each job and the index of characteristics of the individuals who fill those jobs. The pecking order model secures the maximum mean value of production *per capita* by ensuring that the jobs with the highest specifications, according to the index J, go to the individuals with the highest ratings according to the index of individual characteristics C, so that there is a correlation coefficient of one in (2.5), (2.6) and (5.16) between J and C across the economy. From (5.16), we have the present value of the mean value of production *per capita* to be given by:

$$V = \int_0^\infty V_t e^{-rt} dt = V_0 / (r - g_G) \quad where \ \ g_G \equiv g + a_1 g_1 \qquad (5.17)$$

using equations (2.1) – (2.4) and (5.3), where we now require $r > g_G$ in this infinite horizon social objective function. Maximisation of *V* using (2.1) and (5.4) implies a socially optimal level of education to maximise the present value of production *per capita* that is given by:

$$H_i^{***} = a_1 / [a_2 + ((1 + \chi_i^o - \kappa Q_i - G_i)(r - g) / (1 - Q_i))] \qquad (5.18)$$

$$\text{where } G_i \equiv (V_0 \exp(rH_i) / V_{ijH_i} (r - g_G)^2)(\partial g / \partial H_i) \qquad (5.19)$$

when we take account of the impact of additional years H_i of education not only on the individual's own production and of their full tuition costs, but also upon the growth rate g. From (5.13), we have

$$\partial g / \partial H_i = (\partial g_v / \partial H_i) + (\partial g_J / \partial H_i) + (\partial a_2 / \partial H_i) \qquad (5.20)$$

Increased education, not least at the graduate level, may then succeed firstly in raising the rate of growth of the macroeconomic variables within the index v. This includes the rate of technological progress in a process of endogenous growth (Barro and Sala-i-Martin, 1995), such as through a more rapid rate of diffusion of technology from more advanced economies, which more advanced learning and contact with international bodies of knowledge may help to facilitate. The importance of a higher level of education in increasing the speed of adoption of best-practice technology has been emphasised by Nelson and Phelps (1966). Acemoglu *et al* (2006) underline the role of human capital in boosting economic growth both in the adoption of existing frontier technology, and in the innovation of new technology, where the availability of highly-skilled human capital is even more important.

In the case of China, there may be great scope for the deployment of graduate-level skills not only in the improved design and manufacture of existing products, and their production at lower environmental cost than has been involved in China's recent rapid economic growth, but also in the innovation of more sophisticated products and services based upon more advanced technology. This in turn may increase the rate of growth of the value of China's exports, domestic consumer expenditure and other components of its GDP. Thus, whilst in the past non-graduate production and supervisory jobs in low-cost manufacturing have helped to generate a substantial trade surplus for China, achieving greater value added in the face of international competition may in the future require more graduate-level skills in design, engineering and management. The deployment of more graduate level skills in the investment of China's large and growing stock of foreign exchange reserves (that are currently valued in excess of US$1,682 billion) may further boost the rate of growth of its foreign exchange earnings. While these have in the past been invested mainly in fixed interest securities, China is now turning its attention to more active equity investment in overseas enterprises, with a consequent need for more graduate-level investment and management skills.

The above process may be reinforced by a form of *Say's Law*, in which an increased supply of graduates tends to create its own demand, through a steady raising of the job specifications (as reflected in the index J) of those jobs into which graduates are recruited, so that they more fully utilise the additional education which they have received. This process may start in response to an excess supply of graduates by a raising of the nominal job requirements to include a degree, for many jobs and professions where non-graduate had previously been recruited in large numbers. However, over time, technological progress and an increased sophistication of China's products and services may facilitate, and themselves be facilitated by, an upgrading of the actual skills which graduates exercise in the jobs to which they have been recruited. Overeducation therefore needs to be viewed in this context as a dynamic phenomenon, with the analysis including the interaction between both supply- and demand-side variables.

The above processes will also be reinforced if there exists complementarity between the productivity of individual graduates, as well as complementarity between the productivity of individual graduates and the capital and technology which they deploy. Individual graduates may be better able to deploy their enhanced skills in transactions and collaborations with other graduates, so that there is an externality at work in the impact of an increased length of education for an individual on overall social productivity and economic growth (see Easterly, 2001). If an increase in the growth rate, g_1, of the length of education does succeed in boosting the economic growth rate, g, this will itself reinforce the growth rate, g_w, of wages in equations (5.6) and (5.13), and thereby to some extent offset the negative partial effect which an increased supply of more highly educated individuals has on graduate wages and on individuals' desired length of education in (5.7).

In addition to boosting the growth rate g through increases in both g_v and g_J, increased education may boost the rate, a_2, of learning-by-doing in equations (2.1) and (5.3) and (5.13), by which work experience after an individual's years of formal education helps to boost the value of output. Graduate education may facilitate enhanced learning and problem-solving abilities that will enable graduate to progress faster and translate experience into more valuable production at a higher rate per unit time.

All of these influences may increase the marginal impact of additional years' education upon the growth rate g in (5.20), thereby boosting the value of G_i in (5.19) and the socially optimal length of education H_i^{***} in (5.18). Any excess of the individual's desired length of education H_i^* over the socially optimal length of education will then be smaller than otherwise, with overeducation in terms of an excess of H_i^* over H_i^{***} not in general implied. However, the extent and direction of this divergence will depend upon the strength of the *marginal impacts* of years of additional education upon g_v, g_J and a_2 in equations (5.18) – (5.20). That economic growth may be first an increasing, but then a decreasing, function of the percentage of high-skilled individuals in the population is discussed in Rehme (2007). If a failure of graduates at the margin to find jobs that utilise their additional education were to be associated with a permanent state of under-employment of their graduate abilities, then doubts may arise as to the numerical strength of the marginal impacts in (5.20), and hence of the degree to which such individuals' desired lengths of education H_i^* are aligned with the socially optimal length of education H_i^{***}. These doubts may be reinforced by mixed empirical evidence on the link between additional educational investment and economic growth (see e.g. Mankiw et al (1992), Benhabib and Spiegel (1994), Pritchett (2001), Krueger and Lindahl (2001), and de la Fuente and Donenech (2006)). In addition, the achievement of sustained economic growth may depend upon the joint fulfilment of many other conditions than educational expansion (see Easterly, 2001).

Nevertheless, China starts from a relatively low percentage of its population in possession of tertiary education, with only 8.4 per cent of its 25 – 64 year old population having attained tertiary education in 2005, compared to 30 per cent for the United Kingdom and 38 per cent for the United States (OECD, 2007), though with the percentage for China increasing rapidly to 10.2 per cent by 2006. There may still therefore be great scope for even transitionary gains to China from the diffusion of advanced knowledge and technology from more advanced economies, that the expansion of higher education in China can help to achieve. The importance of the *composition* of the human capital stock in disentangling the impact of higher education on economic growth has been emphasised by Aghion *et al* (2006), who found some empirical support from US data for their model in which more advanced education maximises productivity growth for those states which are close to the current technological frontier, whilst less advanced education maximises productivity growth for those states that are far from this frontier. As China seeks to move closer to the international frontiers of technological progress, a substantial input of graduate-level skills may in particular be required if it seeks to develop its own *output-mix* beyond the mass production of low technology products into those based upon more advanced electronics, engineering, science and design. Our own empirical findings have underlined the importance of the characteristics of human capital in a number of directions, including differential rates of importance placed by employers in China on years of education according to the level at which it occurs, as well as rates of reported overeducation that increase substantially with the degree level involved. At the same time, we have found overall a 17.4 percentage rate of self-reported undereducation amongst graduating students across China. As in Table 3 above, this is concentrated particularly amongst students graduating with only a two-year College Diploma, where the rate of undereducation rises to 41.1 per cent, suggesting considerable scope for beneficial additional education within this part of the higher education sector in China.

6. Conclusion

While the overall percentage rate of overeducation in China of 20.5 per cent is higher than that found in several European countries, it is still lower than that found in several studies in the US and UK. Whether this represents an over-investment in graduate education by the individuals concerned, and by China as a whole, will depend very much upon how this investment in higher education interacts with the future rate of economic growth of China as an emergent economy.

The expansion of China's economy, and the effectiveness with which it deploys its rapidly expanding graduate population, clearly has major implications for other economies with which China is competing for world markets. Particularly once it moves beyond the mass production of low cost, low technology products, China may have greater scope than many of its competitors for combining increased technological knowledge with low cost labour supplies in the production of more sophisticated products and services. The pressure of increased international competition and globalisation in these product markets may in turn make the returns to investment in higher education in the US and other advanced economies more interdependent with the development of China's own graduate market, and on the extent to which China does succeed in deploying its rapidly expanding production of graduates in productive graduate-level employment. Such increased interdependence will reinforce the linkage which already exists in the higher education systems of the UK and US, via their large-scale recruitment of students from China, with the job prospects of graduates in China, and hence with the factors which determine these prospects.

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