“Should I go to university, Sir?”

Student ID: 0813207

Word count: 4996 words

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ABSTRACT:

The paper considers the decision faced by individuals, notably at school leaving age, regarding whether or not to enter higher education. It creates a dynamic model over a discrete time period, capturing changing dynamics and updating beliefs. The paper uses the model to identify the maximising action for individuals through an expected value maximisation problem and how this is affected by the behaviour of employers and universities.[1]

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[1] 'Higher education' and 'university' may be used synonymously throughout the paper

[2] Word count excludes equations, headings and appendix

Contents

1 Introduction

The maximum tuition fee charged by universities rose from £3,290 in 2010 / 11 to £9,000 from the following academic year. The debate surrounding university attendance came to the fore and coupled with the bleak economic climate, the decision for prospective students suddenly took on greater scrutiny from each individual’s perspective.

The question posed by thousands of A-level students each year is being asked more critically than ever before with the number of UCAS applications from the UK dropping an alarming 8.7% in 2011 / 12 (Source: UCAS). Students already in higher education also began to ask the complementary question, “should I have gone to university?”, due to the nature of the graduate job market.

This paper attempts to create a model to mimic the decisions made by those faced with an offer for a place at university. The model supposes an individual has achieved the requirements to accept the offer, and then attempts to consider the expected value of all possible actions.

The model will then be used to consider the strategy of individuals, as well as the role of employers and universities, and the effect of increasing trends in the real world today on the actions taken by individuals.

2 Literature Review

The review considers previous research in the higher education field, most notably the areas key to the model.

Hung et al. (2000) analyse the problem in China using a rate of return econometric model. They use the discrete model proposed by Psacharopoulos (1992)

$$r = (E_h - E_s) \,/\, N(E_s + C_h)$$

calculating the rate of return as the difference between higher education wage and school leaver wage divided by the cost of schooling and opportunity cost of a school leaver wage for *N* years of higher education. They found students' expected rate of returns from higher education were much higher than from being a school leaver. The model, however, could be argued as too simplistic, since it ignores non-monetary utility, as well as business cycle shocks. More importantly, it fails to consider how beliefs change and update as an individual makes their decisions. James et al. (1999) note many university applicants are influenced by certain aspects on which their knowledge is limited, such as teaching styles, highlighting the necessity to consider how beliefs update as an individual goes through higher education. Katsuno & Mendelzon (1992) highlight the importance of belief revision, where previous beliefs are found to be incorrect, and belief update, where beliefs are correct and update according to new information.

Human Capital Theory v Sorting[3]

Hung et al. argue their results support human capital theory, which suggests higher education increases the marginal product of workers. Blaug (1985) suggests all jobs require a level of cognitive ability only attainable through formal higher education; an opinion shared by many supporters of human capital theory. Hansen (1970 {noted in Blaug, 1972}) supports the idea of social skill enhancement and the notion of increased productivity, though is unable to pinpoint the specific skills or experiences which underpin the theory.

[3] Sorting is used to define signalling and screening theory; students use degrees as a signal, firms screen candidates according to degrees

Intuitively one can understand how formal schooling will lead to improved cognitive and social abilities (both necessary skills in the workplace), regardless of the course quality. Empirical studies have been limited in their ability to attribute higher wages / marginal product to higher education. Van der Merwe's (2010) econometric study suggests the propensity of graduates to enjoy higher wages is a combination of human capital theory and signalling, though is unable to establish each theory's significance nor suppose a correlation between the two.[4]

Screening suggests firms resort to stereotypes; beliefs reinforced by past experiences or through public beliefs, using higher education as a discriminator. Miller & Volker (1984) empirically demonstrated a strong incidence of screening in Australia, where evidence for human capital theory was significantly limited. Weiss (1995) suggests sorting is inherent and necessary within the labour market.

Matching problem

Moscarini (2005) combines the thinking behind Jovanovic (1984) and Mortensen & Pissarides (1994) to offer analytic solutions for wage distribution and probabilities. Matching (search) theory is a way of viewing the labour market applicant-employer relationship, though due to imperfect information, employers must work on likelihood functions; screening is an integral part of employer matching mechanisms.

Teaching methods

Many economists have commented on the nature of teaching in universities, including Waghid (2006), who finds the dominant "transmission mode" in South Africa is largely due to increasing numbers attending universities.[5] Walker (2001) argues universities should move away from the practice of knowledge transfer from the teacher to student, and should instead encourage a two-way flow of idea generation. Waghid suggests increased deliberation within university curricula would lead to cognitive improvements (notably problem solving), as well as social improvements (notably awareness and discussion). Waghid suggests this would improve universities, but fails to discuss the parameters which define how 'good' a given university may be. Again, the implications for the theories are two-fold, dependent on the scalability and impact of reverting back to a more deliberative teaching style on the quality of education and reputation of the university.

[4] We term the higher wage received from a graduate job vs. non-graduate job, as the 'graduate premium'
[5] This method of teaching is arguably dominant across the UK, notably due to typically high participant numbers

3 Model

The model describes an individual's problem from the age of 18, deciding whether to enter higher education or not. The model supposes the individual has an offer for a place at university at the beginning of the first period. Each period lasts the academic year, beginning in September. We consider the decisions made over a finite horizon, from 18[6] to age A.

Through entering higher education, the individual acquires both human capital and signalling value for prospective employers. The individual gains experience for each year he has a full-time job. An individual at university may also gain experience through an internship / work experience.

Each period is subject to business cycle shocks. Though the choice set remains the same in each period, the beliefs of the individual are updated, as are the payoffs for the respective actions. The model will now be discussed in detail.

For simplicity, the model supposes the differences in living costs between the various actions are insignificant. Though the UK offers a maintenance loan, the model considers only the disutility of tuition fees.

The model builds on the intuition proposed by Mann's (2011) Annualized Cost of Leaving (ACOL) model, taking a similar structure and using the same notation at times.

3.1 Choice Set

The individual faces a decision problem in each period. At each age, a, the individual must choose only one action from the choice set, K. We will first consider the preliminary choice set $K_{prelim} = \{h, e, r, y, i\}$, where the individual is able to combine actions subject to certain constraints. See appendix A.1 for explanation of combinations and constraints.

[6] Since the A-Level system in the UK takes two years on average, less than 2% of accepted UCAS applicants were under 18 in 2011 (Source: UCAS)

h = full-time higher education

e = full-time employment

r = reapply to higher education

y = gap year

i = internship / work experience placement

Before considering the payoff functions for each action or combination of actions, we can reduce the combinations identified, $\{h, hr, hi, e, er, r, ri, y, yr, i\}$, to arrive at the choice set proper.

As shown in appendix A.1, *{hr, y, yr, i}* are all eliminated from the preliminary choice set, thus the choice set is *K* = *{h, hi, e, er, r, ri}*. Where an individual must choose strictly one action from *K*.

3.2 Preference Endowments

At the start of each period the individual has a set of preference endowments, which define the preference reward gained in the period for each action in the choice set. Since the reward functions for non-isolated actions (e.g. *hi, er, ri*) are calculated as summations, as will become clear in section 3.3, the model prescribes the set of preference endowments at age *a* as:

$$\beta_a = \{\beta_a^h, \boldsymbol{\beta_a^e}, \beta_a^r, \boldsymbol{\beta_a^i}\}$$

β_a^h: An individual entering full-time education knows the exact course he will be attending, hence knows his preference reward in the forthcoming period, thus the preference reward for *h* takes only one value.

β_a^r: Similarly, an individual's choice of *r* is unique, hence the preference reward takes only one value. Though the course he will be offered for period *a+1* is unknown, this has no impact on his preference reward for period *a*.

$\boldsymbol{\beta_a^e}$: The decision to apply for full-time employment is, in contrast, with regard to the entire spectrum of *n* jobs available (very large *n*). The *nx1* preference endowment vector $\boldsymbol{\beta_a^e}$ prescribes the preference reward gained for each job.

$\boldsymbol{\beta_a^i}$: The decision to apply for an internship mirrors the full-time employment decision. The *nx1* preference endowment vector $\boldsymbol{\beta_a^i}$ prescribes the preference reward gained for each internship position.

Note preferences vary across each individual and each preference reward, including each element in the two vectors, can take any real number value. Furthermore, β_a updates at the start of every period given the individual's updated beliefs as a result of the past period(s).

3.3 Reward Functions

In each period, the individual receives reward based on the chosen action; reward may be negative. The following section discusses the reward functions for each action in every period, denoted by $R^k(S_a)\ \forall k \in K$, where S_a is the individual's state space at age a (the state space is updated each period according to shocks and the individual's evolving beliefs).

Full-time higher education, h

The UK loan system offers a tuition loan covering the entire cost of the course, repayable after graduation when the individual is earning over a certain threshold.[7] Hence, the financial cost of higher education is considered only as part of the decision to enter the workforce.

The individual does, however, gain reward from their preference endowment, β_a^h, and additionally from any non-repayable loans, such as bursaries or grants (which are offered to low income families), denoted w_a^h. The reward function is subject to a preference shock, ε_a^h. Hence, if an individual enters higher education they receive:

$$R^h(S_a) = \beta_a^h + w_a^h + \varepsilon_a^h$$

Though the reward function may be positive, the significant aspect is the reward gained from the impact of an increase in human capital / signalling value on wages when entering the workforce.

Full-time employment, e

An individual opting to enter the workforce must consider their expected wage. Wages are

[7] Students beginning in 2012/13 only begin repaying loan once earning over £21,000 per annum (Source: Directgov)

calculated as a function of previous level and quality of work experience, φ_a^e, level and quality of education, $\varphi_{a,l}^h$, and grade achieved, $\varphi_{a,g}^h$. The *nx1* wage vector at age *a* is given by:

$$\boldsymbol{w_a^e} = \boldsymbol{w_\varphi^h}(\varphi_{a,l}^h, \varphi_{a,g}^h) + \boldsymbol{w_\varphi^e}(\varphi_a^e) + \boldsymbol{\varepsilon}(\boldsymbol{w})_{\boldsymbol{j_a}}^{\boldsymbol{e}}$$

where $\boldsymbol{w_\varphi^h}$ and $\boldsymbol{w_\varphi^e}$ are *nx1* vector functions of education and work experience, respectively. They calculate the contribution to the wage the individual would receive for every job available, given by the vector $\boldsymbol{w_a^e}$. For example, the functions may be such that two individuals with differing work experience receive the same wage for a given job, or each individual’s wage offered for this job may reflect this difference in experience. The *nx1* vector $\boldsymbol{\varepsilon}(\boldsymbol{w})_{\boldsymbol{j_a}}^{\boldsymbol{e}}$ denotes the wage shocks in the business cycle state j_a.

The model supposes $\boldsymbol{w_\varphi^h}$ and $\boldsymbol{w_\varphi^e}$ are increasing functions, since the higher the level of education / work experience, the greater the value of human capital / signalling. Moffitt (2007) notes marginal returns to higher education fall as the number in higher educations rises.

If an individual elects to look for a new job, they are subject to a search cost, which varies according to the nature of the business cycle in the forthcoming period. An individual already in employment is not subject to this cost. Since the model does not assume an individual has a job offer, the reward function for choosing *e* is modelled as the expected reward using a *nx1* probability vector, $\boldsymbol{\Delta_{j_a}^e}$, the probability of receiving unemployment benefit and the search cost:

$$R^e(S_a) = (\boldsymbol{\Delta_{j_a}^e})^{\mathrm{T}} * (\boldsymbol{\beta_a^e} + \boldsymbol{w_a^e}) + (1 - \sum_{p \in \Delta_{j_a}^e} p) * w_{JSA,a}^e + \mathbb{I}_{a-1}^e * \gamma_{j_a}^e + \mathbb{I}_a^h * \gamma_{\%,a}^h * \gamma_{surp,a}^h + \varepsilon_a^e$$

where $w_{JSA,a}^e$ is the unemployment benefit received,[8] $\mathbb{I}_{a-1}^e$ is the indicator function equal to 0 if the individual is employed at the end of the previous period and 1 otherwise, and $\gamma_{j_a}^e$ is the search cost of finding a job in the business cycle state j_a. $\mathbb{I}_a^h$ is the indicator function equal to 0 if the individual earns below the loan-payback threshold, and 1 otherwise (an unemployed individual is exempt from loan repayments). $\gamma_{surp,a}^h$ is equal to the difference between the expected wage and the threshold. $\gamma_{\%,a}^h$ is the percentage of the surplus to be paid as the loan repayment.[9]

[8] Jobseeker’s Allowance (JSA) is unemployment benefit for those seeking jobs in the UK
[9] Any outstanding loans are written off after 30 years

Reapply to higher education, r

An individual elects to reapply if they are not satisfied with the university course on offer at the beginning of the period. Hence, they gain a reward from their preference endowment, β_a^r, but are subject to a search cost, γ_a^r, and preference shocks, ε_a^r:

$$R^r(S_a) = \beta_a^r + \gamma_a^r + \varepsilon_a^r$$

If the individual elects to enter higher education in the next period, they enjoy the utility of reapplying and being satisfied with their course through the preference endowment of higher education in the next period, β_{a+1}^h. If not satisfied, the individual has a similar decision to make in period *a+1*.

If an individual chooses *er*, the reward functions are summed in order to calculate $R^{er}(S_a)$.

Internship / work experience placement, i

An individual opting to apply for an internship is subject to a search cost depending on the business cycle, $\gamma_{j_a}^i$, though gains an expected utility preference endowment and is subject to shocks, ε_a^i:

$$R^i(S_a) = (\boldsymbol{\Delta}_{\boldsymbol{j_a}}^{\boldsymbol{i}})^{\mathrm{T}} * (\boldsymbol{\beta}_{\boldsymbol{a}}^{\boldsymbol{i}} + \boldsymbol{w}_{\boldsymbol{a}}^{\boldsymbol{i}}) + (1 - \sum_{p \in \Delta_{j_a}^i} p) * 0 + \gamma_{j_a}^i + \varepsilon_a^i$$

where $\boldsymbol{\Delta_a^i}$ is the *nx1* probability vector denoting the probability of each internship. $\boldsymbol{\beta_a^i}$, denotes the preference utility gained from each internship, and $\boldsymbol{w_a^i}$ is the *nx1* wage vector.

The reward function defines the expected reward gained from applying for an internship. The work experience gained from the internship, and hence the human capital / signalling value, increases the value of φ_a^e in the wage equation in future periods.

The shocks $\varepsilon_a = \{\varepsilon_a^h, \varepsilon_a^e, \varepsilon_a^r, \varepsilon_a^i\}$ are included to model the uncertainty that comes with real life. Without loss of generality, we can suppose the shocks are i.i.d and joint normally distributed.

3.4 Business Cycles, Probability Distributions, State Space & Updating Beliefs

Business Cycles

The state of the business cycle, j_a, in period a details the state of the economy and as such employment prospects, represented by the relevant variables in the model. In a downturn, though wages may not necessarily decrease, wage increases may be tempered or halted (representing a decrease in real wages given inflation), and as such it is necessary to consider the wage vector in light of the business cycle.

Similarly, since an ailing economy leads to increasing unemployment,[10] the search costs of finding employment increase, $\gamma_{j_a}^{e}$ and $\gamma_{j_a}^{i}$, as well as the probability of finding employment decreasing, hence $\sum_{p\in\Delta_{j_a}^{e}} p$ and $\sum_{p\in\Delta_{j_a}^{i}} p$ decrease. Supposing we are in a downturn period, since employment prospects are reduced, a trend of bottlenecking occurs, particularly in the graduate market. This may, in fact, have a great impact on the probabilities and wage functions for graduates in future periods, hence the best response for an individual may be to enter the workforce (rather than full-time education).

Probability Distributions

The probability vectors for employment, $\boldsymbol{\Delta}_{j_a}^{e}$, and internships, $\boldsymbol{\Delta}_{j_a}^{i}$, prescribe a probability distribution for all jobs / internships available. The probabilities are not only a function of past work experience, φ_a^e, and education, $\varphi_{a,l}^h$ and $\varphi_{a,g}^h$, but also consider a multitude of other factors affecting employment prospects, notably gender, ethnicity, educational background, family income and region of residence.[11]

Solving their problem, an individual must consider the expected values for future periods for $\varphi_{a,l}^h$ and $\varphi_{a,g}^h$ of the course offered and if they were to reapply. Once again, the above factors are key to calculating the probabilities of gaining a place on a given course, and then the grade attained.

Naturally, there is significant correlation (and hence strictly positive covariance) with many of the factors outlined. The model will thus classify them as ζ, where ζ does not change between periods.

[10] Carneiro, Guimaraes & Portugal (2009)
[11] Statistics for each of these demographics are available from UCAS

State Space and Updating Beliefs

The state space in each period consists of an individual's age, preference endowment, work experience, education experience, whether they ended the previous period with a job, unemployment benefit, outstanding debt from tuition loans and ζ:

$$S_a = \{a, \beta_a, \varphi_a^e, \varphi_{a,l}^h, \varphi_{a,g}^h, \mathbb{I}_{a-1}^e, w_{JSA,a}^e, \gamma_{surp,a}^h, \zeta\}$$

The state space evolves every period, as a result of the individual's choice of action in the past period(s). These updating beliefs are necessary to ensure a dynamic model, where an individual has the ability to learn from the previous period and can choose their strategy after learning of the current business cycle. Notably, with limited information prior studying the course on offer, an individual assumes they are able to achieve a 2.1, on the premise of being offered a place.[12] However, as the individual progresses through the course and takes examinations, their beliefs regarding their success update each period.

3.5 Maximisation Problem

The model now enables us to consider the individual's maximisation problem, as in Mann (2011). An individual maximises their present expected reward over all periods until the final period *A*, at a discount rate of *δ*. The individual's problem at age *a* is the value function:

$$V(S_a) = \max_{\boldsymbol{k} \epsilon \boldsymbol{K}} \mathbb{E}\left[\sum_{i=a}^{A} \delta^{i-a} R^{k_i}(S_i)\right]$$

where $\delta \epsilon (0,1)$, $\boldsymbol{k} = \{k_a, \dots, k_A\}$ defining the action chosen in each period, and $\boldsymbol{K} = \{K_a, \dots, K_A\} = \{K, \dots, K\}$ the set of choice sets for all periods.

Since 2.1% of all accepted UCAS applicants are above the age of 40,[13] we cannot define *A* to be a given age, after which only a non-significant number of individuals choose h. Hence, we can suppose *A* is the final year in which a decision is made, and retirement is taken at the end of

[12] 6 out of 10 students were awarded 2.1 or above in 2010 (Telegraph)
[13] Source: UCAS

this year. Were we able to define *A* < *retirement age*, we would be able to assume the individual opts for full-time employment in every period thereafter.

In all periods, with the exception of the final period *A*, the individual must choose a strategy based on the expected impact of the human capital / signalling value gained in period *a* on all future period rewards.

As discussed, since the individual does not know future shocks, business cycles or the course they will be offered were they to reapply, they must make a discounted expected reward maximisation decision, for $a < A$:

$$V(S_a) = \max_{\boldsymbol{k \epsilon K}} \mathbb{E}[V^k(S_a)]$$

where $V^k(S_a) = R^{k_a}(S_a) + \delta \sum_j \pi_{j_{a+1}|j_a} \sum_q \pi_{q_{a+1}} \mathbb{E}[V^{k_{a+1}}(S_{a+1})|S_a]$

where $\pi_{j_{a+1}|j_a}$ is the probability of the state of the business cycle in period *a+1* given the state witnessed at the start of period a. $\pi_{q_{a+1}}$ is the probability for the higher education course in the next period, if continuing on a course, reapplying or not applying i.e. $\sum_q \pi_{q_{a+1}} = 1$.

In period *A*, the individual maximises their expected reward for the immediate period only, since the action taken in the period has no impact on future periods. Thus, the individual’s problem at age *A* is:

$$V(S_A) = \max_{k_A \epsilon K} \mathbb{E}\left[V^{k_A}(S_A)\right]$$

where the individual chooses the action given the state space which has been updated using all the information gained from periods *a* to *A-1*.

See appendix A.2 for details on solving the problem using backward recursion.

4 Analysis

Though the previous section outlines a way to solve the individual's present value expected maximisation reward problem, we can, more usefully, manipulate the model to consider the strategies of individuals, universities and employers.

4.1 Individuals

Firstly, reconsider the individual's maximisation problem in the first period:

$$V(S_{18}) = \max_{k \epsilon K} \mathbb{E}\left[\sum_{i=18}^{A} \delta^{i-18} R^{k_i}(S_i)\right]$$

To mirror the real world, we note graduate roles typically enjoy higher than average salaries, known as the 'graduate premium'. Hence, we can see that given the state space at the start of the period, there exists a course and expected course (were the individual to reapply), to which the individual would be indifferent between the going to university, employment and reapplying. Let $\overline{\Phi}_a = (\bar{\varphi}^h_{a+1,l}, \mathbb{E}[\bar{\varphi}^h_{a+2,l}])$ denote the course offered in period a (i.e. the level of course to be attained at the start of period $a+1$) and the expected course to be offered in period $a+1$ if an individual reapplies.

Another aspect of the model, which has yet not been explicitly discussed, is the role of the strategies of other individuals and the effect on the expected payoffs. The actions of others impacts the probability distributions for employment and course offered if reapplying, as well as wage functions in all periods. For example, as the number of individuals choosing to enter employment in period a increases, the probability of getting a job decreases, as does the wage vector since the labour supply increases. However, this may cause an increase in graduate wages and probabilities, since the graduate labour supply decreases.

As discussed above, $\overline{\Phi}_a$ denotes the situation in which individual α is indifferent between all action choices in period a. We cannot, however, directly apply this to the overall game with all individuals, since the preferences for each individual, β^{α}_a, are different. An individual with a little respected course offer may value their choice of education a lot more than another individual with a highly respected course offer. Hence, if we ignore the reward gained from individual preferences, we can define the circumstances of indifference, $\bar{\bar{\Phi}}_a = (\bar{\bar{\varphi}}^h_{a+1,l}, \mathbb{E}[\bar{\bar{\varphi}}^h_{a+2,l}])$. Any individual with $(\varphi^h_{a+1,l}, \mathbb{E}[\varphi^h_{a+2,l}]) = \bar{\bar{\Phi}}_a$ would thus be indifferent, where if $\varphi^h_{a+1,l} > \bar{\bar{\varphi}}^h_{a+1,l}$ the individual’s best response would be full-time higher education, supposing $\mathbb{E}[\varphi^h_{a+2,l}] = \mathbb{E}[\bar{\bar{\varphi}}^h_{a+2,l}]$. It is easy to see the various relations between these indicators. The intuition here is that as the number of graduates increases, the probability of finding a ‘graduate premium’ job declines. Hence, as the course quality, probabilities of work and thus expected wages fall, we reach a scenario where enrolling on courses offered below $\bar{\bar{\varphi}}^h_{a+1,l}$ does not maximise $V^\alpha(S_a)$ for individual α.

We can now consider how $\bar{\bar{\Phi}}_{18}$ varies given the actions of employers and universities, where *a=18* is chosen to mimic the real world decision.

4.2 Employers

Consider the recruitment maximisation problem for employers, where they are seeking to optimize the amount they spend on recruitment and wages given expected revenue:

$$\max_{\boldsymbol{\gamma}^{emp}} \sum_{i=a}^{A} \delta^{i-a} \left[(\boldsymbol{\Delta}_i^{emp} * \boldsymbol{rev}_i^{emp}) - w_i^{emp} - \gamma_i^{emp} \right]$$

where $\boldsymbol{\Delta}_i^{emp}$ is the probability distribution for revenue, given the matching problem of applicants / employers, w_i^{emp} the wages paid out (for employees hired from period *a* onwards) and γ_i^{emp} is the recruitment cost in each period *i*. $\boldsymbol{\Delta}_i^{emp}$ is an increasing function in $\boldsymbol{\gamma}_i^{emp}$, since we assume the higher the investment in recruitment, the more information the employers have and the more likely they hire the most capable candidates. $\boldsymbol{\gamma}^{emp}$ denotes the vector $(\gamma_a^{emp}, \dots, \gamma_A^{emp})$.

School leaver hiring

Employers are increasingly showing a tendency to look towards school leavers as the source of their employees, citing the fact that graduates are expensive labour (OECD 2011 notes the UK as having on the highest global ‘graduate premiums’); though their marginal product may be higher, the wage demanded does not maximise the employer's payoff. Furthermore, Mortensen (1988) compares the notions of job matching vs. skill specific training, supporting the idea that hiring school leavers offers the employer the ideal opportunity to provide on the job skill-specific training, tying an employee to the firm and removing uncertainty from the matching problem.

Hence, we can see *ceteris paribus*, an increase in school leaver hiring (hence decrease in graduate hiring) to maximise the payoff function would cause a decrease in $\sum_{i=a}^{A} w_i^{emp}$. The probability distribution would narrow, which may cause a decrease in revenue (notably in earlier periods), hence expected revenue may fall, but the size of the reduction in wage bill would be larger.

Since demand for school leavers increases, the expected value of entering employment without higher education increases, whilst the probability of a 'graduate premium' job falls, hence we see an increase in $\bar{\bar{\Phi}}_{18}$.

Recruitment processes

In order to maximise their payoff, employers are using increasing levels of screening and assessment in the recruitment process, learning more about applicants and shifting $\boldsymbol{\Delta_a^{emp}}$ to the right, thus increasing expected revenue even though costs, γ_a^{emp}, increase. These methods, such as psychometric tests and assessment centres, also increase the search cost for individuals, $\gamma_{j_a}^{e}$. We can consider arbitrary *a* here, since wages are unchanged.

Considering $\bar{\bar{\Phi}}_{18}$ again, we can see that those on the best courses gain more from recruitment where the employer has limited information, since the employer uses the course as its main screening tool, prior to interviews. However, since employers know they will learn a lot more about each candidate, both prior and during the interview / assessment centre process, they are more willing to consider those from courses closer to $\bar{\bar{\Phi}}_{18}$ since the cost is limited, but the upside is finding an exceptional candidate.

The role of internships also witnesses a similar situation. Though search costs, $\gamma_{j_a}^{i}$ negatively affect expected reward, employers are increasingly willing to look beyond the best courses for interns; again, the cost is limited, but the probability distribution, $\boldsymbol{\Delta_a^{emp}}$, shifts to the right. Although these factors reduce the expected reward for the higher courses, university is still the maximising action. Interestingly, individuals with lower screening value through their course enjoy these additional screening methods, thus the probability of achieving a ‘graduate premium’ job increases, hence the set of courses maximising the expected reward function increases i.e. $\bar{\bar{\Phi}}_{18}$ decreases.

4.3 Universities

Consider the teaching problem for universities as the income from tuition fees minus the teaching cost, in any given period a:

$$\max_{\varphi^{uni}_{a-1,g},\gamma^{uni}_{a}} f_a(\varphi^{uni}_{a-1,g},\gamma^{uni}_{a}) * w^{uni}_{a} - \gamma^{uni}_{a}$$

where $\varphi^{uni}_{a-1,g}$ is the grading behaviour, γ^{uni}_{a} the teaching cost, w^{uni}_{a} the tuition fee per course and $f_a(\cdot)$ a demand function for the university in period a, given its grading behaviour in the previous period and spending on teaching in this period; $f_a(\cdot)$ is increasing in γ^{uni}_{a}.

Grade inflation

Suppose universities maximise their payoff by attempting to encourage more students to join their university by increasing the number of higher grades awarded (notably 2:1 and 1st) i.e attempting to increase $f_a(\cdot)$.[14] The intention is to increase the probability of achieving a good grade and hence increase employment prospects. However, if we suppose all universities are following a similar strategy, each individual is aware of the increased probabilities and hence knows they will be competing with more graduates and employers will value their grade less i.e. $\boldsymbol{\Delta}^{e}_{j_a}$ shifts to the left and $\varphi^{h}_{a,g}$ has less of an impact on the wage function.

Subsequently, since more candidates survive the mass screening mechanisms, employers will have to increase their screening thresholds, most notably grade, $\varphi^{h}_{a,g}$, and course, $\varphi^{h}_{a,l}$. Thus, courses closer to $\bar{\bar{\Phi}}_{18}$ will suffer from increased mass screening, hence $\bar{\bar{\Phi}}_{18}$ rises.

[14] Note that the demand function here considers individual preferences; we are looking at the impact of realistic events to the equilibrium $\bar{\bar{\Phi}}_{18}$

Teaching cost

Waghid (2006) and Walker (2001) both argue for changes to the teaching styles in university, most notably a move away from the teacher / student mass education style to a more deliberative style of teaching. Suppose universities take such action, which naturally comes with an increase in γ_a^{uni}, whereby the demand function increases to cover this cost increase.

As a result of increased human capital gained through university, as argued by Waghid, individuals would be compensated higher for their course and grade in the wage function through an increase in $\boldsymbol{w}_{\boldsymbol{\varphi}}^{\boldsymbol{h}}(\varphi_{a,l}^h, \varphi_{a,g}^h)$. Henceforth, since we assume the competition moves in line, thus probabilities remain unchanged for a 'graduate premium' job, the expected wage increases due to $\boldsymbol{w}_{\boldsymbol{\varphi}}^{\boldsymbol{h}}(\varphi_{a,l}^h, \varphi_{a,g}^h)$, thus $\bar{\bar{\Phi}}_{18}$ will fall since going to university now offers greater expected reward than previously.

5 Evaluation

As demonstrated in the previous sections, the model demonstrates great flexibility and considers a wide range of issues. It tackles many of the issues raised in the literature review, notably the issue of updating beliefs, as well as offering an insight into the strategy of an individual given the strategies of others.

The model could be extended to an econometric model, which would help test the theoretical model and offer a more comprehensive model. Using data available regarding university courses (UCAS) and grades, expected wages (ONS), business cycle expectations, unemployment rates (ONS), given the various demographics and accounting for covariance, reasonable estimations to the maximisation problem can be calculated. Since the model's probability distributions $\boldsymbol{\Delta_a^e}$ and $\boldsymbol{\Delta_a^i}$ are so extensive and almost impossible to numerically calculate, any econometric test would have to use a broader set of jobs, with which to assign probabilities. Bajari, Benkard and Levin (2007) describe an algorithm for estimating dynamic games. The paper requires the game to be consistent with Markov perfect equilibrium, notably the memoryless property and subgame perfect equilibria, whereby the model here satisfies both since each action is based on the previous period with updated beliefs.

Related to this is social and character building aspect of higher education, and the associated growth in the manner in which an individual's beliefs change; a very difficult factor to apply expected maximisation theory to, even in light of updating beliefs each period, since intra-period changes could be large and significant, affecting the preference endowments, β_a, in particular.

The model does not attempt to tackle the issue of human capital vs. screening, since the topic is one which would require extensive discussion, as highlighted, and would necessitate a model of great complexity in order to model reality, if it is at all possible given the disagreement amongst scholars.

6 Conclusion

We must consider all concluding remarks in light of the criticism raised in the previous section. However, we have created a model which successfully consider the choices faced by individuals and the relationship between the expected value and the numerous variables affecting this expectation.

The ability to use the model to consider $\overline{\overline{\Phi}}_{18}$ demonstrated that individuals would be more likely to go to university under increased use of psychometric tests and recruitment assessment methods, but would be less likely to attend if there were a shift to school leavers.

Similarly, grade inflation would lead to lower numbers attending university (ignoring individual preferences), whereas increased spending on teaching would, unsurprisingly, increase attendance.

Though $\overline{\overline{\Phi}}_{18}$ ignores individual preferences, we can usefully intimate the behaviour of individuals given the above findings. We would instead see a shift relative to the individual's $\overline{\Phi}_a^{\alpha}$ and thus we can argue the relationships can be directly applied to the original model.

For further studies, the model could usefully be manipulated and extended to 16 year olds; 23.7% of 16-18 year olds were in employed or NEET ("not in education, employment or training") in 2005.[15] Since the decision to go to university is preceded by A-Levels, we could pose the necessary prior question, "should I go to sixth-form, Sir?"

[15] Source: Learning and Skills Council (LSC) (2006)

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A Appendix

A.1 Actions – combinations and constraints

The individual can enter higher education, *h*, and may also apply for an internship, *i*, subject to a search cost. If the individual enters full-time employment, *e*, they are unable to apply for an internship. They may however reapply to higher education, *r*, for enrolment in the next period, at a search cost; individuals already in higher education may also reapply with the same search cost. This allows individuals to apply for a place on a more desirable course than that offered in the first period. If an individual chooses only to reapply, we assume they are able to put in more time to their application and will be more successful in retaking examinations given the increased time endowment available for studying; they may also apply for an internship. An individual can take a gap year (with no internship or education), *y*, and may also reapply. Finally, an individual can apply for an internship alone.

hr: If an individual enters higher education, the individual would reapply if the course is too tough or easy. We suppose it would take at least a term for the individual to have enough information to make a judgement about the entire course and update his beliefs regarding this element. However, since the university application system deadline is early January, the individual can only choose *hr* **without** these updated beliefs. Since an individual only enters university if satisfied with the course, the individual accepting the course and reapplying would contradict the supposition the individual is satisfied.[16]

y, yr: We suppose an individual would not take a gap year solely, due to the opportunity cost of entering the workforce, irrespective of higher education. The model supposes a year of work experience is more valuable in both the current period and the wage function (considering future periods) than a gap year. This also demonstrates that *er* dominates *yr* in terms of strategy.

i: An individual would always opt for *e* over *i*, since a year of employment is more valuable than an internship in the wage function.

[16] Though the final deadline is in March, post-January applications do not have to be considered; similarly, less than 2% of all applications were through clearing in 2011 (Source: UCAS)

A.2 Solution to individual's maximisation problem

Due to the similarity of solving the problem with Mann (2011) and the focus of this project, the solution method has been included here for reference only

For completeness, we will briefly discuss solving the maximisation problem. Solving from the final period backwards, an individual maximises his choice of action as above. In period *A-1*, the individual maximises his choice of action given S_{A-1} and the discounted expected reward in period A. The individual must thus calculate the expected reward in period *A*, considering $\forall k \epsilon K$, which takes the form of a multivariate integral, given the i.i.d shocks:

$$\mathbb{E}[\max_{K}[R^{k_A}(S_A)|\bar{S}_{A-1}]] = \int \dots \int \max_{K}[R^{k_A}(S_A)|\bar{S}_{A-1}] * f(\varepsilon_a)\, d\varepsilon_a$$

where $\bar{S}_a$ is S_a excluding ε_a. The integral calculates the expected maximum reward function in period *A* given $\bar{S}_{A-1}$ and the i.i.d shocks.

Continuing the backward recursion, an identical process can be undertaken for each prior period, ensuring to discount correctly; the process is repeated until a is 18 (as prescribed by the model in period 1).