Breadth vs. Depth : The Effect of Academic Specialization on Labor Market Outcomes

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Abstract

Some systems of higher education require students to choose a major field of study prior to entering university whereas others allow students to postpone this choice. I develop a model of specialization in which individuals receive noisy signals of match quality and accumulate specific skills by taking courses in different fields of study. With later specialization, there is more time to learn about match quality in each field but less time to acquire specific skills once a field of study is chosen. I examine the predictions of this model within the British system of higher education using university administrative data from 1973-1993 and survey data on university graduates in 1980. I find that individuals in the Scottish undergraduate system, where specialization occurs relatively late, are less likely to switch to an occupation that is unrelated to their field of study than their English counterparts. According to the model, this suggests that being well matched to an occupation is relatively more important than having occupation-specific skills. No such difference is found at the graduate level where both the English and Scottish systems coincide in the timing of academic specialization. I also find strong evidence in support of the prediction that individuals who switch earn lower wages. Moreover, this wage differential is larger in Scotland than in England for individuals with greater academic success in high school. Finally, and consistent with the model, individuals who switch experience greater wage growth and higher occupational mobility.

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1 Introduction

Division of labor is an integral aspect in modern society and specializing in one occupation remains an essential feature of the labor market experience. However, in many professional and highly skilled occupations, specialization occurs prior to entering the labor market when an individual chooses a major field of study in university. The timing of such academic specialization varies widely across different systems of higher education: in some systems, students are required to choose a field of study early, while in others, students may postpone this decision until much later. This paper examines the effect of specializing early versus late on wages, mobility, and the the likelihood of switching to an occupation unrelated to the chosen field of study at university. I develop a simple model of specialization in which individuals receive noisy signals of match quality and accumulate specific skills by taking courses in different fields of study. Then I examine the predictions of this model in the context of the British system of higher education.

The American system of higher education is often cited as an example of a broad undergraduate curriculum with relatively late specialization. Compared to many other countries, the US has a strong liberal arts tradition that emphasizes general education and allows students to delay the choice of a major field of study until the second or third year of college.[1] As some observers have argued, "the American tradition of encouraging students to try out new fields, particularly in the first year or two . . . avoid[s] the kind of premature academic specialization characteristic of European university first degrees." (Johnstone and Maloney, 1998, p.25) However, not all European university first degrees are alike. And apart from certain distributional requirements which are often quite minimal, the American system does allow individuals to specialize early if they wish. Thus, the American system of higher education is not so much characterized by a broad curriculum and late specialization as by flexibility in breadth and timing of academic specialization. While an assessment of the American system is also of considerable interest, this paper will focus on the differences within the British system of higher education where the effect of specializing early versus late may be exogenously identified.

Within Great Britain, the Scottish system of higher education is in marked contrast to the English one: "the Scottish pattern differs from that in England and Wales in being broader. First year Scottish students may well study four or five subjects rather than the maximum of two [and usually one]...followed by their English counterparts, and will typically be admitted to

[1] On a related note, Goldin (2001) writes that "the [US] nation that led the world in mass education chose formal, general schooling and not specific, apprenticeship or on-the-job training as the premier method of investing in human capital." She suggests that the divergence from European educational templates may be a consequence of the high geographical mobility in the US.

a faculty rather than a department." (Squires, 1987, p. 157) These differences have remained largely unchanged throughout the twentieth century.[2] Furthermore, labor markets in England and Scotland are relatively well integrated, macroeconomics shocks tend to affect both nations similarly, and common datasets exist that enable consistent comparisons. Thus, Britain offers a unique setting in which to investigate the consequences of different timings of academic specialization.

I develop a theoretical framework to analyze the consequences of specializing earlier versus later. I assume that individuals study a number of different fields prior to specialization. At some point, individuals specialize by choosing one major field of study and continue to study this field exclusively. Upon completing their education, individuals enter the labor market and choose whether to enter an occupation that is related to their chosen field of study or switch to an unrelated occupation. With each course taken in a given field, individuals accumulate skills and receive noisy signals of their match quality to that field. Individuals in regimes characterized by early specialization will take fewer courses in each field prior to specialization and more courses in the chosen field following specialization. Assuming that wages depend positively on both match quality and skills, this simple setup allows for quite a rich analysis of labor market consequences that arise within different regimes. I derive predictions on the probability of switching to an occupation unrelated to the chosen field of study and on wages differentials conditional on such occupational switching.

The predictions of the model are tested directly with UK administrative and survey data on recent graduates from English and Scottish universities. I find that individuals in the Scottish system, where specialization occurs relatively late, are less likely to switch to an unrelated occupation than their counterparts in England. Furthermore, I find evidence in support of a related occupation wage premium in both systems: individuals that switch earn lower wages. I explore the differential in the related occupation wage premium across regimes and provide suggestive results on other long-term labor market outcomes.

To my knowledge, the effect of academic specialization on labor market outcomes has not been examined previously. Indeed, the economics literature is scarce on the effects of different systems of higher education in general. A related study by Dolton and Vignoles (2002) examines whether individuals that choose a broader set of courses in secondary schools in the UK receive a wage premium (and do not find significant returns to a broad curriculum). Altonji (1995) finds

[2] Only recently have certain English institutions begun to introduce course structures that include more breadth and offer greater flexibility (outside the time-period of the present analysis).

the return of additional courses in academic subjects to be small. Several studies investigate whether individuals end up working in occupations related to their major fields of study or training.[3] Theoretical treatments of occupational matching and mobility have been offered by several economists but these are mostly tangential to the present analysis.[4]

The paper proceeds as follows: Section 2 provides a theoretical framework to analyze the consequences of different timings of specialization. Section 3 explores the differences between the English and Scottish systems of higher education in more detail. Section 4 describes the data and the empirical methodology. Section 5 presents results from the regression analysis. Section 6 concludes.

2 Theoretical Framework

This section describes a simple model to characterize the differences between a regime in which individuals are required to specialize early and a regime in which individuals are required to specialize late. Consider the following setting: Individuals are risk neutral and study n courses in each of J fields prior to specialization. Following specialization, individuals study $(N - nJ)$ additional courses in the chosen field of study. Each course in a given field provides a unit of skill and a noisy signal of match quality in that field. After completing a total of N courses, individuals enter the labor market and earn a wage that depends positively on both match quality and field-specific skills. Comparative statics results can be derived by assuming that individuals in the early regime specialize after n^E courses while individuals in the late regime specialize after n^L courses, and that $n^E < n^L$ (so that individuals in the early regime take fewer courses prior to specialization than individuals in the late regime).[5]

I begin by presenting a general framework to analyze the timing of specialization. I proceed to examine a baseline case in which individuals have to enter an occupation in their chosen field of study. Compared to those that specialize later, individuals that are required to specialize early

[3] These include Freeman (1971) who examines how matching to a related occupation varies across majors and Wolbors (2002) who examines the effect of "job mismatches" across different European nations.

[4] Johnson (1978) examines the demand for general and specific education in the presence of occupational mobility. McCall (1990) develops a theory of job matching with an occupation-specific component so that for individuals that have switched job but remained in the same occupation, increased tenure in the previous job lowers the likelihood of separation from the current job. Weiss (1971) shows that individuals that specialize in one occupation should concentrate their investment in education as soon as possible.

[5] Note, we can also investigate differences in the initial breadth of two regimes by positing a different number of required fields of study prior to specialization (J^{Broad} vs. J^{Narrow}). A more general approach might allow different degrees of specializations throughout the educational process with progressively fewer subjects studied over time. Thus, it is quite appropriate to view differences between early and late regimes as a certain type of variation in the breadth of curriculum.

are more likely to make a mistake in choosing a field but will have more time to accumulate specific skills in the chosen field over the course of their education. Consequently, individuals in the late regime will have higher expected wages than their counterparts in the early regime only if the relative return of match quality to skills is sufficiently high.

Then, I allow for the possibility of switching to an alternative field upon entering the labor market and derive predictions on expected wages both within and between regimes.[6] For individuals in the early regime, assessments of perceived ability in the chosen field are more likely to change following specialization and hence, these individuals are more likely to conclude that they made a mistake in choosing a field. However, individuals in the early regime will also lose a greater level of field-specific skills if they do switch. Individuals in the early regime will therefore have higher rates of switching only if there is a sufficiently high relative return of match quality over skills. Within regimes, individuals that do not switch should receive a wage premium since they do not experience any loss in skills and have, on average, higher match quality than individuals that do switch. Comparisons of expected wages and expected wage premiums across regimes will, again, depend on the relative return of match quality to skills in the wage function.

2.1 Setup

Assume that individuals have an identical prior distribution on match quality for all fields that follows a normal distribution with mean μ and and precision p.[7] Match quality, m_j, in each field is a random draw from this prior distribution, so that $m_j = \mu + \xi_j$ where $\xi_j \sim N(0, \frac{1}{p})$.[8] In other words, individual match quality is not correlated across fields and there are no ex-ante differences in expected ability across individuals. Note that in the empirical work, I will attempt to control for indicators of predictable match quality so that the remaining components of match quality are random. Further note that match quality can also be interpreted as the return from a specific field (so that learning about match quality amounts to learning about labor market

[6] Note, in order to simplify the analysis in the presence of switching, I will often consider the special case where there are only two courses and two fields: $N = 2$ and $J = 2$. In this case, individuals in the late regime will study one course in each field prior to specialization and no courses following specialization: $n^L = 1$; individuals in the early regime will specialize prior to studying any courses and then study two courses in the chosen field: $n^E = 0$. The more general model will be explored through simulations.

[7] In general, we expect that priors on match quality will differ across fields and across individuals. Allowing for different priors among fields will require explicit consideration of the relative option value in each field when switching is permitted (which is otherwise identical across fields). This possibility will be further discussed in the section on extensions to the model.

[8] Match quality includes any field-specific component that affects wages (ability, interest, etc.). Indeed, we can broaden this definition to include any field-specific component that affects utility (life-style considerations, etc.) by replacing the objective wage function with a utility function. Implications for wage regressions with a broader definition of match quality will be discussed further in a later section.

conditions in different fields).

In taking a course in a given field, individuals accumulate skills and receive noisy signals of their match quality in that field. For simplicity, suppose that the quantity of skills accumulated in a field, s_j, is equivalent to the number of courses spent studying that field.[9] Each course of study i in field j provides a signal of match quality in that field, $y_{ij} = m_j + \varepsilon_{ij}$ where $\varepsilon \sim N(0, \frac{1}{p^\varepsilon})$.[10] Then the posterior distribution of match quality after studying n courses in field j is a normal distribution with mean μ'_j and precision $p + np^\varepsilon$ where:

$$\mu'_j = \frac{\mu p + p^\varepsilon \sum_1^n y_{ij}}{p + np^\varepsilon}$$

Thus, time spent studying one field does not allow individuals to assess their match quality in other fields. Moreover, the only way to accumulate skills in a certain field is to spend time studying that field.[11] And the quantity of skills in each field immediately prior to specialization is $s' = n$.

After studying n courses in each field, risk neutral individuals will choose the field of study with the highest posterior mean of match quality: $j^{\max} = \arg\max\{\mu'_j\}^J$. Clearly, the field with second highest posterior mean will be $j^{2^{nd}\max} = \arg\max\{\mu'_j\}^J_{j \neq j^{\max}}$. Hence, the highest and second highest posterior means of match quality at the time of specialization will be $\mu'_{j^{\max}}$ and $\mu'_{j^{2^{nd}}\max}$ respectively, each with precision $p + np^\varepsilon$, where:

$$\mu'_{j^{\max}} = \frac{\mu p + p^\varepsilon \max_j \{\sum_1^n y_{ij}\}}{p + np^\varepsilon} \quad \text{and} \quad \mu'_{j^{2^{nd}}\max} = \frac{\mu p + p^\varepsilon \max_{j \neq j^{\max}} \{\sum_1^n y_{ij}\}}{p + np^\varepsilon}$$

Following specialization, individuals will take an additional $(N - nJ)$ courses in the chosen field. So the quantity of skills in the chosen field after receiving the additional signals is $s'' = n + (N - nJ)$. Moreover, individuals will also recieve additional signals in the chosen field, $j^{\max}$. Define these signals as $z_{kj^{\max}} = m_{j^{\max}} + \varepsilon_{kj^{\max}}$. Consequently, the posterior distribution of match quality in the chosen field after $(N - nJ)$ additional signals will also be a normal

[9] I thereby assume that the acquisition of skills is independent of match quality. Allowing for a positive interaction between skills and match quality, i.e. $\widehat{s}_j = s_j e^{m_j}$, will not affect the qualitative predictions of the model. It will merely strengthen the relative importance of match quality and yield predictions closer to the case where α is high relative to β.

[10] The noise in the signal may be due to any number of idiosyncratic factors such as quality of instruction or the particular circumstances of the student at the time.

[11] Allowing for spillovers in knowledge or skills does not alter the qualitative predictions of the model. However, the presence of spillovers does lessen the effect of specialization since learning and accumulation of skills in other fields continues even following specialization.

distribution with mean $\mu''_{j^{\max}}$ and precision $p + np^{\varepsilon} + (N - nJ)p^{\varepsilon}$ where:

$$\mu''_{j^{\max}} = \frac{\mu p + p^{\varepsilon}\left(\max_j \{\sum_1^n y_{ij}\} + \sum_1^{N-nJ} z_{kj^{\max}}\right)}{p + np^{\varepsilon} + (N - nJ)p^{\varepsilon}}$$

The wage in field j upon entering the labor market will be an increasing function of both match quality and skills: $w_j = f(m_j, s_j)$ so that $f'(m) > 0$ and $f'(s) > 0$. Specifically, I assume that wages are an exponential function so that log wages are linear in match quality and skills and identical across fields: $w_j = \exp\left[\alpha\left(m_j\right) + \beta\left(s_j\right)\right]$.[12] For convenience, I shall take $\left(\frac{\alpha}{\beta}\right)$ as an indication of the relative return to match quality. More generally, we might expect a different functional form for wages across different fields.[13] Note that, in this model, there is no independent definition of general skills. One may be said to have general skills only in so far as one has greater levels of skills in alternative fields and this affects wages only case of switching to one of these fields.[14]

2.2 Baseline case: No switching

Suppose that individuals must enter an occupation in their chosen field of specialization, $j^{\max}$. Clearly, individuals that specialize later will have less time to accumulate specific skills in their chosen field of study. However, individuals that specialize later will receive more signals prior to specialization. They will therefore have more accurate assessments of their match quality in each field and will be less likely to make a mistake in choosing a field.[15] Thus, match quality will, on average, be higher for individuals in the late regime. Whether individuals in the early regime ultimately earn higher expected wages than their counterparts in the late regime will depend on the relative return of match quality.[16]

Proposition 1 *There is some* $\left(\frac{\alpha}{\beta}\right)^*$ *such that individuals in the early regime will have higher expected wages than individuals in the late regime if* $\frac{\alpha}{\beta} < \left(\frac{\alpha}{\beta}\right)^*$ *and lower wages if* $\frac{\alpha}{\beta} > \left(\frac{\alpha}{\beta}\right)^*$.

[12] Note, I will be lax on terminology henceforth and generally refer to wages when I mean log wages: $\ln w_j = \alpha\left(m_j\right) + \beta\left(s_j\right)$.

[13] Note that differences in the means of wages across fields can be scaled easily without any change in predictions. Differences in the functional form of wage functions across fields (i.e. the relative return of skills vs. match quality) will affect switching behavior as well as wages. This will be examined further in the empirical section with regressions by field.

[14] Nevertheless, it would be relatively simple to incorporate general skills into the wage function by including some measure of average skill: $\overline{s} = \frac{1}{J}\sum s_j$.

[15] Note, one can also show that the probability of making a mistake is decreasing in p^{ε} (since the signals are more accurate).

[16] One can also show that the optimal point of specialization, n^*, is decreasing in the relative return to match quality, $\frac{\alpha}{\beta}$.

Proof. See Mathematical Appendix ■

Figure 1 plots expected wages from simulations with different relative returns to match quality.[17] Hence, in the case where there is no switching upon entering the labor market, there is a clear tradeoff between skills and match quality in specializing early or late. If skills contribute a lot to wages then individuals will face a high penalty for specializing later. Individuals that specialize early are able to accumulate more specific skills in the chosen field of study whereas individuals that specialize later are able to learn more about their match quality and thereby choose more accurately.

2.3 Probability of switching

Now suppose that individuals can switch to an alternative occupation upon entering the labor market. Clearly, if individuals decide to switch, they will always choose the field with the second-highest posterior mean $j^{2^{nd}\max}$ since all fields other than the one chosen are associated with the same quantity of specific skills and posterior precisions. Hence, all of the analysis can be framed as a comparison between the first best field $j^{\max}$ and the second best field $j^{2^{nd}\max}$ at the time of specialization.[18] Individuals will consider switching if they perceive a mistake in their choice of field $j^{\max}$ due to realizations of subsequent signals of their match quality.

Individuals in the early regime receive more signals in the chosen field after specializing than their counterparts in the late regime. Assessments of perceived match quality in the chosen field will therefore experience relatively greater updating and lead individuals in the early regime to be more likely to conclude that they made a mistake in choosing a field at the point of specialization.[19] However, in switching, individuals will lose the additional skills acquired in the chosen field of study through specialization. Individuals will switch only if the posterior mean of the first best field falls sufficiently below that of the second best field at the time of specialization to overwhelm the loss in specific skills. But the loss in specific skills will always be greater in the early regime. Consequently, whether the probability of switching is higher in

[17] All simulations take $J = 2$, $N = 201$, $\mu = 10$, $p = 4$, and $p^{\varepsilon} = 64$. Furthermore, I assume that $\alpha + \beta = 1$ and normalize the quantity of skill by N. Each simulation is based on 2000 repetitions.

[18] Comparisons to all fields must be considered if we allow for different prior distributions across fields.

[19] Specifically, the posterior distribution likely to change more in response to the additional information in the early regime. Hence, the mean of the posterior distribution of the chosen field is more likely to move below the posterior mean of the second best field at specialization and indicate a perceived mistake. This is particularly intuitive in the simple case where $N = 2$: For individuals in the late regime that only study a course in each field prior to specialization, the probability of perceiving a mistake will be 0 since no additional information is received following specialization. For individuals in the early regime that only study two courses in the chosen field following specialization, the probability of preceiving a mistake will be exactly $\frac{1}{2}$ (because the signal is symmetric about the prior mean).

the early regime will depend on the relative return of match quality.[20]

Proposition 2 *There is some relative return of match quality,* $\left(\frac{\alpha}{\beta}\right)^{**}$*, such that the probability of switching,* $\Pr(w''_{j^{\max}} < w'_{j^{2nd\max}})$*, is higher in the early regime if* $\frac{\alpha}{\beta} > \left(\frac{\alpha}{\beta}\right)^{**}$ *and lower if* $\frac{\alpha}{\beta} < \left(\frac{\alpha}{\beta}\right)^{**}$.

Proof. See Mathematical Appendix ■

Figure 2 plots the probability of switching from simulations with different relative returns to match quality. Observing a higher rate of switching in the early regime than in the late regime (as we will indeed observe in the empirical section) would indicate a high relative return to match quality.

2.4 Wages

Given the important distinction made between individuals that choose occupations related to their fields of study and those that switch to unrelated occupations, predictions on wages are derived both within and between regimes. In the former category, we predict the presence of a wage premium for individuals that do not switch. In the latter category, we examine the differential in the related-occupation wage premium and the difference in overall (unconditional) expected wages between the two regimes.[21]

The quantity of specific skills for individuals that switch is always lower than for individuals that do not switch. Furthermore, match quality conditional on switching is also lower since chosen fields with lower match quality are ones that ultimately lead to bad signals and resulting switches. Thus, on average, individuals that switch will have both lower match quality and lower levels of specific skills than those that do switch. [22]

Proposition 3 *There is a positive related-occupation wage premium: Individuals that switch will have lower expected wages than individuals that do not switch.*

Proof. See Mathematical Appendix ■

[20] Unfortunately, the simple case of $N = 2$ is not sufficiently rich to contain the case of a higher probability of switching in the late regime than in the early regime (since individuals never switch in the late regime).

[21] The differential in the related-occupation premuim does not fully capture all possible wage predictions between regimes. However, a complete ranking of expected wages by switching behavior and regime will not be considered here.

[22] Note that in the case where $N = 2$, individuals in the late regime will never switch. However, for the purposes of comparison, we can consider the case where individuals in the late regime switch for exogenous (or irrational) reasons.

Clearly, the differential in specific skills between individuals that do not switch and those that switch will always be greater in the early regime than in the late regime (since $s''-s'$ is decreasing in n). Hence, if the relative return to skills were sufficiently high, the related-occupation wage premium would also be greater in the early regime than in the late regime. However, whether the differential in match quality between switchers and non-switchers is greater in the late regime than in the early regime depends on the relative probability of making a mistake conditional on switching and the relative probability of switching in the two regimes.

Proposition 4 *The related-occupation wage premium will be higher in the early regime than in the late regime if the return to match quality is sufficiently low. There exist parameter values such that the related-occupation wage premium is higher in the late regime.*

Proof. See Mathematical Appendix ■

Figure 3 plots the wage premium from simulations with different relative returns to match quality. Predictions on overall wages across the two regimes will likewise depend on the relative return to match quality, probability of making mistakes, and the probability of switching in the early and late regimes:

Proposition 5 *There is some* $\left(\frac{\alpha}{\beta}\right)^{***}$ *such that individuals in the early regime will have higher expected wages than individuals in the late regime if* $\frac{\alpha}{\beta} < \left(\frac{\alpha}{\beta}\right)^{***}$.

Proof. See Mathematical Appendix ■

Figure 4 plots overall expected wages from simulations with different relative returns to match quality. Thus, wage predictions across regimes will generally not be unambigious. This accords with the result from the baseline case described earlier and suggests that the superiority of one regime over the other depends critically on the relative return of match quality and skills, as well as other parameters (such as the precision of the signals, variance of the prior distribution, and exact course structure and timing of specialization.

2.5 Extensions

Throughout we assume that individuals are risk neutral. Introducing risk aversion will not alter the decision at the point of specialization since the precisions of the posterior distributions across fields are identical; individuals will continue to choose the field with the highest posterior mean. However, in considering a switch, the presence of risk aversion will make the relative precisions of the posterior distributions relevent. In particular, switches may be less common because

even in instances where the chosen field has a lower posterior mean than another field, its lower variance may be sufficiently valuable to risk averse individuals to prevent any consideration of switching. Morever, this effect is greater in the early regime since the trade-off between the variances of the posteriors at time of specialization and the posterior of the chosen field after the receipt of additional signals will be more extreme. Hence, we might expect the difference in switching between the early and late regimes to be smaller in the presence of risk aversion.[23]

The assumption that the prior distributions on match quality are identical across fields is necessary to avoid option value considerations. Under this assumption, the choice of field of study at the point of specialization is not affected by the possibility of later switching. However, allowing for different prior distributions on match quality across fields implies that individuals are forward looking. Fields with a larger prior variance would have greater option value in the early regime than in the late regime.[24] Hence, individuals in the early regime are more likely to choose a field with a lower posterior mean at the point of specialization because of a greater option value. Since such fields have a lower ex-ante probability of having the highest match quality than the field with the highest posterior mean, we expect more switching in the early regime due to option value considerations.[25]

The model presented above does not contain any dynamic labor market effects such as wage growth and occupational mobility. If we suppose that there are diminishing returns to skills, we might expect that wage growth is higher for individuals that switch to unrelated occupations. Whether the differential in wage growth between non-switchers and switchers is greater in the early regime or late regime will depend on the relative return to match quality.[26] We can introduce job mobility by assuming that true match quality is revealed on the job. This fits well into the model since individuals receive wages which depend on actual ability (rather than perceived ability). Therefore, once individuals discover their true match quality, they may decide that they prefer to change jobs. Unfortunately, this apparantly simple modification substantially complicates the analysis since individuals may now alter their switching behavior

[23] Note, however, that effect of risk aversion diminishes with n since the variance of the posterior distribution converges at a rate $\sqrt{n}$.

[24] More signals following specialization and consequently greater updating in the early regime assures a higher probability that the ultimate posterior mean will surpass that of the chosen field.

[25] Note that this effect is probably small since the option value needs to be greater than the difference in the posterior means of match quality between the relevant fields. Furthermore, the presence of risk aversion would counteract the benefits of having high variance in the posterior distributions.

[26] On the one hand, individuals in the late regime are more likely to have higher match quality in the field to which they switch since they received more signals on each field prior to specialization. On the other hand, individuals in the early regime that switch are likely to have a greater return to skill accumulation since they begin with less skills.

in response to the knowledge that they may later change jobs in case of an erronous switch. Nevertheless, we might expect that individuals that have already switched are more likely to change occupations once in the labor market since they will lose relatively less specific skills. These dynamic outcomes will be examined further in the empirical section even though they are currenlty outside the scope of the model proper.

3 Background: Higher Education in Great Britain

The British system of higher education provides a unique setting in which to examine the predictions of the theoretical framework. Higher education in England and Scotland, though similar in aim and overall structure, varies widely in curriculum breadth and in admissions procedures. In England, students generally apply for a specific field of study at a particular university.[27] Once admitted to a specific field of study, English students usually follow a narrow curriculum that focusses on the main subject and allows for little study of other subjects.[28] In contrast, Scottish students are typically admitted to a faculty rather than a department; in some cases (e.g. University of Stirling), admission is to the university at large. Moreover, Scottish students "who intend to take an honours degree are generally required to take classes additional to their honors subjects in the first two years." (Hunter, 1971, p. 238)[29] Thus, students in Scotland choose a field of study much later than their English counterparts. Given these clear differences, it is quite appropriate to regard the English system of higher education as an "early regime" and the Scottish system of higher education as a "late regime".[30]

The differences among English and Scottish universities arose from their unique respective historical traditions. English universities were largely independent and free to set their curriculum and course structures. Oxford and Cambridge maintained their focus on the traditional subjects (classics, Aristotelian philosophy, and mathematics with less emphasis on modern subjects such as natural science) long into the nineteenth century. (Evans, 1975, pp. 266-96) The

[27] There some exceptions: for example, students in Cambridge are accepted into the engineering faculty and only specialize in a certain sub-field of engineering during the course of their studies.

[28] Again, there are exceptions: for example, in Cambridge, the system of Tripos allows some flexibility in making changes to courses of study; and certain universities offer courses of study, such as Oxford's PPE (Politics, Philosophy, Economics) course, that allow a students to study a broader range of subjects.

[29] Conversations with various university officials confirmed this fact. For example, at the Universities of Edinburgh and Glasgow, students "pick-up" two additional subjects during the first year; then, in the second year, students can drop any of their subjects and "pick-up" another one.

[30] This is indirectly supported by evidence that the proportion of individuals that change their field of study between admission and graduation in Scottish universities is more than double that of English universities under various classifications of fields. While it may be unclear whether this represents breadth of curriculum or flexibility, both are conducive to later specialization.

provincial civic universities established later in urban centers did not substantially break from the traditions of the "ancient" universities. On the other hand, Scottish universities became regulated under the Universities (Scotland) Act of 1858 which set up an executive comission to draw up uniform conditions for courses of study. The Universities (Scotland) Act of 1889 further increased the choice of subjects available in Scottish universities, reflecting the "traditional Scottish preference for a broad general education." (Hunter, 1971, p. 237)

In addition to differences in higher education, England and Scotland also differ in their system of secondary school education. In England, students generally require GCE Advanced-level examinations (A-levels) in 2 or 3 subjects to gain acceptance into university.[31] In l989, a new exam, the Advanced Supplementary examination (AS-level) was brought in to broaden the curriculum; it was to be the same standard as A-level, but half the content. Students were encouraged to substitute two AS-levels for one of their A-levels but most universities did not regard these examinations as commensurate alternatives and it did little to change the character of English secondary school education. In Scotland, on the other hand, students generally require SCE Higher Examinations in 5 or 6 subjects to gain acceptance into university.[32] More recently, Advanced Highers and Higher Still certifications have been introduced to provide the opportunity for further specialization in secondary school. However, universities continue to use Highers as the primary basis for admission and there is little doubt that the Scottish system of secondary education provides a broader curriculum than the English one.[33] Again, the reasons for these differences in secondary school curriculum can be traced to historical antecedents. In a sense, specialization trickled down from the universities to secondary schools. Moreover, early influence of English universities on secondary school leaving exams was far stronger than that of Scottish universities since Scottish secondary school leaving certificates had to be approved by the Scottish Education Department.

[31] Interestingly, the introduction of A-levels in 1951 to replace the Higher School Certificates was a response to the criticism that these latter qualifications were denying opportunity to pupils with talent in individual subjects who were less successful in others (especially in foreign language requirements). Indeed, the Higher School Certificates had attempted to ensure that pupils followed a sufficiently broad and balanced curriculum by requiring candidates to achieve the minimum standard in a range of subjects for a pass.

[32] These Scottish qualifications evolved directly from the earlier Leaving and Intermediate Certificates which required proficiency over a group of subjects rather than in single subjects.

[33] Indeed, there is evidence that secondary school students in Scotland take more examinations and that these examinations constitute a greater breadth of fields than for their English counterparts.

4 Data and Empirical Strategy

4.1 Data

Data for the empirical analysis come from two sources: the Universities Statistical Record (USR) and the 1980 National Survey of Graduates and Diplomates (NSGD). The USR consists of administrative data on all students in UK universities undertaking courses of one academic year or longer between 1972-1993: almost 1.9 million undergraduates and over 1 million graduate students.[34] These administrative data include detailed background information on demographic characteristics and entry qualifications in addition to information related to the degree attained. This is supplemented by information on the first destination that includes occupation, industry and location of the job held six months following graduation. Unfortunately, there is no wage data available in the USR. The NSGD contains information obtained from a national postal survey of some 8,000 graduates undertaken in 1986/7 by the British Department of Employment. It includes a random sample of one in six university graduates and one in four of all other leavers from other institutions in 1980 in Great Britain.[35] The NSGD contains information about their 1980 qualification, their subsequent labor market experience (occupation, industry, and wages for four subsequent jobs) and further educational pursuits.[36] It also contains information about their high school examination results and some questions regarding satisfaction with their 1980 qualification. Unfortunately, it is not possible to identify specific universities in the NSGD and so it is not possible to determine whether individuals attended university in England or Scotland (instead, there is information on whether students took English or Scottish secondary school leaving exams).

Note that neither datasets is representative of the overall population. Therefore, we might be concerned that the English and Scottish samples of university graduates may not be comparable because of differing participation rates. Using two nationally representative datasets which include all individuals born in Great Britain during one week in 1958 and 1970 (National Child Development Study and British Cohort Study respectively), I have calcaluted the percentage of individuals that have attained a first degree from university by age 26. In both of these datasets, the participation rates to university are remarkably similar between England and Scotland: 8%

[34] Excluded are students enrolled in the Open University, Cranfield University, the independent University of Buckingham, and the former polytechnics and central institutions which obtained university status from 1992 onwards.

[35] Excluded from the present analysis are graduates from polytechnics and other institutions.

[36] In order to make the findings from the NSGD directly comparable to those from the USR, I often restrict attention to the first job in the 6 months following the 1980 qualification.

of the 1958 cohort and 12% of the 1970 cohort.[37]

Table 1 reveals that average characteristics of those attending English and Scottish universities are quite similar in both the USR and NSGD. There is a slightly larger percentage of females and married students in Scottish universities and they tend to be slightly younger on average.[38] As expected, the majority of students with occupation data in both England and Scotland enter employment in the UK. However, a substantial number of individuals appear to be working concurrently while pursuing further study in the UK. Table 2 indicates that the composition of broad fields of study across the two nations is somewhat comparable. Nevertheless, relatively more students in Scotland study health sciences, business, and law and relatively fewer study social sciences and arts.[39] A variable that features prominently in the theoretical analysis is whether individuals switch to an unrelated occupation upon entering the labor market. Such a measure has not been widely considered in labor economics previously.[40] Individuals are said to switch to an unrelated occupation when the subject of their degree and their occupation do not correspond to the same field of study. Essentially, I classify the subjects of study into narrow (42), broad (12) and very broad (6) categories. Then I match occupations according to these same classifications. In other words, I map both fields of study and occupations onto these consistent categories (see Data Appendix for more details). Clearly, broader classifications indicate lower rates of switching since only drastic changes in occupational field will register. However, the rate of switching is substantially lower in Scotland than in England according to all classification; in terms of the broad classification, 13% fewer individuals in Scotland switch to an occupation unrelated to their field of study compared to those in England.

4.2 Empirical Strategy

The base sample for the occupational switching and wage regressions includes all individuals that attained a BA degree and are employed 6 months following completion of their qualification. Alternative sampling restrictions will be explored: (i) excluding individuals continuing higher education since including all individuals with occupation data may select against successful students that do not need to work while studying higher degrees, (ii) excluding unclassified occupations (e.g. manual and clerical occupations) since individuals in one nation may be more

[37] The oft-mentioned higher participation rate in Scotland includes students enrolled in non-university higher education institutions.

[38] Note that the median age of students during their first year in university is 19 in both England and Scotland.

[39] This pattern of studying fields that are not normally offered in secondary school (law, business, etc.) is also consistent with allowing for specialization after entering university.

[40] Freeman (1971) considers whether such a measure varies across different fields of study.

likely to end up in non-standard occupations, (iii) coding individuals that are unemployed as switches since rates of unemployment may be higher in one nation than another, (iv) excluding education/coding education as a non-switch since education is particularly subject to misclassification, (v) restricting the English sample to individuals in northern England since this offers perhaps a more comparable population to Scotland.[41]

The effect of a Scottish degree on the probability of switching is captured by γ in the following regression:

$$SWITCH_i = \beta' X_i + \lambda SCOTDEG_i + \varepsilon_i$$

Most specifications will also include controls for field of study, region of work, and a variety of demographic and background characteristics. However, attainment of a Scottish or English degree is not randomly assigned. Rather, once they complete their secondary eduction, individuals can choose to attend univerisities in either England or Scotland. Table 2 shows the migration patterns from prior residence to university: 3.3% of individuals with English prior residence choose to study in Scotland while 7.4% of individuals with Scottish prior residence choose to study in England.[42] There may be systematic differences between those individuals that decide to attend university in an alternative regime. If these differences are uncorrelated with the probability of switching then this does not pose a problem. However, if individuals that migrate to university have a different likelihood of switching then the estimate from OLS will be biased. This might arise because individuals that migrate have certain unobserved characterstics, such as ability, which are correlated with the likelihood of switching. Or, more directly, individuals might choose a regime based on their own expected likelihood of switching (i.e. individuals from England that have less precise priors on their ability may decide to attend universities in Scotland where the decision to specialize is delayed). Hence, we will also consider regressions in which we instrument for the attainment of a Scottish or English degree with the region of prior residence. Since the type of degree and region of prior residence are not available in the NSGD, we shall run a reduced form of the probability of switching on the type of school leaving

[41] On this final sample restriction, I also consider whether there are different migration patterns for work in London from Northern England as compared to Scotland. However, I find that few individuals from either region (approximately 5% from each) migrate to London for work. Note, this result emerges from a different dataset (National Survey of Graduates 1985/90) since neither the USR or NSGD contains detailed regions of work and origin.

[42] Note that, since England is much more populous, the 3.3% of English individuals that study in Scotland make up over 18% of the student body in Scottish universities.

examinations (Scottish or English).[43]

Predictions on wages are examined through the following regression:

$$\log W = \beta' X_i + \lambda SCOTDEG_i + \gamma SWITCH_i + \delta \left(SWITCH_i * SCOTDEG_i \right) + \varepsilon_i$$

Most specifications will also include controls for field of study, region of work, industry, and a variety of demographic and background characteristics. λ captures the difference in wages between England and Scotland among individuals that do not switch. γ captures the difference in wages between individuals that switch and individuals that do not switch in England (the related occupation wage premium for individuals in England). Finally, δ captures the differential between the related occupation wage premium in Scotland and England. Other differentials of interest may include the related-occupation wage premium for individuals in Scotland $(\lambda + \delta)$ and the difference between England and Scotland among individuals that do switch ($\gamma + \delta$). Since wage data is only available in the NSGD, the type of high school leaving exams will be used instead of the type of degree.

5 Results

5.1 Occupational Switching

Due to the large sample size, data from the USR allows for very accurate estimation of the probability of switching between England and Scotland. Table 3 indicates that the probability of switching to a job unrelated to the undergraduate field of study is significantly lower for individuals that attained a Scottish degree than for their counterparts with an English degree. Indeed, the difference in the probability of switching between England and Scotland is negative and usually significant in every year between 1973-1993 (results not shown). According to the theoretical model, this difference suggests that the relative return to match quality is sufficiently high to overwhelm the greater loss of skills in an early regime.

This difference in the probability of switching becomes smaller if we control for the composition of fields of study between England and Scotland, indicating that individuals in Scotland tend to study fields that are associated with less switching.[44] Furthermore, the difference also

[43] While there is some choice available with the type of secondary school, through boarding school, it is undoubtedy much less than in university (the correlation between Scottish residence and attendance in Scottish high school is .96). Furthermore, few secondary schools in Scotland offer English leaving examinations (the correlation between attendance in a Scottish high school and sitting Scottish leaving examinations is .98).

[44] Also, much of the variation in the probability of switching is explained by fields (the R^2 increases from .05

becomes smaller once we control for the region of work so that perhaps there is less switching associated with Scottish employers who prefer to hire individuals with related qualifications.[45] Signs on the covariates generally accord with intuition: females tend to switch more while married students tend to switch less. Students that received higher honors in their undergraduate degrees and those that scored well on their secondary school leaving exams (A-levels or Scottish Highers) tend to switch less. And there is some limited evidence that older (mature) students tend to switch less.

The difference in the probability of switching between England and Scotland increases when we instrument for the attainment of a Scottish degree with region of prior residence. This lends support to the hypothesis of non-random selection: If individuals that are less focused and hence more likely to switch choose to do their degrees in Scotland, OLS estimates of the difference in the probability of switching in Scotland will be downwards biased indicating more switching than with random assignment. Since individuals with Scottish degrees tend to switch less than their English counterparts, IV estimates should and do indicate an even greater differential. As the type of degree and the region of prior residence are not available in the NSGD, we can only consider a reduced form regression of the rate of switching on the type of school leaving examinations. Table 4 shows that these estimates are generally consistent with those from the USR.[46]

Note that the differential in the rates of switching between England and Scotland remains significant and substantial in all of the alternative sample restrictions described earlier. Results are also generally robust to alternative classifications of fields (narrow and very broad), alternative instruments in the USR regressions (location of secondary school and type of secondary school leaving exams), and non-linear regressions (probit and logit).

5.2 Wages

Table 5 provides clear evidence for a related-occupation wage premium: individuals earn significantly lower wages when they switch to occupations unrelated to their fields of study. Moreover, this differential appears to be somewhat larger, though not significantly so, for individuals with Scottish secondary school exams than their English counterparts. This is consistent with the

to .41 once controls for fields of study are included)

[45] Note that the decision to work in England or Scotland is probably endogenous since individuals that decide to switch may also make systematically different decisions about where they wish to work.

[46] Note that the difference in the probability of switching between English and Scottish leaving exams becomes insignificant when controlling for both composition of fields and region of work.

earlier implication, from switching behavior, that the relative return to match quality is relatively high (otherwise, the loss of skills would be a more important determinent of wages and we would expect that the wage premium be higher in England than in Scotland). Individuals with English secondary school exams that do not switch appear to have higher wages than their Scottish counterparts, but this effect disappears once controls for region of work are included.[47] Finally, the covariates in the wage regressions have the expected signs.

High school GPA has a positive effect on the differential in the wage premium between England and Scotland. In other words, among individuals with a high GPA, those in Scotland have a smaller wage premium than those in England; among individuals with a low GPA, those in Scotland have a larger wage premium than those in England (see columns 3 and 4). Even more striking, individuals in Scotland with a high GPA do not seem to earn a wage premium at all. This interesting pattern clearly demands further investigation. Perhaps individuals with a high GPA in high school are high ability students that have high match quality in several fields of study. Since switching fields upon entering the labor market is associated with a lower drop in specific skills in a late regime, we might not expect a marked wage premium in Scotland for these high ability individuals.[48]

Note that the basic findings regarding wages are robust to the alternative sample restrictions and classification of fields described in the previous section.

5.3 Graduate students

Regressions of wages and switching behavior for individuals with graduate degrees are presented in Table 6. Columns (1) and (2) show that there is no significant difference in the probability of switching between England and Scotland for both the USR and NSGD. Since graduate degrees in both England and Scotland are similar in terms of specialization (i.e. both require admission to a very specific course of study), these results are reassuring. Moreover, they may provide indirect support for the contention that the source of the difference in probability of switching between England and Scotland derives from systems of undergraduate education and not from some other characteristic inherent to Scottish or English individuals or labor market conditions particular to a specific region. We can also examine the probability of switching to a graduate degree in

[47] Indeed, we expect that other factors influence the difference in wages between England and Scotland. A comparison of wage differences (premiums) across nations may be less subject to confounding effects than a comparison of wage levels.

[48] It seems more unlikely that there are greater opportunities for pursuing lucrative careers in unrelated occupations (such as consulting, etc.) in Scotland. Also note that GPA may be capturing some measure of skills (although perhaps different from skills acquired in university).

a field that is unrelated to the undergraduate field of study. Columns (3) and (4) indicate that the probability of switching to an unrelated postgraduate degree is not significantly different for individuals with a Scottish undergraduate degree than for their English counterparts.[49] Finally, Column (5) confirms the presence of a related-occupation wage premium for graduate degrees but no other significant wage differences between England and Scotland.

5.4 Outcomes over time

Although outside the scope of the model proper, I also consider several longer-term labor market outcomes. Table 7 reveals that the differential in rates of switching between England and Scotland falls slightly over the first two years and then increases by several percentage points in later years (while levels of switching in both nations increase over time). This may imply that individuals in England experiment more in the job market than individuals in Scotland. Table 8 suggests that wage premium effectively disappears 6 years following the attainment of the degree; in other words, wage growth for individuals that switch is substantially greater (and just barely insignificant).[50] If we believe skills are also accumulated on the job but that the return to skills have dminishing returns, we might expect wages of individuals that switch to converge with wages of individuals that do not switch. There are no significant differences in long-term wage outcomes across nations. On a related matter, there appear to be no significant differences in formal job training between England and Scotland.[51]

Table 9 examines the probability of occupational mobility over time. Individuals that switch are significantly more likely to change to a job in a different occupational field after several years. This is consistent with the theoretical analysis where individuals that switch have identical quantities of skill in alternative fields and so further changes in occupation are not as severely pernalized.[52] Furthemore, among individuals that do not switch, those in Scotland are significantly less likely to change to another occupation in later years.

Finally, respondents in the NSGD were asked: "On reflection, how beneficial has your [1980] qualification been to you in:" (i) getting an interesting job; (ii) securing a good income; and

[49] One possible explanation may be that the relative return to match quality for success in further study is different than for wages. If one believe that further study at the graduate level puts more emphasis on the specific skills and knowledge acquired at the undergraduate level than a job in the labor market, the updating effect may not longer overwhelm the greater loss of skills in the early regime.

[50] Note, however, that the wage premium remains large and significant if controls for field of study are not included. Wage growth among switchers also drops substantially without field controls.

[51] Nonetheless, there may still be greater informal learning on the job for Scottish individuals to make up for lower levels of skill upon entering the labor market.

[52] An alternative explanation may be that individuals that switch are inherently less stable workers.

(iii) becoming a widely educated person. Table 10 highlights results from these subjective assessments.[53] Individuals that switch are significantly less likely to consider their qualification beneficial in obtaining an interesting job. Indeed, this effect remains strong even after controlling for wages, subjective assessments of securing a good income, and controls for field of study. Note that it is possible that individuals which switch consider themselves as having interesting jobs but not as a direct result of their qualification. Nevertheless, this may provide some suggestive evidence for the non-pecuniary benefits of not switching. On the other hand, individuals that switch are significantly more likely to report that their qualification contributed to them becoming more widely educated. However, this effect becomes insignificant once controls for field of study are included, suggesting that individuals that consider themselves widely educated were the ones that selected certain fields of study with particularly high rates of switching (e.g. humanities and social sciences).

6 Conclusion

This paper examined the effect of different timings of academic specialization on a variety of labor market outcomes. I developed a simple model in which differences in the probability of switching to occupations unrelated to the chosen field of study and differences in wages across regimes depend on the relative return to match quality. In addition, I predict that individuals who do not switch to unrelated occupations should receive a wage premium. Evidence from the British data confirm the presence of a related-occupation wage premium. Furthermore, I find that individuals in the Scottish system, where specialization occurs relatively late, are less likely to switch to an unrelated occupation than their counterparts in England indicating high relative returns to match quality. That the wage premium in England is not larger than in Scotland is also consistent with high relative returns to match quality. Finally, results on wage growth and occupational mobility, though outside the scope of the model, accord with intuition.

These findings suggest that certain features of higher education have important labor market consequences. In particular, the timing of academic specialization effects the likelihood of working in a related occupation, wages, and occupational mobility. Whether a regime in which individuals are required to specialize early is superior to one in which individuals are required to specialize late depends on the relative return to match quality, the structure of the prior distributions on match quality in different fields, and other structural parameters. Evidence in

[53] These regressions are run as ordered probits. Categories include: "not at all", "a little", "a lot", and "a great deal". Similar results are obtained when collapsing these categories in larger groups.

support of a high relative return to match quality may favor a late regime such as Scotland since mistakes in the choice of major field are costly. However, if certain populations have more accurate prior information on match quality, an early regime may prove less wasteful. Indeed, with a heterogenous population, the benefits of an early or a late regime may accrue to different individuals. At present, with a comparison of just two nations, the question remains open.

7 Theoretical Appendix

The results presented in this appendix are for a simple case where there are only two courses and two fields: $N = 2$ and $J = 2$. In this case, individuals in the late regime will study one course in each field prior to specialization and no courses following specialization: $n^L = 1$; individuals in the early regime will specialize prior to studying any courses and then study two courses in the chosen field: $n^E = 0$. Note that this simplification does abstract from some important features of the model: there will be no switching in the late regime since these individuals do not study any courses following specialization. Consequently, the theoretical possibility of greater switching in the late regime than in the early regime will not arise in this special case. Since there is no switching in the late regime, wage comparisons across regimes conditional on switching will be meaningless. However, for the sake of comparison, we can suppose that some individuals in the late regime do switch for other exogenous reasons.

Proof of Proposition 1

We begin by determining expected wages in general (for either regime):

$$\begin{aligned}
E\left(w_{j^{\max}}\right) &= E\left[\alpha m_{j^{\max}} + \beta s\right] \\
&= \beta s + \alpha E\left[m_{j^{\max}}\right] \\
&= \beta s + \alpha E\left[m_{j^{\max}} \mid j^{\max} = \arg\max_j \{m_A, m_B\}\right] \Pr\left(j^{\max} = \arg\max_j \{m_A, m_B\}\right) \\
&\quad + \alpha E\left[m_{j^{\max}} \mid j^{\max} = \arg\min_j \{m_A, m_B\}\right] \Pr\left(j^{\max} = \arg\min_j \{m_A, m_B\}\right) \\
&= \beta s + \alpha E\left[\max_j \{m_A, m_B\}\right][1 - PRM] + \alpha E\left[\min_j \{m_A, m_B\}\right] PRM \\
&= \beta s + \alpha E\left(m_{(2)}\right)[1 - PRM] + \alpha E\left(m_{(1)}\right) PRM \\
&= \beta s + \alpha\left(\mu + \frac{1}{\sqrt{\pi p}}\right)[1 - PRM] + \alpha\left(\mu - \frac{1}{\sqrt{\pi p}}\right) PRM \\
&= \beta s + \alpha\left[\mu + \frac{1}{\sqrt{\pi p}}(1 - 2PRM)\right] \\
\text{since } m_j &= \mu + \xi_j \text{ where } \xi_j \sim N(0, \frac{1}{p}) \\
\text{so } \omega_j &= \frac{m_j - \mu}{\sqrt{\frac{1}{p}}} \sim N(0,1) \text{ and } E\left(\omega_{(2)}\right) = \frac{1}{\sqrt{\pi}} \\
\text{and } E\left(m_{(2)}\right) &= \frac{E\left(\omega_{(2)}\right)}{\sqrt{p}} + \mu = \mu + \frac{1}{\sqrt{\pi p}} \\
\text{and } E\left(m_{(1)}\right) &= \mu - \frac{1}{\sqrt{\pi p}}
\end{aligned}$$

The probability of making a mistake in the late regime is as follows:

$$\begin{aligned}
PRM_L &= \Pr\left(j^{\max} \neq \arg\max_j \{m_A, m_B\}\right)^L \\
&= \Pr\left(m_{j^{\max}} < \max\{m_A, m_B\}\right)^L \\
&= \Pr\left(m_A < m_B \cap \mu'_A > \mu'_B\right) + \Pr\left(m_B < m_A \cap \mu'_B > \mu'_A\right) \\
&= 2\Pr\left(m_A < m_B \cap \mu'_A > \mu'_B\right) \\
&= 2\Pr\left(m_A < m_B \cap y_{1B} > y_{1B}\right) \\
&= 2\Pr\left(m_A < m_B \cap m_A + \varepsilon_{1A} > m_B + \varepsilon_{1B}\right) \\
&= 2\Pr\left(\varepsilon_{1B} - \varepsilon_{1A} < m_A - m_B < 0\right) \\
&= 2\Pr\left(Y < X < 0\right) \\
&= 2\int_{-\infty}^{0}\int_{y}^{0} f_Y(y) f_X(x) dxdy \\
&= 2\int_{-\infty}^{0}\int_{y}^{0} \phi\left(\frac{y}{\sqrt{\frac{2}{p^{\varepsilon}}}}\right)\phi\left(\frac{x}{\sqrt{\frac{2}{p}}}\right) dxdy < \frac{1}{2}
\end{aligned}$$

The probability of making a mistake in the early regime is as follows:

$$PRM_E = \Pr\left(m_{j^{\max}} \neq \max\{m_A, m_B\}\right)^E = \frac{1}{2}$$

Since, the distributions of X and Y are as follows:

$$\begin{aligned}
Y &= \varepsilon_{1B} - \varepsilon_{1A} \sim N\left(0, \frac{2}{p^{\varepsilon}}\right) \\
&\therefore \quad \frac{X}{\sqrt{\frac{2}{p^{\varepsilon}}}} = \frac{\varepsilon_{1B} - \varepsilon_{1A}}{\sqrt{\frac{2}{p^{\varepsilon}}}} \sim N(0,1) \\
X &= m_A - m_B = \xi_A - \xi_B \sim N\left(0, \frac{2}{p}\right) \\
&\therefore \quad \frac{Y}{\sqrt{\frac{2}{p}}} = \frac{m_A - m_B}{\sqrt{\frac{2}{p}}} \sim N(0,1)
\end{aligned}$$

Given the expressions for expected wages and the probability of making a mistake, expected wages in the late regime are:

$$\begin{aligned}
E\left(w_{j^{\max}}\right)^L &= \beta s + \alpha\left[\mu + \frac{1}{\sqrt{\pi p}}\left(1 - 2PRM_L\right)\right] \\
&= \beta + \alpha\left[\mu + \frac{1}{\sqrt{\pi p}}\left(1 - 2PRM_L\right)\right] \\
&= \beta + \alpha\mu + \frac{\alpha}{\sqrt{\pi p}}\left(1 - 2PRM_L\right)
\end{aligned}$$

And expected wages in the early regime are:

$$\begin{aligned} E\left(w_{j^{\max}}\right)^E &= \beta s + \alpha\left[\mu + \frac{1}{\sqrt{\pi p}}\left(1 - 2PRM_E\right)\right] \\ &= 2\beta + \alpha\left[\mu + \frac{1}{\sqrt{\pi p}}\left(1 - 2\frac{1}{2}\right)\right] \\ &= 2\beta + \alpha\mu \end{aligned}$$

Finally, we can derive a cutoff for the relative return to match quality such that expected wages are higher in the early regime if the relative returns to match quality are above that cutoff and lower otherwise:

$$\begin{aligned} E\left[w_{j^{\max}}\left(n^E\right)\right] &> E\left[w_{j^{\max}}\left(n^L\right)\right] \; iff \\ 2\beta + \alpha\mu &> \beta + \alpha\mu + \frac{\alpha}{\sqrt{\pi p}}\left(1 - 2PRM_L\right) \\ \beta &> \frac{\alpha}{\sqrt{\pi p}}\left(1 - 2PRM_L\right) \\ \frac{\alpha}{\beta} &< \frac{\sqrt{\pi p}}{\left(1 - 2PRM_L\right)}\left(> 0\right) \\ so\ \exists\left(\frac{\alpha}{\beta}\right)^* \; s.t. E\left[w_{j^{\max}}\left(n^E\right)\right] &> E\left[w_{j^{\max}}\left(n^L\right)\right] \; if \; \frac{\alpha}{\beta} < \left(\frac{\alpha}{\beta}\right)^* \\ \text{and } E\left[w_{j^{\max}}\left(n^E\right)\right] &< E\left[w_{j^{\max}}\left(n^L\right)\right] \; if \; \frac{\alpha}{\beta} > \left(\frac{\alpha}{\beta}\right)^* \end{aligned}$$

Proof of Proposition 2

The probability of switching in the early regime with $N = 2$ $(n^L = 0)$:

$$\begin{aligned} PRS_E &= \Pr\left(w''_{j^{\max}} < w'_{j^{2nd\,\max}}\right) \\ &= \Pr\left(\alpha\mu''_{j^{\max}} + \beta s'' < \alpha\mu'_{j^{2nd\,\max}} + \beta s'\right) \\ &= \Pr\left(\mu''_{j^{\max}} < \mu'_{j^{2nd\,\max}} - 2\frac{\beta}{\alpha}\right) \\ &= \Pr\left(\frac{\mu p + p^{\varepsilon}\sum_{k=1}^{2} z_{kj^{\max}}}{p + 2p^{\varepsilon}} < \mu - 2\frac{\beta}{\alpha}\right) \\ &= \Pr\left(2\xi_j + \varepsilon_{1j} + \varepsilon_{2j} < -\frac{\beta}{\alpha}\frac{2\left(p + 2p^{\varepsilon}\right)}{p^{\varepsilon}}\right) \\ &= \Phi\left(-\frac{\beta}{\alpha}\frac{2\left(p + 2p^{\varepsilon}\right)}{p^{\varepsilon}\sqrt{\frac{4}{p} + \frac{2}{p^{\varepsilon}}}}\right) \\ &> 0 \end{aligned}$$

Effect of $\left(\frac{\alpha}{\beta}\right)$ on the probability of switching in the early regime:

$$\frac{\partial PRS_E}{\partial\left(\frac{\alpha}{\beta}\right)}=\frac{\partial}{\partial\left(\frac{\alpha}{\beta}\right)}\left[\Phi\left(-2\left(\frac{\alpha}{\beta}\right)^{-1}\sqrt{p+\frac{p^2}{2p^{\varepsilon}}}\right)\right]>0$$

The probability of switching in late regime with $N=2$ $(n^L=1)$:

$$\begin{aligned}
PRS_L &= \Pr\left(w''<w'\right)\\
&= \Pr\left(\alpha\mu''_{j^{\max}}+\beta s''<\alpha\mu'_{j^{2^{nd}\max}}+\beta s'\right)\\
&= \Pr\left(\frac{\mu p+p^{\varepsilon}\max_j\{y_{ij}\}}{p+p^{\varepsilon}}<\frac{\mu p+p^{\varepsilon}\max_{j\neq j^{\max}}\{y_{ij}\}}{p+p^{\varepsilon}}\right)\\
&= \Pr\left(\max\{y_{1A},y_{1B}\}<\min\{y_{1A},y_{1B}\}\right)\\
&= 0
\end{aligned}$$

Hence, the probability of switching is higher in the early regime than in the late regime. But as the relative return to match quality falls, the difference in the probability of switching falls (until there is no difference when $\alpha=0$). With a non-trivial probability of switching in the late regime, the probability of switching would be higher in the early regime.

Proof of Proposition 3

In the early regime (with $n=0, N-nJ=2$), the decision to choose a field is completely arbitrary since it is taken prior to any information. Hence, we can assume that individuals always choose a certain field (i.e. A) without loss of generality. After taking two courses in field A, individuals receive two signals in A and must then decide whether to switch or not.

Expected wages conditional on switching:

$$\begin{aligned}
&E\left(w\mid Switch\right)^E=E\left(w_B\mid w''_A<w'_B\right)\\
=\;& E\left(\alpha m_B+\beta s_B\mid z_{A1}+z_{A2}<2\mu-\frac{\beta}{\alpha}\frac{2\left(p+2p^{\varepsilon}\right)}{p^{\varepsilon}}\right)\\
=\;& \alpha\mu+\alpha E\left(\xi_B\mid\xi_A<-\frac{\beta}{\alpha}\frac{\left(p+2p^{\varepsilon}\right)}{p^{\varepsilon}}-\frac{\varepsilon_{A1}+\varepsilon_{A2}}{2}\right)\\
=\;& \alpha\mu+\alpha E\left(\xi_B\mid\xi_A<\widetilde{K}\right)\\
=\;& \alpha\mu+\alpha E\left(\xi_B\right)\\
=\;& \alpha\mu
\end{aligned}$$

Expected wages conditional on not switching:

$$\begin{aligned}
E\left(w \mid NoSwitch\right)^{E} &= E\left(w_A \mid w''_A > w'_B\right) \\
&= E\left(\alpha m_A + \beta s_A \mid z_{A1} + z_{A2} > 2\mu - \frac{\beta}{\alpha}\frac{2\left(p+2p^{\varepsilon}\right)}{p^{\varepsilon}}\right) \\
&= 2\beta + \alpha E\left(m_A \mid m_A > \mu - \frac{\beta}{\alpha}\frac{\left(p+2p^{\varepsilon}\right)}{p^{\varepsilon}} - \frac{\varepsilon_{A1}+\varepsilon_{A2}}{2}\right) \\
&= 2\beta + \alpha\mu + \alpha E\left(\xi_A \mid \xi_A > -\frac{\beta}{\alpha}\frac{\left(p+2p^{\varepsilon}\right)}{p^{\varepsilon}} - \frac{\varepsilon_{A1}+\varepsilon_{A2}}{2}\right) \\
&= 2\beta + \alpha\mu + \alpha E\left(\xi_A \mid \xi_A > \widetilde{K}\right)
\end{aligned}$$

Therefore, for the early regime: $E\left(w \mid \ NoSwitch\right)^{E} > E\left(w \mid \ Switch\right)^{E}$ since $E\left(\xi_A \mid \xi_A > \widetilde{K}\right) > 0$ and $2\beta > 0$.

There are no switches in the late regime (with $n = 1, N - nJ = 0$). Since there are no switches, expected wages will be identical to the baseline case of no switching with $N = 2$, $n = 1$, and $J = 2$.

$$\begin{aligned}
E\left(w \mid NoSwitch\right)^{L} &= E\left(\alpha m_{j^{\max}} + \beta s_{j^{\max}}\right) \\
&= \beta + \alpha\left(\mu + \frac{1}{\sqrt{\pi p}}\right)\left[1 - PRM_L\right] + \alpha\left(\mu - \frac{1}{\sqrt{\pi p}}\right)PRM_L \\
&= \beta + \alpha\left[\mu + \frac{1}{\sqrt{\pi p}}\left(1 - 2PRM_L\right)\right]
\end{aligned}$$

For the sake of comparison, we can suppose that some individuals do switch (either irrationally or for exogenous reasons). In this instance, individuals will have the following expected wages:

$$\begin{aligned}
E\left(w \mid Switch\right)^{L} &= \beta + \alpha E\left(m_{(1)}\right)\left[1 - PRM_L\right] + \alpha E\left(m_{(2)}\right)PRM_L \\
&= \beta + \alpha\left(\mu - \frac{1}{\sqrt{\pi p}}\right)\left[1 - PRM_L\right] + \alpha\left(\mu + \frac{1}{\sqrt{\pi p}}\right)PRM_L \\
&= \beta + \alpha\left[\mu + \frac{1}{\sqrt{\pi p}}\left(2PRM_L - 1\right)\right]
\end{aligned}$$

Therefore, for the late regime: $E\left(w \mid \ NoSwitch\right)^{L} > E\left(w \mid \ Switch\right)^{L}$ since $PRM < \frac{1}{2}$.

Proof of Proposition 4

Wage premium in the early regime:

$$\begin{aligned}
& E\left(w \mid \ NoSwitch\right)^{E} - E\left(w \mid \ Switch\right)^{E} \\
= \ & 2\beta + \alpha\mu + \alpha E\left(\xi_A \mid \xi_A > \widetilde{K}\right) - \alpha\mu \\
= \ & 2\beta + \alpha E\left(\xi_A \mid \xi_A > \widetilde{K}\right)
\end{aligned}$$

Wage premium in the late regime:

$$\begin{aligned} & E\left(w \mid \ NoSwitch\right)^{L} - E\left(w \mid \ Switch\right)^{L} \\ = \ & \beta + \alpha\left[\mu + \frac{1}{\sqrt{\pi p}}\left(1 - 2PRM_{L}\right)\right] - \left\{\beta + \alpha\left[\mu + \frac{1}{\sqrt{\pi p}}\left(2PRM_{L} - 1\right)\right]\right\} \\ = \ & \frac{\alpha}{\sqrt{\pi p}}\left[\left(1 - 2PRM_{L}\right) - \left(2PRM_{L} - 1\right)\right] \\ = \ & \frac{2\alpha}{\sqrt{\pi p}}\left(1 - 2PRM_{L}\right) \end{aligned}$$

Wage premium in late regime may be larger than in the early regime if:

$$\begin{aligned} \frac{2\alpha}{\sqrt{\pi p}}\left(1 - 2PRM_{L}\right) \ & > \ \alpha E\left(\xi_{A} \mid \xi_{A} > \widetilde{K}\right) \\ \frac{2}{\sqrt{\pi p}}\left(1 - 2PRM_{L}\right) \ & > \ E\left(\xi_{A} \mid \xi_{A} > \widetilde{K}\right) \end{aligned}$$

If $\frac{\alpha}{\beta}$ is sufficiently small, then $E\left(w \mid \ NoSwitch\right)^{E} - E\left(w \mid \ Switch\right)^{E} > E\left(w \mid \ NoSwitch\right)^{L} - E\left(w \mid \ Switch\right)^{L}$ (the trivial case where $\alpha = 0$, implies a wage premium of 2β in the early regime and 0 in the late regime). If $\frac{\alpha}{\beta}$ is large (i.e. take $\beta = 0$), then $E\left(w \mid \ NoSwitch\right)^{E} - E\left(w \mid \ Switch\right)^{E} < E\left(w \mid \ NoSwitch\right)^{L} - E\left(w \mid \ Switch\right)^{L}$ only if PRM and $E\left(\xi_{A} \mid \xi_{A} > \widetilde{K}\right)$ are small. But $E\left(\xi_{A} \mid \xi_{A} > \widetilde{K}\right)$ is small when $\widetilde{K} = -\frac{\beta}{\alpha}\frac{\left(p + 2p^{\varepsilon}\right)}{p^{\varepsilon}} - \frac{\left(\varepsilon_{A1} + \varepsilon_{A2}\right)}{2}$ is small. Note that $E(\widetilde{K}) = -\frac{\beta}{\alpha}\frac{\left(p + 2p^{\varepsilon}\right)}{p^{\varepsilon}}$.

[INCOMPLETE]

Proof of Proposition 5

In the early regime:

$$\begin{aligned} E\left(w\right)^{E} \ & = \ E\left(w \mid Switch\right)^{E} PRS_{E} + E\left(w \mid NoSwitch\right)^{E}\left(1 - PRS_{E}\right) \\ & = \ \alpha\mu PRS_{E} + \left[2\beta + \alpha\mu + \alpha E\left(\xi_{A} \mid \xi_{A} > \widetilde{K}\right)\right]\left(1 - PRS_{E}\right) \\ & = \ 2\beta\left(1 - PRS_{E}\right) + \alpha\mu + \alpha E\left(\xi_{A} \mid \xi_{A} > \widetilde{K}\right)\left(1 - PRS_{E}\right) \end{aligned}$$

In the late regime:

$$\begin{aligned} E\left(w\right)^{L} \ & = \ E\left(w \mid Switch\right)^{L} PRS_{L} + E\left(w \mid NoSwitch\right)^{L}\left(1 - PRS_{L}\right) \\ & = \ \beta + \alpha E\left(m_{(2)}\right)\left(1 - PRM_{L}\right) + \alpha E\left(m_{(1)}\right) PRM_{L} \\ & = \ \beta + \alpha\mu + \frac{\alpha}{\sqrt{\pi p}}\left(1 - 2PRM_{L}\right) \end{aligned}$$

Therefore, the difference in average wages between the early regime and late regime is as

follows:

$$\begin{aligned}
E(w)^E &> E(w)^L \\
2\beta(1-PRS_E)-\beta &> \frac{\alpha}{\sqrt{\pi p}}(1-2PRM_L)-\alpha E\left(\xi_A \mid \xi_A > \widetilde{K}\right)(1-PRS_E) \\
\beta(1-2PRS_E) &> \frac{\alpha}{\sqrt{\pi p}}(1-2PRM_L)-\alpha E\left(\xi_A \mid \xi_A > \widetilde{K}\right)(1-PRS_E) \\
\frac{\beta}{\alpha}(1-2PRS_E) &> \frac{1}{\sqrt{\pi p}}(1-2PRM_L)-E\left(\xi_A \mid \xi_A > \widetilde{K}\right)(1-PRS_E)
\end{aligned}$$

Clearly, if $\frac{\beta}{\alpha}$ is sufficiently high, we will have $E(w)^E > E(w)^L$ whereas if $\frac{\beta}{\alpha}$ is sufficiently low, we will have $E(w)^L > E(w)^E$. The tradeoff here is similar to the one derived without switching.

8 Data Appendix

Complete documentation for the Universities' Statistical Record, 1972/73-1993/4: Undergraduate Records, Postgraduate Records and the National Survey of 1980 Graduates and Diplomates, 1986-1987 are available from the UK Data Archive: http://www.data-archive.ac.uk. Details of the variables constructed for this study are described as follows:

Occupational Switch

An occupational switch is defined as a binary variable that takes on a value of 1 if an individual is employed in an occupation that is unrelated to his major field of study at the undergraduate level, and 0 otherwise. In order to determine whether an individual is employed in an occupation that is related or unrelated to his field of study, I classify both occupation and field of study into consistent categories. I consider three different classifications: narrow (42 categories), broad (12 categories) and very broad (6 categories). These alternative classifications are constructed in a hierarchical fashion and delineated in detail in Appendix Table 1. Occupations and fields of study are coded according to each of the alternative classifications. Where the occupation and field of study are classified in different categories, occupational switch takes on a value of 1. For example, an individual that studies physics at university will have their field of study coded as "physics" according the narrow classification, "physical sciences" according to the broad classification, and "mathematical, computer, and physical sciences" according to the very broad classification. If this individual is employed as a computer programmer, the occupational switch variable will take on a value of 1 according to the narrow and broad classifications and a value of 0 according to the very broad classification. I focus on the broad classification in most of the analysis in this paper.

In addition, I construct an ordered qualitiative variable based on all the classifications that determines the "distance" of occupational switch. This variable takes on a value of 0 if there is no occupational switch according to any classification, 1 if there is an occupation switch according to the narrow classification, 2 if there is an occupational switch according to the broad classification, and 3 if there is no occupational switch according the very broad classification. Note, I will also consider occupational switching from the graduate level. This variable is defined analagously except that the field of study is the one studied at the graduate level.

Academic Switch

An academic switch is defined as a binary variable that takes on a value of 1 if an individual's field of study at the graduate level is unrelated to their field of study at the undegraduate level, and 0 otherwise.

Degree Honors

There is some variation in honors classifications among universities in general, and between Scottish and English institutions in particular. Hence, I aggregate honors levels into roughly comparable categories. The honors variable takes on the value of 4 for a 1st, unclassified, and enhanced degree class, 3 for upper 2nd and undivided 2nd degree class, 2 for lower 2nd, ordinary, Aegrotata, and Pass, and 1 for 3rd, 4th and General degree class.

High school GPA

Scores on secondary school leaving exams are officially coded as letter grades (A, B, C, etc.). These are converted into numerical scores where A=10, B=8, C=6, D=4, and E=2. Average scores are then standardized by nation and combined so that the overall distribution of high school GPA has mean 0 and standard deviation 1.

Region of Work

Region of work is classified as England, Scotland, Wales, and Northern Ireland in the USR. Region of work is classified as London, Southern England, Midlands, East Anglia, Northern England, Wales, Scotland, and Northern Ireland in the NSGD.

Industry

Industry are classified according to broad SIC codes: Agriculture, Forestry, and Fisheries (0), Mining (1), Mineral Extraction and Production (2), Heavy Manufacturing (3), Light Manufacturing (4), Construction (5), Wholesale and Retail Trade (6), Transportation, Communication, and Public Utilities (7), Financial and Business Services (8), Professional and Related Services (9)

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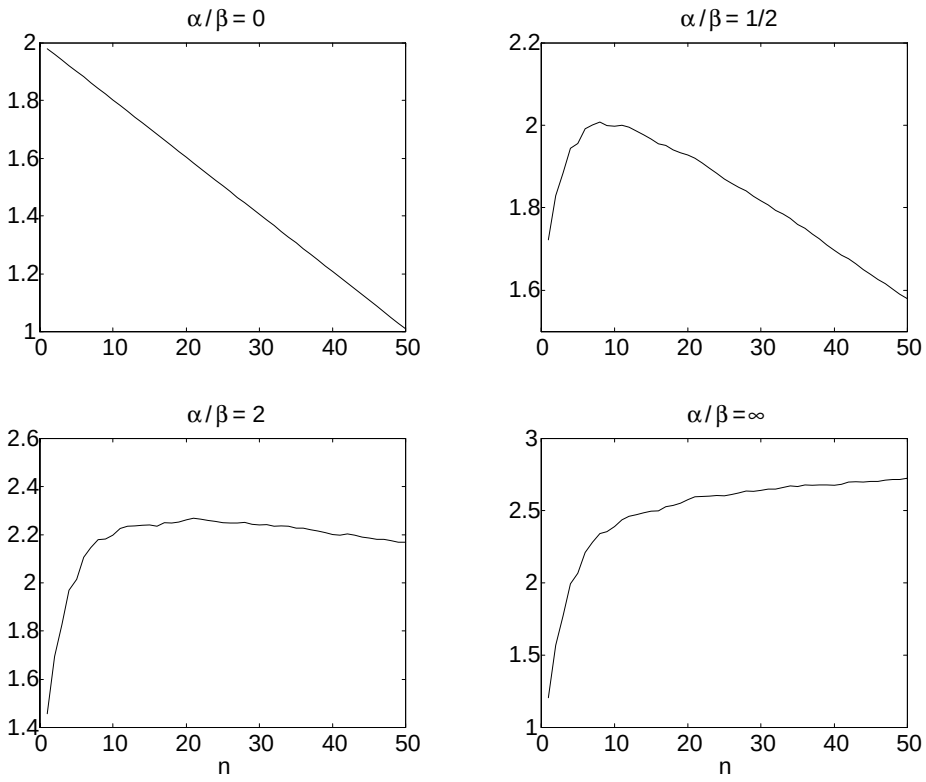
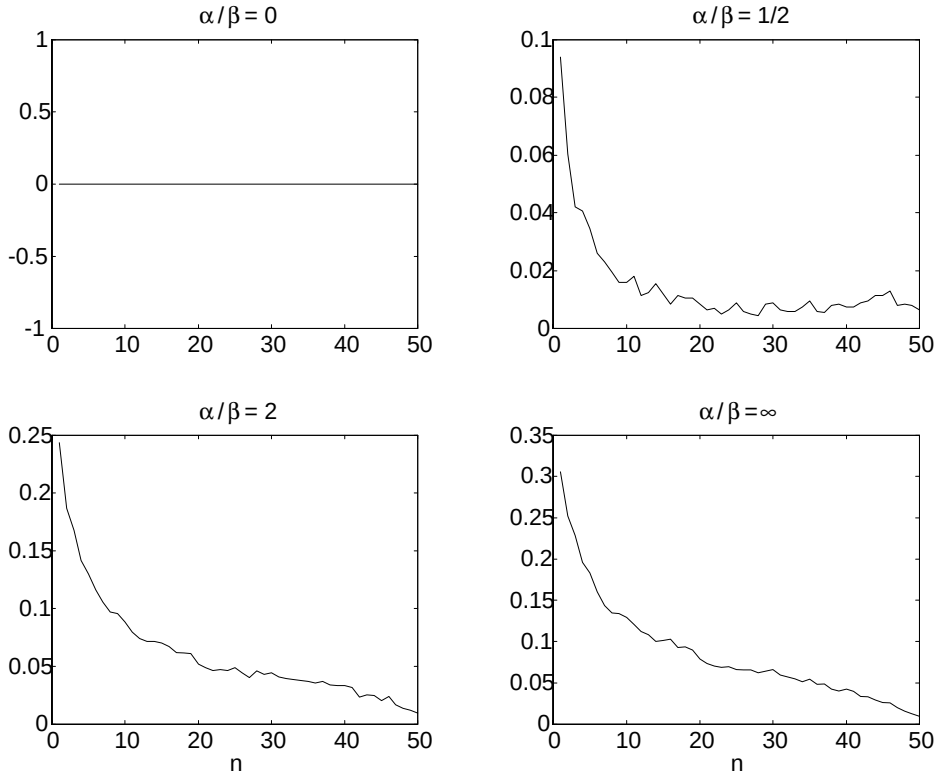
Figure 1: Expected Wages (without Occupational Switching) by Timing of Specialization



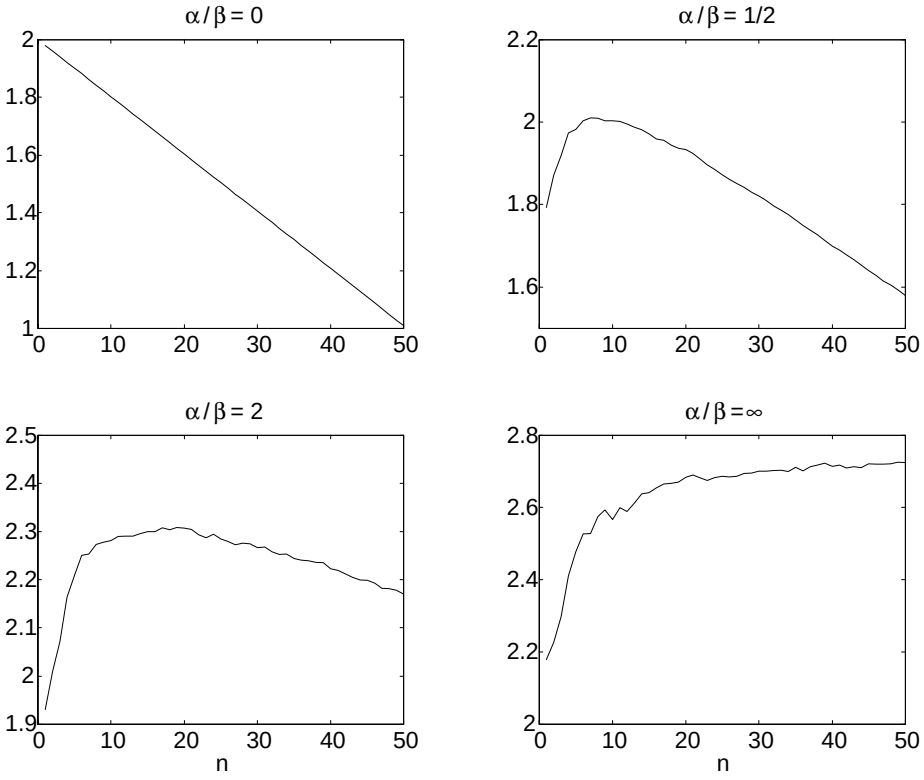
Notes: All simulations are for $J = 2$, $N = 101$, $\mu = 0$, $p = 5$, and $p^{\varepsilon} = 10$. Horizontal axis measures, n, number of courses taken prior to specialization. Expected wages are log wages determined according to $\ln w_j = \alpha m_j + \beta s_j^*$ where $s_j^* = \frac{s_j}{N/J} + \mu$ are normalized skills.

Figure 2: Probability of Switching by Timing of Specialization



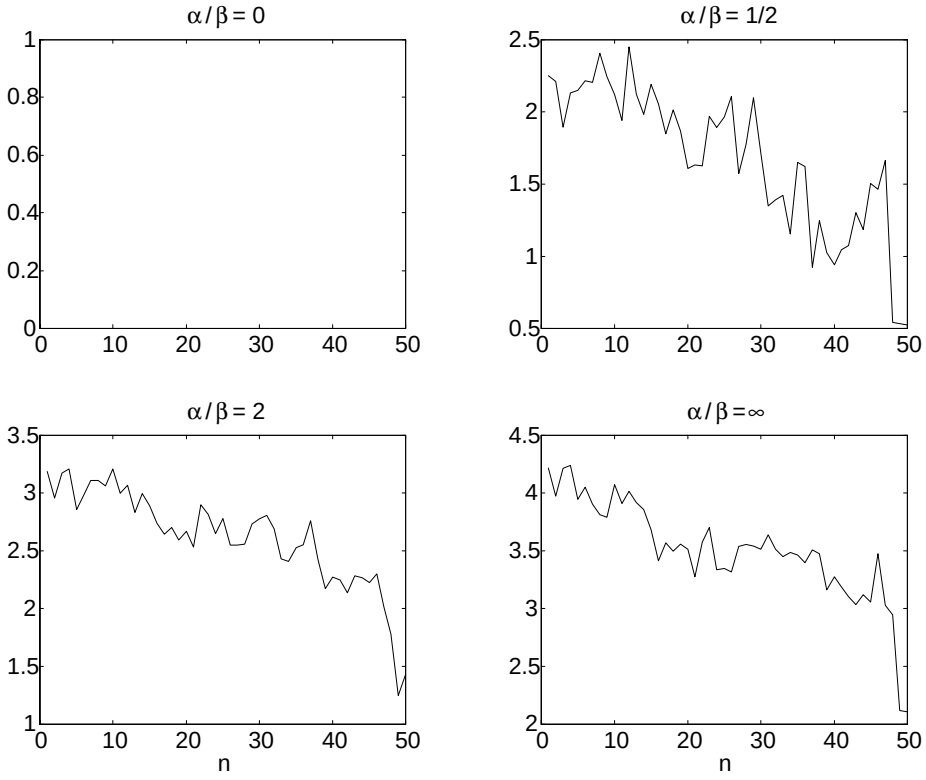
Notes: All simulations are for $J = 2$, $N = 101$, $\mu = 0$, $p = 5$, and $p^{\varepsilon} = 10$. Horizontal axis measures, n, number of courses taken prior to specialization.

Figure 3: Expected Wages by Timing of Specialization



Notes: All simulations are for $J = 2$, $N = 101$, $\mu = 0$, $p = 5$, and $p^{\varepsilon} = 10$. Horizontal axis measures, n, number of courses taken prior to specialization. Expected wages are log wages determined according to $\ln w_j = \alpha m_j + \beta s_j^*$ where $s_j^* = \frac{s_j}{N/J} + \mu$ are normalized skills.

Figure 4: Expected Wage Premium by Timing of Specialization



Notes: All simulations are for $J = 2$, $N = 101$, $\mu = 0$, $p = 5$, and $p^{\varepsilon} = 10$. Horizontal axis measures, n, number of courses taken prior to specialization. Expected wages are log wages determined according to $\ln w_j = \alpha m_j + \beta s_j^*$ where $s_j^* = \frac{s_j}{N/J} + \mu$ are normalized skills. Vertical axis measures the expected difference in wages between individuals that do not switch and individuals that switch

Table 1: Summary Statistics

USR	*English Degrees*			*Scottish Degrees*		
	Means	SD	Obs	Means	SD	Obs
Individual characteristics						
Female	0.39	0.49	1463623	0.41	0.49	244308
Married (during degree)	0.05	0.22	1463623	0.07	0.26	244308
Average Age (upon completion)	23.50	4.06	1463439	23.58	4.32	244270
GPA (out of 30)	20.29	6.41	1248321	19.30	5.92	204590
Number of high school subjects	3.25	1.11	1248321	5.10	2.56	204590
Degree characteristics						
Honors	2.44	0.77	1251168	2.37	0.67	198109
Entry qualifications (school exams)	0.15	0.35	1463623	0.16	0.37	244308
Successful completion	0.86	0.35	1463623	0.81	0.39	244308
Duration	3.29	0.67	1463623	3.86	0.70	244308
Occupational Switching						
Very broad classification	0.48	0.50	619451	0.36	0.48	95149
Broad classification	0.55	0.50	619451	0.42	0.49	95149
Narrow classification	0.72	0.45	619451	0.58	0.49	95149

NSGD	*English High School Exams*			*Scottish High School Exams*		
	Means	SD	Obs	Means	SD	Obs
Individual characteristics						
Female	0.41	0.49	3827	0.43	0.49	550
Married (7 years after degree)	0.50	0.50	3785	0.55	0.50	545
Average Age (upon completion)	22.18	2.51	3767	22.29	2.95	540
GPA (out of 30)	19.75	5.74	3792	18.03	5.83	547
Number of high school subjects	3.25	0.89	3829	5.23	1.12	550
Degree characteristics						
Honors	2.44	0.77	3805	2.33	0.67	547
Occupational Switching						
Very broad classification	0.62	0.49	2010	0.44	0.50	308
Broad classification	0.68	0.47	2010	0.50	0.50	308
Narrow classification	0.78	0.42	2010	0.63	0.48	308
Log annual earnings	8.46	0.39	3465	8.41	0.40	507

Notes: The base sample for the USR includes all individuals that attained a BA degree between 1973-1993 and are employed in a job 6 months following graduation. The base sample for the NSGD includes all individuals that attained a BA degree in 1980 and are employed in a job 6 months following graduation. Median age at the start of the degree is 19 for both nations. GPA is an average measure of the achievement in secondary school leaving exams out of 30 (but standardized by nation in all regressions). Honors is a measure of success at university standardized across nations taking descrete values from 0 (no honors) to 4 (highest honors). Occupational switch is defined as 1 if field of study at the undergraduate level is equivalent to the occupational field of first job 6 months following degree and 0 otherwise (see Data Appendix for further discussion of classification groups).

Table 2: Further Summary Statistics on Degrees and First Destinations

	USR		*NSGD*	
	England	Scotland	English High School Students	Scotland High School Students
Degree Field Composition (%)				
Mathematical and Computer Sc.	6.4	5.5	4.8	4.7
Physical Sciences	11.7	10.4	14.6	10.6
Architecture	1.3	3.2	1.2	1.7
Engineering	14.7	14.8	12.7	18.7
Life Sciences	8.0	9.8	10.6	10.2
Health Sciences	10.4	13.9	2.4	3.2
Social Services and Welfare	5.0	3.9	4.0	2.6
Social Sciences	14.6	11.0	23.3	20.8
Business	3.5	6.0	2.4	4.2
Law	5.2	6.2	4.7	7.2
Education	1.9	2.1	2.3	4.2
Art	17.3	13.2	17.2	12.1
Post-BA Activity (%)				
Entering employment	64.9	65.6	61.9	64.1
Further study	23.8	24.3	27.7	29.0
Unemployed/Non-employed	11.4	10.1	10.5	6.9
Region of Work (%)				
England	79.8	21.6	86.4	23.2
Scotland	0.7	68.2	1.9	70.2
Wales	5.6	0.5	4.0	0.7
Northern Ireland	2.6	0.5	0.3	0.0
Abroad	11.3	9.1	7.4	5.9
Region of Prior Residence (%)				
England	96.7	3.3		
Scotland	7.4	92.6		

Notes: Fields of study are based on a broad classification (other classifications are discussed in the Data Appendix). Foreign students returning overseas are excluded from counts of Post-BA activity. More detailed subgroups for region of work are available in the NSGD data.

Table 3 : The Effect of Attaining a Scottish Degree on Occupational Switching (USR sample)

Dependent variable: occupational switch					
	No Field Controls	*OLS*	*OLS*	*2SLS*	*2SLS*
	(1)	(2)	(3)	(4)	(5)
SCOTTISH DEGREE	-0.123***	-0.054***	-0.032*	-0.072***	-0.067***
	[0.042]	[0.013]	[0.016]	[0.010]	[0.016]
Female	0.074***	0.017***	0.017***	0.017***	0.017***
	[0.011]	[0.004]	[0.004]	[0.004]	[0.004]
Married	-0.084***	-0.026***	-0.024***	-0.024***	-0.023***
	[0.017]	[0.007]	[0.007]	[0.007]	[0.007]
GPA (in High School)	-0.045***	-0.006**	-0.006*	-0.006*	-0.006**
	[0.013]	[0.003]	[0.003]	[0.003]	[0.003]
Age at Start					
Age 19	0.012*	0	-0.001	-0.003	-0.003*
	[0.006]	[0.002]	[0.002]	[0.002]	[0.002]
Age 20	0.021*	0.003	0.001	-0.002	-0.002
	[0.011]	[0.003]	[0.003]	[0.002]	[0.002]
Age 21	-0.014	-0.020***	-0.021***	-0.024***	-0.023***
	[0.014]	[0.005]	[0.005]	[0.006]	[0.006]
Level of Honors					
High Honors	-0.129***	-0.048***	-0.047***	-0.046***	-0.046***
	[0.032]	[0.008]	[0.008]	[0.008]	[0.008]
Higher Honors	-0.003	-0.066***	-0.067***	-0.066***	-0.066***
	[0.012]	[0.006]	[0.006]	[0.006]	[0.006]
Highest Honors	-0.120***	-0.102***	-0.103***	-0.102***	-0.103***
	[0.019]	[0.008]	[0.008]	[0.008]	[0.008]
Constant	0.764***	0.800***	0.802***	0.803***	0.804***
	[0.025]	[0.021]	[0.021]	[0.021]	[0.020]
Field of Study		X	X	X	X
Region of work			X		X
Observations	410977	410977	410977	410977	410977
R-squared	0.05	0.41	0.41	0.41	0.41
1st stage R-squared				0.69	0.75

Notes: Huber-White standard errors, clustered by university in brackets. * and ** indicate significance at the 5% and 1% level respectively. Dependent variable is defined as 1 if field of study at the undergraduate level is equivalent to the occupational field of first job 6 months following degree and 0 otherwise (according to the broad classification of fields - see Data Appendix). SCOTTISH DEGREE is instrumented with nation of prior residence in columns (4) and (5). Omitted age group is "Age<18" and omitted honors category is "No honors". Year fixed effects included in all regressions. Sample includes all students that attained a first degree in England and Scotland (excluding Wales) with occupation data.

Table 4 : The Effect of Sitting Scottish Exams on Occupational Switching (NSGD sample)

Dependent variable: occupational switch				
	(1)	(2)	(3)	(4)
SCOTTISH HIGH SCHOOL EXAMS	-0.170*** [0.032]	-0.085*** [0.026]	0.017 [0.040]	-0.087*** [0.026]
SCOTTISH EXAMS*GPA				-0.038 [0.025]
Female	0.158*** [0.022]	0.034* [0.019]	0.032* [0.019]	0.035* [0.019]
Married	-0.059*** [0.022]	-0.017 [0.017]	-0.016 [0.017]	-0.017 [0.017]
GPA (in High School)	0.028** [0.011]	0.004 [0.009]	0.001 [0.009]	0.009 [0.010]
Age at Completion				
Age 22	0 [0.024]	0.002 [0.019]	0.003 [0.019]	0.001 [0.019]
Age 23	-0.006 [0.034]	0.005 [0.029]	0.003 [0.029]	0.005 [0.029]
Age 24	0 [0.040]	-0.02 [0.032]	-0.016 [0.032]	-0.02 [0.032]
Level of Honors				
High Honors	0.057 [0.038]	-0.016 [0.030]	-0.008 [0.029]	-0.017 [0.030]
Higher Honors	0.041 [0.039]	-0.044 [0.031]	-0.039 [0.031]	-0.045 [0.031]
Highest Honors	-0.149*** [0.058]	-0.062 [0.045]	-0.056 [0.045]	-0.061 [0.045]
Constant	0.621*** [0.038]	0.437*** [0.053]	0.468*** [0.055]	0.437*** [0.053]
Field of Study		X	X	X
Region of Work			X	
Observations	1895	1895	1895	1895
R-squared	0.06	0.42	0.43	0.42

Notes: Huber-White standard errors. * and ** indicate significance at the 5% and 1% level respectively. Dependent variable is defined as 1 if field of study at the undergraduate level is equivalent to the occupational field of first job 6 months following degree and 0 otherwise (according to the broad classification of fields - see Data Appendix). Omitted age group is "Age<21" and omitted honors cateogry is "No honors". Sample includes all students that attained a first degree in 1980 and are employed within 6 months of completing their degree.

Table 5 : The Effect of Sitting Scottish Exams and Occupational Switching on Annual Earnings (NSGD sample)

Dependent variable: log annual earnings, 6 months after completing degree				
	(1)	(2)	(3)	(4)
SCOTTISH HIGH SCHOOL EXAMS	-0.005 [0.035]		0.005 [0.034]	0.004 [0.034]
SWITCH		-0.074*** [0.026]	-0.071*** [0.027]	-0.071*** [0.026]
SWITCH*SCOTTISH EXAMS			-0.016 [0.042]	-0.012 [0.042]
SCOTTISH EXAMS*GPA				-0.046** [0.020]
SWITCH*GPA				-0.005 [0.017]
SWITCH*SCOTTISH EXAMS*GPA				0.100*** [0.035]
Female	-0.055*** [0.016]	-0.055*** [0.016]	-0.054*** [0.016]	-0.054*** [0.016]
Married	0.026* [0.015]	0.025* [0.015]	0.025* [0.015]	0.025* [0.015]
GPA (in High School)	0.024*** [0.009]	0.023*** [0.009]	0.023*** [0.009]	0.025** [0.012]
Age	0.028 [0.042]	0.024 [0.042]	0.024 [0.042]	0.033 [0.041]
Age-squared	0 [0.001]	0 [0.001]	0 [0.001]	0 [0.001]
Level of Honors				
High Honors	0.026 [0.022]	0.027 [0.022]	0.028 [0.022]	0.03 [0.022]
Higher Honors	0.079*** [0.024]	0.076*** [0.024]	0.076*** [0.024]	0.078*** [0.024]
Highest Honors	0.037 [0.054]	0.034 [0.053]	0.034 [0.054]	0.037 [0.054]
Constant	7.851*** [0.542]	7.915*** [0.543]	7.921*** [0.545]	7.809*** [0.539]
Field of Study	X	X	X	X
Region of Work	X	X	X	X
Observations	1719	1719	1719	1719
R-squared	0.27	0.28	0.28	0.28

Notes: Huber-White standard errors. * and ** indicate significance at the 5% and 1% level respectively. Dependent variable is defined as log annual earnings in first job 6 months after completion of an undergraduate degree. SWITCH is defined as 1 if field of study is equivalent to the occupational field of first job 6 months following degree and 0 otherwise (according to the broad classification of fields - see Data Appendix). Omitted honors cateogry is "No honors". Industry fixed effects included in all regressions. Sample includes all students that attained a first degree in 1980 and are employed within 6 months of completing their degree.

Table 6 : Graduate Occupational Switching, Academic Switching and Wages

Dependent variable:	occupational switch		academic switch		log annual earnings
	USR	*NSGD*	*USR*	*NSGD*	*NSGD*
	(1)	(2)	(3)	(4)	(5)
SCOTTISH DEGREE/ HIGH SCHOOL EXAMS	0.007	0.01	0.047	0.012	-0.017
	[0.018]	[0.045]	[0.035]	[0.045]	[0.061]
SWITCH					-0.117**
					[0.037]
SWITCH*SCOTTISH EXAMS					-0.031
					[0.075]
Female	-0.004	0.04	0.023***	0.119**	-0.097**
	[0.005]	[0.031]	[0.005]	[0.030]	[0.029]
Married	0.021***	-0.006	-0.044***	0.042	-0.019
	[0.007]	[0.029]	[0.013]	[0.029]	[0.025]
GPA (in High School)		0.003		-0.02	-0.008
		[0.015]		[0.015]	[0.014]
Level of Honors (in BA)					
High Honors		-0.058		-0.051	0.023
		[0.050]		[0.057]	[0.067]
Higher Honors		-0.073		-0.129*	0.085
		[0.051]		[0.056]	[0.071]
Highest Honors		-0.141*		-0.285**	0.244**
		[0.068]		[0.072]	[0.081]
Constant	0.611***	0.804**	0.213***	0.642**	8.384**
	[0.035]	[0.083]	[0.076]	[0.088]	[0.544]
Field of Study	X	X	X	X	X
Region of Work					X
Observations	55095	858	276492	982	774
R-squared	0.32	0.38	0.24	0.17	0.32

Notes: Huber-White standard errors, clustered by university in USR samples. * and ** indicate significance at the 5% and 1% level respectively. Occupational switch is defined as 1 if field of study is equivalent to the occupational field of first job 6 months following degree and 0 otherwise (according to the broad classification of fields - see Data Appendix). Academic switch is defined as 1 if field of study at undergraduate level is equivalent to the field of study at graduate level and 0 otherwise (according to the broad classification). Log annual earnings are defined for the first job 6 months after completion of a graduate degree. Omitted honors category is "No honors". USR regressions also include type of degree, entry qualification, and year fixed effects. NSGD regressions also include controls for age. Additional controls in wage regressions include industry fixed effects.

Table 7: The Effect of Sitting Scottish Exams and Occupational Switching on Wage Growth (NSGD sample)

Dependent variable: growth in log annual earnings (over 6 year interval)

	Entire sample			Restricted sample		
	(1)	(2)	(3)	(1)	(2)	(3)
SCOTTISH HIGH SCHOOL EXAMS	0.019		0.031	0.027		0.028
	[0.048]		[0.052]	[0.050]		[0.052]
SWITCH		0.077**	0.081**		0.054	0.054
		[0.034]	[0.035]		[0.036]	[0.038]
SWITCH*SCOTTISH EXAMS			-0.024			-0.005
			[0.062]			[0.067]
Female	-0.141***	-0.141***	-0.141***	-0.136***	-0.136***	-0.137***
	[0.025]	[0.026]	[0.026]	[0.027]	[0.027]	[0.027]
Married	-0.001	0	0	0.02	0.021	0.021
	[0.022]	[0.022]	[0.022]	[0.023]	[0.023]	[0.023]
GPA (in High School)	-0.016	-0.015	-0.015	-0.01	-0.008	-0.009
	[0.012]	[0.012]	[0.012]	[0.013]	[0.013]	[0.013]
Age	0.076	0.08	0.08	0.089	0.09	0.09
	[0.053]	[0.053]	[0.053]	[0.055]	[0.055]	[0.055]
Age-squared	-0.002**	-0.002**	-0.002**	-0.002**	-0.002**	-0.002**
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Level of Honors						
High Honors	0.018	0.018	0.018	0.024	0.025	0.024
	[0.034]	[0.034]	[0.034]	[0.037]	[0.037]	[0.037]
Higher Honors	0.029	0.032	0.033	0.02	0.024	0.024
	[0.036]	[0.036]	[0.036]	[0.039]	[0.039]	[0.039]
Highest Honors	0.135**	0.138**	0.140**	0.099	0.1	0.101
	[0.061]	[0.061]	[0.061]	[0.066]	[0.065]	[0.065]
Constant	0.429	0.36	0.365	-0.043	-0.068	-0.061
	[0.715]	[0.709]	[0.711]	[0.740]	[0.737]	[0.737]
Field of Study	X	X	X	X	X	X
Region of Work	X	X	X	X	X	X
Observations	1632	1632	1632	1159	1159	1159
R-squared	0.19	0.2	0.2	0.27	0.27	0.27

Notes: Huber-White standard errors. +, * and ** indicate significance at the 10%, 5% and 1% level respectively. Dependent variables are defined as log annual earnings in first job 6 months after completion of an undergraduate degree, log annual earnings in current job 6.5 years after completion of an undergraduate degree, and the log change in annual earnings. SWITCH is defined as 1 if field of study is equivalent to the occupational field of first job 6 months following degree and 0 otherwise (according to the broad classification of fields - see Data Appendix). Omitted honors cateogry is "No honors". Industry fixed effects included in all regressions. Sample only includes students that attained a first degree in 1980 and are employed within 6 months of completing their degree. Restricted sample excludes individuals that had a further occupational change in the labor market

Table 8 : The Effect of Sitting Scottish Exams on Occupational Switching over Time (NSGD sample)

Dependent variable: occupational switch after…	0.5 years	2.5 years	4.5 years	6.5 years
SCOTTISH EXAMS	-0.100** [0.025]	-0.099** [0.025]	-0.131** [0.025]	-0.133** [0.025]
Female	0.029 [0.018]	0.032 [0.019]	0.029 [0.019]	0.028 [0.018]
Married	-0.015 [0.017]	-0.005 [0.017]	-0.011 [0.017]	-0.008 [0.017]
GPA (in High School)	0.005 [0.008]	0.008 [0.009]	0.001 [0.009]	0.006 [0.009]
Age at Completion				
Age 22	-0.002 [0.018]	0.003 [0.019]	-0.004 [0.019]	0.001 [0.019]
Age 23	-0.009 [0.029]	-0.007 [0.029]	0.009 [0.029]	-0.001 [0.029]
Age 24	-0.053 [0.031]	-0.032 [0.030]	-0.008 [0.030]	-0.003 [0.031]
Level of Honors				
High Honors	-0.01 [0.029]	-0.028 [0.029]	-0.022 [0.029]	-0.033 [0.028]
Higher Honors	-0.049 [0.030]	-0.062* [0.030]	-0.069* [0.030]	-0.092** [0.029]
Highest Honors	-0.090* [0.045]	-0.105* [0.046]	-0.099* [0.045]	-0.106* [0.045]
Constant	0.416** [0.049]	0.411** [0.049]	0.450** [0.050]	0.520** [0.050]
Field of Study	X	X	X	X
Observations	2076	2076	2076	2076
R-squared	0.41	0.38	0.37	0.38

Notes: Huber-White standard errors. * and ** indicate significance at the 5% and 1% level respectively. Dependent variables are defined as 1 if field of study at the undergraduate level is equivalent to the occupational field of job at 6 months, .2.5 years, 4.5 years, and 6.5 years following degree and 0 otherwise (according to the broad classification of fields - see Data Appendix). Omitted age category is "Age<21" and omitted honors cateogry is "No honors". Industry fixed effects included in all regressions. Sample only includes students that attained a first degree in 1980 and are employed within 6 months of completing their degree.

Table 9: The Effect of Sitting Scottish Exams and Occupational Switching on Occupational Mobility (NSGD sample)

Dependent variable: change to a job in a different occupational field after…

	2.5 years		*4.5 years*		*6.5 years*	
	(1)	(2)	(3)	(4)	(5)	(6)
SCOTTISH HIGH SCHOOL EXAMS	-0.048**	-0.016	-0.051*	-0.068**	-0.077**	-0.074*
	[0.019]	[0.020]	[0.024]	[0.025]	[0.025]	[0.029]
SWITCH		0.108**		0.097**		0.128**
		[0.021]		[0.026]		[0.029]
SWITCH*SCOTTISH EXAMS		-0.042		0.049		0.016
		[0.036]		[0.045]		[0.048]
Female	0.035	0.034	0.032	0.029	0.042	0.039
	[0.018]	[0.018]	[0.021]	[0.021]	[0.023]	[0.023]
Married	-0.032*	-0.029	-0.035	-0.032	-0.011	-0.007
	[0.015]	[0.015]	[0.018]	[0.018]	[0.019]	[0.019]
GPA (in High School)	-0.007	-0.006	-0.014	-0.011	-0.012	-0.006
	[0.007]	[0.007]	[0.008]	[0.009]	[0.009]	[0.009]
Age	0.006	0.008	0.013	0.015	0.015	0.017
	[0.009]	[0.009]	[0.011]	[0.011]	[0.012]	[0.012]
Age-squared	-0.000*	-0.000*	-0.000**	-0.000**	-0.000**	-0.000**
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Level of Honors						
High Honors	0	0	0.049	0.048	0.036	0.035
	[0.025]	[0.025]	[0.028]	[0.028]	[0.033]	[0.033]
Higher Honors	-0.001	0.003	0.061*	0.064*	0.017	0.019
	[0.026]	[0.026]	[0.030]	[0.030]	[0.034]	[0.034]
Highest Honors	-0.061*	-0.053	-0.038	-0.034	-0.062	-0.059
	[0.030]	[0.030]	[0.038]	[0.038]	[0.043]	[0.044]
Constant	-0.002	-0.029	-0.148	-0.182	-0.007	-0.054
	[0.213]	[0.211]	[0.252]	[0.251]	[0.273]	[0.271]
Field of Study	X	X	X	X	X	X
Observations	2022	2022	2019	2019	2022	2022
R-squared	0.04	0.05	0.05	0.06	0.04	0.06

Notes: Huber-White standard errors. * and ** indicate significance at the 5% and 1% level respectively. Dependent variables are defined as 1 if occupational field at 6 months after the completion of the undergraduate degree is equivalent to the occupational field of job at 2.5 years, 4.5 years, and 6.5 years following degree and 0 otherwise (according to the broad classification of fields - see Data Appendix). SWITCH is defined as 1 if field of study is equivalent to the occupational field of first job 6 months following degree and 0 otherwise. Omitted honors cateogry is "No honors". Industry fixed effects included in all regressions. Sample only includes students that attained a first degree in 1980 and are employed within 6 months of completing their degree.

Table 10: Subjective Assessments of Benefits of Education (NSGD Sample)

Dependent variable: "How beneficial has your qualification been to you in…"

	"Getting an Interesting Job"		*"Becoming an Educated Person"*	
	(1)	(2)	(3)	(4)
SCOTTISH HIGH SCHOOL EXAMS	-0.142 [0.131]	-0.141 [0.131]	0.123 [0.114]	0.116 [0.117]
SWITCH	-0.322** [0.069]	-0.269** [0.078]	0.365** [0.059]	0.138 [0.071]
SWITCH*SCOTTISH EXAMS	0.290+ [0.163]	0.284+ [0.163]	-0.435** [0.148]	-0.406** [0.151]
Female	-0.01 [0.060]	-0.025 [0.062]	0.065 [0.054]	-0.038 [0.057]
Married	0.001 [0.054]	0.002 [0.055]	-0.022 [0.050]	0.003 [0.050]
GPA (in High School)	0.002 [0.026]	0.011 [0.026]	-0.017 [0.025]	-0.018 [0.026]
Age at Completion				
Age 22	-0.041 [0.061]	-0.039 [0.061]	0.095 [0.055]	0.069 [0.056]
Age 23	0.06 [0.081]	0.03 [0.084]	0.108 [0.077]	0.051 [0.080]
Age 24	-0.02 [0.108]	-0.055 [0.108]	0.260** [0.100]	0.182 [0.101]
Level of Honors				
High Honors	0.257** [0.089]	0.279** [0.091]	0.135 [0.084]	0.075 [0.087]
Higher Honors	0.357** [0.094]	0.379** [0.097]	0.344** [0.088]	0.253** [0.090]
Highest Honors	0.592** [0.155]	0.617** [0.154]	0.278* [0.135]	0.313* [0.136]
Field of Study		X		X
Observations	1981	1981	1992	1992

Notes: Huber-White standard errors. +, * and ** indicate significance at the 10%, 5% and 1% level respectively. Results are from ordered probit regressions. Dependent variables are ordered categorical variables that take on values from 1 ("Not at all") to 4 ("A lot"). SWITCH is defined as 1 if field of study is equivalent to the occupational field of first job 6 months following degree and 0 otherwise (according to the broad classification of fields - see Data Appendix). Omitted age group is "Age<21", omitted honors cateogry is "No honors". Industry fixed effects included in all regressions. Additional controls include log annual earnings in the first job after 6 months and subjective measures of how beneficial the qualification has been to securing a good income. Sample only includes students that attained a first degree in 1980 and are employed within 6 months of completing their degree.

APPENDIX TABLE 1: FIELDS OF STUDY

11 PHYSICAL, MATHEMATICAL AND COMPUTER SCIENCES
- **111 Mathematical and Computer Sciences**
  - 1110 Other
  - 1111 Mathematical Sciences
  - 1112 Computer Sciences
- **112 Physical Sciences**
  - 1120 Other
  - 1121 Environmental
  - 1122 Chemistry
  - 1123 Geology
  - 1124 Physics

12 ENGINEERING AND ARCHITECTURE
- **121 Architecture**
  - 1210 Architecture
- **122 Engineering**
  - 1220 Other
  - 1221 Aerospace, aeronautical, astronautical engineering
  - 1222 Chemical engineering
  - 1223 Civil engineering
  - 1225 Electrical, electronics, communications engineering
  - 1227 Industrial engineering
  - 1228 Materials
  - 1229 Mechanical engineering

13 LIFE AND HEALTH SCIENCES
- **131 Life Sciences**
  - 1310 Other
  - 1311 Agriculture
  - 1312 Biology
- **132 Health Sciences**
  - 1320 Other
  - 1321 Physicians
  - 1322 Nursing

21 SOCIAL SCIENCES AND SERVICES
- **211 Social Service Studies**
  - 2110 Other
  - 2111 Psychology
  - 2112 Social Work
- **212 Social Sciences**
  - 2120 Other
  - 2121 Economics
  - 2122 History
  - 2123 Geography
  - 2124 Government, Public Administration

22 BUSINESS and LAW
- **221 Business**
  - 2210 Other
  - 2211 Accounting, Financial
  - 2212 Management
  - 2213 Sales
- **222 Law**
  - 2221 Law

23. EDUCATION and ARTS
- **231 Education**
  - 2310 Education
- **232 Arts**
  - 2320 Other
  - 2321 English
  - 2322 Art
  - 2323 Performing arts
  - 2324 Languages
  - 2325 Religion and Philosophy