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

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Abstract

This paper examines the tradeoff between early and late specialization in the context of higher education. While some educational systems require students to specialize early by choosing a major field of study prior to entering university, others allow students to postpone this choice. I develop a model in which individuals, by taking courses in different fields of study, accumulate field-specific skills and receive noisy signals of match quality in these fields. With later specialization, students have more time to learn about match quality in each field but less time to acquire specific skills once a field is chosen. I derive comparative static predictions between regimes with early and late specialization, and test these predictions across British systems of higher education using university administrative data and survey data on 1980 university graduates. I find that individuals in Scotland, where specialization occurs relatively late, are less likely to switch to an occupation that is unrelated to their field of study compared to their English counterparts who specialize earlier. According to the model, this suggests that the return to being well matched to an occupational field is high relative to the return to specific skills and there may therefore be benefits to later specialization. I also find strong evidence in support of the prediction that individuals who switch to unrelated occupations earn lower wages but no evidence that the cost of switching differs between those specializing early and late.

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1 Introduction

Division of labor - the tendency of individuals to specialize in specific occupations - is an important feature of the modern labor market. However, for many professional occupations, such as those held by scientists, engineers, managers, lawyers, and teachers, specialization begins prior to labor market entry when an individual chooses a major field of study in university. The timing of such academic specialization varies across different systems of higher education. In some countries, students are required to choose a field of study before they apply to college. In others, students may postpone the decision until late in their college careers. These differences highlight the trade-off between the benefits of accumulating more human capital in a particular field by specializing early *versus* delaying choice in order to gather additional information about alternative fields by specializing later. I explore the consequences of early and late specialization by comparing labor market outcomes across two educational systems with different exogenous constraints on the timing of academic specialization.

To understand the effects of early and late specialization, I develop a model that distinguishes between different systems of higher education. I assume that individuals initially take courses in a number of different fields of study but must specialize at some point by choosing one field and taking their remaining courses in this field exclusively. A key aspect of the model is that individuals learn about their unobserved match quality in different fields by taking courses. Each course in a given field of study provides a unit of field-specific skills and a signal of match quality in that field. Later specialization gives students more time to learn about match quality in different fields but it affords less time to acquire field-specific skills after a field is chosen. Upon completing their education, individuals choose whether or not to switch to an occupation that is unrelated to their chosen field of study. Wages in a given occupational field are assumed to be increasing in both field-specific skills and match quality. The model then distinguishes between regimes with early and late specialization, and generates comparative static predictions concerning wages and the likelihood of switching to an unrelated occupational field across the two regimes.

I compare the labor market consequences of specializing early versus late across two British systems of higher education. Within Great Britain, the English and Scottish undergraduate systems impose very different constraints on the timing of academic specialization. In England, students generally apply for a specific field of study at a particular university while still in secondary school. Once admitted to study a certain field, they usually follow a narrow curriculum that focuses on the chosen subject and allows for few courses in any other field. That is, English students are required to specialize early. In contrast, Scottish students are typically admitted to a broad faculty

rather than a specific field. They are generally required to take several different subjects during their first two years before specializing in a particular field. That is, Scottish students are required to generalize early and specialize late. These differences in the timing of academic specialization between England and Scotland have existed for more than a century.[1] A comparison across England and Scotland is useful because the labor markets in these two nations are relatively well integrated and macroeconomic policies are determined by a common government. Britain is thus a particularly appropriate setting in which to examine the consequences of specializing early versus late.

I test the model's comparative static predictions across the corresponding English and Scottish systems of higher education using university administrative data and survey data of 1980 university graduates. 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. According to the model, this implies a high return to field-specific match quality relative to specific skills and there may therefore be benefits to specializing later. No such difference is found between England and Wales, or between England and Scotland at the graduate level, where the timings of academic specialization are similar. In both regimes, individuals who switch to occupations unrelated to their chosen field of study are expected to earn lower wages than those who do not because they lose field-specific skills and will, on average, have lower levels of match quality in the alternative fields. I find strong evidence that individuals who switch to unrelated occupations earn lower wages, on average. Wage predictions across regimes will generally depend on the return to match quality relative to the return to specific skills. In the case of England and Scotland, however, there are no significiant differences in average wages or in wage differentials related to occupational switching after controlling for demographic and occupational characteristics.

The distinction between early and late specialization in different systems of higher education has been noted by various scholars in the education literature.[2] In economics, academic specialization is closely related to the important distinction between general and specific education. In changing environments, general education may be more valuable than specific training.[3] Moreover, general skills are often deemed more useful in implementing new technology.[4] Krueger and Kumar (2002)

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

[2] Johnstone and Maloney (1998) and Trow (1999) compare the U.S. and European systems of higher education. Evans (1976), Hunter (1971), Osborne (1967), and Squires (1987) compare the English and Scottish systems.

[3] Goldin (2001) suggests that high geographical and occupational mobility may explain the prominence of general education in America, in contrast to the European tradition of vocational and apprenticeship training. Johnson (1979) explores the positive relation between general education and occupational mobility and shows that exogenous general education raises the probability of job change.

[4] Nelson and Phelps (1966) show that greater technological change may raise the return to education and Welch (1970) provides some related evidence.

argue that the specialized training favored in Europe may account for the slowdown in European economic growth during periods of rapid technological change. In the context of academic specialization, individuals who emerge from an educational system that requires early specialization will have more specific skills in a particular field, while their counterparts in a system that allows for later specialization will have more skills in a range of fields. Thus, the model I present in this paper predicts that regimes which allow for later specialization are otherwise even more preferable when there is substantial labor market volatility. However, with imperfect information about match quality, I can derive non-trivial predictions across different educational systems in the absence of any labor market volatility. In a static labor market with perfect information, Weiss (1971) shows that it is not optimal to delay the investment in education or to change occupations when human capital accumulation is perfectly specific to a particular occupation. Allowing for imperfect information about match quality, I find that it may be better to delay specialization. Furthermore, the arrival of new information about match quality may lead some individuals to switch to an occupation that is unrelated to their chosen field of study.

That education may provide individuals with valuable information about their match quality to different fields of study in addition to skills is not emphasized much in the literature on human capital. A notable exception is Altonji (1993) who introduces a model where individual discover their relative preferences between two fields of study by attending college.[5] Learning about match quality is a more prominent feature in models of job turnover. Shaw (1987) and McCall (1990) extend the notion of job match quality presented by Johnson (1978) and Jovanovic (1979a) to the occupational level and present evidence for learning about occupational match quality. In this paper, learning about match quality in different fields of study provides information on match quality in the occupations related to these fields. The process of learning about match quality in a particular field is complementary to the acquisition of specific skills in that field.[6] The trade-off associated with specialization arises *not* between the accumulation of human capital and learning about match quality *per se*, but rather, between the accumulation of human capital in *a particular field* and the possibility of learning about match quality in *alternative fields*. For simplicity, the model does not allow for skills that are transferable across fields. A person has general skills only in the sense of having greater levels of specific skills in a variety of alternative fields, and this

[5] A related paper is by Hvide (2003) who extends Spence's (1973) signaling model to allow for learning about overall ability (rather than match quality in specific fields of study) and suggests that certain types of education, such as U.S. bachelor's degrees, may primarily provide information about ability, while others, such as U.K. bachelor's degrees, serve to augment productivity.

[6] Contrast this with the competing tasks of on-the-job search and firm specific human capital acquisition in Jovanovic (1979b).

affects wages only when switching into one of these fields. Incorporating some notion of general skills into the wage function would, all other things equal, make the late regime more attractive. Freeman's (1971) landmark study on occupational choice found that the supply of college students responds to economic incentives such as salaries and employment opportunities.[7] While I abstract from differences in earnings across fields in the theoretical model, I do control for these differences in the empirical analysis.

The American system of higher education is often cited as an example of an educational system with a broad undergraduate curriculum and relatively late specialization.[8] However, though the U.S. has a strong liberal arts tradition that emphasizes general education and allows for later specialization, American undergraduates *can* exploit their elective courses and specialize early, if they wish. The U.S. 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. Indeed, a system that enables individuals to choose when to specialize may be optimal if students have sufficient information to experiment in a productive fashion. While an assessment of the U.S. system is of considerable theoretical and intrinsic interest, this paper avoids the problem of endogenous choice by focusing on a comparison between systems which impose exogenous constraints on the timing of academic specialization.

The paper proceeds as follows: Section 2 develops a simple model of academic specialization. Section 3 derives comparative static predictions across regimes with early and late academic specialization. Section 4 explores the differences between the English and Scottish systems of higher education in more detail. Section 5 describes the data and the empirical methodology. Section 6 presents results from the regression analysis. Section 7 concludes.

2 A Model of Academic Specialization

This section introduces a simple model of academic specialization: Suppose that individuals take n courses in each of J fields of study prior to specialization. Each course in a given field provides a unit of field-specific skill and a noisy signal of match quality in that field. In specializing, individuals choose a field and take $(N - nJ)$ additional courses in this chosen field of study. After completing a total of N courses, individuals choose whether to enter into an occupational field that is related

[7] Berger (1988) and Rumberger and Thomas (1993) provide more recent evidence. Freeman (1971) also provides valuable insight into the process of choosing a major. In a survey of college students in the Boston area, he finds that most final career plans are made during the college period, and that the choice of a college major and the choice of occupation are closely related decisions.

[8] The formative years of higher education in the U.S. are surveyed by Goldin and Katz (1999).

to their chosen field of study or to switch to an unrelated occupation. Upon entering the labor market, individuals earn a wage that is increasing with both match quality and field-specific skills. I describe this basic setup in greater detail below. In section 3, I proceed to examine the comparative statics between an early regime in which individuals are required to specialize after n^E courses in each field and a late regime in which individuals are required to specialize after n^L courses in each field, where $n^E < n^L$.[9]

2.1 Setup

Assume that individuals are risk neutral and have identical prior distributions on match quality for all fields that follow a normal distribution with mean μ and variance σ. In general, we may expect that prior distributions on match quality will differ across fields. However, I abstract from such prior differences here to keep the model parsimonious. Allowing for differences in prior distributions would require a series of additional parameters without adding much to the underlying intuition. I consider the effect of allowing for risk aversion in section 3.5.

Match quality, m_j, in any field j is a random draw from the prior distribution, so that $m_j = \mu + \xi_j$ where $\xi_j \sim N(0,\sigma)$. Match quality is therefore uncorrelated across fields. Match quality includes any field-specific component of education that affects wages – for example, inherent ability or interest which contributes to productivity in a specific field.[10] In the empirical analysis, I will attempt to control for indicators of predictable match quality so that the remaining components of match quality are random.

By taking courses in a given field, individuals will (1) accumulate field-specific skills and (2) 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.[11] Each course of study i in field j provides a signal of match quality in that field, $y_{ij} = m_j + \varepsilon_{ij}$ where $\varepsilon_{ij} \sim N(0,\sigma_\varepsilon)$ and $i = 1...n$. Noise in the signal may be due to any number of idiosyncratic factors such as the quality of instruction or the particular circumstances of the student at the time. I assume that studying one field does not allow individuals to assess their match quality in other

[9] 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 specialization 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.

[10] Indeed, we can broaden this definition to include any field-specific component that affects utility (e.g. life-style considerations) by replacing the objective wage function with a utility function.

[11] 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.

fields and the only way to accumulate skills in a particular field is to spend time studying that field. I will consider the possibility of spillovers across fields in section 3.5.

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 $\frac{\partial f}{\partial m} > 0$ and $\frac{\partial f}{\partial s} > 0$. Specifically, I assume that wages are an exponential function, $w_j = \exp[\alpha m_j + \beta s_j]$, so that log wages are linear in match quality and skills and identical across fields.[12] I take $\left(\frac{\alpha}{\beta}\right)$ as an indication of the return to match quality relative to the return to specific skills. More generally, we might expect a different functional form for wages across different fields. In the empirical analysis, I compare outcomes for individuals within fields so that mean differences in wages across fields can be ignored.[13] Finally, I suppose that individuals only consider wages when making educational and occupational decisions. However, if I were to consider utility as a function of non-pecuniary factors as well, I would derive analogous predictions.

2.2 Choice of field at specialization

The posterior distribution of match quality after studying n courses in field j is a normal distribution with mean μ'_j and variance σ'.[14] And the quantity of skills in each field if chosen following specialization is $s'' = n + (N - nJ)$. Therefore, in specializing, risk neutral individuals with identical prior distributions across fields will choose the field of study with the highest expected wages:

$$Choose j^* = \arg\max_{j \in J} \left\{ E\left[w\left(\mu'_j, s''\right)\right]\right\}$$

Since the quantity of specific skills in each field is identical, individuals will simply choose the field with the highest posterior mean of match quality, $j^* = \arg\max\{\mu'_j\}^J$. Thus, the posterior mean of match quality in the chosen field at the time of specialization will be μ'_{j^*}.[15]

2.3 Decision on whether to switch

Following specialization, individuals will take an $(N - nJ)$ additional courses in the chosen field. Thus, the quantity of skills in the chosen field prior to entering the labor market will be $s'' =$

[12] Note that when discussing predictions in subsequent sections, I will use the terms wages and log wages interchangeably to denote $\ln w_j = \alpha m_j + \beta s_j$. Since we are interested in relative effects of match quality and skills, we will often assume that $\beta + \alpha = 1$ without loss of generality.

[13] Nevertheless, differences in the functional form of wage functions across fields such as the relative return of match quality to specific skills will affect both switching behavior and wages.

[14] The posterior mean is a weighted average of the prior mean and the mean of the signals: $\mu'_j = \left(\mu\sigma^{-1} + \sigma_\varepsilon^{-1} \sum y_{ij}\right) / \left(\sigma^{-1} + n\sigma_\varepsilon^{-1}\right)$. The posterior variance is $\sigma' = \left(\sigma^{-1} + n\sigma_\varepsilon^{-1}\right)^{-1}$. See DeGroot (1970).

[15] Specifically, $\mu'_{j^*} = \left(\mu\sigma^{-1} + \sigma_\varepsilon^{-1} \max_j \left\{\sum y_{ij}\right\}^J\right) / \left(\sigma^{-1} + n\sigma_\varepsilon^{-1}\right)$.

$n + (N - nJ)$. Moreover, individuals will receive additional signals in the chosen field, j^*. Define these signals as $z_{kj^*} = m_{j^*} + \varepsilon_{kj^*}$, where $k = nJ...N$. Consequently, the posterior distribution of match quality in the chosen field after $(N - nJ)$ additional signals will be a normal distribution with mean μ''_{j^*} and variance σ''.[16] Now, given the opportunity to switch to another field prior to entering the labor market, individuals will compare expected wages in the chosen field with expected wages in the next best field:

$$OccupationalSwitch \iff E\left[w\left(\mu''_{j^*}, s''\right)\right] < \max_{j \neq j^*, j \in J} \left\{E\left[w\left(\mu'_j, s''\right)\right]\right\}$$

Intuitively, individuals will switch if the posterior mean of match quality in the chosen field falls sufficiently far below the posterior mean of another field to overwhelm the loss in specific skills from switching. Note that, if individuals decide to switch, they will always choose the field with the second-highest posterior mean, j^a, since all fields other than the one chosen are associated with the same quantity of specific skills and posterior variance. The decision whether to switch can therefore be framed as a comparison between the first best field, j^*, and the field that was second best at the time of specialization, j^a.

3 Theoretical Analysis

This section derives comparative static predictions across regimes with early and late specialization. Early regimes require individuals to specialize after taking n^E courses in each field; late regimes require individuals to specialize after taking n^L courses in each field, where $n^E < n^L$. I begin by examining wages in a baseline case where no occupational switching is permitted; that is, individuals must enter their chosen field of study. Then I consider the case where occupational switching is allowed and compare the probability of switching across the two regimes. Given the important distinction made between individuals who choose occupations related to their fields of study and those who switch to unrelated occupations, predictions on wages are derived both within and between regimes. Since analytic solutions of this Bayesian updating model are difficult to derive, the main results are presented with simulations.[17]

[16] So that $\mu''_{j^*} = \left(\mu\sigma^{-1} + \sigma_\varepsilon^{-1} \max_j \left\{\sum y_{ij}\right\}^J + \sigma_\varepsilon^{-1} \sum z_{kj^*}\right) / \left(\sigma^{-1} + n\sigma_\varepsilon^{-1} + (N - nJ)\,\sigma_\varepsilon^{-1}\right)$ and $\sigma'' = \left(\sigma^{-1} + n\sigma_\varepsilon^{-1} + (N - nJ)\,\sigma_\varepsilon^{-1}\right)^{-1}$.

[17] An appendix containing analytical proofs for the special case where there are only two courses and two fields (where $N = 2$ and $J = 2$) is available upon request. 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: $n^E = 0$.

3.1 Baseline case: No occupational switching

Suppose that individuals must enter an occupation in their chosen field of specialization, j^*. Individuals that specialize later will have less time to accumulate specific skills in their chosen field of study but will receive more signals in each field 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. Match quality will, on average, be higher for individuals in the late regime. Hence, whether individuals in the early regime ultimately earn higher expected wages than their counterparts in the late regime will depend on the return to match quality relative to the return to field-specific skills.

Proposition 1 *Suppose that switching is not permitted. Then there is some* $\widetilde{(\alpha/\beta)}$ *such that individuals in the early regime will have higher expected wages in the chosen field,* $E\left[w\left(\mu''_{j^*},s''\right)\right]$, *than individuals in the late regime if* $\alpha/\beta < \widetilde{(\alpha/\beta)}$ *and lower wages if* $\alpha/\beta > \widetilde{(\alpha/\beta)}$.

Simulations of expected wages confirm this proposition over a broad set of parameter values. Figure 1 plots expected wages for an early and a late regime over the full range of relative returns to match quality which are normalized by taking $\beta = (1-\alpha)$ so that (α/β) goes from 0 to ∞ as α goes from 0 to 1.[18] When the relative return to match quality is high (i.e. α close to 1), individuals that specialize later will earn higher wages.

3.2 Probability of occupational switching

Now suppose that individuals can switch to an alternative occupational field prior to entering the labor market. Posterior distributions at the time of specialization will be more diffuse for individuals in the early regime. Moreover, these individuals will receive more signals in the chosen field after specializing than their counterparts in the late regime. In the early regime, assessments of perceived match quality in the chosen field will therefore experience relatively greater updating and make individuals more likely to conclude that they made a mistake when they initially inferred their field with the highest match quality.[19] However, in switching, individuals will lose the additional skills

[18] All simulations are based on 5000 repetitions for $J = 2$,$N = 21$,$\mu = 0$,$\sigma = 25$, and $\sigma_\varepsilon = 100$. Early regimes are characterized by $n^E = 2$; late regimes are characterized by $n^L = 6$. Expected wages are log wages determined according to $E(\ln w_j) = E(\alpha m_j + \beta \widehat{s_j})$ where $\widehat{s_j} = \frac{s_j}{N/J} + \mu$ are normalized skills.

[19] Specifically, the posterior distribution is 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 case where individuals specialize immediately prior to entering the labor market. In this case, the probability of perceiving a mistake will be 0 since no additional information is received following specialization.

acquired in the chosen field of study through specialization. Individuals will therefore switch only if the posterior mean of the first best field falls not merely below that of the second best field, but sufficiently far below it to overwhelm the loss in specific skills. The loss in specific skills will always be greater in the early regime. Consequently, whether the probability of switching is higher in the early regime will depend on the relative return of match quality.[20]

Proposition 2 *There is some relative return to match quality,* $\widehat{(\alpha/\beta)}$*, such that the probability of switching,* $\Pr\left[w\left(\mu''_{j^*},s''\right) < w\left(\mu'_{j^a},s'\right)\right]$*, is higher in the early regime if* $\alpha/\beta > \widehat{(\alpha/\beta)}$ *and lower if* $\alpha/\beta < \widehat{(\alpha/\beta)}$*.*

Figure 2 plots the probability of switching for an early and a late regime by the relative returns to match quality. Observing a higher rate of occupational switching in the early regime than in the late regime, as emerges from the empirical analysis, implies that the return to match quality is high relative to the return to specific skills.

3.3 Wages within regimes

The quantity of specific skills for individuals who switch to occupations unrelated to their chosen field of study is always lower than for those who enter related occupations. Furthermore, match quality conditional on switching is generally lower since chosen fields with lower match quality are the ones that ultimately lead to bad signals and cause switching. Thus, on average, individuals who switch will have lower levels of both match quality and specific skills than those who do not switch. Of course, we assume that the individual's decision is optimal so expected wages from switching must be higher than expected wages from not switching. Therefore, the proposition below holds in the cross-section and not for an individual's counterfactual comparison:

Proposition 3 *Individuals who switch will, on average, have lower wages than those who do not switch:* $E\left[w\left(m_{j^a},s'\right) \mid w\left(\mu''_{j^*},s''\right) < w\left(\mu'_{j^a},s'\right)\right] < E\left[w\left(m_{j^*},s''\right) \mid w\left(\mu''_{j^*},s''\right) > w\left(\mu'_{j^a},s'\right)\right]$

Figure 3 confirms that the wage loss associated with occupational switching is indeed negative for the full range of relative returns to match quality in both regimes. As an extension, suppose that individuals continue to accumulate field-specific skills on the job (either from on-the-job training or learning by doing). Further assume that there are diminishing returns to specific skills. Then

[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 do not receive any additional information following specialization.

individuals who switch will have higher rates of wage growth since they begin with lower levels of specific skills in their occupational fields.

3.4 Wages between regimes

Wage comparisons between regimes are less clear-cut. Consider the differential in wage loss between the early and late regimes: The difference in specific skills between individuals who do not switch and those who switch will always be greater in the early regime than in the late regime since $(s'' - s')$ is decreasing in n. However, evaluating the differential in match quality across regimes is more involved. Individuals in the late regime will generally have higher match quality in both the chosen field of study and the alternative field of study since they receive more signals on match quality in all fields prior to specialization.[21] The differential in match quality across regimes will therefore depend on the specific distributional assumptions and the values of ancillary parameters (other than α and β). Consequently, the overall differential in wage loss will also be ambiguous. A sufficiently low return to match quality relative to specific skills will assure that the wage loss is greater in the early regime. But certain parameter values and distributional functions can yield a greater wage loss in the late regime.

Proposition 4 *If (α/β) is small, the average expected wage loss from switching will be greater in the early regime than in the late regime.*

Figure 3 plots the wage loss in an early and a late regime for a range of relative returns to match quality.[22] Comparisons of overall wages across regimes will not, in general, be unambiguous either. Individuals who switch will have more specific skills in the late regime than in the early regime while differentials in match quality will be ambiguous for the reasons described earlier. Abstracting from deviations due to the conditional expectation of match quality, individuals that do not switch will have more specific skills in the early regime but lower average match quality in the late regime.

Proposition 5 *Suppose that switching is permitted. Then there is some $\widetilde{\widetilde{(\alpha/\beta)}}$ such that individuals in the early regime will have higher expected wages, $E[w(m,s)]$, than individuals in the late regime if $\alpha/\beta < \widetilde{\widetilde{(\alpha/\beta)}}$ and lower if $\alpha/\beta > \widetilde{\widetilde{(\alpha/\beta)}}$.*

[21] Actual match quality conditional on switching will depend on rather complicated conditional expectations. Furthermore, note that individuals in the early regime make more mistakes in their initial choice of field at the time of specialization so switches are more likely to yield corrections to higher match quality. This is particularly apparent when there are only two fields – in this case, match quality in the alternative field will always be greater in the early regime.

[22] For the parameter values chosen (μ,σ,σ_{ε},n^E,n^L,N, and J), it appears that the wage loss in the early regime always exceeds the wage loss in the late regime.

Expected wages in an early and a late regime are shown in Figure 4 for different relative returns to match quality. As in the baseline case described earlier, this finding suggests that the superiority of one regime over the other depends critically on the relative returns to match quality and field-specific skills.

3.5 Extensions

Throughout I have assumed that individuals are risk neutral. Introducing risk aversion will not alter the decision at the point of specialization since the variances of the posterior distributions across fields are identical; individuals will continue to choose the field with the highest posterior mean. However, in considering an occupational switch, the presence of risk aversion will make the relative variances of the posterior distributions relevant. Specifically, 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 so as to prevent switching. Moreover, this effect is stronger in the early regime since the trade-off between the posterior variances at the time of specialization and the posterior variance of the chosen field after the receipt of additional signals will be more extreme. Occupational switching will therefore decline more in the early regime than in the late regime due to the presence of risk aversion.[23]

The assumption that the prior distributions on match quality are identical across fields implies that individuals do not need to consider the possibility of later switching when making their initial choice of field at the time of specialization. However, if fields have different prior distributions on match quality then fields with a larger prior variance have greater option value in the early regime than in the late regime. 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. 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 the greater option value. Since such fields have lower expected match quality than that of the field with the highest posterior mean, we expect more occupational switching in the early regime due to option value considerations.[24]

The model presented above does not contain any dynamic labor market effects such as occupational mobility. We can introduce occupational 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

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

[24] 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.

actual ability rather than perceived ability. Therefore, once individuals discover their true match quality, they may decide that they prefer to change occupations. Unfortunately, this apparently simple modification substantially complicates the analysis since individuals may now alter their switching behavior in response to the knowledge that they may later change occupations in case of an erroneous switch.

As mentioned earlier, the model contains no truly general skills. A person has general skills only in the sense of having greater levels of specific skills in a variety of alternative fields, and this affects wages only when switching into one of these fields. Nevertheless, it would be relatively simple to incorporate general skills into the wage function by including some measure of average skill in the fields not chosen for specialization: $\overline{s} = \frac{1}{J}\sum^{j \neq j^*} s_j$. All things equal, this would make the late regime more attractive for individuals. More generally, we can consider the possibility of spillovers in skills across fields. This would tend to make the late regime more appealing because additional learning about match quality would be less costly in terms of forgone skill acquisition.

4 Background: Higher Education in Great Britain

The British system of higher education provides a particularly appropriate setting in which to examine the predictions of the theoretical framework. Undergraduate education in England and Scotland, though similar in aim and overall structure, varies widely in required curriculum breadth. In England, students generally apply for a specific field of study at a particular university.[25] Once admitted to a specific field, English students usually follow a narrow curriculum that focuses on the main subject and allows for little exposure to other subjects.[26] In contrast, Scottish students are typically admitted to a faculty rather than a department; in some universities, admission is to the university at large. Furthermore, they are required to take several different subjects during their first two years. As an undergraduate prospectus for the University of Edinburgh explains:

> "You would normally take courses in three or more subjects in the first year and, commonly, these are followed by second courses in at least two of the subjects in your second year. This will then give you a choice from two, or even three, subjects to pursue to degree level, and you can delay this decision until quite a late stage...In choosing courses to be taken in the first two years, you can select from a very wide range of courses offered across several faculties."

[25] 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.

[26] 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 students to study a broader range of subjects.

Similar course structures exist in most Scottish universities. Scottish universities thus allow for substantial choice among fields of study within faculties and, to some degree, across faculties as well.[27] Students in Scotland are *required* to take a broader range of courses and choose a field of study much later than their English counterparts.[28] 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".

There is some variation in the average length of undergraduate degree between England and Scotland. Although there is a fair amount of heterogeneity among degrees within each nation, most English degrees are completed within 3 years whereas most Scottish degrees are completed within 4 years. However, many Scottish students enter university after 6 years of secondary schooling rather than the 7 years customary in England. According to this calculation, English and Scottish students who attain a BA degree receive roughly the same number of years of schooling. Loosely speaking, the first year of university in Scotland may sometimes correspond to the final year of secondary school in England. But even so, since English students apply to university in the beginning of their final year of secondary school when they are already specialized to some degree, and Scottish students only make their final choice of field at the end of their second year of university, there is substantial difference in the timing of specialization.

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) The provincial civic universities established later in urban centers did not substantially depart from the traditions of the "ancient" universities. Even with the introduction of broad faculties and additional courses of study, admissions remained at the departmental level.[29] On the other hand, Scottish universities became regulated under the Universities (Scotland) Act of 1858 that set up an executive commission to

[27] Note, however, that changing across certain fields is not always possible (e.g. from history to physics without the necessary prerequisites). Moreover, certain professional faculties, such as medicine and law, are more insular. Engineering is usually a separate faculty but changes from the physical sciences are often permitted.

[28] Numerous scholars of British educational systems have noted that Scottish institutions allow for later specialization than English ones: e.g. Hunter (1971), Osborne (1967), Squires (1987). Personal conversations and correspondences with university administrators in England and Scotland confirm these observations. This is also 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.

[29] There are some notable exceptions such as the University of Keele which gained full independent status in 1962, and implemented an experimental modular curriculum.

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 large part, these two Acts of Scottish Parliament determined the distinctive characteristics of universities in Scotland, including the emphasis on late academic specialization.

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.[30] 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 an 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.[31] 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.[32] Again, the reasons for these differences in secondary school curriculum can be traced to historical antecedents. In effect, specialization trickled down from the universities to secondary schools. Moreover, the 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.

The difference in the timing of academic specialization between the English and Scottish systems of undergraduate education does not arise with graduate level education. Graduate degrees in both England and Scotland require admission to a specific course of study. As a result, comparisons of labor market outcomes between England and Scotland at the graduate level can serve as a valuable "placebo test." These comparisons are explored further in Section 6. The discussion

[30] 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. Dolton and Vignoles (2002) examine the effect of choosing a broader set of courses in secondary school in the United Kingdon.

[31] 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.

[32] 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.

above has focused on England and Scotland but Great Britain also includes Wales, which has a distinct system of higher education. However, in contrast to Scotland, the timing of academic specialization in Wales is identical to that of England. Undergraduate students in Wales apply to a specific course of study in similar fashion as in England. Hence, though we will exclude Wales from the main empirical analysis, comparisons between England and Wales at the undergraduate level can also serve as an important "placebo test."

5 Data and Empirical Strategy

5.1 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.[33] For the most part, we shall focus on students that completed their degree in 1980 so that it corresponds with the data from the NSGD. 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 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 leavers from other institutions in 1980 in Great Britain.[34] The NSGD contains information about their 1980 qualification, their subsequent labor market experience (occupation, industry, and wages for four jobs) and further educational pursuits. There is also information about their high school examination results and some questions regarding satisfaction with their 1980 qualification. Although it is not possible to identify specific universities in the NSGD, there is information on whether students took English or Scottish secondary school leaving exams.

Note that neither dataset is representative of the overall population. Therefore, we might be concerned that the English and Scottish samples of university graduates may not be comparable

[33] 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.

[34] I exclude graduates from polytechnics and other institutions from the present analysis. Engineering students in Scottish universities are oversampled in the NSGD. Consequently, it is more important to control for fields of study with the NSGD sample.

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 (the National Child Development Study and British Cohort Study respectively), I have calculated 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% of the 1958 cohort and 12% of the 1970 cohort.[35]

Table 1 reveals that the average characteristics of those attending English and Scottish universities are quite similar in both the USR and NSGD. These summary statistics are generally for the sample of students used in the regression analysis. There is a slightly larger percentage of women and married students in Scottish universities. The average age upon completion of the first degree is almost equivalent in England and Scotland but the average duration of the degree is somewhat longer in Scotland. However, although the average age that students begin university is slightly lower in Scotland, the median age of students during their first year in university is 19 for both England and Scotland. The raw GPA scores shown in Table 1 are converted from letter grades in the A-level and Scottish Higher school leaving examinations. In the regression analysis, these scores are normalized within nation so that coefficients represent the effect of a one standard deviation increase in GPA. Honor level is a measure of success at university ranging from 0 (no honors) to 4 (highest honors) based on the class of degree awarded and standardized across nations. Students in England are slightly more likely to successfully complete their degree than students in Scotland. Table 2 indicates that the composition of broad fields of study across the two nations is comparable. Nevertheless, relatively more students in Scotland study health sciences, business, and law and relatively fewer study social sciences and arts.[36] The composition of occupations across the two nations is also largely comparable. As expected, the majority of students in both England and Scotland enter employment in the UK. The lower rate of unemployment among Scottish individuals is a consequence of the oversampling of engineering graduates who are less likely to be unemployed than others. Note that some individuals appear to be working concurrently while pursuing further study in the UK. Results from the IEA Third International Mathematics and Science Study (TIMSS) in 1994-95 indicate no significant differences between England and Scotland in the mathematics achievement for students in fourth and eighth grade.[37]

[35] The oft-mentioned higher participation rate in Scotland usually includes students enrolled in non-university higher education institutions (such as polytechnics and colleges of education).

[36] 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.

[37] There are, however, some differences in the science achievement scores. English students in the eight grade appears to do somewhat better than their Scottish counterparts, although there is no significant difference for fourth

The theoretical analysis presents an important distinction between individuals who enter an occupation that is related to their field of study and those who switch to an unrelated occupation upon entering the labor market. I construct a variable *SWITCH* that captures occupational switching by grouping fields of study and occupations into categories (see the Data Appendix for more details). As shown in Appendix Table 1, I allow for three gradations of classification: narrow (42 categories), broad (12 categories), and very broad (6 categories). Individuals are said to switch to an unrelated occupation when the field of study of their degree and their occupational field are in different categories (subject to the gradation of classification). Therefore, an occupational switch is defined as 1 if the occupational field is different from the field of study at university, and 0 otherwise.[38] Clearly, broader classifications indicate lower rates of occupational switching since only drastic changes from fields of study to occupational fields will register. However, the rate of occupational switching is substantially lower in Scotland than in England according to all classifications. For example, in terms of the broad classification, the rate of occupational switching in Scotland is between 10 and 20 percentage points lower than the rate of occupational switching in England. Most of the empirical analysis will focus on the broad classification of fields.

Using data from the USR, Figure 5 plots the rates of occupational switching, unemployment, and the continuation of further studies following graduation from 1973-1993 as well as the proportion of individuals who change a major field of study while in university. The raw differential in occupational switching between England and Scotland persists over time. On the other hand, the rates of unemployment and further study are very similar across England and Scotland for most years. Indeed the recessions in the early 1980s and early 1990s appear to be associated with an increase in the rate of occupational switching.

5.2 Empirical Strategy

The base sample for the occupational switching and wage regressions includes all individuals who were aiming to attain a BA degree in 1980 (whether successful or not) and are employed full-time in the first year following completion of their qualification. I exclude individuals pursuing graduate studies while working because this may select for weaker students who need to work while pursuing higher degrees. Using the USR, I verify that the main results for occupational switching hold

graders.

[38] 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.

for other years as well. Furthermore, I explore a variety of alternative sampling restrictions: (i) including graduate students who have occupation data, (ii) including unclassified occupations (e.g. manual and clerical occupations) instead of coding them as switches since individuals in one nation may be more likely to end up in non-professional occupations, (iii) coding individuals that end up unemployed as switches since this may be the result of a differential macroeconomic shock across the two nations. (iv) restricting to individuals that attained a BA degree in 1980. I also consider excluding the fields of education and business or coding them as a non-switches since they are particularly subject to misclassification.

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

$$SWITCH_{ij} = \beta' \mathbf{X}_{ij} + \lambda SCOT_{ij} + \phi_j + \varepsilon_{ij} \tag{1}$$

$SWITCH_{ij}$ is a dummy variable for an occupational switch for individual i in field j. $SCOT_{ij}$ is a dummy variable indicating the individual received a Scottish degree and therefore specialized late. ϕ_j is a set of field of study effects. $\mathbf{X}_{ij}$ are control variables, and ε_{ij} is a disturbance term. However, attainment of a Scottish or English degree is not randomly assigned. Rather, once they complete their secondary education, individuals can choose to attend universities in either England or Scotland. Table 2 shows the national breakdown of individuals studying in England and Scotland. The migration patterns from prior residence to university indicates that 3.3 percent of individuals with English prior residence choose to study in Scotland while 7.4 percent of individuals with Scottish prior residence choose to study in England.[39] 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 OLS estimates will be biased. This might arise because individuals who migrate have certain unobserved characteristics, 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. For example, individuals from England that have less precise priors on match quality may decide to attend universities in Scotland where academic specialization is postponed. Hence, I will also consider regressions in which I 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, I use the type of school leaving examinations (whether Scottish or

[39] 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.

English) to estimate a reduced form equation of the probability of occupational switching.[40]

Predictions on wages are examined through the following regression model:

$$w_{ij} = \beta' X_{ij} + \lambda SCOT_{ij} + \gamma SWITCH_{ij} + \delta\left(SCOT_{ij} \times SWITCH_{ij}\right) + \phi_j + \varepsilon_{ij} \qquad (2)$$

where w_{ij} is log annual earnings. Most specifications will also include controls for region of work and industry. λ captures the difference in wages between England and Scotland among individuals that do not experience occupational switching. γ captures the difference in wages between individuals that switch and individuals that do not switch in England – i.e. the wage loss in England. Finally, δ captures the *differential* in wage loss between Scotland and England. Other differentials of interest may include the wage loss for individuals in Scotland $(\lambda + \delta)$ and the wage difference between English and Scottish individuals that switch $(\gamma + \delta)$. All wage regressions are estimated with data from the NSGD so I use the type of high school leaving exams as a proxy for the type of degree or the region of prior residence.

6 Results

6.1 Occupational Switching

Predictions on occupational switching are examined with both the USR and NSGD in Tables 3 and 4 respectively. Across almost all specifications, the probability of an occupational switch is significantly lower for individuals that attain a Scottish degree as compared to their English counterparts. The estimated difference in occupational switching between England and Scotland from the preferred 2SLS specification is approximately 6 percentage points, which is substantial considering that the rate of occupational switching in Scotland is about .42. Indeed, the coefficient on *SCOT* from equation (1) is negative and significant in almost all years between 1973 and 1993 (results not shown). According to the theoretical model, this difference suggests that the return to match quality is high relative to the return to specific skills. For only if the return to match quality is sufficiently high would the increase in expected match quality associated with switching to an unrelated occupation overwhelm the greater loss of skills, and lead to a higher probability of switching in a regime that requires early specialization like England.

[40] While there is some choice available with the type of secondary school, through boarding school perhaps, it is undoubtedly 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).

Using data from the USR, Table 3 shows the pattern of occupational switching for students who graduated in 1980. As a baseline, Panel A includes all English students. Regressions include controls for gender, marital status, age, SES level, high school GPA, and honors level received in university. In column (1), I estimate the difference in the probability of occupational switching between England and Scotland without controlling for fields of study or region of work. Once I control for the composition of fields across nations in column (2), the estimated differential in occupational switching declines substantially. In other words, not only do individuals in Scotland switch less, but they also tend to study fields that are associated with less switching.[41] Also note that much of the variation in occupational switching is explained by differences across fields of study (the R^2 increases from .07 to .48 once controls for fields of study are included). In column (3), I add controls for region of work and the coefficient on *SCOT* becomes smaller still, suggesting that there may be less switching among Scottish employers who prefer to hire individuals with related qualifications. However, this specification needs to be interpreted with care since the decision to work in England or Scotland is probably endogenous; individuals that decide to switch may also make systematically different decisions about where they wish to work. In columns (4), (5) and (6), I instrument for the attainment of a Scottish degree with the region of prior residence.[42] 2SLS estimates of the difference in occupational switching between England and Scotland increase substantially and lend support to the hypothesis of non-random selection: If individuals who are less focused and hence more likely to switch decide to get their degrees in Scotland, OLS estimates of occupational switching in Scotland will be biased towards more switching. Similarly, if individuals who are more focused and less likely to switch decide to get their degrees in England, OLS estimates of occupational switching in England will be biased towards less switching. Since individuals with Scottish degrees are, in fact, less likely to switch than their English counterparts, 2SLS estimates should *and do* indicate an even greater differential in occupational switching. Panel B uses information from the USR to restrict the sample of English students to those from northern England since they are probably the most convincing comparison group to individuals from Scotland.[43] The pattern of occupational switching between Scotland and northern England appears to be even stronger than

[41] Note, however, that English students may endogenously choose broader fields which facilitate switching to avoid specializing in an excessively narrow field.

[42] Coefficient estimates are almost equivalent when instrumenting for attainment of a Scottish degree with the type of secondary school leaving exams completed (English A-levels or Scottish Highers) or with the location of secondary school (England or Scotland).

[43] 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.

one found when all students from England are included.

Table 4 uses data from the NSGD to examine occupational switching between England and Scotland. We estimate a reduced-form equation where *SCOT* is a dummy variable identifying whether students took English or Scottish secondary school leaving exams, because that is the only indicator available in the NSGD. As a result, we cannot restrict the sample to individuals from northern England. Again, all regressions include controls for gender, marital status, age, SES level, high school GPA, and honors level received in university. Columns (1), (2) and (3) show the reduced-form effect of having completed a Scottish degree on the likelihood of working in an occupation unrelated to the chosen field of study in the first year following graduation. Confirming our results from the USR, students from England are more likely to experience occupational switching than their counterparts from Scotland.[44] However, the NSGD also contains information on student outcomes six years following the completion of their degree. Columns (4), (5), and (6) indicate that the differential in occupational switching between England and Scotland remains after six years. Even larger results are obtained if we consider all individuals employed six years following completion of the BA degree by including those who were not employed within six months of completing their degree (results not shown). This may imply that individuals in England also experiment more than individuals in Scotland once in the labor market.

A full set of robustness checks is shown in column (1) of Appendix Table 2. Appendix Table 3 shows occupational switching by field of study. Not surprisingly, there are no significant differences in occupational switching across England and Scotland for certain fields such as health, business, and education. The degree in medicine is an extremely specialized course in both English and Scottish institutions. And both education and business provide a very broad set of skills that may dampen the differences that usually arise from early versus late specialization.[45] Appendix Table 4 examines occupational switching within the field of engineering. A degree in engineering has a well-defined occupation associated with it and is likely to be similar across the two nations. Using the narrow classification we can identify occupational switches by subfield (i.e. from mechanical engineering to becoming an electrical engineer). The main results are confirmed in this setting: Individuals who study engineering in Scotland are less likely to switch to an unrelated occupation than their counterparts who study engineering in England.

"Placebo" experiments

[44] Note that the difference in the probability of occupational switching between England and Scotland in column (3) becomes insignificant when controlling for both composition of fields and region of work.

[45] More generally, estimates of differences in occupational switching between England and Scotland may vary across fields because of differing relative returns to match quality. Learning about match quality may be more important in certain fields than in others.

In addition to the various robustness checks discussed above, Table 4 presents additional "placebo tests" to verify that the differential in occupational switching between England and Scotland is not due to unobserved characteristics. Panel A examines the difference in occupational switching between England and Wales for 1980 college graduates using data from the USR where we can identify whether individuals attended university in Wales. Undergraduate students in both England and Wales apply to a specific course of study in university so we would expect no difference in occupational switching between England and Wales. The specifications are analogous to those in Panel A of Table 3.[46] Columns (1), (2) and (3) report the results from OLS regressions where *WALES* is a dummy variable indicating whether individuals completed university in Wales. Columns (4), (5) and (6) show results from the 2SLS regressions where the attainment of a Welsh degree is instrumented with the region of prior residence. With the exception of column (1), all the specifications imply that there is no significant difference in occupational switching between England and Wales. Indeed, in many cases, the sign of the coefficient is positive. As mentioned earlier, the timing of academic specialization in Wales is identical to that of England. Thus, the absence of a differential in occupational switching between England and Wales is reassuring and supports the contention that the difference in occupational switching between England and Scotland is a consequence of the timing of specialization.

Panel B examines the difference in occupational switching between England and Scotland, but at the graduate level. Since graduate degrees in both England and Scotland are similar in terms of specialization – both require admission to a very specific course of study – we expect to see no difference in occupational switching at the graduate level. The USR has separate files containing information on students with graduate degrees. We focus on the sample of students who completed their studies in 1980 and therefore entered the labor market at the same time as the undergraduate students discussed above. Columns (1), (2) and (3) report results from the OLS regressions where *SCOTGRAD* is a dummy variable indicating whether individuals completed their graduate degrees in Scotland.[47] Clearly, there is no significant difference in the probability of occupational switching between England and Scotland at the graduate level. The NSGD includes students who graduated from college in 1980 and completed their graduate degrees some years after. Columns (4), (5) and (6) report results from the reduced form regression where the completion of graduate degrees in Scotland is proxied by whether students took English or Scottish secondary school leaving exams.

[46] The sample of individuals from England is restricted to those from western England which borders Wales but similar results are obtained when individuals from all of England are included.

[47] The USR does not contain information on birth region so we cannot instrument for whether an individual attained a Scottish degree with their place of birth or place of residence prior to commencing their studies.

Again there is no significant difference in occupational switching between England and Scotland at the graduate level. These results also support the argument that the difference in occupational 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.

I also examine the probability of switching to a graduate degree in a field that is unrelated to the undergraduate field of study – "academic switching" (results not shown). The probability of switching to an unrelated graduate degree is generally not significantly different for individuals with a Scottish undergraduate degree than for individuals with an English undergraduate degree. Indeed, the sign is actually positive in most cases (including some specifications where it is significant). One possible explanation is that the relative return to match quality for success in further study is different than for wages in the labor market. If further study at the graduate level puts more emphasis on the specific skills acquired at the undergraduate level than a job in the same occupational field, the benefits from switching may no longer overwhelm the greater loss of skills in the early regime. In other words, the relative return to academic skills in graduate education may be substantially larger than that in the job market.

Alternative explanations for occupational switching

Occupational switching may arise for reasons other than those described by a model of academic specialization. If certain individuals are particularly indecisive – "lemons" – they may be more likely to experience occupational switching. Other individuals may simply be more adept at making changes and therefore also more likely to switch to an occupation unrelated to their field of study. While these characteristics are generally unobservable, I can examine whether occupational switching is correlated to other decisions, such as a change in major field of study during university. Regression analysis confirms that individuals who change a field of study during university are also significantly more likely to experience an occupational switch (not shown, but can be seen from the slope of the lines in Figure 6).[48] However, students in Scotland are much more likely to change their declared major field of study after entry into university since they are not required to specialize until later. According to the USR sample of 1980 graduates, 14 percent of Scottish students change their field of study during university compared to just 6 percent of the English students (see Panel B of Figure 5 for a graph of this differential across all years). This provides evidence that the differential in occupational switching between England and Scotland is not driven by a lower

[48] Using the USR, I can record changes to the major field of study by observing that the field of study upon entering university is different from the field of study in the degree awarded.

propensity to make changes in Scotland.

Occupation switching may also be driven by the availability of jobs in different occupational fields. If certain sectors suffer shocks to labor demand, recent graduates may be forced to switch to a different occupational field than the one they studied. Appendix Table 5 shows the percentage of individuals employed in different occupational fields by field of study in 1980. As expected, certain fields of study have substantial outflows into unrelated occupational fields (social sciences, physical sciences, and arts). Other occupational fields have substantial inflows from unrelated field of study (business, engineering, education). However, evidence for flows in both directions – for example, from math/computer sciences to physical sciences *and* vice versa – suggests that occupational switching is not driven solely by the availability of jobs in different occupational fields.

Variation across universities

A comparison of labor market outcomes across England and Scotland has the disadvantage of including only two nations. An alternative approach could have been to compare student outcomes across universities. In Scotland, there is some variation in exactly when students are required to specialize (either after the first or second year). In England, although almost all universities require students to apply to a specific field prior to entry, there is some variation in the penalty to changing fields of study once students are enrolled in a specific course. Since these penalties are difficult to quantify, we might consider using the actual proportion of students that change fields as a proxy for the penalty.[49] However, any comparison across universities will suffer from selection bias as students choose among the many university available to them. We expect that individuals who are unsure about what to study are more likely to choose a university with less stringent penalties and also more likely to switch to an unrelated occupation upon entering the labor force. Moreover, using the actual proportion of students that change fields as a proxy may well confound the actual penalty with student characteristics that are correlated with these changes and other labor market outcomes. Indeed, if students who switch fields are also more likely to switch to unrelated occupations, then any unequal distribution of students across universities will yield this correlation. Figure 6 plots the proportion of individuals that switch to an unrelated occupation by the proportion of students that change fields of study while in university. The positive correlation for both England and Scotland would mistakenly suggest that students attending universities with less stringent penalities for specializing later are also more likely to switch to an unrelated occupation – a rather different result from the one we reached by comparing across nations. Selection bias is a serious problem

[49] In some Scottish universities, students are required to write down their expected field of study. In others, students are coded as within the broad faculty to begin with and changed appropriately when they select a specific field. This could be viewed as a zero penalty on switching within a faculty.

here. Note that Figure 6 does provide some evidence for the findings between England and Scotland. That most of the points representing Scottish universities lie below the English ones confirms that individuals in Scotland are less likely to switch to an unrelated occupation.

6.2 Wages

Wage regressions using data from the NSGD are presented in Table 6. Columns (1), (2) and (3) explore the effects on wages in the first job held in the first year after completing a BA degree, while columns (4), (5), and (6) examine the effects on wages in the job held six years after completing a BA degree. In addition to gender, marital status, age, high school GPA, honors level, all wage regressions include controls for field of study, industry, and regions of work since wages may differ markedly across degree subjects, regions, and industry. Column (1) reveals that there is no significant difference in average annual earnings between England and Scotland in the first year following completion of the degree – the coefficient on $SCOT$ from equation (2) is not significant. But column (2) provides strong evidence in support of the theoretical prediction that individuals who switch to an occupation unrelated to their field of study at university earn lower wages in the first year – the coefficient on $SWITCH$ is negative and significant. Indeed, occupational switching leads to a substantial wage loss of around 7 percentage points, comparable in magnitude to the negative wage differential for women in the same sample. The coefficient on $SCOT \times SWITCH$ in column (3) indicates that this wage loss is not significantly different between England and Scotland. Recall that the theoretical prediction on the differential in wage loss across regimes was ambiguous but that the simulations (which introduced additional distributional assumptions) determined a greater wage loss in an early regime like England. The positive sign of the interaction is consistent with that result. Column (4) shows that there is no significant difference in average annual earnings between England and Scotland after six years. Interestingly, columns (5) and (6) indicate that individuals who switch to an occupation unrelated to their field of study at university in the first year have average annual wages six years hence that are no different than their counterparts who did not switch. In other words, controlling for background variables, individuals who experience occupational switching appear to make up the difference over time. Robustness checks for these findings are presented in columns (2), (3), and (4) of Appendix Table 2.

That individuals who experience occupational switching make up the difference in wages over time is interesting but not necessarily surprising. Recall that predictions on wage growth depended on additional assumptions. If field-specific skills are also accumulated on the job but these skills have diminishing returns, we would expect that occupational switching is associated with greater

wage growth in the early years after graduation. Table 7 shows the growth in annual wages over the six years following completion of a BA degree. Columns (2) and (3) confirm that individuals who switch to an unrelated occupation upon entering the labor market experience greater wage growth than their counterparts who do not switch. Although insignificant, the signs on $SCOT$ and $SCOT * SWITCH$ accord with the general intuition: individuals who switch in Scotland experience lower wage growth than their English counterparts since they have higher levels of specific skills upon entering the labor market; individuals that do not switch in Scotland experience greater wage growth than their English counterparts since they have lower levels of specific skills upon entering the labor market. Part of the wage differential experienced by individuals who switch to unrelated occupations may be associated with unobservables that are correlated with occupational switching rather than a direct causal effect. However, the fact that these individuals catch with their counterparts who did not switch suggests that it is probably not the primary explanation. Figure 7 plots the relative change in wages over time for the different subgroups.[50] Scottish individuals who enter occupations related to their field of study tend to experience the most wage growth.

6.3 Other results

Although outside the scope of the model proper, I also consider several dynamic labor market outcomes. The preceding section already examined the results on wage growth from Table 7. Columns (4), (5), and (6) of Table 7 explore occupational mobility which is defined as a further change in occupational field *following* entry into the labor market.[51] Individuals who experience occupational switching are significantly more likely to change to a job in a different occupational field after several years. This is consistent with the theoretical analysis because individuals who switch have an identical level of specific skills in alternative fields so that further changes in occupation are not as severely penalized. Again, some individuals who switch may simply be inherently less stable workers. Furthermore, among individuals who 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 (iii) becoming a widely educated person. Table 8 highlights results from these subjective assessments.[52]

[50] Log annual earnings for English individuals that do not switch are assigned an index of 100 for both starting wages in 1981 and current wages in 1987. Log annual earnings for all other groups are calculated relative to this base.

[51] On a related note, there appear to be no significant differences in formal job training between England and Scotland. 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] These regressions are run as ordered probits. Categories include: "not at all", "a little", "a lot", and "a great

Individuals who switch to an occupation unrelated to their field of study 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 fields of study. Note that it is possible that individuals who 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 entering an occupation related to the field of study at university. On the other hand, individuals who experience occupational switching are significantly more likely to report that their qualification contributed to their becoming more widely educated. However, this effect becomes much smaller and only marginally significant once controls for field of study are included, suggesting that individuals who 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).

7 Conclusion

Specialization is a fundamental feature of many economic decisions. This paper examined the trade-off between the acquisition of specific skills early in one's college education versus broader training and learning about match quality in different fields of study. I developed a model of specialization in which individuals, by taking courses in different fields of study, accumulate field-specific skills and receive noisy signals of match quality in these fields. Then, I derived and tested comparative static predictions between regimes with early and late specialization across the corresponding English and Scottish systems of higher education. I found 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, who specialize early. No such differential was observed at the graduate level or between England and Wales where the systems coincide in the timing of specialization. I also found strong evidence in support of the prediction that individuals who switch to unrelated occupations experience lower wages. Although there is also evidence that wage differentials between individuals who do and do not switch tend to converge over time, these findings confirm that differences in the timing of academic specialization can have important labor market consequences.

Assessing whether one regime yields superior outcomes to another is not without its difficulties. Direct wage comparisons across nations are subject to many confounding factors outside the realm of higher education. Nevertheless, the empirical findings do suggest that a regime which allows

deal". Similar results are obtained when collapsing these categories into larger groupings.

students to specialize late, such as Scotland, may be preferable to a regime that requires students to specialize early like England. Individuals in England are more likely to undertake an occupational switch and therefore have lower wages. According to the theoretical analysis, an appraisal of regimes with early versus late specialization depends crucially on the return to match quality relative to the return to field-specific skills. Since the comparison of occupational switching behavior across the two nations indicates that the relative return to match quality is high, there is further support that a late regime which provides individuals with more time to learn about their match quality in different fields may yield better labor market outcomes. As noted previously, the possibility of exogenous switching due to labor market volatility also favors a late regime which provides for more skill in other fields. Interestingly, there does appear to be a recent trend towards broader education and later specialization in English universities.[53]

Whether one regime is preferred to another also depends on other structural parameters, such as the accuracy of information on match quality prior to commencing education. A higher prior variance on match quality implies that a longer period of learning is valuable. Hence, if certain populations have more accurate information about their match quality, a regime that requires early specialization may not necessarily lead to many costly mistakes. Indeed, with a heterogeneous population, the benefits associated with early or late specialization may accrue to different individuals. The theoretical model abstracts from distributional concerns by assuming that individuals are identical but these considerations may, in fact, be important in evaluating different systems of higher education. However, both distributional considerations and possible inefficiencies arise because individuals are forced to specialize at a particular time. Allowing individuals to choose when to specialize might be optimal, especially with a heterogenous population. Perhaps the U.S. system of higher education, which is characterized by flexibility in breadth and timing of specialization, dominates both the English and Scottish systems. Clearly, we would need to assume that individuals choose optimally when to specialize. If, instead, there is some lumpiness in human capital investments and students do not have sufficient information to experiment in a productive manner, such flexibility can lead students to end up with unproductive programs of study. Indeed, Trow (1999) has argued that American undergraduates often take incoherent courses of study and indulge in excessive experimentation. An examination of the American educational system would be a valuable next step in extending our knowledge of academic specialization.

[53] Many universities have recently established modular course structures which allow for more flexibility and a broader curriculum.

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A 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 group fields of study and occupations into categories (see the Data Appendix for more details). As shown in Appendix Table 1, I allow for three gradations of classification: narrow (42 categories), broad (12 categories), and very broad (6 categories). 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, the occupational switch variable 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 qualitative 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 analogously except that the field of study is the one studied at the graduate level.

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, undivided 2nd degree class, and ordinary, 2 for lower 2nd, 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.

SES

Individual SES scores are based on parental occupations as follows: 0-unstated, retired, or unknown, 1-professionals workers, 2-intermediate workers, 3-skilled non-manual, 4-skilled manual, 5-partially skilled, 6-unskilled, and 7-unemployed.

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)

Wages

Wages are, in fact, annual earnings as reported by individuals in a retrospective survey. Accurate measures of wages are available at two times: starting wages in the first job and "current wages" in the last job reported approximately 6 years after completing the first degree.

B Mathematical 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. Generalizing the analytical results for any N and J is difficult because most expressions become intractable.

Proof of Proposition 1. In the case where there is no switching, expected wages upon entering the labor market will depend on expected match quality and skills in the chosen field of study, j^*:

$$\begin{aligned} E\left(\ln w_{j^*}\right) &= E\left[\alpha m_{j^*} + \beta s_{j^*}\right] \\ &= \beta s_{j^*} + \alpha E\left[m_{j^*}\right] \end{aligned}$$

Expected match quality in the chosen field, $E\left[m_{j^*}\right]$, can expressed as a function of the means of the order statistics of the true match quality in the two different fields since the probabilities of choosing each order statistic are mutually exclusive and exhaustive:

$$E\left[m_{j^*}\right] = \sum_{k=1}^{2} E\left[m_{(k)}\right] \Pr\left(m_{j^*} = m_{(k)}\right)$$

Standard results from order statistics can be used to derive explicit expressions for the means of $m_{(1)}$ and $m_{(2)}$:[54]

$$E\left[m_{(2)}\right] = \left(\mu + \frac{1}{\sqrt{\pi p}}\right), E\left[m_{(1)}\right] = \left(\mu - \frac{1}{\sqrt{\pi p}}\right)$$

The probability of making a mistake in choosing a field at the point of specialization, $PRM = \Pr\left(m_{j^*} = m_{(1)}\right)$, can be expressed as the sum of two exhaustive but symmetric events:

$$\begin{aligned} PRM &= \Pr\left(m_{j^*} = m_{(1)}\right) \\ &= \Pr\left(m_A < m_B \cap \mu'_A > \mu'_B\right) + \Pr\left(m_A < m_B \cap \mu'_A > \mu'_B\right) \\ &= 2\Pr\left(m_A < m_B \cap \mu'_A > \mu'_B\right) \end{aligned}$$

[54] Bose and Gupta (1959) derive closed-form expressions for the means of order statistics from standard normal distributions in sample sizes up to 5. The maximal and minimal order statistics for a sample size of 2 are $\frac{1}{\sqrt{\pi}}$ and $-\frac{1}{\sqrt{\pi}}$ respectively.

For the late regime, the probability of making a mistake is as follows:

$$\begin{aligned} PRM^{L} &= 2\Pr\left(\varepsilon_{1B}-\varepsilon_{1A}<m_{A}-m_{B}<0\right) \\ &= 2\int_{-\infty}^{0}\int_{y}^{0}\phi\left(\frac{y}{\sqrt{\frac{2}{p^{\varepsilon}}}}\right)\phi\left(\frac{x}{\sqrt{\frac{2}{p}}}\right)dxdy< \frac{1}{2} \end{aligned}$$

For the early regime, the choice of field occurs prior to receiving any information. Hence, we can suppose that individuals choose at random or always choose a certain field, A, without loss of generality. The probability of making a mistake in the early regime is therefore $PRM^{E}=\frac{1}{2}$.

So expected wages in the late regime will be:

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

And expected wages in the early regime will be:

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

Therefore, we can derive the condition under which expected wages will be higher in the late regime:

$$E\left[\ln w_{j^*}\right]^{L}\gtrless E\left[\ln w_{j^*}\right]^{E} \iff \frac{\alpha}{\beta}\gtrless\frac{\sqrt{\pi p}}{\left(1-2PRM^{L}\right)}\left(>0\right)$$

■

Proof of Proposition 2. An occupational switch occurs when expected wages in the alternative field, j^{a}, are higher than expected wages in the chosen field, j^{*}. Hence, the probability of switching, PRS, can generally be expressed as $\Pr\left(w''_{j^*}<w'_{j^a}\right)$. In the early regime, expected match quality when switching is equal to the prior mean since no information is received in the alternative field. Hence the probability of switching in the early regime is:

$$\begin{aligned} PRS^{E} &= \Pr\left(w''_{j^*}<w'_{j^a}\right) \\ &= \Pr\left(\ln w''_{j^*}<\ln w'_{j^a}\right) \\ &= \Pr\left(\alpha\mu''_{j^*}+\beta s''<\alpha\mu'_{j^a}+\beta s'\right) \\ &= \Pr\left(\mu''_{j^*}<\mu-2\frac{\beta}{\alpha}\right) \\ &= \Pr\left(\frac{\mu p+p^{\varepsilon}\sum_{k=1}^{2}z_{kj^*}}{p+2p^{\varepsilon}}<\mu-2\frac{\beta}{\alpha}\right) \\ &= \Phi\left(-\frac{\beta}{\alpha}\frac{2\left(p+2p^{\varepsilon}\right)}{p^{\varepsilon}\sqrt{\frac{4}{p}+\frac{2}{p^{\varepsilon}}}}\right)>0 \end{aligned}$$

In the late regime, there will be no switching since no additional information is received following the choice of field:

$$\begin{aligned} PRS^{L} &= \Pr\left(w''_{j^*} < w'_{j^a}\right) \\ &= \Pr\left(\alpha\mu''_{j^*} + \beta s'' < \alpha\mu'_{j^a} + \beta s'\right) \\ &= \Pr\left(\max_j \{y_{1j}\}^J < \min_j \{y_{1j}\}^J\right) = 0 \end{aligned}$$

Hence, the probability of switching is higher in the early regime than in the late regime. But as the relative return to match quality declines, the difference in the probability of switching falls (until there is no difference when $\alpha = 0$):

$$\frac{\partial PRS^{E}}{\partial\left(\frac{\alpha}{\beta}\right)} = 2\sqrt{p + \frac{p^2}{2p^{\varepsilon}}}\phi\left(-2\left(\frac{\alpha}{\beta}\right)^{-1}\sqrt{p + \frac{p^2}{2p^{\varepsilon}}}\right) > 0$$

In this simplified case where $N = 2$, the probability of switching is always higher in the early regime. However, more generally, a sufficiently low relative return to match quality may generate a higher probability of switching in the late regime. ■

Proof of Proposition 3. Recall that, in the early regime, the decision to choose a field is completely arbitrary since it is taken prior to any information. Hence, we suppose that individuals always chooses field A without loss of generality. Conditional on not switching, expected wages will be:

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

Conditional on switching, expected wages will be:

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

Therefore, for the early regime, expected wages conditional on switching are lower than expected wages conditional on not switching since $E\left(\xi_A \mid \xi_A > \widetilde{K}\right) > 0$ and $2\beta > 0$.

As mentioned earlier, there are no switches in the late regime. Hence, expected wages will be

identical to the baseline case of no switching:

$$E\left(\alpha m_{j^*}+\beta s_{j^*}\right)^L=\beta+\alpha\left[\mu+\frac{1}{\sqrt{\pi p}}\left(1-2PRM^{\,L}\right)\right]$$

However, for the sake of comparison, we can suppose that some individuals do switch for exogenous reasons. In this instance, individuals will have the following expected wages:

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

Therefore, for the late regime, expected wages conditional on switching are lower than expected wages conditional on not-switching since $PRM^{\,L}<\frac{1}{2}$. ■

Proof of Proposition 4. We continue to assume that there are exogenous switches in the late regime in order to derive some results regarding the relative wage loss in the early and late regimes. Wage loss in the early regime will be:

$$\begin{aligned}\Delta^E &= E\left(\ln w_A \mid w''_A > w'_B\right)^E-E\left(\ln w_B \mid w''_A < w'_B\right)^E\\ &= 2\beta+\alpha\mu+\alpha E\left(\xi_A \mid \xi_A>\widetilde{K}\right)-\alpha\mu\\ &= 2\beta+\alpha E\left(\xi_A \mid \xi_A>\widetilde{K}\right)\end{aligned}$$

Wage loss in the late regime due to exogenous switching will be:

$$\begin{aligned}\Delta^L &= E\left(\ln w \mid \ NoSwitch\ \right)^L-E\left(\ln w \mid \ Switch\right)^L\\ &= \frac{\alpha}{\sqrt{\pi p}}\left[\left(1-2PRM^{\,L}\right)-\left(2PRM^{\,L}-1\right)\right]\\ &= \frac{2\alpha}{\sqrt{\pi p}}\left(1-2PRM^{\,L}\right)\end{aligned}$$

Clearly the wage loss in the early regime will exceed the wage loss in the late regime for sufficiently small $\frac{\alpha}{\beta}$ (the trivial case where $\alpha=0$ implies a wage loss of 2β in the early regime and 0 in the late regime).[55] Otherwise, the wage loss in the late regime can exceed the wage loss in the early regime if:

$$2\beta+\alpha E\left(\xi_A \mid \xi_A>\widetilde{K}\right)>\frac{2\alpha}{\sqrt{\pi p}}\left(1-2PRM^{\,L}\right)$$

Thus, if $\frac{\alpha}{\beta}$ is large, then the wage loss in the late regime will exceed the wage loss in the early regime only if $PRM^{\,L}$ 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 $\widetilde{K}$ $=-\frac{\beta}{\alpha}\frac{(p+2p^{\varepsilon})}{p^{\varepsilon}}-\frac{(\varepsilon_{A1}+\varepsilon_{A2})}{2}$ is small.

Note that, with exogenous switching in both the early and late regimes, the differential in wage loss across the two regimes will depend on the relative return to match quality. The wage loss in

[55] Note, however, that there will actually be no switching when $\alpha=0$ so such unambiguous comparisons will not be observed.

the early regime due to exogenous switching will be:

$$\widehat{\Delta}^E = 2\beta + \frac{2\alpha}{\sqrt{\pi p}}\left(1 - 2PRM^E\right)$$

Therefore, in the simple case of exogenous switching in both regimes, we can derive the condition under which expected wage loss will be higher in the late regime:

$$E\left(\Delta^L\right) \gtrless E\left(\widehat{\Delta}^E\right) \Longleftrightarrow \frac{\alpha}{\beta} \gtrless \frac{\sqrt{\pi p}}{(PRM^E - PRM^L)} (> 0)$$

since $PRM^E > PRM^L$. ■

Proof of Proposition 5. Expected wages in the early regime will depend on the probability of switching, PRS^E:

$$\begin{aligned} E(\ln w)^E &= E\left(\ln w_A \mid w''_A > w'_B\right)^E \left(1 - PRS^E\right) + E\left(\ln w_B \mid w''_A < w'_B\right)^E PRS^E \\ &= \left[2\beta + \alpha\mu + \alpha E\left(\xi_A \mid \xi_A > \widetilde{K}\right)\right]\left(1 - PRS^E\right) + \alpha\mu PRS^E \\ &= 2\beta\left(1 - PRS^E\right) + \alpha\mu + \alpha E\left(\xi_A \mid \xi_A > \widetilde{K}\right)\left(1 - PRS^E\right) \end{aligned}$$

Expected wages in the late regime (in the absence of exogenous switching):

$$E(\ln w)^L = \beta + \alpha\mu + \frac{\alpha}{\sqrt{\pi p}}\left(1 - 2PRM^L\right)$$

Therefore, we can derive the condition under which expected wages will be higher in the late regime in the presence of switching:

$$E(\ln w)^L \gtrless E(\ln w)^E \Longleftrightarrow \frac{\alpha}{\beta} \gtrless \frac{1 - 2PRS^E}{\frac{1}{\sqrt{\pi p}}\left(1 - 2PRM^L\right) - E\left(\xi_A \mid \xi_A > \widetilde{K}\right)\left(1 - PRS^E\right)}$$

■

Table 1: Summary Statistics for 1980 College Graduates

	England			Scotland		
	Mean	SD	Obs	Mean	SD	Obs
Panel A: USR						
Individual characteristics						
Female	0.37	0.48	9,601	0.40	0.49	2,814
Married (during degree)	0.03	0.18	9,601	0.05	0.22	2,814
Average age (upon completion)	19.59	2.30	9,601	19.19	2.66	2,814
High School GPA (out of 30)	21.07	6.41	9,601	20.27	6.19	2,814
Number of high school subjects	3.23	0.71	9,601	4.78	1.30	2,814
Degree characteristics						
Honors	2.39	0.74	9,601	2.31	0.61	2,814
Duration	3.35	0.75	9,601	4.13	0.72	2,814
Entry qualifications[a]	0.13	0.34	59,781	0.11	0.32	10,578
Successful completion[a]	0.85	0.35	59,781	0.80	0.40	10,578
Changed major	0.04	0.21	9,115	0.10	0.30	2,387
Occupational switching						
Very broad classification	0.38	0.49	9,601	0.32	0.47	2,814
Broad classification	0.49	0.50	9,601	0.40	0.49	2,814
Narrow classification	0.66	0.47	9,601	0.57	0.49	2,814
Panel A: NSGD						
Individual characteristics						
Female	0.33	0.47	1,103	0.30	0.46	198
Married (6 years after degree)	0.53	0.50	1,103	0.59	0.49	198
Average age (upon completion)	21.96	1.37	1,103	22.24	2.07	198
High School GPA (out of 30)	6.57	1.94	1,103	6.18	1.91	198
Number of high school subjects	3.20	0.70	1,103	5.15	1.05	198
Degree characteristics						
Honors	2.42	0.80	1,103	2.51	0.72	198
Occupational switching						
Very broad classification	0.48	0.50	1,103	0.30	0.46	198
Broad classification	0.56	0.50	1,103	0.36	0.48	198
Narrow classification	0.69	0.46	1,103	0.53	0.50	198
Annual earnings						
Log earnings after 1 year	8.43	0.32	1,042	8.38	0.37	193
Log earnings after 6 years	9.42	0.48	1,086	9.40	0.41	197

Notes: The base sample for the Universities Statistical Records (USR) includes all individuals that attained a BA degree in 1980 and are employed in a job 6 months following graduation. The base sample for the 1980 National Survey of Graduates and Diplomates (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). [a] is out of the unrestricted sample including unemployed and graduate students.

Table 2: Further Summary Statistics on Degrees and Destinations for 1980 College Graduates

	USR		NSGD	
	England	Scotland	England	Scotland
Degree Field Composition (%)				
Math and Computer Sciences	6.7	5.1	8.5	4.0
Physical Sciences	8.9	7.3	13.5	7.6
Architecture	1.7	1.6	1.9	2.5
Engineering	12.5	9.7	21.9	30.3
Life Sciences	6.3	9.1	7.6	8.6
Health Sciences	17.7	24.1	4.3	5.6
Social Services and Welfare	3.2	4.5	3.4	2.0
Social Sciences	13.1	11.0	18.4	15.2
Business/Accounting	3.9	6.7	5.0	6.6
Law	8.8	7.8	1.5	10.6
Education	0.9	1.6	1.4	2.0
Art	16.1	11.5	12.7	5.1
Occupational Field Composition (%)				
Math and Computer Scientists	5.3	4.7	6.4	5.1
Physical Scientists	7.5	8.1	3.9	2.4
Architects/Planners	1.5	1.9	1.7	2.2
Engineers	11.3	9.4	11.7	18.3
Life Scientists	NA	NA	1.5	2.2
Medical Professionals	17.9	24.4	3.2	3.5
Social Services Professionals	1.7	2.1	2.3	2.0
Social Scientists	2.0	2.5	1.9	2.2
Accountants/Managers	25.4	23.6	21.6	17.8
Lawyers/Judges	8.0	7.3	3.2	6.4
Educators/Teachers	16.4	14.0	14.3	13.0
Artists/Journalists/Entertainers	3.1	2.1	2.6	3.1
Post-BA Activity (%)[a]				
Entering employment	76.7	79.3	61.9	64.1
Further Study	11.6	10.1	27.7	29.0
Unemployed	11.6	10.6	10.5	6.9
Region of Work (%)				
England	87.6	34.5	87.3	26.8
Scotland	1.2	59.1	1.7	70.2
Wales	1.9	1.0	3.5	0.5
Northern Ireland	0.4	0.6	0.3	0.0
Abroad	9.0	4.7	7.2	2.5
Region of Prior Residence (%)				
England	91.9	17.6		
Scotland	0.6	78.8		
Wales	4.9	0.4		
Northern Ireland	1.2	2.0		
Abroad	1.4	1.2		

Notes: Composition of fields of study and occupational fields are based on a broad classification (other classifications are discussed in the Data Appendix). Occupational field represents the first job 6 months after completing degree. Life scientists are classified together with physical scientists in the USR. 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. [a] is out of the unrestricted sample including unemployed and graduate students.

Table 3: Effect of Scottish Degree on Occupational Switching for 1980 College Graduates (USR sample)

dependent variable: switched to occupation unrelated to field of study

Panel A: Scotland vs. England

	OLS			*2SLS*		
	(1)	(2)	(3)	(4)	(5)	(6)
SCOT	-0.076**	-0.035**	-0.018	-0.112**	-0.056**	-0.057*
	[0.018]	[0.013]	[0.018]	[0.039]	[0.016]	[0.023]
Main controls	X	X	X	X	X	X
Field of study effects		X	X		X	X
Region of work effects			X			X
R^2	0.07	0.48	0.48	0.07	0.48	0.48
Observations	12,415	12,415	12,415	12,415	12,415	12,415
Mean of dep. variable	0.47	0.47	0.47	0.47	0.47	0.47

Panel B: Scotland vs. Northern England

	OLS			*2SLS*		
	(1)	(2)	(3)	(4)	(5)	(6)
SCOT	-0.087*	-0.048**	-0.057*	-0.103*	-0.067**	-0.090**
	[0.028]	[0.017]	[0.022]	[0.047]	[0.019]	[0.023]
Main controls	X	X	X	X	X	X
Field of study effects		X	X		X	X
Region of work effects			X			X
R^2	0.09	0.50	0.50	0.09	0.50	0.50
Observations	4,180	4,180	4,180	4,180	4,180	4,180
Mean of dep. variable	0.42	0.42	0.42	0.42	0.42	0.42

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 in the 1st year following degree and 0 otherwise (according to the broad classification of fields - see Data Appendix). SCOT is defined as 1 for Scottish degree and 0 for English degree. SCOT is instrumented with nation of prior residence in columns (4), (5), and (6). Main controls include sex, marital status, age, high school GPA, university honors level, and parent SES. Sample includes all students who aimed to attain a first degree in England and Scotland with occupation data and were not pursing further studies. Panel B is restricted to students in England whose region of prior residence was northern England (including North East and Tyne, and all Yorkshire)

Table 4: Effect of Scottish Degree on Occupational Switching for 1980 College Graduates (NSGD)

dependent variable: switched to occupation unrelated to field of study

	***1 year** after completing degree*			***6 years** after completing degree*		
	(1)	(2)	(3)	(4)	(5)	(6)
SCOT	-0.197**	-0.114**	0.002	-0.219**	-0.138**	-0.054
	[0.037]	[0.027]	[0.044]	[0.037]	[0.028]	[0.044]
Main controls	X	X	X	X	X	X
Field of study effects		X	X		X	X
Region of work effects			X			X
R^2	0.06	0.45	0.47	0.05	0.40	0.41
Observations	1,301	1,301	1,301	1,301	1,301	1,301
Mean of dep. variable	0.54	0.54	0.54	0.64	0.64	0.64

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 in the 1st year following the degree and 0 otherwise (according to the broad classification of fields - see Data Appendix). SCOT is defined as 1 for having completed Scottish school leaving exams and 0 for English school leaving exams. Main controls include sex, marital status, age, high school GPA, university honors level, and parent SES. Sample includes all students who aimed to attain a first degree in England and Scotland with occupation data and were not pursing further studies.

Table 5: "Placebo Tests" of Occupational Switching

dependent variable: switched to occupation unrelated to field of study

Panel A: Wales vs. England (USR sample)

	OLS			*2SLS*		
	(1)	(2)	(3)	(4)	(5)	(6)
SCOT	0.092	0.013	0.017	-0.063	-0.018	-0.017
	[0.061]	[0.019]	[0.022]	[0.123]	[0.031]	[0.044]
Main controls	X	X	X	X	X	X
Field of study effects		X	X		X	X
Region of work effects			X			X
R^2	0.06	0.48	0.48	0.05	0.48	0.48
Observations	10,956	10,956	10,956	10,956	10,956	10,956
Mean of dep. variable	0.51	0.51	0.51	0.51	0.51	0.51

Panel B: Graduate-level Occupational Switching in Scotland and England

	USR Sample (OLS)			*NSGD sample (reduced form)*		
	(1)	(2)	(3)	(4)	(5)	(6)
SCOT	0.033	0.019	0.010	0.048	0.062	0.039
	[0.030]	[0.038]	[0.035]	[0.048]	[0.040]	[0.072]
Main controls	X	X	X	X	X	X
Field of study effects		X	X		X	X
Region of work effects			X			X
R^2	0.02	0.19	0.19	0.01	0.24	0.27
Observations	4,400	4,400	4,400	976	976	967
Mean of dep. variable	0.49	0.49	0.49	0.58	0.58	0.58

Notes: Huber-White standard errors, clustered by university in brackets. * and ** indicate significance at the 5% and 1% level respectively. Dependent variable in Panel A (B) is defined as 1 if field of study at the undergraduate (graduate) level is equivalent to the occupational field of first job in the 1st year following degree and 0 otherwise (according to the broad classification of fields - see Data Appendix). WALES is defined as 1 for Welsh degree and 0 for English degree. WALES is instrumented with nation of prior residence in columns (4), (5), and (6) of Panel A. SCOTGRAD is defined as 1 for graduate Scottish degree and 0 for graduate English degree. Columns (4), (5), and (6) of Panel B show the reduced form using Scottish school leaving exams as a proxy for a Scottish graduate degree.

Table 6: The Effect of Scottish Degree and Occupational Switching on Log Annual Earnings (NSGD)

dependent variable: log annual earnings

	1 year *after completing degree*			***6 years*** *after completing degree*		
	(1)	(2)	(3)	(4)	(5)	(6)
SCOT	-0.007 [0.035]		-0.028 [0.031]	-0.008 [0.051]		-0.016 [0.049]
SWITCH		-0.069* [0.033]	-0.077* [0.033]		0.019 [0.033]	0.016 [0.034]
SCOT*SWITCH			0.055 [0.051]			0.019 [0.062]
Main controls	X	X	X	X	X	X
Field of study effects	X	X	X	X	X	X
Region of work effects	X	X	X	X	X	X
R^2	0.24	0.25	0.25	0.27	0.27	0.27
Observaations	1235	1235	1235	1283	1283	1283
Mean of dep. variable	8.42	8.42	8.42	9.35	9.35	9.35

Notes: Huber-White standard errors in brackets. * and ** indicate significance at the 5% and 1% level respectively. Dependent variable in columns (1), (2), and (3) is defined as log annual earnings in the 1st year after completion of an undergraduate degree. Dependent variable in columns (4), (5), and (6) is defined as log annual earnings in the 6th year after completion of an undergraduate degree. SWITCH is defined as 1 if field of study is equivalent to the occupational field of first job in the 1st year following degree and 0 otherwise (according to the broad classification of fields - see Data Appendix). SCOT is defined as 1 for Scottish high school exams and 0 for English high school exams. Main controls include sex, marital status, age, high school GPA, university honors level, parent SES, and industry fixed effects. Sample includes all students who aimed to attain a first degree in England and Scotland with occupation data and were not pursing further studies.

Table 7: The Effect of Scottish Degree and Occupational Switching over Time (NSGD sample)

dependent variable	*growth in log annual earnings*			*occupational mobility*		
	(1)	(2)	(3)	(4)	(5)	(6)
SCOT	0.026 [0.059]		0.038 [0.055]	-0.092 [0.048]		-0.133** [0.048]
SWITCH		0.084 [0.044]	0.089* [0.044]		0.092* [0.037]	0.079* [0.038]
SCOT*SWITCH			-0.033 [0.077]			0.101 [0.065]
Main controls	X	X	X	X	X	X
Field of study effects	X	X	X	X	X	X
Region of work effects	X	X	X	X	X	X
R^2	0.18	0.19	0.19	0.08	0.09	0.09
Observations	1235	1235	1235	1301	1301	1301
Mean of dep. variable	0.94	0.94	0.94	0.24	0.24	0.24

Notes: Huber-White standard errors in brackets. * and ** indicate significance at the 5% and 1% level respectively. Dependent variable in columns (1), (2), and (3) is defined as growth in log annual earnings in the 6 years following completion of the undergraduate degree. Dependent variable in columns (4), (5), and (6) is defined as 1 if occupational field after 6 years is equivalent to the occupational field after 1 year following completion of an undergraduate degree. SWITCH is defined as 1 if field of study is equivalent to the occupational field in the 1st year following degree and 0 otherwise (according to the broad classification of fields - see Data Appendix). SCOT is defined as 1 for Scottish high school exams and 0 for English high school exams. Main controls include sex, marital status, age, high school GPA, university honors level, parent SES, and industry fixed effects. Sample includes all students who aimed to attain a first degree in England and Scotland with occupation data and were not pursing further studies.

Table 8: Subjective Assessments (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)
SCOT	-0.135 [0.138]	-0.179 [0.141]	0.036 [0.119]	0.016 [0.123]
SWITCH	-0.239** [0.082]	-0.203* [0.095]	0.344** [0.071]	0.113 [0.090]
SCOT*SWITCH	0.248 [0.198]	0.269 [0.198]	-0.528** [0.183]	-0.502** [0.184]
Main controls	X	X	X	X
Field of study effects		X		X
Observations	1205	1205	1203	1203
Mean of dep. variable	3.07	3.07	2.89	2.89

Notes: Huber-White standard errors in brackets. * and ** indicate significance at the 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 in the 1st year following degree and 0 otherwise (according to the broad classification of fields - see Data Appendix). SCOT is defined as 1 for Scottish high school exams and 0 for English high school exams. Main controls include sex, marital status, age, high school GPA, university honors level, parent SES, industry fixed effects, log annual earnings in the first year and subjective measures of how beneficial the qualification has been to securing a good income. Sample includes all students who aimed to attain a first degree in England and Scotland with occupation data and were not pursing further studies.

Appendix Table 1: Classification of Fields

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

Notes: Field are classified in very broad (2 digit), broad (3 digit), and narrow (4 digit) classifications. Broad classifications are in boldface. Detailed descriptions of fields of study and occupations are available from the author.

Appendix Table 2: Robustness Checks

Coefficient of Interest	*Differential in Occupational Switching (SCOT)*		*Differential in Wages (SCOT)*	*Wage Loss (SWITCH)*	*Differential in Wage Loss (SCOT*SWITCH)*
	USR	NSGD	NSGD	NSGD	NSGD
	(1)	(2)	(3)	(4)	(5)
Baseline	-0.056**	-0.114**	-0.028	-0.077*	0.055
	[0.016]	[0.027]	[0.031]	[0.033]	[0.051]
Classification of Fields					
Narrow	-0.034**	-0.05	-0.073	-0.051	0.094*
	[0.010]	[0.031]	[0.039]	[0.028]	[0.045]
Very Broad	-0.056**	-0.097**	0.003	-0.078*	-0.035
	[0.016]	[0.029]	[0.040]	[0.032]	[0.044]
Occupational Restrictions					
Unemployed as Switch	-0.056**	-0.116**	-0.034	-0.069*	0.031
	[0.016]	[0.027]	[0.031]	[0.027]	[0.045]
Unclassified Occupations as Switch	-0.056**	-0.089**	-0.028	-0.074*	0.054
	[0.016]	[0.026]	[0.031]	[0.033]	[0.051]
Include Graduate Students	-0.049**	-0.116**	-0.025	-0.075*	0.06
	[0.015]	[0.027]	[0.032]	[0.033]	[0.051]
Graduate Students as Non-switch	-0.056**	-0.114**	-0.028	-0.077*	0.055
	[0.016]	[0.027]	[0.031]	[0.033]	[0.051]
Field Restrictions					
Exclude Education	-0.056**	-0.119**	-0.029	-0.076*	0.061
	[0.016]	[0.027]	[0.031]	[0.034]	[0.051]
Education as Non-switch	-0.056**	-0.117**	-0.032	-0.077*	0.065
	[0.016]	[0.027]	[0.031]	[0.034]	[0.051]
Exclude Business	-0.056**	-0.107**	-0.022	-0.092**	0.055
	[0.016]	[0.029]	[0.034]	[0.035]	[0.052]
Business as Non-Switch	-0.056**	-0.101**	-0.029	-0.091**	0.061
	[0.016]	[0.027]	[0.031]	[0.035]	[0.051]
Include Combined Fields	-0.056**	-0.106**	-0.055	-0.074*	0.042
	[0.016]	[0.027]	[0.031]	[0.032]	[0.048]
Degree Attainment					
Attained BA	-0.056**				
	[0.016]				

Notes: Huber-White standard errors in brackets, clustered by university for USR samples. *, **, indicate significance at the 5% and 1% level respectively. Coefficients from the USR sample are for 2SLS with main controls, controls for field of study, but no controls for region of work. Coefficients on occupational switching from in the NSGD sample include main controls, controls for field of study, but no controls for region of work. Coefficients on all wage regressions include main controls, controls for field of study, region of work, and industry.

Appendix Table 3: Occupational Switching by Field (USR, 1973-93)

dependent variable: occupational switch

	Math/Comp	*Physical*	*Architect*	*Engineer*	*Biology*	*Health*	*Social Serv.*	*Social Sci.*	*Business*	*Law*	*Educ*	*Arts*
SCOT	-0.155** [0.041]	-0.062* [0.023]	-0.137 [0.072]	-0.118** [0.020]	-0.098** [0.033]	-0.003 [0.014]	-0.080** [0.027]	-0.050** [0.007]	-0.054 [0.033]	-0.094** [0.015]	-0.089 [0.057]	-0.084* [0.033]
Main controls	X	X	X	X	X	X	X	X	X	X	X	X
Observations	23,596	27,132	4,669	45,994	19,919	56,091	11,345	36,795	14,620	22,013	4,061	37,147
R^2	0.04	0.09	0.09	0.02	0.05	0.08	0.05	0.01	0.05	0.04	0.11	0.03
Mean of dep. variable	0.61	0.72	0.20	0.28	0.66	0.05	0.70	0.92	0.12	0.16	0.15	0.83

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 in the 1st year following degree and 0 otherwise (according to the broad classification of fields - see Data Appendix). SCOT is defined as 1 for Scottish degree and 0 for English degree. Main controls include sex, marital status, age, high school GPA, university honors level, parent SES, and year fixed effects. Sample includes all students who aimed to attain a first degree in England and Scotland with occupation data and were not pursing further studies.

Appendix Table 4: Effect of a Scottish Degree on Occupational Switching for Engineers (USR, 1979-93)

dependent variable: switched to occupation unrelated to engineering subfield

	OLS			*2SLS*		
	(1)	(2)	(3)	(4)	(5)	(6)
SCOT	-0.112**	-0.043*	-0.028	-0.102*	-0.046*	-0.031
	[0.040]	[0.019]	[0.017]	[0.038]	[0.019]	[0.016]
Main controls	X	X	X	X	X	X
Sub-field effects		X	X		X	X
Region of work effects			X			X
R^2	0.02	0.43	0.43	0.02	0.43	0.43
Observations	45,994	45,994	45,994	45,994	45,994	45,994
Mean of dep. variable	0.28	0.28	0.28	0.28	0.28	0.28

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 in the 1st year following degree and 0 otherwise (according to the broad classification of fields - see Data Appendix). SCOT is defined as 1 for Scottish degree and 0 for English degree. SCOT is instrumented with nation of prior residence in columns (4), (5), and (6). Main controls include sex, marital status, age, high school GPA, university honors level, and parent SES. Sample includes all students who aimed to attain a first engineering degree in England and Scotland with occupation data and were not pursing further studies.

Appendix Table 5: Percentage Employment in Different Occupational Fields by Field of Study in 1980 BA Degree (USR)

ENGLAND

	Occupational Field											
Field of Study	*Unclassified*	*Math/Comp*	*Physical*	*Architect*	*Engineer*	*Health*	*Social Serv.*	*Social Sci.*	*Business*	*Law*	*Educ*	*Arts*
Math/Comp	*5.1*	**35.0**	3.5	0.1	5.7	0.1	0.6	1.0	37.5	0.2	10.2	0.9
Physical Sci.	*8.8*	8.2	**21.8**	0.9	16.7	0.7	1.0	2.7	26.4	0.9	10.1	1.8
Architeture	*2.8*	0.4	5.1	**64.5**	10.6	0.1	0.2	0.5	14.1	0.4	0.7	0.7
Engineering	*6.0*	3.7	7.0	0.8	**67.0**	0.1	0.2	0.6	12.5	0.3	1.3	0.6
Biology	*12.0*	2.7	25.4	0.5	11.1	3.2	1.3	2.6	28.3	0.5	10.2	2.1
Health	*1.4*	0.1	1.9	0.0	0.5	**93.3**	0.2	0.4	1.4	0.1	0.6	0.2
Social Serv	*13.1*	2.0	1.6	0.2	1.5	5.3	**27.1**	4.5	28.1	1.0	13.2	2.5
Social Sci.	*13.8*	2.3	0.7	1.4	1.1	0.9	2.9	**6.9**	52.1	3.0	10.7	4.2
Business	*6.2*	3.0	0.3	1.4	1.5	0.2	0.4	1.2	**82.5**	0.5	2.1	0.6
Law	*2.9*	0.3	0.1	0.0	0.1	0.1	0.7	1.6	11.2	**81.1**	1.0	0.9
Education	*3.5*	0.4	0.2	0.0	0.2	2.8	1.9	0.8	6.5	0.1	**82.1**	1.5
Arts	*17.0*	1.4	0.2	0.1	0.5	1.3	3.1	4.6	30.7	2.2	24.6	**14.4**

SCOTLAND

	Occupational Field											
Field of Study	*Unclassified*	*Math/Comp*	*Physical*	*Architect*	*Engineer*	*Health*	*Social Serv.*	*Social Sci.*	*Business*	*Law*	*Educ*	*Arts*
Math/Comp	*3.7*	**43.9**	3.0	0.1	5.9	0.2	0.3	0.8	31.6	0.2	10.1	0.3
Physical Sci.	*7.8*	8.5	**23.6**	1.9	21.0	0.8	0.9	2.3	21.4	0.3	9.9	1.5
Architeture	*3.5*	0.4	3.9	**74.8**	5.9	0.0	0.3	0.6	8.7	0.6	0.7	0.6
Engineering	*5.8*	2.4	4.5	1.0	**75.2**	0.1	0.2	0.8	8.1	0.1	1.5	0.4
Biology	*11.0*	1.9	30.3	0.6	16.3	2.9	1.2	2.5	25.5	0.3	6.5	1.3
Health	*1.0*	0.1	1.5	0.0	0.8	**95.0**	0.1	0.2	1.0	0.0	0.2	0.1
Social Serv.	*12.6*	3.6	2.1	0.2	1.9	4.5	**27.9**	5.2	26.3	0.7	12.7	2.3
Social Sci.	*12.3*	2.7	0.8	2.9	1.5	1.0	3.5	**8.5**	50.0	1.7	10.5	4.6
Business	*5.9*	1.7	0.3	0.4	2.4	0.2	0.3	1.3	**84.5**	0.4	2.0	0.6
Law	*1.2*	0.1	0.0	0.0	0.1	0.1	0.3	1.3	8.0	**87.7**	0.5	0.6
Education	*5.1*	0.2	0.0	0.0	0.1	6.4	1.6	0.3	2.6	0.0	**83.6**	0.3
Arts	*13.6*	1.5	0.1	0.1	0.4	1.4	2.9	4.8	26.0	1.2	25.9	**22.2**

Figure 1: Expected Wages without Occupational Switching by Relative Return to Match Quality

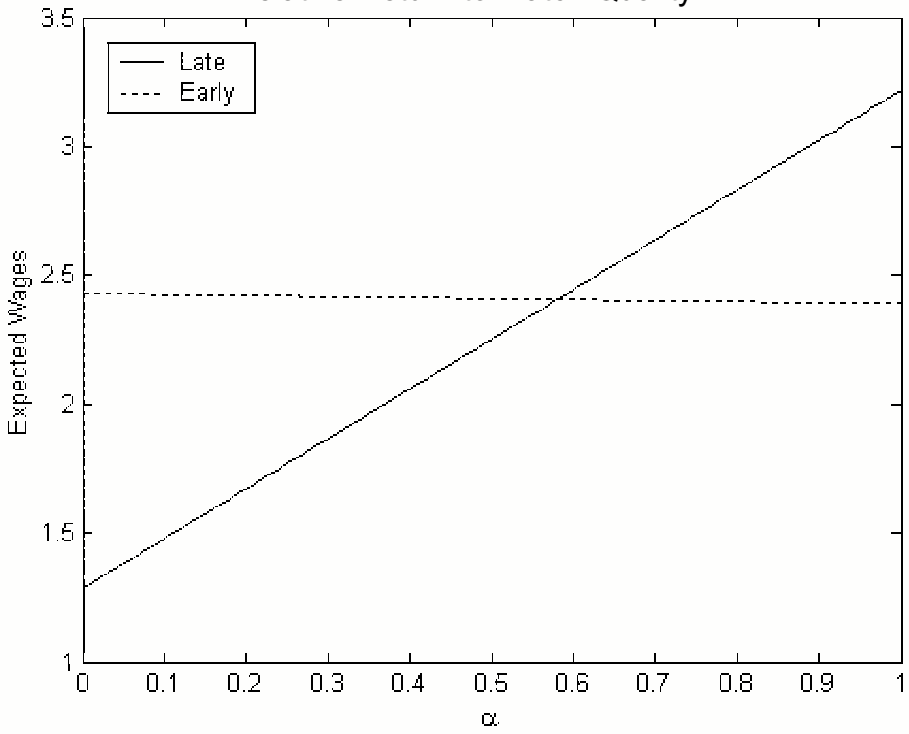
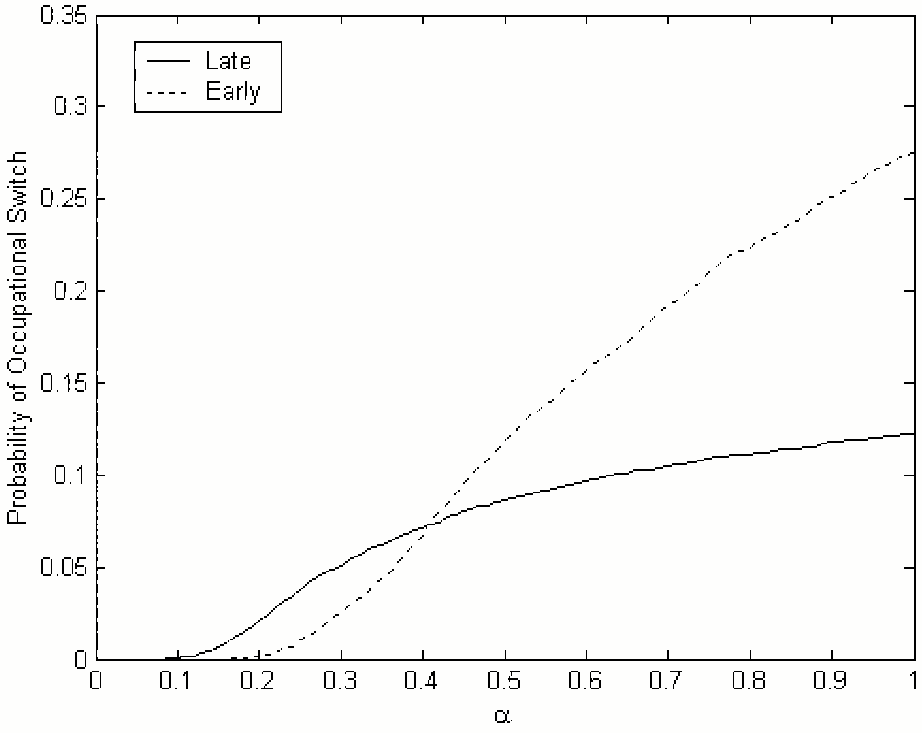


Figure 2: Probability of Occupational Switching by Relative Return to Match Quality



Notes: All simulations are based on 5000 repetitions for $J=2$, $N=21$, $\mu=0$, $\sigma=25$, and $\sigma_\varepsilon=100$. Early regimes are characterized by $n^E=2$; late regimes are characterized by $n^L=6$. The relative returns to match quality are normalized by taking $\beta=(1-\alpha)$ so that (α/β) goes from 0 to ∞ as α goes from 0 to 1. Expected wages are log wages determined according to $E(\ln w_j)=E(\alpha m_j + \beta s_j)$ where $s_j=[s_j/(N/J)]+\mu$ are normalized skills.

Figure 3: Expected Wage Differential by Relative Return to Match Quality

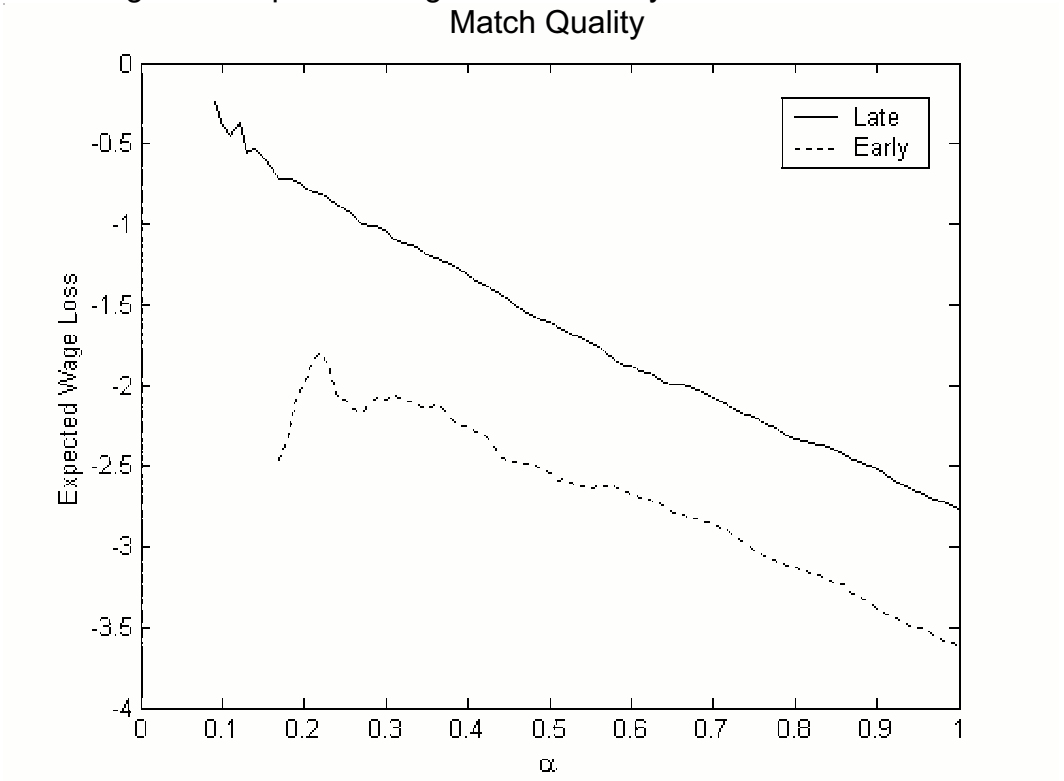
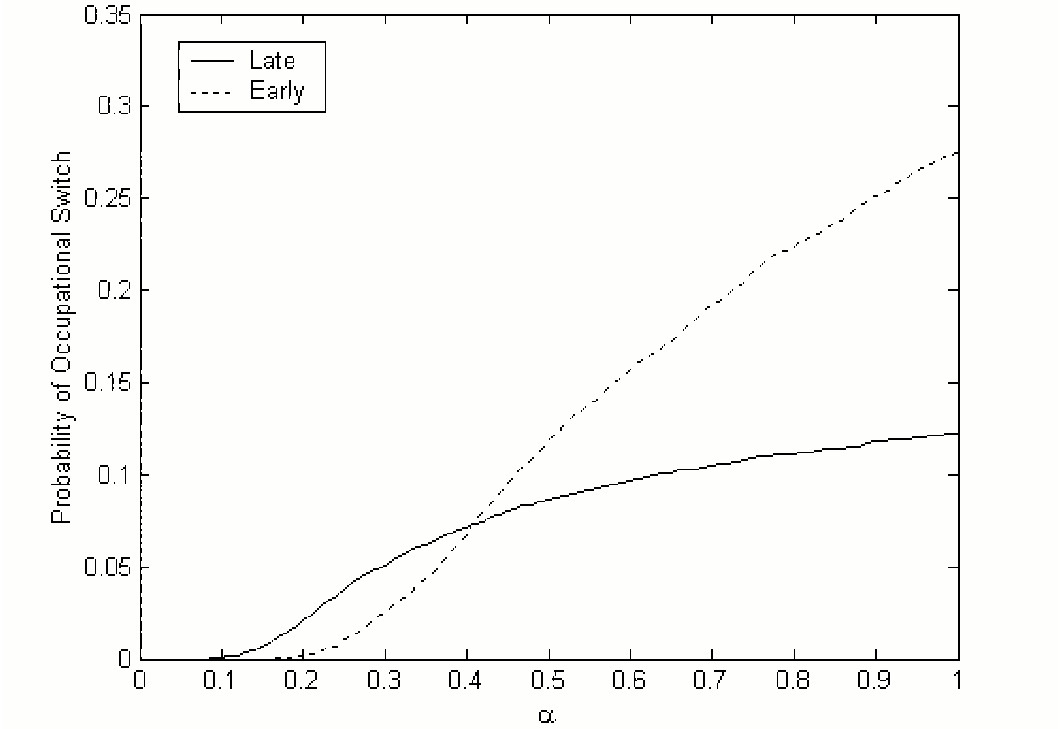
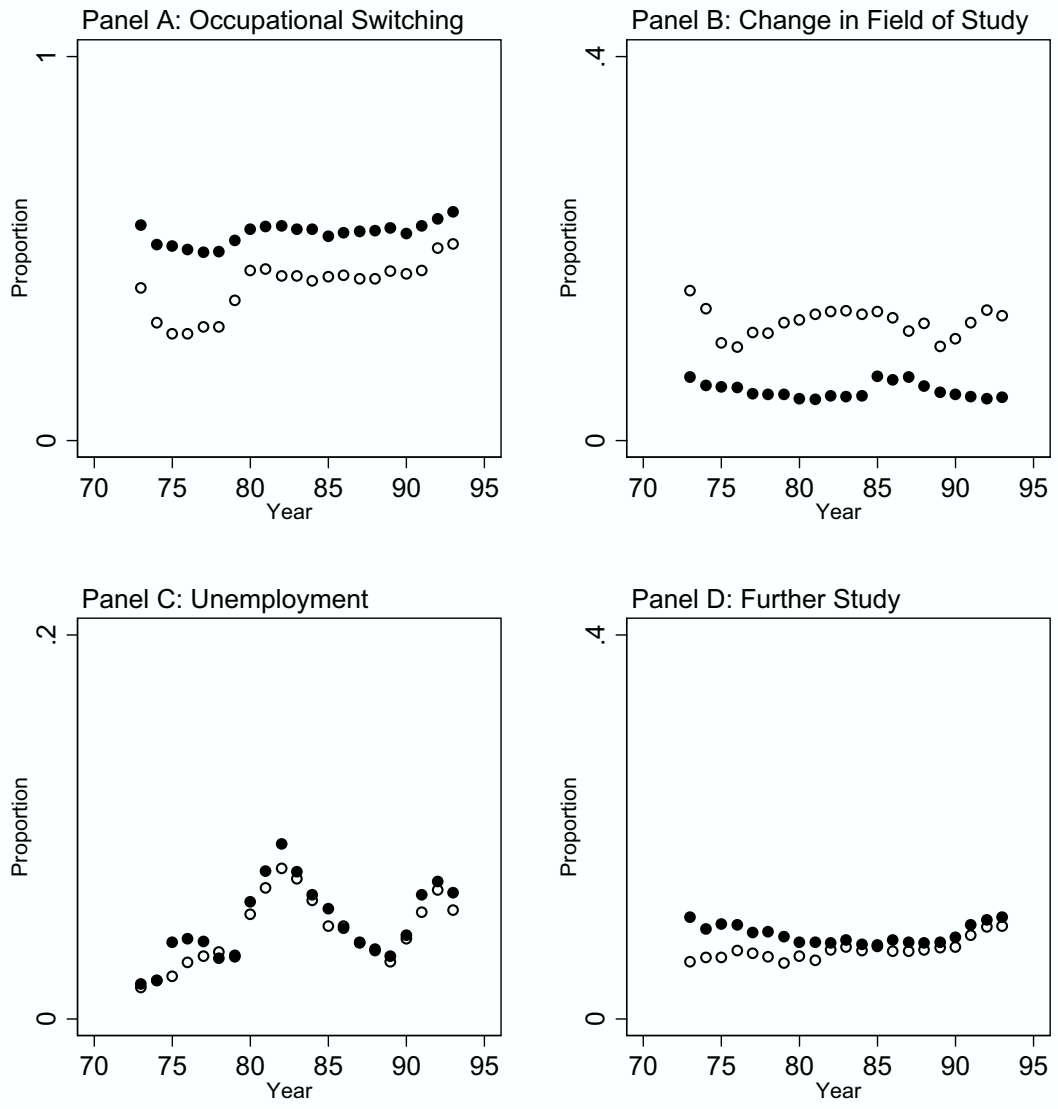


Figure 4: Expected Wages by Relative Return to Match Quality

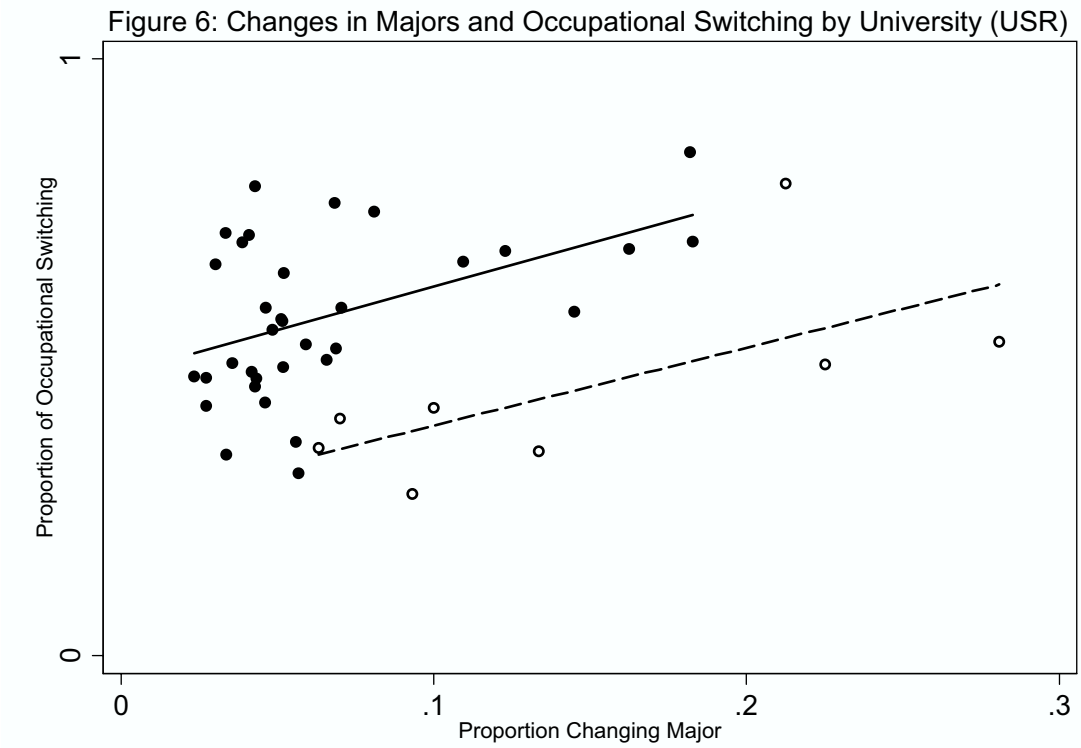


Notes: All simulations are based on 5000 repetitions for $J=2$, $N=21$, $\mu=0$, $\sigma=25$, and $\sigma_\varepsilon=100$. Early regimes are characterized by $n^E=2$; late regimes are characterized by $n^L=6$. The relative returns to match quality are normalized by taking $\beta=(1-\alpha)$ so that (α/β) goes from 0 to ∞ as α goes from 0 to 1. Expected wages are log wages determined according to $E(\ln w_j)=E(\alpha m_j+\beta s_j)$ where $s_j=[s_j/(N/J)]+\mu$ are normalized skills.

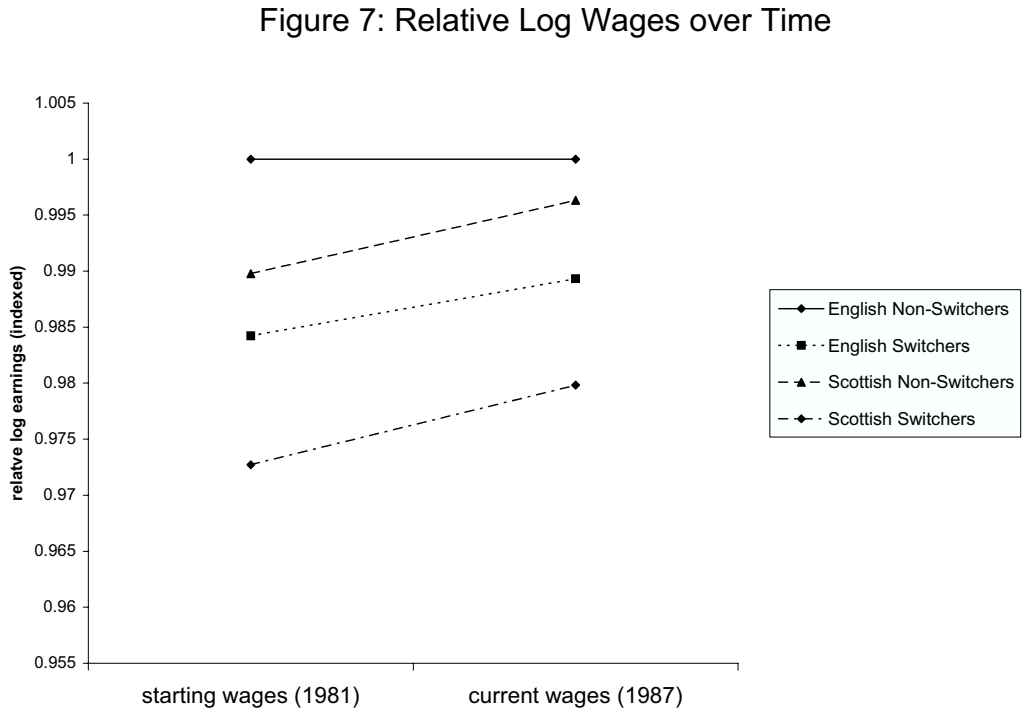
Figure 5: Outcomes by Year of Graduation (USR sample)



Notes: Closed and open circles represent England and Scotland averages respectively. Outcomes based on USR samples of undergraduates from 1973-1993. Occupational switching is calculated with the broad classification (see Appendix Table 1). Change of field of study is determined by students who receive a degree in a field different from the one they applied for. Unemployment and Further study are during the 1st year following graduation.



Notes: Closed and open circles represent English and Scottish university averages respectively. Outcomes based on USR samples of undergraduates from 1973-1993. Occupational switching is calculated with the broad classification (see Appendix Table 1). Change of field of study is determined by students who receive a degree in a field different from the one they applied for.



Notes: Log annual earnings for English individuals that do not switch are assigned an index of 100 for both starting wages in 1981 and current wages in 1987. Log annual earnings for all other groups are calculated relative to this base.