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College Curricular Dispersion: More Well-Rounded or Less Well Trained?

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Abstract: Students are typically given a large amount of freedom to choose the level of "curricular dispersion": the tight focus or lack thereof in the courses they elect to take while in college. There is little evidence about what predicts students' curricular dispersion, whether it affects later college or labor force outcomes, or, in fact, how to measure curricular dispersion. In this paper we develop a measure of curricular dispersion and use data from Washington State to explore its predictors and associated outcomes. We find that prior dispersion predicts future dispersion but not subsequent changes in college major. We report mixed findings on the associations between curricular dispersion and overall college GPA, the probability of graduation, and early career wages.

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College Curricular Dispersion: More Well-Rounded or Less Well Trained?

1. Introduction

Some students enter college with a clear notion of the course of study they wish to undertake and stick with it through graduation. Others sample different courses and majors, pursuing myriad academic interests. The merits of the amount of "curricular dispersion" that students experience during their college careers is hotly debated. Some advocate dual benefits of having a more focused curricular path: accumulating credits more quickly in a specific major will increase a student's likelihood of graduation (and earlier graduation), and be beneficial in the labor market because the student will enter with more in-depth specialized human capital. On the other hand, a narrow curricular focus could lead to match issues, such as a poorer fit between a student's major and his or her interests. This in turn could affect the likelihood that the student completes college, or also lead to a poorer job match in the labor market, as the major will be influenced by the credentials a student leaves college with. A lack of a well-rounded set of skills could also make the student more vulnerable to shocks to particular sectors of the economy. We discuss these divergent viewpoints further in the next section. Despite the scholarly debate about the merits of curricular dispersion, there is very little empirical evidence on the extent to which there is curricular dispersion in college, what factors predict it, or the consequences of it.

These issues matter because college administrators have a significant amount of control over students' curricular experiences. Colleges directly influence their students' curricular dispersion by setting the general education requirements associated with a degree, or how easy it is to switch majors. Departments within schools determine how many courses outside the field students are allowed to take. Enrollment caps in courses that are necessary for completion in a major or the timing of requirements for major declaration are likely to influence the choice of courses, as is the specific guidance that students receive about their options (Avery, Howell, & Page, 2014). The belief that students need more guidance to ensure a coherent college course experience has led to a growing number of colleges to more actively shape students' college career paths through "guided pathways" in which faculty map out different curricular options, students are advised to choose a pathway early, and academic advisors track their progress more closely against specified academic plans.[1] Furthermore, college students themselves may wish to have better information about the implications of curricular choices.

Given the rhetoric around curricular dispersion, it is surprising that there is no common measure used to describe how dispersed or focused is an individual's college curriculum. *The development of such a measure, and the illustration of its uses, is the focus and main contribution of our paper.* We first identify the pattern of course-taking by all students across departments in each university. We define an individual student's curriculum as having more dispersion when the student's set of courses are taken from departments that have weaker ties between them (e.g., English and Chemistry) than from departments with strong ties (e.g., Chemistry and Biology), where the strength of the tie is determined by aggregate course-taking behavior.

Using individual-level panel data from public colleges in the state of Washington, we find that curricular dispersion is highest during the junior year and lowest during freshman year, and that there is substantial variation in levels of dispersion across the ten colleges in our sample and across various majors. We find that, conditional on pre-college student characteristics and a student's initial major choice, curricular dispersion in the student's prior course-taking and having previously switched major are each positively associated with subsequent curricular dispersion. Students who have switched majors before are more likely to do so again, but previous dispersion is not *conditionally* associated with future major switching. We find that curricular dispersion during the student's junior year is positively associated with the probability of "on-time" graduation. However, for those who graduate on-time, sustained dispersion over the entire college career is negatively related to both final college GPA and early career wages. Dispersion within any particular year is positively associated with improved GPA and higher wages, although these associations are generally insignificant. In other words, dispersion in short bursts is modestly associated with good outcomes, but dispersion over a long period of time is more strongly associated with negative outcomes.

In sum, our findings suggest that sustained unfocused college careers are associated with poor outcomes. However, these findings on the relationship between curricular dispersion and future education and labor market outcomes should not be seen as causal; we cannot tell whether the conditional associations we observe reflect causal relationships between curricular dispersion and outcomes or whether heterogeneity in unobserved student characteristics (e.g., "flakiness" or "curiosity") produce these associations. We find that while institutional factors are important, variation in dispersion is largely explained by individual-level heterogeneity. Given this, we are careful not to draw strong conclusions about these conditional associations.

2. **Evidence on Course Dispersion and Outcomes**

College students in the United States have a tremendous amount of choice in carving out their educational pathway (Goldin & Katz, 2009). They choose between whether or not to attend college, types of college institutions, particular colleges and their attributes, and different college majors. These choices have important labor market implications. The labor market returns to attending and completing college in general are well-known and well-studied (e.g., Card, 1999; Oreopoulos & Petronijevic, 2013). Recent attention has focused on the consequences of the particular courses that college students take, in the form of the choice between different majors and the consequences of that choice (Freeman & Hirsch, 2008; Zafar, 2011; Carnevale, Cheah, & Strohl, 2012; Beffy, Fougere, & Maurel, 2012; Stinebrickner & Stinebrickner, 2014; Long, Goldhaber, & Huntington-Klein, 2014; Altonji, Kahn, & Speer, 2014; Stange, 2015; Wiswall & Zafar, 2015).

Student choice of courses in college may reflect a personal preference for diversity or novelty, or be influenced by changing information about their skills in different fields (e.g. Altonji, Blom, & Meghir, 2012). For instance, several studies of major switching have focused on switching as a response to the revelation of personal ability in a particular field. Stinebrickner and Stinebrickner (2014) examine the attainment of a degree in science, finding that students tend to enter college optimistic about the ability to attain a degree in a science field but typically adjust their perceived science aptitude downwards, leading many of those who initially major in the sciences to switch majors. Arcidiacono (2004) also focuses on the impact of students learning about their skill sets. He models major switching as a response to the revelation of unexpectedly low grades in a chosen field. Students who receive lower grades than they would expect given high school grades and SAT scores are more likely to switch, and do not perform as well in their later college careers. Arcidiacono, Hotz, and Kang (2012) use subjective expectations data to elicit students' expected aptitude in fields other than their own. They find that the choice to switch majors is driven both by differences in student perceptions of their own ability in the major, and, especially among students with low perceptions of their own ability, differences in student perceptions of labor market returns to major.

Students who complete a wider variety of courses while in college may be receiving a more well-rounded education and be better prepared for success in the workplace because they end up with a better fit between their academic credentials and their skill set and interests and/or because they can draw upon different disciplinary approaches to problem solving. To our knowledge there is only one study that touches on the extent to which curriculum dispersion influences college outcomes (and only tangentially as it focuses on a guided college pathway, which entails different types of interventions),[2] and to our knowledge no research on the relationship between curriculum dispersion and labor market outcomes.

The above studies of curricular dispersion see early course-taking as a way for students to explore different fields and learn about their own abilities given that they enter college with imperfect knowledge of their own abilities. But, interestingly, scholars have different views about the virtues of course diversity. Scott-Clayton (2011) and Jenkins and Cho (2014) argue that an overabundance of course options combined with a great deal of flexibility in how students pursue a course of study helps explain high college dropout rates, while others (Grubb, 2006; Malamud, 2010) suggest that finding the right fit between individual preferences and abilities and academic pursuits is essential for later success.

Scott-Clayton (2011), for instance, describes the "structure hypothesis" that "students will be more likely to persist and succeed in programs that are tightly and consciously structured with relatively little room for individuals to deviate on a whim—or even unintentionally—from the paths toward completion, and with limited bureaucratic obstacles for students to circumnavigate." (p. 1). This hypothesis is focused on community college, but this same line of reasoning about curricular dispersion also applies to students in four-year schools (Jenkins and Cho, 2014). The underlying idea is that while the myriad curricular options students have allows for customization of the college experience, it ultimately may serve as a hindrance to successful progression and persistence given limits to rational decision-making ability.[3] Beyond issues of persistence, curricular dispersion may lead students to be less well-trained in a particular area.

3. **Data and Measures**

a. Measuring Curriculum Dispersion

One barrier to the study of curriculum dispersion is that there is not a well-developed or obvious measure of the extent of divergence in a student's course choices. In this section, we develop a measure of curricular dispersion that can be used to estimate how similar or dispersed is a given set of courses. We develop a measure of the "distance" between academic departments, and then use this measure to characterize the extent to which a student's curriculum is dispersed based on the departments in which she takes courses: a student's curriculum is highly dispersed if the distances between the departments in which she takes courses are large, or focused if the distances between the departments are small. We define two departments as close to each other to the extent that students who take courses in one department are more likely to take courses in the other department.

Students at a particular college at the same time face similar institutional constraints in choosing courses. So, if we observe that courses in two given departments j and k are commonly taken by the same students at that college, then this tells us either that students who prefer to take courses in j also prefer to take courses in k (i.e. the courses offer similar types of consumption value or rely on similar skill sets) or that taking courses in one of the departments makes courses in the other department more appealing (i.e. the two types of courses are complements). Either of these reasons can signify that the two departments are positively associated or "close together." The complementary nature of two departments may be determined by policy in addition to utility, for example if all courses in department *j* require courses from *k* as a prerequisite. The course-taking decision problem faced by students naturally suggests that the correlation over students between course-taking in one department and course-taking in another, or some other measure which is intuitively similar to correlation, is a good indicator of how "close" or "far apart" these departments are (either as a function of student preferences or institutional policies).

Based on this insight, we construct a correlation-based measure of distance as illustrated by the following $N \times J$ matrix, N is the total number of students in a particular university, J is the number of departments in that university, C_{ij} is the number of courses taken by student *i* in department *j*, and each cell entry reflects the proportion of courses[4] taken by student *i* that are in department *j*:

$$\begin{bmatrix} \frac{C_{11}}{\sum_{j=1}^{J} C_{1j}} & \frac{C_{12}}{\sum_{j=1}^{J} C_{j1}} \cdots & \frac{C_{1J}}{\sum_{j=1}^{J} C_{j1}} \\ \frac{C_{21}}{\sum_{j=1}^{J} C_{2j}} & \frac{C_{22}}{\sum_{j=1}^{J} C_{2j}} \cdots & \frac{C_{2J}}{\sum_{j=1}^{J} C_{2j}} \\ \vdots & \vdots & \vdots \\ \frac{C_{N1}}{\sum_{j=1}^{J} C_{Nj}} & \frac{C_{N2}}{\sum_{j=1}^{J} C_{Nj}} \cdots & \frac{C_{NJ}}{\sum_{j=1}^{J} C_{Nj}} \end{bmatrix}$$

We define distance d_{jk} between departments *j* and *k* as equal to ½ × (1 - correlation of the *j* and *k* columns in the matrix above). d_{jk} ranges from 0 (when there is perfect positive correlation between course-taking in departments *j* and *k*, and thus no "distance") to 1 (when there is perfect negative correlation between course-taking in departments *j* and *k*). This correlation-based measure has three nice features: (1) it is simple to estimate, (2) it is intuitive and easy to explain, and (3) it is scale invariant (the distance between departments is not a function of the size of the departments).

To illustrate this construction, Table 1 lists the distances between the ten departments at the University of Washington at Seattle with the highest enrollments. Among these ten, the closest departments are Biology to Chemistry followed by Math to Physics, while the furthest apart are Chemistry to Economics followed by Chemistry to English. Figure 1 uses classical multidimensional scaling (Torgerson, 1952) to plot these distances, creating a two-dimensional representation of the nine-dimensional map. In this 2-D representation, we see some clear organization that seems intuitively reasonable, with the physical sciences clustered on the left and social sciences grouped on the right, and with Math lying between Physics and Economics and Biology lying between Chemistry and Psychology.

[TABLE 1 ABOUT HERE]

[FIGURE 1 ABOUT HERE]

Next, we use these distances in deriving the dispersion of a student's set of courses. For each student i and time period $[t \rightarrow t+h]$, we calculate the student's dispersion $D_{i,t\rightarrow t+h}$ as the average distance of every link between that student's courses.[5,6] So, for example, if the student took one course in j, two in k, and three in l from time t to time $t+h$, her dispersion would be: $D_{i,t\rightarrow t+h} = (2d_{jk} + 3d_{jl} + 6d_{kl} + 0d_{jj} + 1d_{kk} + 3d_{ll})/15$. Note that since this dispersion measure is a weighted average of distances, and since distances range from 0 to 1, the dispersion score also ranges from 0 to 1 with lower scores indicating less dispersion. Finally, note that since $d_{jj} = 0$, a student who only took courses in one department would have a dispersion score of 0.

The interpretation of the measure is straightforward: if a student takes a lot of similar courses, the weighted average distances between her courses will be very low, and so the measure of dispersion will be very low, and vice versa. To illustrate the relationship between course-taking patterns and the measure of dispersion, we create two course-taking profiles, which are reported in Table 2. Student A takes a perfectly even mix of courses – six in each of our representative departments. This student's dispersion measure is 0.51 as the student has not made an effort to be either focused or intentionally atypical. We compare this to a very focused Biology student who takes mostly Biology courses, along with a few Chemistry, Math, and Physics courses. This student has a dispersion score of 0.21, which is much closer to 0 given the high share of courses in one department. Figure 2 illustrates these course-taking profiles, where the weights on each link reflect the number of connections between courses that each link represents. We can think of this figure as if it were a campus map where the length of an arrow represents the distance in terms of rarity that courses from both departments are in a student's curriculum. In this sense, Student A is "walking" all over campus (perhaps literally) while Student B is mostly staying put in the Biology "building", sometimes walking to Chemistry, and occasionally heading over to the more distant Math and Physics.

[TABLE 2 ABOUT HERE]

[FIGURE 2 ABOUT HERE]

b. Data

We now illustrate the use of this curricular dispersion measure by applying it to data on a set of college students. We use data from a statewide university reporting system that includes registration and transcript records for students enrolled in public four-year universities in the state of Washington: the three campuses of the University of Washington (UW), the four campuses of Washington State University (WSU), Western Washington University, Central Washington University, and Eastern Washington University. Our analytical sample includes 22,642 students whose first-time enrollment in one of these universities occurred during the fall of 2007 or 2008.[7] We exclude students who transfer into these universities with more than 15 credits (approximately one college quarter) completed elsewhere so that the analytical sample includes the student's nearly complete course-taking history.[8]

Administrative records from these universities include full college transcript information, with details on class standing (freshman/sophomore/etc.), courses taken each quarter and grades earned, degree completion, demographic information, and some admissions information including high school GPA and SAT scores.[9] These data are linked through the state's Educational Research Data Center (ERDC) warehouse to Unemployment Insurance data, which includes information on employment and wages in the first year after leaving college among those employed in the state of Washington.

Table 3 presents descriptive statistics on students in the full sample and for subsamples who persisted further in these colleges. Unsurprisingly, students who progress farther through college tend to have higher grades (both in college and high school) and slightly higher SAT scores, and are more likely to graduate and earn more in the labor market. Roughly one-in-six students switch their declared major at any point during their career at these colleges, and such switching is most prevalent during the student's junior year followed by senior year. This pattern is to be expected, since students in their first year have generally not yet declared a major and if they have, have not had much time to switch.

[TABLE 3 ABOUT HERE]

We standardize our measure of curricular dispersion to ease interpretation such that across the full sample of college entrants, the mean of dispersion is 0 and the standard deviation is 1. As shown in the top panel of Table 3, students who progress farther through college tend to have slightly lower levels of dispersion; the sample who completed a bachelor's degree on-time had dispersion that was 0.07 s.d. lower than the full sample of all entrants to these colleges. We also, surprisingly, observe that among all entrants, dispersion is lowest during the freshman year, increases during sophomore year, is highest during junior year, and then declines somewhat during senior year. We illustrate this pattern in another way in Figure 3, which shows the share of students' courses taken in a focal department (i.e., the department in which the student takes the most courses). We observe a decline in the focal department's share of courses between freshman and sophomore year, a modest increase in the focal department's share between sophomore and junior year, and then a substantial increase in the focal department's share of courses between junior and senior year. Taken together, these results suggest that for students who make it to the bachelor's degree, the college career can be characterized by a period of early focus, then exploration in the middle years, and then a refocusing in the last year.

[FIGURE 3 ABOUT HERE]

Figure 4 illustrates the distribution of our dispersion measure for all students in our sample calculated over the student's whole academic career. The dispersion measure has a tight distribution with long tails. The lack of weight to the right of .5 (which would indicate that the student takes courses that are negatively correlated with each other) indicates that, by and large, students take "coherent" course sets, where the courses they choose to take are those that are also taken together by other students. The tight distribution illustrated in Figure 4 means that the scale on which differences in dispersion between students occurs is modest.

[FIGURE 4 ABOUT HERE]

Table 4 shows large differences in levels of dispersion across campuses, and this is related to the number of course offerings and majors. Curricular dispersion is lowest at the branch campuses of Washington State University at Spokane, Vancouver, and Tri-Cities and the University of Washington at Bothell. The very low level of dispersion at WSU Spokane is not surprising given its admissions policy to narrowly defined programs:

> “WSU Spokane houses undergraduate degree completion programs in Nursing, Nutrition and Exercise Physiology, and Speech and Hearing Sciences. Students interested in these programs must complete the first two years of study at WSU Pullman, WSU Tri-Cities or WSU Vancouver or at another institution prior to starting their programs at WSU Spokane.” (WSU Spokane, 2015).

[TABLE 4 ABOUT HERE]

UW-Bothell, which has the second lowest dispersion, also offers a small number of majors and most students are community college transfers and are directly admitted to a particular major when they first enroll. As a result, only 12% of UW-Bothell students ever switch major. Students attending the flagship campuses of UW-Seattle and WSU-Pullman have higher levels of dispersion, which is consistent with the vast number of departments at each flagship campus. Overall, there is a significant .184 correlation between the logged number of departments at a campus and the average overall dispersion among its students.

In Table 5, we show the average career dispersion for students with different final declared majors, defined at the two-digit Classification of Instructional Programs (CIP) level. There is a wide range of differences in levels of dispersion over majors. The difference between the least dispersed major, Architecture, and the most dispersed, Liberal Arts, is nearly two standard deviations of the distribution of dispersion over students. In general, the measure seems to conform to expectations about how much freedom in course-taking students are given, with job-focused restrictive majors like Architecture, Arts, Engineering, Health, and Computer and Information Sciences (CIS), at the low end of the dispersion scale, and broader disciplines that encourage wider course taking like Social Sciences, Law, Cultural/Area Studies, and Liberal Arts, at the high end of the scale. This table backs up the use of the measure in general, as majors tend to map to dispersion in expected ways. Additionally, it gives us a sense of where some fields for which we do not have a strong prior fall. There are a few surprises, with Engineering Technologies near the middle, and Interdisciplinary Studies at the low end. In the case of Interdisciplinary Studies, many students in this major are taking courses mainly in two or three closely related departments, which would lead to a low dispersion measure.

[TABLE 5 ABOUT HERE]

4. The Antecedents of Curricular Dispersion and its Association with Outcomes

a. Predicting Dispersion and Major Switching

We next seek to understand what antecedent factors are associated with a student's curricular dispersion and decisions to switch majors. In this section we explore an application of our dispersion measure, as a means of determining the student background characteristics that are associated with dispersion and major switching, and how dispersion and switching relate to later outcomes, conditional on student background. Our base specification is given in Equation 1, which models one observation per student i and college quarter t, and is restricted to students who have completed 45 or more credits:

$$Y_{it} = \alpha_0 + \alpha_1 D_{i,t-3\to t-1} + \alpha_2 Switch_{i,<t} + \alpha_3 X_i + \alpha_4 T_{it} + \alpha_5 C_{it} + \varepsilon_{it} \qquad (1)$$

Y_{it} is the outcome variable of interest and is defined as either $D_{i,t\to t+2}$, which is the above-defined measure of curricular dispersion over the next three quarters of course-taking,[10] or $Switch_{it}$, which is an indicator variable that equals 1 if the student switched major in quarter t (i.e., the student's declared major in quarter t is different from their declared major during the last quarter in which the student was enrolled). $D_{i,t-3\to t-1}$ is the measure of curricular dispersion over the three immediately preceding quarters. $Switch_{i,<t}$ is an indicator variable equal to one if

student i has ever switched major before quarter t. X_i is a vector of non-time-varying student information including high school GPA, SAT scores, out-of-state status, race and gender, and a set of fixed effects for the initial major the student declares. T_{it} is a vector of indicators for whether the student's cumulative SAT scores fall into the top, middle, or bottom tercile among other students in the major they are enrolled in at the beginning of quarter t. C_{it} is a set of indicators that capture whether the student's number of credits completed before quarter t fall within 5-credit increments at time t (e.g., 45-49 prior credits, 50-54 prior credits,…). Standard errors are clustered by student and initial major.

This specification allows us to estimate whether dispersion and switching are persistent or temporary, or appear to influence each other (through α_1 and α_2), which types of students are more likely to switch or have a dispersed course mix (through α_3), whether students appear to be influenced by their skills relative to others in their current major (through α_4), and at what times in students' college careers they are likely to switch or take a dispersed course mix (through α_5).

The dispersion models are estimated using OLS. We estimate the major switching model using a probit specification to measure the probability that the student i switches their major at time t, Pr ($Switch_{it}$), and present the results as the mean marginal effect. Student/quarters are omitted from the major switching regression if they have not yet declared a major.

b. Predicting Later Outcomes

Next, we evaluate whether college and labor market outcomes are conditionally associated with curricular dispersion and major switches. Our base specifications are in Equations 2 and 3:

$$Y_i = \beta_0 + \beta_1 X_i + \beta_2 D_{i,t-x \to t-y} + \varepsilon_i \quad (2)$$

$$Y_i = \beta_0 + \beta_1 X_i + \beta_2 S_{i,t-y \to t-x} + \varepsilon_i \quad (3)$$

Y_i is the outcome of interest: either the student's cumulative college GPA at the time they conclude their education (GPA_i), an indicator variable that equals 1 if student i earns a bachelor's degree within five years of starting college ($EarnedBA_i$, which is evaluated using a probit specification), or the log hourly wage the student earns in the first year after leaving college (ln (W_i)), among those who are employed in Washington.[11] X_i is, as above, a vector of non-time-varying student background controls, including a set of fixed effects for the initial declared major. We also present a wage specification which includes an additional set of fixed effects for final declared major. $D_{i,t-x \to t-y}$ is a measure of curricular dispersion during various periods of the college career (e.g., during sophomore year) or a measure of curricular dispersion over the entire college career. $S_{i,t-x \to t-y}$ is an indicator for switching major during various periods of the college career or an indicator for ever switching major.

5. Results

a. Predicting Curricular Dispersion and Major Switches

Table 6 shows the results of regressions that predict curricular dispersion and major switches (corresponding to Equation 1). In the first column, we find that current curricular dispersion (from *t* to *t+2*) is strongly and positively related to dispersion in the prior three quarters and positively related to having previously switched majors, implying a persistence in a student's tendency to try unusual curricular combinations. Conditional on prior dispersion and prior major switches, students whose SAT test scores place them in the bottom-third of their major pursue less curricular dispersion. Out-of-state and non-Hispanic students take classes that are more dispersed in subsequent quarters. The R^2 value for the curriculum dispersion regression is very high at 0.89; curriculum dispersion can be explained accurately using only prior curriculum activity and a short list of student background characteristics. Much of this explanatory power comes from prior dispersion. Leaving out prior dispersion, the R^2 value is .18. This suggests that much of curricular dispersion is representative of unobserved between-student heterogeneity. Indeed, an ANOVA of quarterly dispersion on student, college, and major reveals that 69.0% of quarterly dispersion is explained by variance between students, 21.1% by variance between campuses, and 1.4% by variance between academic quarters.

The second column of Table 6 shows that prior curricular dispersion does not have a significant effect on the probability that a student switches majors. This result may indicate that dispersion is not leading students to find majors to which they are better matched. However, this may conflate two effects of different signs – it is possible that some students use a high-dispersion curriculum to find and switch to another major, and other students use a high-curriculum dispersion as a substitute for major switching, using the wide mix of courses to sate their curiosity. Also, we show a strong, positive relation between prior major switches and future major switches; students who have switched majors in prior quarters are 6.8 percentage points more likely to switch major in quarter *t*. Finally, female students are more prone to switch majors conditional on prior dispersion, prior major switches, and other characteristics.

[TABLE 6 ABOUT HERE]

b. Curricular Dispersion and Later Education and Labor Market Outcomes

Table 7 shows the results of regressions that predict later outcomes as a function of curricular dispersion and major switches (corresponding to Equations 2 and 3). Curricular dispersion during the student's junior year is positively associated with the likelihood of completing a bachelor's degree within 5 years, with a one-standard deviation in dispersion during the junior year being associated with a .8 percentage point increase in the likelihood of on-time graduation. There are also positive associations between dispersion during particular years (sophomore, junior, and senior years) and early career wages conditional on graduation.[12] However, dispersion over the entire college career is negatively associated with college GPA and wages.[13] Keeping in mind that we do not correct for selection bias, a one standard deviation increase in curricular dispersion over the college career is associated with a lower post-graduation wage (1 year after graduation) of about 3.5 percent.[14] This pair of results implies that while dispersion in the short term can help students find out what they are good at and help develop a wide range of skills, dispersion over a long stretch is associated with a lack of focus that is not prized in the labor market (although the direction of causality between a lack of focus and a long-term dispersed curriculum is not clear). The fact that many focused job-oriented majors tend to have low average dispersion (as shown in Table 5) likely also plays a part, although much of the relationship between dispersion and wages remains even after controlling for final major.

[TABLE 7 ABOUT HERE]

Switching major is positively associated with college GPA – thus it appears that such switches help students to find majors in which they can perform better in terms of grades. Yet, switching majors is negatively associated with the probability of earning a bachelor's degree within 5 years. So, while the student may get better grades, the major switch appears to be detrimental to their completion, or at least delays completion. The relationship of major switching with college GPA may be indicative of students choosing to switch into easier majors where they are more likely to end up on the top end of the grade distribution. However, this effect seems to be weak, and applies largely to those already at the low end of the ability distribution. Of students who were in the top third of the SAT distribution in their original major and who switched, 62% switched to a major with a higher average combined SAT, while among those who were in the bottom third of the SAT distribution in their original major and who switched, 55% switched to a major with a lower average combined SAT. This pattern suggests that students are seeking majors where they will be closer to the mean ability. The negative relationship between switching major and earning a degree may reflect that students switch when they are having general academic difficulties (as in Arcidiacono, 2004), or that major switches cause difficulty completing a degree as many of the classes the student took no longer count towards the requirements of their major. The positive effect on GPA and the negative effect on the probability of graduating with a degree appear to cancel each other out such that switching major has no conditional association with labor market wages.

6. Conclusion

The central goal of this paper is to develop a measure of curricular dispersion for use by subsequent scholars. There is a significant amount of debate about the merits of students having more structured curricular pathways in college, but very little empirical evidence connecting college pathways to postsecondary and labor market success. The lack of evidence can largely be attributable to data limitations and the lack of clean metric of dispersion. Our paper provides such a measure that we believe is simple to compute and intuitive.

Only recently has the kind of dataset we utilize – data that connects students' course-taking patterns to college graduation and the labor market – become widely available. Not surprisingly then, methods for characterizing course-taking and a students' curricular experiences are also in their infancy. The measure we develop in this paper defines at least one way to characterize curricular dispersion.

We find considerable differences across universities, across majors, and across students in the amount of curricular dispersion exhibited by students. Differences across universities and majors highlight how institutional design has significant control over the degree to which students explore different departments. General education requirements, the structure of prerequisites, and the number of courses required to graduate in a particular major enforce limits on the amount of exploration that is possible and the amount that is incentivized. Information about the effects of these requirements and of university guidance of student curricular choice is an important and under-addressed issue in higher education policy.

Colleges have a large role in determining the extent of students' curricular dispersion or focus. We find that differences between campuses explain about 21% of variation in quarterly dispersion. As an example, the flagship campus of the University of Washington at Seattle, which offers students an incredibly wide range of majors and disciplinary breadth that facilitates students' exploration, has 25% of students switch major at least once during their college career. In contrast, the UW branch campus at Bothell (11 miles northeast of the flagship campus) offers a much smaller number of majors and most undergraduate students are transfers who are directly admitted to a particular major when they first enroll. As a result, only 12% of students at UW Bothell ever switch major and there is a 0.8 s.d. difference in levels of dispersion between UW Seattle and UW Bothell.

We apply our measure in assessing the association between curricular dispersion, major switches, college graduation, and labor market earnings. We are careful not to describe our findings as causal relationships given that that unobserved individual student heterogeneity is likely to be correlated both with course-taking patterns and later college and labor market success. Still, our findings are suggestive. While curricular dispersion allows students to shop around and develop a broader mix of skills, to the student's benefit, doing so for too long appears to come at a cost: lower college GPA and lower wages in the year immediately following graduation. Switching major, meanwhile, allows the student to find an area in which they can get good college grades, but also appears to slow progress on earning a degree and has no immediate labor market payoff. Thus, these results suggest that the extent to which a broader college experience leads a student to be more well-rounded must be taken in moderation. Too much dispersion, or switching major, is associated with students who are less well trained rather than more well-rounded, at least for their immediate post-college prospects.

We cannot make policy prescriptions forcefully because we cannot distinguish the causal effects of dispersion and major switching from unobserved student heterogeneity. However, our results that can be taken as suggestive evidence in favor of moderate amounts of dispersion. Some students may be done a disservice by being locked into fixed curricular pathways from the outset. At the same time, students in general may need more structure and guidance than offered in a purely open curricular environment to avoid falling into a college career that is unfocused and not as productive as it could be.

Notes

[1] For more detail on these guided pathways, and some examples of colleges that have adopted them, see Jenkins and Cho (2014). Bailey, Jaggars, and Jenkins (2015) argue that community colleges should dispense with the current pick-and-choose cafeteria-style model in favor of "guided pathways," set programs that require a student to talk to someone in order to take classes outside the student's program.

[2] Preliminary findings (Scrivener, Weiss, and Sommo, 2012) from a random assignment study suggests that strong guidance and supports for students pursuing an associate's degree leads to greater persistence and credit accumulation.

[3] Psychologists examine the relationship between choice set size and the ability to make good choices and be satisfied with them. Some results suggest that there is a "too-much-choice" problem and that large choice sets lead to undesirable choices (Iyengar & Lepper, 2000; Botti & Iyengar, 2006). However, it should be noted that whether there is a "too-much-choice" effect is sensitive to context, and in a meta-analysis the size of the effect is found to be nearly zero (Scheibehenne, Greifeneder, & Todd, 2009, 2010).

[4] We use the proportion of courses in each department taken by student i, rather than the raw count of the number of courses, so that each student is given equal weight in the determination of distances between departments. An argument could be made that the course-taking decisions of students who take a higher number of courses should be given greater weight. As a practical matter, this choice makes little difference for our ultimate distance measures when applied to our data.

[5] Formally, we can describe the universe of college courses as a weighted complete graph $G(\boldsymbol{V}, \boldsymbol{E})$. The graph can be described as a vector of vertices $\boldsymbol{V}$, each element of which represents a single college course, and a set of edges $\boldsymbol{E}$. There is an edge, or connection, between every set of two courses j and k. Put another way, one can imagine a connect-the-dots puzzle; each dot is a vertex, and each line drawn between the dots is an edge. Each edge $e(j, k) \in \boldsymbol{E}$ has an associated distance d_{jk}. The goal is to produce a measure of the dispersion of the student's curriculum between time period t and $t + h$, which is a function of the distances between the departments hosting the courses that student k takes during this period. A natural place to look

for such a measure would be in the literature on network analysis, which studies the properties of linked graphs. However, measuring the extent to which an entire network is closely linked is not a topic of interest in network analysis. There are measures such as centrality (Newman, 2010), which examine how strongly a particular node is connected to the rest of the network, but centrality does not take into account the strength of links across the entire graph. The measure that comes closest to our topic of interest is the weighted Cheeger Constant (Cheeger, 1970), which measures whether or not there are two separate groups of vertices that are only loosely linked to each other. However, the weighted Cheeger Constant does not take into account weak links in multiple areas or the relative strength of close links.

[6] When linking across courses in different departments, the number of links equals (the number of courses in department *j*) × (the number of courses in department *k*). When linking across courses in a single department *j*, the number of links equals (the number of courses in department *j*) × ((the number of courses in department *j*) – 1)/2.

[7] In the case that a student takes courses at more than one college in the sample, their total dispersion measure is the average of the dispersion calculated at each college, weighted by the total number of credits taken at that college.

[8] We include students who enter with 15 or fewer college credits as some of these students completed such college credits during high school.

[9] SAT scores and high school grade point average are missing for out-of-state students. In subsequent regression analysis, these missing variables are set to zero and the indicator for out-of-state absorbs the effect of these missing data. Full-sample SAT terciles may not contain exactly one-third of students due to ties within major.

[10] To keep dispersion figures comparable, we actually use the next 45 credits of course-taking, rather than the next three quarters. Similarly, $D_{i,t-3\rightarrow t-1}$ refers to the previous 45 credits of course-taking.

[11] We do not include those without jobs as being unemployed because we cannot distinguish between unemployment and leaving the state. Because the unemployed and those who leave the state are not included, results concerning wages are likely biased towards zero by selection.

[12] We use only the wages of those who graduated so that they will be more comparable. However, results using wages unconditional on graduation are similar, with point estimates of freshman, sophomore, junior, senior, and overall dispersion of .006, .014, .017, .022, and -.031 without controlling for final major, respectively.

[13] To understand how the sign reversal is mechanically possible, note that the "any time" dispersion is not just a sum of the other dispersions; it's calculated differently because it takes into account dispersion across years as well. So the sign reversing for GPA just means that while dispersion in a particular period is associated with higher GPA, dispersion over one's career is associated with lower GPA.

[14] Since prior studies have generally found that the labor market returns to education increase with age (Hanoch, 1967; Wachtel, 1975; Deardon et al., 2002; and Long, 2010), the conditional associations between curricular dispersion and later wages may be larger. Unfortunately our panel does not extend out long enough to assess the relationship to wages beyond a year.

References

Altonji, J.G., Blom, E. & Meghir, C., (2012). Heterogeneity in Human Capital Investments: High School Curriculum, College Major, and Careers. *Annual Review of Economics, 4(1),* pp.185–223.

Altonji, J. G., Kahn, L. B., & Speer, J. D. (2014). Trends in Earnings Differentials Across College Majors and the Changing Task Composition of Jobs. *American Economic Review (Papers and Proceedings)*, *104*(5), 387–393.

Arcidiacono, P. (2004). Ability Sorting and the Returns to College Major. *Journal of Econometrics, 121* (1-2), 343-375.

Arcidiancono, P., Hotz, J., & Kang, S. (2012). Modeling College Major Choice Using Elicited Measures of Expectations and Counterfactuals. *Journal of Econometrics*, *166* (1), 3-16.

Avery, C., Howell, J.S., & Page, L. (2014). A Review of the Role of College Counseling, Coaching, and Mentoring Postsecondary Outcomes. *College Board*, Research Report, October.

Bailey, T. R., Jaggars, S.S., & Jenkins, D. (2015). *Redesigning America's Community Colleges: A Clearer Path to Student Success*, Cambridge, MA: Harvard University Press.

Beffy, M., Fougere, D., & Maurel, A. (2012). Choosing the Field of Study in Postsecondary Education: Do Expected Earnings Matter? *Review of Economics and Statistics , 94* (1), 334-347.

Botti, S., & Iyengar, S. S. (2006). The Dark Side of Choice: When Choice Impairs Social Welfare. *Journal of Public Policy & Marketing*, *25*(1), 24–38.

Carnevale, A. P., Cheah, B., & Strohl, J. (2012). *Hard Times, College Majors, Unemployment and Earnings: Not All College Degrees Are Created Equal*. Georgetown University Center on Education and the Workforce.

Card, D., (1999). The Causal Effect of Education on Earnings. In O. E. Ashenfelter & D. Card, eds. *Handbook of Labor Economics*. New York: North-Holland, pp. 1801 – 1863.

Cheeger, J. (1970). *A Lower Bound for the Smallest Eigenvalue of the Laplacian. Problems in Analysis (Papers Dedicated to Salomon Bochner, 1969)*. Princeton Univ. Press, Princeton, N. J., 195–199.

Deardon, L., Ferri, J., & Meghir, C. (2002). The Effect of School Quality on Educational Attainment and Wages. *The Review of Economics and Statistics*, *84*(1), 1–20.

Freeman, J. A., & Hirsch, B. T. (2008). College Majors and the Knowledge Content of Jobs. *Economics of Education Review*, *27*(5), 517–535.

Goldin, C.D. & Katz, L.F., (2009). *The Race between Education and Technology*, Cambridge, MA: Harvard University Press.

Grubb, N. (2006). “Like, What Do I Do Now?”: The Dilemmas of Guidance Counseling. In T. Bailey & V. Morest eds. *Defending the Community College Equity Agenda*, Baltimore, MD: Johns Hopkins University Press, pp. 195-222.

Hanoch, G. (1967). An Economic Analysis of Earnings and Schooling. *Journal of Human Resources*, *2*, 310–329.

Iyengar, S. S., & Lepper, M. R. (2000). When Choice is Demotivating: Can One Desire Too Much of a Good Thing? *Journal of Personality and Social Psychology*, *79*(6), 995–1006.

Jenkins, D., & Cho S-W. (2014). Get With the Program… and Finish It: Building Guided Pathways to Accelerate Student Completion. *CCRC Working Paper No. 66.*

Long, M.C. (2010). Changes in the Returns to Education and College Quality, *Economics of Education Review*, *29*, 338–347.

Long, M.C., Goldhaber, D., & Huntington-Klein, N. (2014). Do Students' College Major Choices Reflect Changes in Wages? *CALDER Working Paper No. 107.*

Malamud, O. (2010). Breadth vs. Depth: The Timing of Specialization in Higher Education. *Labour, 24(4)*, 359-390.

Newman, M.E.J. (2010). *Networks: An Introduction.* Oxford University Press.

Oreopoulos, P., & Petronijevic, U. (2013). Making College Worth It: A Review of Research on the Returns to Higher Education. *The Future of Children, 23*(1), 41-65.

Scheibehenne, B., Greifeneder, R., & Todd, P. M. (2009). What Moderates the Too-Much-Choice Effect? *Psychology & Marketing*, *26*(3), 229–253.

-- (2010). Can There Ever Be Too Many Options? A Meta-Analytic Review of Choice Overload. *Journal of Consumer Research*, *37*(3), 409–425.

Scott-Clayton, J. (2011). *The Shapeless River: Does a Lack of Structure Inhibit Students' Progress at Community Colleges?* Columbia University, Teachers College. Community College Research Center.

Scrivener, S., Weiss, M.J., and Sommo, C. (2012). What can a multifaceted program do for community college students? Early results from an evaluation of Accelerated Study in Associate Programs (ASAP) for developmental education students. New York, NY: MDRC.

Stange, K. (2015). Differential Pricing in Undergraduate Education: Effects on Degree Production by Field. *Journal of Policy Analysis and Management*, *34*(1), 107-135.

Stinebrickner, R. and Stinebrickner, T. R. (2014). A Major in Science? Initial Beliefs and Final Outcomes for College Major and Dropout. *Review of Economic Studies*, *81*(1), 426-472.

Torgerson, W. S. (1952). Multidimensional Scaling: I. Theory and Method. *Psychometrika*, *17*, 401-419.

Wachtel, P. (1975). The Effect of School Quality on Achievement, Attainment Levels, and Lifetime Earnings. *Explorations in Economic Research*, *2*(4), 502–536.

Wiswall, M., & Zafar, B. 2015. Determinants of College Major Choice: Identification Using an Information Experiment. *Review of Economic Studies, 82*(2), 791-824.

WSU Spokane. (2015). Requirements and Applying. Accessed on February 17, 2015 from http://spokane.wsu.edu/admissions/apply.html

Zafar, B. (2011). How Do College Students Form Expectations? *Journal of Labor Economics ,* *29* (2), 301-348.

Table 1: Distances Between Ten Departments at the University of Washington at Seattle

	BIOL	CHEM	COMM	POLS	ECON	ENGL	MATH	PHYS	PSYC	SOCI
Biology	0.00	0.33	0.58	0.58	0.62	0.60	0.61	0.48	0.53	0.57
Chemistry		0.00	0.61	0.61	0.64	0.63	0.50	0.40	0.59	0.60
Communications			0.00	0.51	0.53	0.55	0.60	0.60	0.55	0.51
Political Science				0.00	0.52	0.54	0.61	0.60	0.56	0.53
Economics					0.00	0.54	0.50	0.60	0.56	0.56
English						0.00	0.61	0.55	0.61	0.54
Math							0.00	0.39	0.61	0.62
Physics								0.00	0.60	0.61
Psychology									0.00	0.51
Sociology										0.00

Figure 1: Two-Dimensional Representation of Distances Between 10 Selected Departments at the University of Washington at Seattle

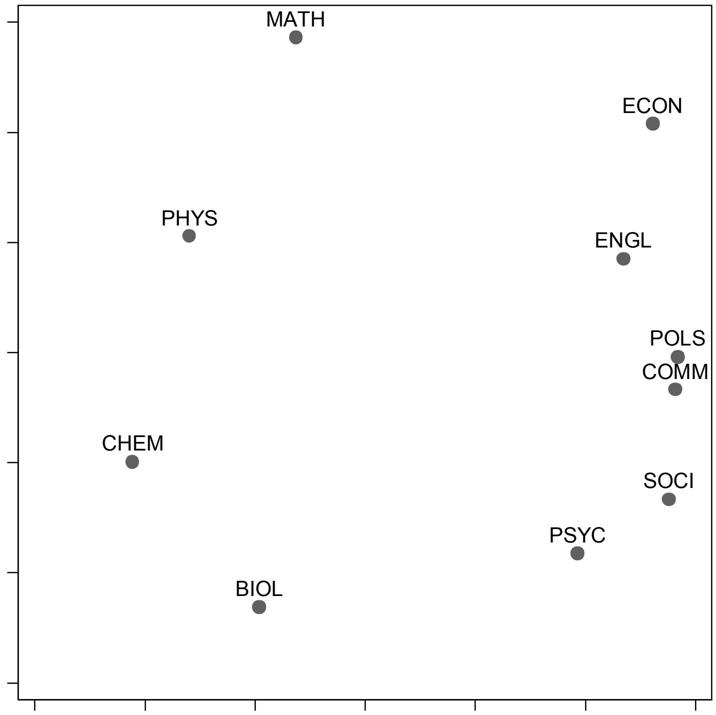


Table 2: Curriculum Dispersion for Two Hypothetical Students

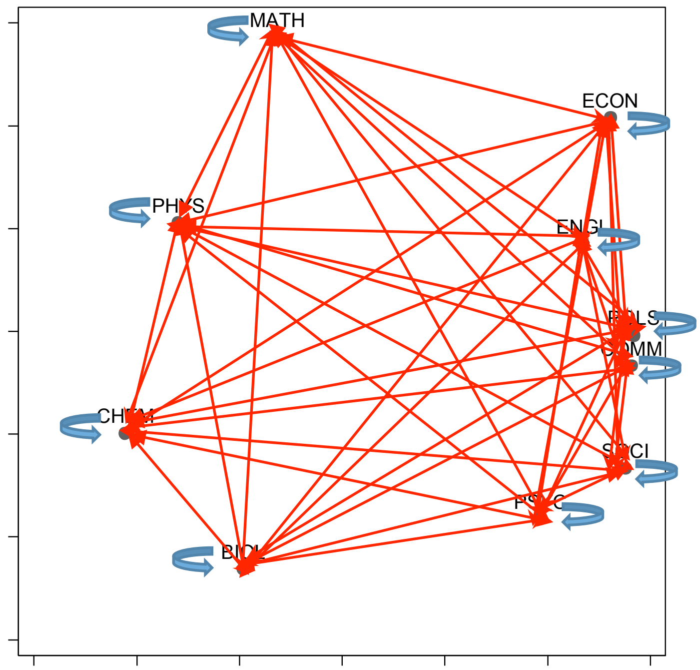
	Number of Courses Taken by…	
Department	Student A	Student B
Biology	6	45
Chemistry	6	10
Communications	6	0
Political Science	6	0
Economics	6	0
English	6	0
Math	6	5
Physics	6	5
Psychology	6	0
Sociology	6	0
CurriculumDispersion :	0.51	0.21

Figure 2: Weights Placed on Links Between Courses to Compute Curricular Dispersion for Two Hypothetical Students

Student A:

(Red lines have weight = 36 and distance given in Table 1)

(Blue thick arrows have weight = 15 and distance = 0)



Student B:

(Green line has a weight = 450)

(Purple lines have a weight = 225)

(Burnt Orange lines have a weight = 50)

(Teal line has a weight = 25)

(Blue thick arrows have weights as follows: Biology = 990; Chemistry = 45; Math = 10; and Physics = 10)

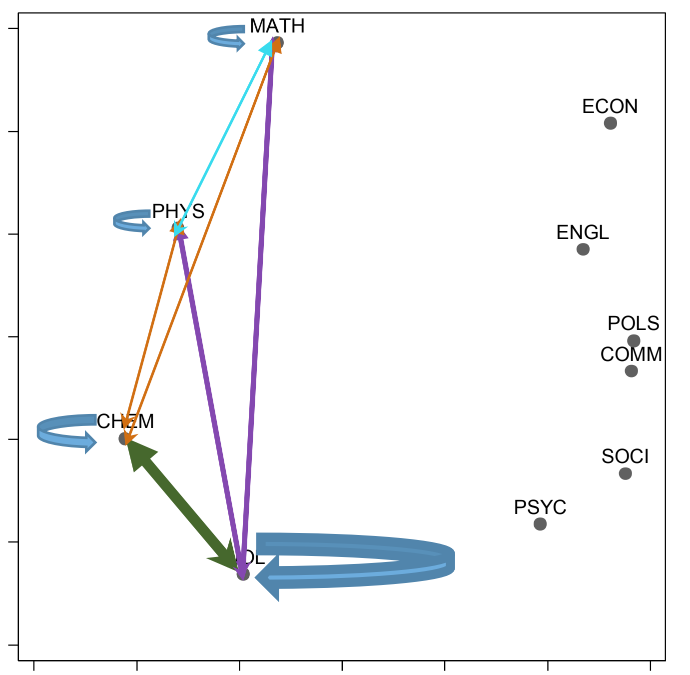


Table 3: Descriptive Statistics

Variable	All Fall 2007 and Fall 2008 Entrants		Those Who Completed: >45 Credits		Those Who Completed: >90 Credits		Those Who Completed: >135 Credits		Those Who Earned a Bachelor's Degree	
Coursetaking Behavior:										
Standardized *CurriculumDispersion* during:										
freshman year	-0.09	(0.98)	-0.09	(0.95)						
sophomore year	-0.04	(0.97)			-0.06	(0.90)				
junior year	0.09	(0.98)					0.06	(0.98)		
senior year	0.00	(1.00)							0.00	(1.00)
any time	0.00	(1.00)	-0.02	(0.94)	-0.03	(0.89)	-0.06	(0.81)	-0.07	(0.88)
SwitchedDeclaredMajor during:										
freshman year	1.0%		1.0%							
sophomore year	5.0%				7.0%					
junior year	9.0%						13.0%			
senior year	7.0%								12.0%	
any time	17.0%		21.0%		22.0%		23.0%		23.0%	
Pre-College Student Characteristics:										
High school grade point average	3.33	(0.9)	3.32	(0.8)	3.34	(0.8)	3.36	(0.8)	3.37	(0.8)
SAT math score	492	(202)	532	(160)	538	(154)	540	(153)	542	(154)
SAT critical reading score	475	(195)	512	(155)	518	(148)	519	(148)	520	(149)
SAT math + SAT reading in top-third of initial major	31%		35%		36%		36%		37%	
SAT math + SAT reading in bottom-third of initial major	40%		34%		33%		32%		31%	
Female	53%		54%		54%		55%		56%	
Black	3%		3%		3%		3%		3%	
Hispanic	7%		7%		7%		6%		6%	
Asian American	13%		14%		14%		14%		14%	
American Indian	2%		2%		2%		2%		2%	
Low-income	21%		21%		21%		20%		19%	
Out-of-state	14%		8%		7%		7%		7%	
Cohort = 2008-09 entrants	55%		55%		55%		55%		54%	
College Outcomes:										
GPA	2.89	(0.74)	3.04	(0.57)	3.08	(0.54)	3.10	(0.53)	3.12	(0.53)
EarnedBachelor'sDegree	64%		78%		85%		91%		100%	
Wages	15.08	(8.62)	15.12	(8.52)	15.25	(8.68)	15.37	(8.78)	15.57	(8.87)
Number of Observations	22,642		18,619		16,972		15,830		14,484	

Notes: Numbers in parentheses give the standard deviation for continuous variables. Low-income is equal to one if the student is eligible for either a Pell Grant or a Washington State Need Grant.

Figure 3: Concentration of Courses in a Focal Department

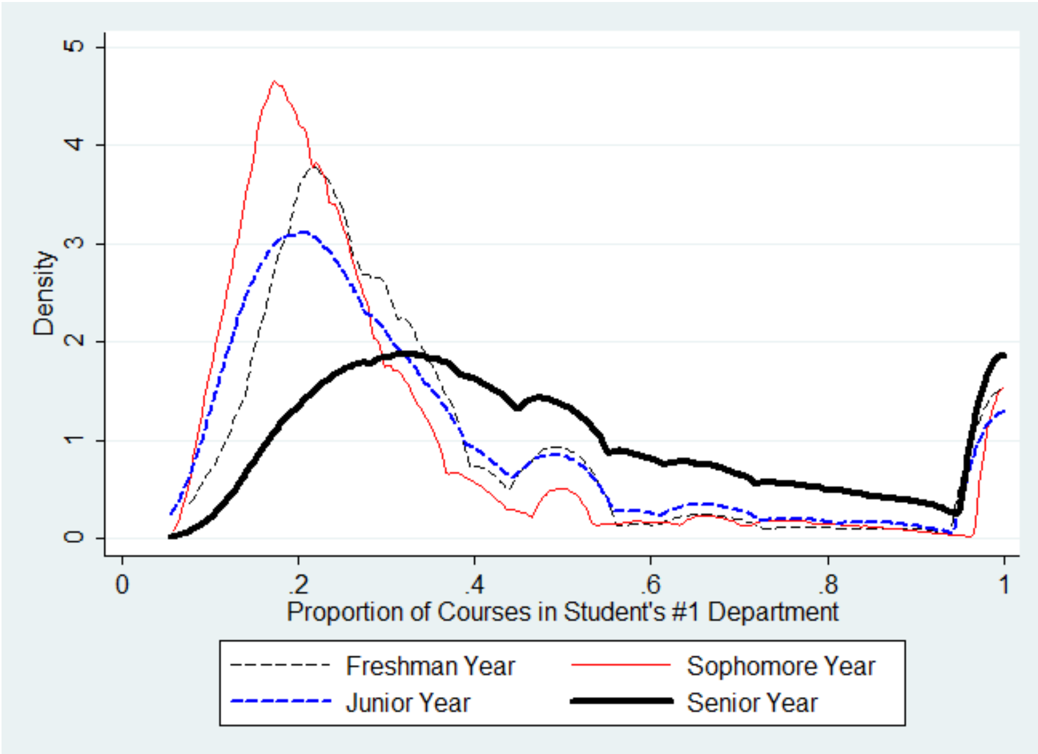


Figure 4: The Distribution of Curricular Dispersion

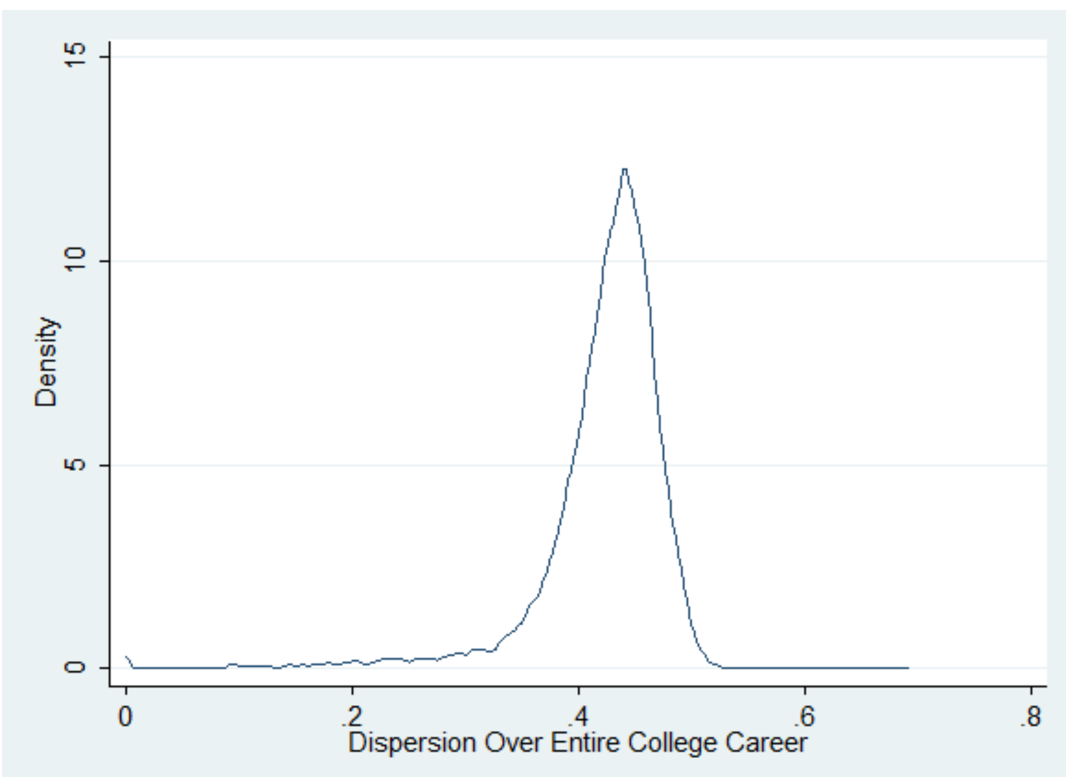


Table 4: Students' Career Dispersion by Campus

Campus	Mean	(s.d.)
WSU Spokane	-4.02	(2.49)
UW Bothell	-0.79	(1.68)
WSU Vancouver	-0.57	(2.01)
WSU Tri-Cities	-0.32	(1.61)
Western Wash. U.	-0.04	(0.90)
UW Tacoma	-0.01	(1.34)
UW Seattle	-0.01	(0.81)
Eastern Wash U.	0.01	(0.95)
Central Wash U.	0.06	(1.13)
WSU Pullman	0.10	(1.05)

UW = University of Washington
WSU = Washington State University

Table 5: Average Career Dispersion by Final Declared Major

Major	Mean	(s.d.)
Architecture	-1.19	(0.91)
Visual and Performing Arts	-1.11	(1.53)
Engineering	-0.60	(0.79)
Health	-0.58	(1.41)
Computer and Info Sciences	-0.51	(0.81)
Transportation	-0.47	(1.01)
Interdisciplinary Studies	-0.37	(1.20)
Physical Sciences	-0.36	(0.78)
Public Administration	-0.25	(0.64)
English Literature	-0.21	(0.76)
Mathematics and Statistics	-0.18	(0.57)
Education	-0.14	(1.37)
Psychology	-0.12	(0.74)
Biology	-0.05	(0.60)
Philosophy and Religious Studies	0.00	(0.78)
Engineering Technologies	0.03	(0.65)
Foreign Literature	0.04	(0.67)
Communication Technologies	0.05	(0.43)
Family and Consumer Sciences	0.07	(0.89)
Parks, Recreation, Leisure	0.10	(0.50)
Law Enforcement	0.15	(0.76)
Natural Resources and Conservation	0.18	(0.54)
Agriculture	0.19	(0.47)
Business	0.25	(0.64)
History	0.26	(0.66)
Communication	0.28	(0.57)
Social Sciences	0.28	(0.63)
Law	0.31	(0.55)
Cultural/Area Studies	0.42	(0.51)
Military Science	0.43	(0.89)
Liberal Arts	0.61	(0.77)

Table 6: Factors Predicting Curricular Dispersion and Likelihood of Switching Major

Regressor	Curricular Dispersion			Switched Major		
Curriculum Dispersion during last 45 credits	0.891	(0.012)	***	0.001	(0.012)	
Previously Switched Major	0.032	(0.008)	***	0.068	(0.008)	***
High school grade point average	0.006	(0.006)		0.002	(0.006)	
SAT math score	0.002	(0.002)		0.003	(0.002)	
SAT critical reading score	-0.001	(0.002)		-0.002	(0.002)	
SAT math + SAT reading in top-third of major	0.007	(0.005)		0.005	(0.005)	
SAT math + SAT reading in bottom-third of major	-0.013	(0.004)	***	0.005	(0.004)	
Female	-0.000	(0.003)		0.006	(0.003)	**
Black	0.000	(0.007)		0.007	(0.007)	
Hispanic	-0.011	(0.005)	**	0.002	(0.005)	
Asian American	-0.006	(0.009)		0.004	(0.009)	
American Indian	0.004	(0.009)		-0.007	(0.009)	
Low-income	-0.001	(0.004)		0.002	(0.004)	
Out-of-state	0.042	(0.016)	***	0.007	(0.016)	
Number of Observations	116,390			114,362		
R^2 / McFadden's Psuedo R^2	0.89			0.10		

Notes: Numbers in parentheses give the standard error of the coefficient. Standard errors are clustered by student and initial major. ***, **, and * respectively denote statistical significance at the two-tailed 1%, 5%, and 10% levels. Regressions control for initial declared major and indicators for number of prior credits completed (in 5-credit increments). Major switching results are marginal effects from a probit regression. Full regression results are available from the authors.

Table 7: Conditional Associations of Curricular Dispersion and Switching Major with College Outcomes and Wages

Estimated "effect" of Curricular Dispersion during…	…for those who…	On GPA		On Earned Bachelor's Degree		On ln(Wages)		On ln(Wages), controlling for final major	
freshman year…	completed 45 credits.	0.006 (0.012)		-0.08% (0.50%)		0.009 (0.006)		0.007 (0.006)	
sophomore year…	completed 90 credits.	0.022 (0.013)	*	0.40% (0.50%)		0.015 (0.005)	**	0.013 (0.005)	**
junior year…	completed 135 credits.	0.028 (0.014)	*	0.80% (0.40%)	**	0.019 (0.005)	***	0.016 (0.005)	***
senior year…	earned a bachelor's degree.	0.029 (0.015)	*			0.022 (0.006)	***	0.018 (0.006)	***
any time…	earned a bachelor's degree.	-0.089 (0.020)	***			-0.035 (0.010)	***	-0.030 (0.008)	***

Estimated "effect" of Switching Major during…	…for those who…	On GPA		On Earned Bachelor's Degree		On ln(Wages)		On ln(Wages), controlling for final major	
freshman year…	completed 45 credits.	-0.082 (0.022)	***	-3.10% (1.20%)	***	0.011 (0.029)		0.029 (0.047)	
sophomore year…	completed 90 credits.	0.025 (0.038)		0.16% (1.10%)		0.020 (0.013)		0.023 (0.009)	***
junior year…	completed 135 credits.	0.018 (0.023)		-1.39% (1.11%)		-0.010 (0.014)		0.001 (0.010)	
senior year…	earned a bachelor's degree.	0.013 (0.024)				-0.014 (0.009)		-0.024 (0.011)	*
any time…	earned a bachelor's degree.	0.059 (0.018)	***			-0.003 (0.017)		0.003 (0.009)	

Notes: Numbers in parentheses give the standard error of the estimated treatment effect. Two-way clustered standard errors are used at the campus/initial major level. ***, **, and * respectively denote statistical significance at the two-tailed 1%, 5%, and 10% levels. Full regression results are available from the authors.