Are Universities Biased Against the Liberal Arts? Academic Chopping Blocks at the Double Facing University

By

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ABSTRACT

Universities face difficult challenges across countless fronts, and one of the biggest fears is that recent changes have particularly harmed the liberal arts, leading to fewer liberal arts classes, students, faculty, programs, and departments. There is evidence that some universities have reduced liberal arts faculty and closed liberal arts programs and departments. Practical fields such as business and computer science also have a growing presence on university campuses. What do these changes mean when it comes time for universities to restructure, an activity I label the academic chopping block? Does the growth of practical fields make liberal arts classes, programs, and departments more vulnerable to termination? Are universities more likely to close liberal arts fields than practical arts fields during times of retrenchment and reorganization?

In three chapters, this dissertation argues that the answer to these related questions is no. Overall, population shifts might favor practical fields, but practical fields are most likely to suffer when chopping blocks terminate academic programs and departments. To explain this finding, the dissertation puts forth a double-facing theory of university change. It proposes that academic disciplines are broken into those that are shielded by institutional forces and those that face quasi-markets. Liberal arts disciplines are institutionalized and are thus less vulnerable to closure than are practical arts disciplines, such as engineering, which are shaped by quasi-market forces. Three chapters provide the following evidence:

1. Universities were more likely to add practically-oriented departments, such as engineering, business, and biomedicine, than liberal arts programs between 1975 and 2010.
2. Conversely, practically-oriented departments, such as engineering and business, were more likely to close than liberal arts departments between 1975 and 2010.

3. Between 1984 and 2012, universities were far more likely to close low-enrollment engineering programs than low-enrollment language programs.
4. Although the biomedical sciences are seen as being some of the most commercially-oriented fields on campuses, biomedical departments have a higher failure rate than do liberal arts science departments.

In sum, this dissertation challenges many accepted assumptions about higher education in America.

INTRODUCTION TO THE THREE DISSERTATION CHAPTERS

Introduction

Universities face difficult challenges across countless fronts. Politicians pressure universities to be more affordable, state governments cut public funding, and at least a few politicians characterize professors as lazy out of touch elites (Benton 2010; Nazworth 2015; Luzer 2012; Levy 2013). Furthermore, the population of potential students is much more ethnically and economically diverse than it was in decades earlier (Hamline et. al 2010), and student debt is rising (Eaton et. al forthcoming). What do these changes mean for the structure of disciplines? Has this environment compelled universities to change their courses, programs, and department offerings and if so has restructuring benefited some disciplines at the expense of others?

One of the biggest fears is that recent changes have particularly harmed the liberal arts, leading to fewer liberal arts classes, students, faculty, programs, and departments (Nussbaum 2012; Slaughter 1993). There is evidence that some universities have reduced liberal arts faculty and closed liberal arts programs and departments (Flaherty 2014; Rogers 2013; Jaschik 2010). Practical fields such as business and computer science also have a growing presence on university campuses (Brint et. al 2005; Kraatz and Zajac 1996; Rawlings 2012). What does these changes mean when it comes time for universities to restructure, an activity I label *the academic chopping block*? Does the growth of practical fields make liberal arts classes, programs, and departments more vulnerable to termination? Are universities more likely to close liberal arts fields than practical arts fields during times of retrenchment and reorganization?

In three chapters, this dissertation argues that the answer to these related questions is no. Overall, population shifts might favor practical fields, but practical fields are most likely to

suffer when chopping blocks terminate academic programs and departments. To explain this finding, the dissertation puts forth a *double-facing theory* of university change. It proposes that academic disciplines are broken into those that are shielded by institutional forces and those that face quasi-markets. Liberal arts disciplines are institutionalized and are thus less vulnerable to closure than practical arts disciplines, such as engineering, which are shaped by quasi-market forces. Three chapters provide the following evidence:

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3. Between 1984 and 2012, universities were far more likely to close low-enrollment engineering programs than to close low enrollment language programs.
4. Although the biomedical sciences are seen as being some of the most commercially-oriented fields on campuses, I found that biomedical departments have a higher failure rate than liberal arts science departments.

In sum, this dissertation challenges many accepted assumptions about higher education in America. The findings specifically contest three existing theories of university change (Slaughter 1993, 1998; Volk et al. 1995; Kraatz and Zajac 1996, Frank and Gabler 2006). This work also sets the stage for new research on university change and adds fodder to important debates within organizational studies.

The Changing University

There is much debate today about how universities are changing and how they should change. To some conservatives, professors are a lazy, entrenched, special interest group. Shielded from real markets, universities rely too heavily on old habits, they are unresponsive to

student needs, and they don't understand or don't care about efficiency. For example, when talking about the University of Wisconsin, Governor Scott Walker argued,

> "Maybe it's time for faculty and staff to start thinking about teaching more classes and doing more work." (as cited in Nazworth 2015)

Florida Governor Rick Scott also received a great deal of attention for saying:

> "If I'm going to take money from a citizen to put into education then I'm going to take that money to create jobs. So I want that money to go to degrees where people can get jobs in this state. Is it a vital interest of the state to have more anthropologists? I don't think so." (as cited in Kleinman 2015)

This discourse from the Right implies that universities are isolated from important societal and market changes. Specifically attacking such humanities programs, they suggest that universities ignore relevant job skills and maintain liberal arts programs far beyond their use. Less politicized groups, such as the National Center for Higher Education Management Systems suggest that there is a mismatch between university financing and university outcomes, and they specifically attack legacy budgeting that largely favors the liberal arts (Jones 2013).

Political Progressives, particularly those associated with universities, have a different argument: Once governed by thoughtful faculty, these cherished public institutions are now driven by an administrative class beholden to shortsighted business ideologies. For example, Martha Nussbaum describes changes to universities in the following way:

> Thirsty for national profit, nations, and their systems of education, are heedlessly discarding skills that are needed to keep democracies alive. If this trend continues, nations all over the world will soon be producing generations of useful machines, rather than complete citizens who can think for themselves, criticize tradition, and understand the significance of another person's sufferings and achievements. The future of the world's democracies hangs in the balance. (Nussbaum 2012:2)

Political progressives and academic critics, such as Nussbaum, assert that universities have become beholden to narrowly defined market indices. Noting the closure of language, literature, and philosophy programs, these analysts say that the commercialization of higher education has hurt the liberal arts, specifically the humanities.

Such arguments can seem rather heated and political debates come and go, but these political debates are occurring during what appears to be long-term changes to American universities. There have also been multiple visions of the university, and questions about university missions, purposes, constituents, have sparked and will continue to spark debate. But one of the more influential visions of the university is that of the public goods university (for a review see Kleinman and Osley-Thomas 2014). Advocates of this view see universities as serving the larger good of society and argue that these organizations should not reflect market demand, but should serve to supplement market weaknesses and failures. In doing so, the university should facilitate the free flow of information and provide research that can be shared by all members of society. Higher education develops citizen potential and human capital and fosters other legitimate pursuits of the nation-state (Gumport 2000). Although, universities might pursue economically relevant research, they also have a duty to promote culturally relevant scholarly pursuits. Students might be offered job training, but the primary objective is to train students for a life of engaged citizenship (Bok 2007; Nussbaum 2012). Here, universities support those faculty, courses, programs, and departments that can promote citizenship and culturally relevant scholarship.

A completely different vision of the university, relies upon a corporate metaphor, and puts forth a vision of the university as a sector of the economy that produces and sells goods (for reviews and critiques see (Gumport 2000; Kirp 2003; Reading 1995). In this vision, universities

do not create citizens, they do not pursue basic research, and they do not have a cultural agenda. Instead, universities choose students and research projects that are most profitable. Here, faculty members are seen as producers, and research is a commercial product, and students are consumers.

Many have argued that the public goods university in the US has been overwhelmed by the market view in recent years (Gumport 2000; Kirp 2003; Reading 1996; Bok 2003; Geiger 2004; Nussbaum 2010; Slaughter and Rhoades 2004). According to these analysts, institutional power has shifted substantially away from faculty members and towards administrators (Hogan 2013), and university administrators have redefined the notion of public good in terms that justify the private interests of universities (Glenna et al. 2007). Universities increasingly orient to students as consumers and decreasingly think of them as citizens. University patenting has increased substantially since the early 1980s (Berman 2008) and technology transfer offices have appeared on many campuses (Mowery 2001).

Academic Chopping Blocks

It is in this shifting context that my dissertation explores the fate of disciplines. I specifically consider academic chopping blocks, a term that I use to refer to the closing of academic programs and departments during times of restructuring and retrenchment. What do the mentioned trends, both real and imagined, mean for the fate of disciplines when it comes time for universities to close their departments and programs? Generally speaking, liberal arts disciplines such as philosophy and history will find more support among advocates of the public goods university. Conversely, market driven universities will lend more of their support to academic disciplines that provide clear economic value for students and for the university. But what has

really happened to academic disciplines over the last 50 years? Is there a bias against the liberal arts such that liberal arts programs and departments more likely to be closed. Existing scholarship implicitly or explicitly makes the following claims about academic chopping blocks:

- *Market Proximity*: According to academic capitalism, academic faculty, programs, research, and departments that sit far from quasi-markets will most likely be closed at academic chopping blocks (Slaughter 1993, 1998). Thus, during times of restructuring, universities will cut the liberal arts.

- *Gender*: Another part of academic capitalism argues that academic programs that are populated by women will most likely be closed at academic chopping blocks (Slaughter 1993, 1998). This dimension is considered in chapter 3 only.

- *Institutional Culture:* Contemporary shifts in institutional culture suggest that academic research has shifted away from an interest in basic research fields and towards interest in applied fields (Frank and Gabler 2006). Thus, academic chopping blocks will cut the liberal arts.

- *Unbiased Markets:* Research by Kraatz and Zajac (1996) raise the possibility that there is no bias against the liberal arts. Instead, universities are sensitive to shifts in student and other market demands. Here it does not matter whether demand fail for the liberal arts or the practical arts. This dimension is considered in chapter 3 only.

In this dissertation, I challenge these three claims by providing a *double-facing* theory of university change. This double-facing theory integrates market and institutional explanations and thus provides a more nuanced view of organizational change. First, I contend that universities are shaped by both institutional culture *and* markets, and that market forces influence some academic disciplines and that institutional culture shapes others. Liberal arts disciplines and their departments, such as history and English, are shaped through university efforts to conform to institutional culture (namely universal ideals of what universities should be and should offer). In contrast, practically oriented disciplines, such as engineering and business, are shaped by the market. Second, I propose that proponents of academic capitalism are incorrect to assume that market proximity guarantees the success of practically oriented disciplines and their

departments. Instead, I argue that market proximity means that practically oriented disciplines are vulnerable to the turbulent ups and downs of market demand. In a sense, they churn. By this I mean that universities adjust to changing market dynamics by closing lagging departments and programs and replacing them with new ones. When faced with department closures, institutional culture shields liberal arts disciplines, while practically oriented disciplines face the whims of the market. Consequently, liberal arts disciplines will have a smaller closure rate than practical arts disciplines.

Chapter 1: To test this theory, Chapter 1 specifically focuses on academic department closures and asks whether practically oriented departments such as engineering and business have a higher closure rate than liberal arts departments such as history and philosophy. Drawing on a sample of more than 8,000 departments from 276 universities in the College Catalog Study data, this chapter uses event history analysis to demonstrate that, as predicted by the double-facing theory, liberal arts departments have a lower failure rate than practical arts departments.

For the survival analysis in Chapters 1 and 2, I coded the following changes as closures: departments coded as terminated, departments coded as dropping a discipline, or departments that were reduced to a program. In Chapter 3, I coded a program as failing if it was terminated or if it was reduced to an academic minor. I coded programs as surviving if they were merged into a single program, merged into a general program (e.g., general engineering), combined with a second academic program, or transformed into a different program. Since I wanted to distinguish between changes involving evolution and changes involving termination I coded merged, split, reconstituted, and surviving departments and programs as survivals (censored). Some organizational studies code merging organizations as eliminations, however I decided to count these as surviving since it's difficult to know how to interpret a merged department or

program. Such organizational changes might indicates an evolving research field. Or it might indicate a decision on the part of universities to downgrade a selection of disciplines.

Chapter 2: While the first chapter of my dissertation provides a broad look at the university as a whole, the second chapter zooms in on a smaller component of American universities. It does so by looking at what many scholars believe to be the most commercialized portion of contemporary American universities: the biomedical sciences. If practically oriented disciplines and their departments are more vulnerable to closure than liberal arts disciplines, then the patterns in chapter one should be replicated when looking at the most commercialized portion of American universities. I hypothesize that biomedical science departments will have a higher closure rate than traditional science departments, and I show that this is, indeed, the case with a combination of data from the Association of American Medical Colleges and from the College Catalog Study. This data supports my contention that market forces impact practical fields, while institutional culture tends to shape traditional liberal arts fields.

Chapter 3: My next chapter challenges a third approach to understanding university change. Critics interested in student demand might look at this work and ask: does the smaller failure rate of liberal arts departments in your work necessarily mean that they are institutionalized? Couldn't it also be the case that universities follow student demand equally for the liberal arts and for the practical arts and that practical departments were closed more frequently because they suffered larger declines in student demand than their liberal arts counterparts? Critics interested in gender might also raise the possibility that universities are biased against programs populated by women.

To address these questions, Chapter 3 compares the closure rate of low enrollment language and literature programs with low-enrollment engineering programs. Data comes from National Center for Education Statistic's *Integrated Postsecondary Education Data System* (IPEDS). If universities are simply following student demand, we would expect to find similar closures among low-enrollment engineering and language programs. Conversely, if universities are biased towards women we would see higher closures of language programs (which more female students enroll in). However, if universities work to conform to institutional culture when dealing with the liberal arts and do not consider gender, we should find that the closure of low enrollment language programs is smaller than the number of low enrollment engineering programs. Results are consistent with the double-facing theory of change. Low enrollment language programs do have a smaller failure rate than low enrollment engineering programs.

In total, my dissertation looks beyond the accepted wisdom and shows that existing approaches to university change are incomplete or lack nuance. I offer a more fine-tuned disciplinary-based approach to institutional culture *and* market forces, which argues that some disciplines are shielded from quasi-markets by institutional culture and others are not. Further, my research provides findings that are consistent with the idea that the liberal arts and associated sciences are not the most vulnerable disciplines on campus, contradicting the assumptions of many commentators.

As will be clearer in the following chapters, this dissertation goes beyond immediate question of closure by contributing to a number of other theoretical questions and debates. Beyond its contribution to the debate between market and new institutional explanations, this work has the potential to contribute to how we should explain ubiquity among organizations. The results of this dissertation align with more recent arguments that ubiquity of organizational forms is not

simply the result of institutional culture. Organizations can also be ubiquitous because they are satisfying large market demand (Colyvas and Jonnson 2011; Kraatz and Zajac 1996). Furthermore, it raises an issue for ethnographies of university change. Most previous examinations of department and program termination have been ethnographies with small samples. While providing rich data it's very difficult to understand whether they are measuring broad national patterns or idiosyncratic local situations. By clarifying some important national patterns about academic chopping blocks, this dissertation opens opportunities for integrating in-depth ethnographies with broad national analyses. Finally, it also contributes to attempts to measure university responses to market change (Brint et. al 2012), and it provides an improved method for measuring new institutionalism.

The dissertation also addresses the heated political rhetoric that has dominated debates over the future of the US university. Some conservatives imply that universities are isolated from important societal and market changes. My results suggest that the arguments presented by conservative pundits are either incomplete or incorrect because universities do show signs of responding to the market. The bulk of growth in universities over the last 40 years has been towards more market relevant fields. Furthermore, in the case of low enrollment engineering programs, universities do show a willingness to close practical programs that fail to serve student needs. These results suggest that, while universities are far from nimble, they are responsive to market changes, and they do in fact care about student needs. Arguments from the Left - as well as higher education scholars - are also either incomplete. Business values have crept into the university, but universities do still appear to value the humanities, the liberal arts, and a public goods mission, even if these values are under attack from short sighted pundits, at least for now.

The behavior of universities that my research documents make perfect sense. My opinion is that universities should carefully watch whether their practical programs are responding to need from employers. Why should we continue to train nuclear engineers when the US energy industry is no longer hiring nuclear engineers? Language programs however are a different matter. Unlike engineering programs, language and other humanistic programs offer general skills that employers continue to say are very important for employees in this economy (Hora et. al 2015). In my opinion, they also excellent training for citizenship. Universities should continue to offer programs that provide important training for general skills even when student enrollment is low and when politicians use these programs as punching bags.

In all, this dissertation provides data and argument that I hope will enrich a debate that sometimes lacks nuance or adequate data. Decisions about the future of US higher education is too important to be based simply on narrow ideology and short-term thinking.

CHAPTER 1: THE ACADEMIC CHOPPING BLOCK: LIBERAL ARTS AND PRACTICAL ARTS DEPARTMENT CLOSURES AT THE *DOUBLE FACING* UNIVERSITY (1975-2010)

Introduction

American universities are confronting multiple pressures to restructure as the result of significant budget crises, controversies over student debt, and the growth of online education. Such changes have stoked serious fears that American universities are fundamentally changing and not necessarily for the better. One of the biggest fears is that recent academic restructuring has particularly harmed the liberal arts, leading to larger cuts of liberal arts classes, students, faculty, programs, and departments. To many commentators, any threats to the liberal arts amounts to a threat to the very purpose and character of American universities, since the liberal arts teach subjects that are central to critical thinking, communication and civic virtues.

It's highly probable that, when adding new programs and departments, universities prefer not to add liberal arts programs and departments, and, furthermore, there's some evidence that overall population shifts have meant that the liberal arts play a declining role on campuses overall. But, when it comes time to terminate programs and departments, have universities preferred to terminate liberal arts departments and programs? Most existing scholarly literature thinks so or implies as much (Brint et. al 2012; Frank & Gabler 2006; Frank, Schofer, & Torres 1994; Gabler & Frank 2005; Slaughter 1993, 1998). I take a different position. In what follows I propose a *Double-Facing Theory* of university change and provide data showing that practical arts departments, such as engineering and business, as a group, have a higher failure rates than liberal arts departments, as a group. In particular, I argue that academic disciplines are not simply shaped by commercial values (see e.g, Slaughter 1993, 1998), or global institutional culture (see e.g, Frank & Gabler 2006). Instead, this paper proposes that all academic disciplines face quasi-

market forces but some are shielded by institutional forces. Liberal arts disciplines are institutionalized and are thus less vulnerable to closure than practical arts disciplines, such as engineering, which are shaped by quasi-market forces.

To test this alternative account, I specifically focus on academic department closures. Drawing on a sample of more than 8,000 departments from 276 universities, this paper uses event history analysis to demonstrate that liberal arts departments have a lower failure rate than practical arts departments. In doing so, this paper challenges the prevailing view that the liberal arts are the disciplines most vulnerable to closure. I also suggest that when it comes to university academic chopping blocks, advocates of academic capitalism got it backwards, and global new institutionalism offers an incomplete theory and data. While my analysis does not necessarily offer an optimistic vision of the future of the liberal arts, it does show that the liberal arts clearly have a resilience that has been unreported and unexplored. In what follows, I outline the existing theories of global new institutionalism and academic capitalism. Following this I demonstrate their shortcomings, propose an alternative account, and provide supporting data.

I want to emphasize that throughout this paper I am specifically looking at academic chopping blocks, a term which I am using to distinguish my analysis from research that examines population shifts. These are two separate but equally important questions. While many studies investigate how overall population percentages are moving in one direction or another, this analysis of academic chopping blocks studies what happens when universities specifically decide to terminate academic departments. This is my question: when faced with the choice between closing one department over another, what do they choose to close? Academic capitalism and new institutionalism probably still have important things to say about population shifts but this

paper is not designed to assess that question. I do however provide a description of general population shifts as a way of contextualizing the question of academic chopping blocks.

Existing Literature

STEVEN BRINT & COLLEAGUES: What academic disciplines are American academic chopping block most likely to close, practical arts disciplines or liberal arts disciplines? While much of the existing literature talks about population shifts, these papers provide implications for academic chopping block even if they do not so explicitly. So, for example, Steven Brint and colleagues provide one of the largest empirical studies that lend support to the idea that the liberal arts have suffered the most over the past 50 odd years. Using IPEDS[1] data on undergraduate enrollment rates, they set out to find the most declining academic programs between 1971 and 2006. Concentrating on academic programs that were offered by 20% of all universities in 1971, the authors identify 15 individual academic programs that experienced both absolute and relative decline during the period.[2] Of these 15 declining academic programs only two were practical arts fields, while most absolute and relative decline occurred for romance languages, Germanic languages, history, and sociology.[3]

QUASI-MARKET BIAS: A different group of analysts argue that the liberal arts are threatened by a growing trend towards commercial rationality throughout American universities

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[1] *Integrated Postsecondary Education Data System.* U.S. Department of Education. Institute of Education Sciences, National Center for Education Statistics.

[2] Relative decline occurred when a program was not offered by new universities that were added after 1971. Here the existing population of the given program did not decline but it also did not expand with the expanding population of universities. Absolute decline occurred when the population of a given program in 2006 was smaller than the population of the program in 1971.

[3] They also provide data on niche fields which existed at least 5% of universities in 1971. Notable declines were among the secretarial sciences, zoology, library science, and Slavic languages.

(Gumport 2000; Kirp 2003; Reading 1995; Bok 2007; Geiger 2004)[4]. Although this idea comes in many flavors, Sheila Slaughter and colleagues provide one of the more prominent approaches to the "commercial university" that addresses the question of academic restructuring (Slaughter and Leslie 1997; Slaughter and Rhoades 2004; Slaughter 1993, 1998; Volk et al. 1995). University change, they argue, is not an inevitable result of external forces, nor is it the result of technical factors (such as student demand). Instead when faced with structural changes, universities officials rely upon cultural values and must conform to dominant discourses when making important policy decisions. Since the 1980s, Slaughter argues that the dominant discourse is the "market" such that organizational change is predicted primarily by an activity's relationship to the "quasi-market".[5] Activities with clear market relevance—activities closer to quasi-markets—fare better, according to Slaughter and her colleagues, than activities with less market value. Although their empirical studies consider resource allocation and faculty positon cuts, this work implies that those academic programs and departments that can successfully characterize[6] themselves as being relevant to quasi-markets are consistently supported by

[4] Writing in a similar tradition Walter Powell and Jason Owen Smith argue that the commercial values now driving the life sciences could bleed into other academic fields with negative impacts: "If commercial achievement becomes the bellwether for academic fields, and if policies and procedures tailored to the life sciences are applied across university, then the city of the intellect may become a strikingly more homogenous environment as less commercially viable scientific subfields begin to struggle and social science and liberal arts departments feel an increasing need to justify their existence terms of commercial potential" (2002:124)

[5] The term "quasi-markets" comes in later work involving Sheila Slaughter (Taylor et al. 2013). I use it throughout this paper since it nicely foregrounds the fact that universities face incentives and competition not just from typical markets but also from federal and state governments, among other things.

[6] Such characterization is not natural; instead Slaughter argues that some disciplines have simply been more successful at characterizing themselves as being relevant to the market (Slaughter 1993; see also Engell and Dangerfield 1998).

administrators while others are deemphasized or closed.[7] Of course such organizational conditions fundamentally disadvantage the arts and humanities, according to Slaughter and others, because they rely primarily on publications for prestige, and because they are distant from quasi-markets.

GLOBAL INSTITUTIONALISM: Scholars from the new institutional tradition have a very different explanation of why departments close and why specific academic disciplines decline. Generally speaking, here organizational practices and change are shaped not by efficiency or rationality; instead practices and change come about because organizations strive to satisfy taken for granted norms of what constitutes the best organizational practices (DiMaggio and Powell 1983). When it comes to universities, for example, Davis and Powell assert that "in order to be perceived as legitimate by the wider environment, educational organizations adapt to formal structure to conform to institutional norms." (358). By conforming to global myths about what universities are and should be, universities can achieve the stability of institutionalization, and, in doing so, they mimic each other, are loath to make radical changes, and ultimately become very similar over time. Finally, any substantial organizational change within the university comes about because of changes in global myths about what the proper university is and is not the result of differing student demand or different university resources. Importantly David John Frank and colleagues argue that many changes in university structure are the result of centuries' long shift in global myths about what universities should study. In brief, cultural

[7] Three other propositions are also provided: First, merit is no longer primarily established through publication; instead professors are rewarded for attaining success within the market or with market-like activities (Slaughter and Leslie 1997:222). Second, in so far as market values are gendered, activities populated primarily by men are privileged within the university (Slaughter 1993). Third, research activities are seen as more profitable and are given greater support than instructional activities

research has shifted away from an interest in basic fields and towards an interest in applied fields. Although not stated explicitly, this theoretical position implies that we should find a great number of terminations among such fields as Classics, philosophy, astronomy and theology but increases among disciplines geography, sociology, engineering, and economics. In total, although these authors have distinctive explanations, they imply similar conclusions: American universities are most likely to close the courses, programs, and departments of the liberal arts.

Considerations about the Existing Literature

All of these approaches provide invaluable insights into the question of department closures; however, there are a number of issues that lead me to reexamine the question of academic chopping blocks.

Consideration #1 Data Limitations: Existing studies provide a rich background for understanding university change. I owe much to these prior researchers, and I would most likely have arrived at similar conclusions when shown the existing data. With this in mind, most prior studies either have a large sample of universities and a small sample of disciplines, or they examine a small sample of universities and a large sample of disciplines (see Table 1). Studies with a small sample of universities provide rich detail, however, they have a tree versus forest problem. As many of the authors themselves admit, it is difficult to know whether these studies measure broad national patterns or local idiosyncratic situations. Studies with a smaller selection of disciplines have potentially missed the most vulnerable fields since some disciplines go unassessed. Ideally we would have a data set with both a large sample of universities and a large sample disciplines. Rawlings (2012) meets this criteria but relies upon IPEDS, a data set that is a notoriously unreliable source for program cuts. The College Catalog Study is the best data set at

the moment. It has 276 universities with all disciplines, excluding medical schools. Although imperfect, this data provides a much wider sample of both disciplines and universities.

Table 1
University and Disciplines Samples for Existing Literature

	University Sample	Discipline Sample	Unit of Analysis
Volk et. al 1995	1 Public AAU Research University	72 Departments, All Disciplines	State Appropriated Dollars to Each Department
Slaughter 1993	AAUP Sample Of 17 Universities	A Selection of Disciplines Deemed Most Relevant To AAUP	Faculty Position Cuts
Slaughter 1998	AAUP Sample Of 17 Universities	All Disciplines	Faculty Salary Data
	5 AAU Public Universities	All Disciplines	Resource Allocation
Brint et. al 2005	All Universities	Most Disciplines	Degree Completions
Brint et. al 2012	All Universities	Academic Programs That Were Represented In At Least 5% Of Four-Year Colleges And Universities In 1970-1	Relative Decline / Absolute Closure of Academic Programs
Gabler and Frank 2006	1 University From Most Countries	A Selection Of Liberal Arts	Share of Faculty Position by Discipline
Gumport 1993	2 Public Universities	All Disciplines	Academic Program Cuts
Eckel 2002	4 Public Universities	All Disciplines	Academic Program Cuts
Rawlings 2012	829 Universities (1970-1990)	All Disciplines	Academic Program Cuts and Additions
Morphew 2000a	1 University	1 Academic Program	Academic Program Cuts

Bastedo & Gumport 2003	2 Public Higher Ed Systems	All Disciplines	Academic Program Cuts

Consideration #2 Quasi-Market Bias vs. Quasi-Market Churning: Academic capitalism specifically argues that quasi-market proximity is an essential good for academic fields and their departments, because there is a bias on the part of universities towards quasi-markets. I take a different position. In so far as organizations satisfy quasi-market demand, market proximity is a benefit that reinforces existing organizational structures but, if market demand shrinks or changes, market proximity can be a major detriment prompting organizational change or failure (Kraatz 1998; D'Aunno, et al. 2000). In the context of higher education this suggests that universities enact organizational change in an attempt to survive market changes and that changing consumer preference can specifically harm academic disciplines and their departments (Kraatz and Zajac 1996; Kraatz 1998; Jaquette 2011). Consequently, universities will "churn" their practical fields. I argue that as quasi-market demand changes they will add and close departments and programs in an attempt to adjust university offerings to market demand. Quasi-market proximity can be both a blessing and a curse, sometimes bolstering academic fields and their departments and sometimes threatening them. To be sure, institutional culture can also change, but quasi-markets typically move faster.

Of course defining the market for any given academic discipline is extremely complicated because universities serve multiple constituencies ranging from state governments, the federal government, student interest, parents interests, and the priorities of any number of nonprofit organizations and foundations. That said scholars have shown that student demand for an academic field is probably the most important market (see Kraatz and Zajac 1996; Brint et. al.

2012; Rawlings 2012). Depending upon the individual circumstances of individual disciplines and universities, demand from large donors, from NSF, from social movements, and from the labor market are all potentially important (Hackett 1990; Finkelstein et al. 1984; Olzak & Kangas 2008; Sharma et. al 2006).

Consideration #3: Institutional Culture vs. Quasi-Market Forces: Accounts offered by new institutionalism and academic capitalism have a third challenge. Both approaches assume that their theories apply to all academic disciplines. However, a comprehensive look at the literature suggests that universities appear to follow institutional culture at some times, but appear to following market priorities at other times.[8] In support of new institutionalism, Frank and Gabler (2006) found many of the patterns predicted by their theory of large-scale historical shifts in global culture. Patricia Gumport (2002) also invokes new institutionalism to explain the explosion of humanities degree programs at San Jose State University (see also Brint & Karabel 1991; Gates 1997; Gumport 1993). In terms of market driven explanations, Summers' case study of the University of Washington[9] supports the claim that administrators give preferential support to market relevant education (Summers 2005; see also Slaughter 1993; 1998; [10] Volk et

[8] This observation is what prompted Craig Rawlings to suggest that some universities are driven by the market while others are driven by institutional culture (2012; 2013).

[9] When looking at one academic year 2002-2003, he finds that 17% of students aiming to enroll in humanities courses were rejected due to lack of space. Unmet student demand was similar for the arts and social sciences but was smaller for other core subjects such as natural science, engineering, and business.

[10] Slaughter (1993) found that retrenchment disproportionally hurt the humanities, fine arts, social sciences and education. Such unequal prioritizing was evident even when controlling for student demand In another paper, Slaughter (1998) looked at five public universities and found that state funds were disproportionally provided to the science and professional schools, particularly those closer to corporate, professional, and research markets. This pattern crossed all five measures of institutional support (salaries, services, supplies, equipment, and support salaries).

al. 2001). Slaughter (1993) witnessed similar patterns during the academic retrenchment of the 1980s. With this in mind, I must agree with Rawlings' suggestion that neither academic capitalism nor new institutionalism provide complete stories of university change. [11] Instead we should explore the ways in which universities are shaped both by the market and by institutional culture. The subsequent question is: which types of programs are affected by institutional factors and which by market forces?

Consideration #4: Institutionalized Disciplines and Quasi-Market-Driven Disciplines: According to Rawlings, the confusing empirical results discussed above can be reconciled by splitting universities into those universities that are institutionalized and those that are shaped by the market, and the main split is between high status universities and low status universities. Striving to maintain their higher status, according to Rawlings, high status universities use academic programs to signal that they have satisfied the legitimate norms about what universities should look like and thus maintain institutionalized fields even in the face of declining student interest. Interested in maintaining their status position, high status universities also close and open programs at a much lower rate than lower status universities. Low status universities, by contrast, Rawlings suggests, are unconstrained by legitimate expectations about what universities are and thus respond not to institutional pressures but to market demand. Consequently, they exhibit less stability in departmental openings and closing as they seek to match their academic program offerings with market demand.

[11] In addition, recent research on the commercialization of the university suggests that commercialization forces are uneven (Kleinman & Osley-Thomas 2014) and disparate in their impact (Shapin 2008).

I believe this approach is insightful but also has limitations. Rawlings' argument sets up important expectations. First, if institutional culture shapes higher status universities, we would expect to find higher status universities of fairly uniform shape and function (Frank & Gabler 2006; DiMaggio and Powell 1983). In contrast, if markets drive lower status universities we would expect to find many lower status universities of different shapes and functions as they work to fulfill different niches (Carroll & Swaminathan 2000; Olzak & Kangas 2008; Rawling 2012)[12]. Following Rawlings' account, different low status universities should offer different suites of academic programs and departments because they each serve different markets. But as we know the liberal arts are uniformly offered at nearly every four-year university in the country. Just as high status universities have philosophy, chemistry, literature, sociology, mathematics, so do most low status universities.[13] When it comes to liberal arts programs, evidence suggests that most low status schools appear to conform to institutional myths about what a university is and what a university must contain.[14]

Second if high status universities are primarily shaped by institutional culture we would expect a great deal of uniformity among high status universities (see e.g, DiMaggio and Powell 1983; Frank & Gabler 2006); however this is largely not the case for the practical arts. We know that there is a great deal of differentiation and regional variation among practical fields. Some elite universities offer very few practical programs, while high status state universities often offer

[12] Rawlings argues for example that, "lower status institutions compete for more specialized reputational niches by differentiating programs in ways that appear more strategically savvy."(2012:5)

[13] Brint et. al 2012 found that in 2006 81.6 % of four year colleges had history programs; 86% had English programs; 72% had chemistry programs; and 47% had physics programs.

[14] Institutional theory also suggests that changes to market-driven organizations should not stimulate widespread cultural protest. However, we do see signs of protest appearing even when low status universities close their liberal arts programs (see e.q., Jaschik 2010; Price 2013; Rogers 2013; Reich 2011)

specialized engineering programs (e.g. architectural engineering or mineral engineering).[15] Exceptions exist of course. Most universities offer business and nursing programs, but on the whole, practical departments amount to niche fields in the grand scheme of American universities. This diversity suggests that high status universities are also adapting to external demands and thus show signs of market influence (see e.q, Thompson 1967; Kraatz & Zajac 1996).

The Double-Facing Chopping Block

In total it appears that we have universities with a fairly uniform set of liberal arts degrees and with a highly variable range of practical arts degrees. Consequently, we must generate a theoretical account that explains why lower status universities largely offer the same liberal arts disciplines and departments as high status universities and why practical arts departments are highly variable both at lower status universities and higher status universities. I suggest that rather than splitting universities by status, we should split individual universities into those parts that churn (open and close) in response to quasi-market changes and those parts that are shielded from market changes by institutional culture. In a sense we have *double-facing* universities. Some parts of individual universities face market forces while other parts of the same universities face institutional forces and both high status universities and low status universities face institutional forces and market forces. Liberal arts fields face institutional culture, while practical arts fields face the market.

[15] Even popular practical fields often constitute niche fields. For example, at its peak, industrial engineering was only at 9% of four-year colleges (Brint et al. 2012).[15] Environmental engineering is another niche field, graduating 596 students in 2000 compared to the 23,000 graduating arts students (Brint et. al 2012).

So what does this mean for academic chopping blocks and department closures in particular? Well, if practical degrees do, in fact, face quasi-markets, and if they face market churning rather than market bias, we would expect to find that practical arts disciplines, such as engineering, are in fact the disciplines that are most vulnerable to closure on American campuses. This is because universities attempt to adjust to quasi-market changes by adding and closing practical departments. Practical departments face the possibility of being replaced by another more market relevant practical field. In contrast liberal arts departments are shielded from quasi-market changes by institutional culture.[16] Thus, in contrast to the prevailing view, I suggest that practical arts departments face a greater threat of closure than liberal arts departments. Consequently I put forth the following three hypotheses:

> H1: Liberal arts departments as a whole will have a smaller failure rate than practical arts departments as a whole.
>
> H2: We will see only minor difference between the department closure rates at high status schools and the closure rates at lower status school.

Just to be clear, I am not arguing that the total number of practical arts fields on American universities has gotten smaller over time. Instead, I contend that when faced with a decision about what departments to close (and when given the choice between terminating liberal arts departments or practical arts departments), universities more frequently close practical arts departments. This activity of closing the practical arts fields can simultaneously occur while practical arts fields are added to the university. Unfortunately the college catalogs study data is not set out to examine department births (see Appendix 4), but this is an important question for

[16] This is a viewed shared with Hearn and Belasco (2015)

future research. I will, however, provide data on general population shifts as a way to contextualize the question of academic chopping blocks.

Data and Analysis

To test these hypotheses, I conduct a multivariate, longitudinal, event history analyses of academic department closures between 1975 and 2010. I use two data sets developed by Steven Brint, the College Catalog Study (Brint et. al 2011a) and the Institutional Data Archive (Brint et. al 2011b).[17] The College Catalog Study has department level information on 286 four-year colleges and universities. Mergers, closures, and department additions are tracked at five-year intervals between 1975 and 2010, such that we have department status information for the following years: 1975-76, 1980-81, 1985-86, 1990-91, 1995-96, and 2000-01, 2005-06, and 2010-11. The Institutional Data Archive contains university level characteristics such as membership within the Association of American Universities and the Baron's Profile of American College Selectivity.

Practical vs. Liberal Arts Departments. All departments in this data set were classified as either liberal arts or practical arts following the example of Brint et. al (2005). Practical arts departments include such majors as advertising, education, engineering, and law, while liberal arts departments include literature, history, philosophy, and performing arts (See Appendix 1). Table 2 summarizes the total number of departments in the analyses as well as the number of lower and higher status universities. This includes departments that existed in 1975 or emerged

[17] Despite its shortcomings I found that this data set was the most reliable source on closures. Using IPEDS enrollment data to study program closures is simply not tenable in its existing condition because it is extremely difficult to identify when a potential closure is in fact a closure or an accounting change on the part of IR offices at individual universities.

after 1975. Noticeably, the number of liberal arts departments in the sample is higher than the number of practical arts departments (5163 versus 2925). The sample also has more lower status universities than higher status universities.

Status: Following various other studies I use selectivity to as a proxy for university status under the assumption that highly selective schools are higher status schools and less selective schools are lower status schools (Brint et al. 2012b; Kraatz and Zajac 1996; Jaquette 2011). I specifically use Barron's selectivity index from 2005. Those universities with a selectivity ranking of 1, such as the University of Pennsylvania, or a ranking of 2, such as the University of Michigan Ann Arbor, are coded as higher status universities. All other universities are coded as lower status. A description of the sample can be seen below in Table 2.

Table 2
Sample Description (University and Department Types)

Granting	University Type				Departments	
	Higher Status	Lower Status	Private	Public	Practical	Liberal
BA Granting	30	76	94	12	355	1523
Masters	0	83	23	60	915	1259
Doctoral	46	41	34	53	1655	2381

Control Variables

I also control for a number of additional variables that previous research demonstrate are important to understanding university change. For example, prior organizational literature suggests that organizations with smaller size are more likely to make organizational changes so as to better match their products to the market (Hannan and Freeman, 1977, 1989; Baum and Haveman, 1997). It seems plausible that larger universities will have more resources and thus will be able to better weather various budget crises (see e.g., Brint et. al 2012). Consequently I

control for *University Size*, comparing those universities with less than 5000 incoming enrolled freshman with those universities with more than 5000 enrolled freshman. Prior research also finds that different types of universities will have different department closure rates (see e.g., Brint et. al 2012). With this in mind I control for *University Type*. Drawing on the 1994 Carnegie Classification of Universities, I run three separate analyses for doctoral granting universities, masters granting universities, baccalaureate granting colleges. Department failure rates might also differ for *Public Universities Versus Private Universities* so I control for these characteristics (Tolbert 1985; Brint et. al 2012). I also control for the *Most Declining Practical and Liberal Fields* as identified by Stephen Brint.[18]). Finally I run analyses that control for *Tuition Dependence,* which is defined as the percentage of total university revenue that came from tuition in the academic year 1999-2000. Since accounting standards were different for public and private universities these two groups are assessed separately

Descriptive Results

As a way of contextualizing this study of academic chopping blocks, I first describe population shifts among the 272 universities in the sample. Table 3 counts the number of practical and liberal departments for each year. Unlike previous studies of student completions (Brint 2005) and faculty composition (Frank and Gabler 2006), the population of departments, in this sample, did not turn towards the practical arts. Instead, it has been relatively stable for these

[18] In a study of academic programs, Brint et. al (2012) identified 21 rapidly declining programs that existed in at least 20% of universities in 1970 (see Appendix 2). In contrast, my analysis compares two groups of academic departments (liberal versus practical). Although I expect that these two groups will capture important differences in the rate of closures, I most control for the possibility that the most declining individual fields as identified by Brint could have a higher failure rate than the group of liberal arts as a whole or have a higher failure rate than the group of practical arts as a whole. Consequently I control for the most declining practical fields and the most declining liberal fields as identified by Brint et. al (2012a).

universities between 1975 and 2010. For example, in 1980, 58% of departments at doctoral granting universities were liberal arts departments. By 2010, 61% of departments at doctoral granting universities were liberal arts departments.

Table 3
Population Shifts among Departments in the Sample

University	Discipline	1980	1985	1990	1995	2000	2005	2010
Doctoral	Liberal	1958	2031	2045	2079	2109	2059	2085
Doctoral	Practical	1419	1543	1524	1486	1424	1312	1325
Masters	Liberal	1088	1113	1123	1147	1196	1164	1178
Masters	Practical	527	581	598	635	652	622	646
BA	Liberal	1372	1390	1407	1408	1393	1346	1369
BA	Practical	244	254	291	288	287	267	280

Although this data set is not set up to study department additions (see Appendix 4), we can use this data to infer that the addition rates of practical arts departments is higher than the addition of liberal arts departments in this sample. By combining this data on population shifts with the failure rate results that follow, we can see that the addition rates of practical arts departments is higher. This goes along with the idea that practical department are churning.

Table 4 breaks the data into cohorts and shows how many departments per cohort experienced each type of risk. So, for example, within the 1980 cohort, 238 practical departments survived to 2010, 21 were split into two departments, 56 were merged, 103 failed, and 65 were reduced to program level. This table provides the first glimpse into academic chopping blocks. Although the total number of practical arts departments is smaller in the data

set as a whole, the number of failed practical arts departments is higher than the number of liberal arts departments in every cohort besides 2000.

Table 4
Sample Description (Risk Threat by Cohort)

Cohort	Category	Depts per Cohort that Survived to 2010	CENSORED Changed Depts appear as a new Depts in the next cohort			TERMINATED Department removed from Data Set		
			Merged into 1 Dept	Split into 2 Depts	Added To a Dept	Failed	Dropped From a Dept	Reduced to Program
1975	Liberal	2890	610	185	410	118	30	195
1975	Practical	975	397	53	174	214	14	192
1980	Liberal	255	83	69	28	31	12	31
1980	Practical	238	56	21	25	103	4	65
1985	Liberal	238	64	41	36	21	12	25
1985	Practical	238	55	21	31	51	3	33
1990	Liberal	289	44	30	18	19	11	26
1990	Practical	257	54	12	25	39	6	34
1995	Liberal	314	28	30	19	19	14	27
1995	Practical	248	36	11	21	27	8	29
2000	Liberal	247	26	20	17	19	18	22
2000	Practical	270	6	4	13	18	10	31
2005	Liberal	549	15	13	15	13	9	33
2005	Practical	482	9	4	7	39	11	32

Next, Table 5 describes the overall activity in the sample between 1975 and 2010. The first column describes the number of departments that existed in 1970 but did not exist in their original form in 2010. These departments may have disappeared from the sample because of additions, splits, mergers as well as failures. The second column describes the number of departments that existed in the 2010 cohort did not exist in this form in 1975. These departments may have appeared in the sample because of additions, splits, mergers as well as *additions*. The

third column describes the number of departments that survived unchanged between 1975 and 2010, and the last column describes a percentage of departments that survived unchanged. Overall we can see that liberal arts departments were far more likely to survive unchanged during this time period, while a much smaller percentage of practical arts departments survived unchanged. This finding aligns with my argument that the practical arts are churning.

Table 5
Unchanged vs Changed Departments 1975-2010

University	Discipline	# Depts. Missing by 2010	#Depts. Appeared after 1975	#Depts. Unchanged 1975-2010	# Depts. Existing in 2010	% Depts. Unchanged in 2010
Doctoral	Liberal	590	717	1368	2085	65.6%
Doctoral	Practical	967	873	452	1325	34.1%
Masters	Liberal	560	650	528	1178	44.8%
Masters	Practical	420	539	107	646	16.6%
BA	Liberal	509	506	863	1369	63.0%
BA	Practical	135	171	109	280	38.9%

I also provide a chart that disaggregates the categories of practical and liberal arts fields. The results of the comparison between practical and liberal arts fields would be misleading if, for example, there was a group of practical fields with a smaller failure rate than the average liberal arts field. This turns out not to be the case, however. Table 6 groups all departments into 16 categories and shows that 1.6% of physical sciences, 3.0% of humanities, 8.8% of business, and 7.5% of education departments closed during the period of study.[19]

[19] This chart provides a preliminary exploration of academic capitalism claims that not all professional fields are created equal. It is proposed that culturally gendered fields, for example, have less value than high-end professional fields, and those would have a higher failure rate. Table 3 demonstrates that education departments and business departments fail at similar rates. Academic Capitalism would also predict that the biomedical sciences would have a low failure rate. This is not the case in this sample.

Table 6
Discipline Disaggregation
(Closed=Failed Only)

Department Discipline	Closed Depts.	Total Depts	% Closed
Physical Science and Math	22	1349	1.6
Humanities and Languages	64	2101	3.0
Visual and Performing Arts	36	1181	3.0
Social Sciences	67	1763	3.8
Agriculture, Veterinary Medicine, and Animal Science	13	291	4.5
Social Services	6	120	5.0
Biological and Life Sciences	28	559	5.0
Engineering, Computer Science	89	1408	6.3
Architecture, Design, Planning	11	157	7.0
Communications	25	345	7.2
Education	65	865	7.5
Business	70	796	8.8
Biomedical Sciences	22	215	10.2
Health Professions	81	606	13.4
Home Economics, Physical Education	58	411	14.1
Dentistry	45	168	26.8
Prof Studies, Library Science	23	62	37.1

Discipline Disaggregation
(Closed=Failed Depts, Reduced to Program, Dropped From)

Department Discipline	Closed Depts.	Total Depts	% Closed
Physical Science and Math	88	1349	6.5
Agriculture, Veterinary Medicine, and Animal Science	25	291	8.6
Visual and Performing Arts	117	1181	9.9
Social Sciences	177	1763	10.0
Humanities and Languages	211	2101	10.0
Biological and Life Sciences	69	559	12.3
Social Services	15	120	12.5
Engineering, Computer Science	177	1408	12.6
Communications	44	345	12.8
Education	140	865	16.2
Arch and Planning	26	157	16.2
Business	150	796	16.6
Biomedical Sciences	43	215	18.8
Health Professions	149	606	20.0
Home Economics, Physical Education	105	411	24.6
Dentistry	77	168	25.5
Prof Studies, Library Science	32	62	51.6

Statistical Model

For this analysis, I use a Weibull model because I am interested in the time trajectory of department closure and because Weibull model is ideal for capturing the waiting time to closure since it is a flexible monotonic function that is well suited to handle very disparate phenomena involving waiting times. The Weibull distribution is a natural functional form for failures with monotonically increasing or decreasing risk. Each academic department in the data set is assigned various covariates, and each is designated as surviving or closing within the interval 1975 to 2010. STATA estimates hazard ratios (or effects) associated with each covariate. The main model for the hazard of closing of department j is as follows:

$$h(t)=p[e^{(-p(x1\beta1+ \ldots + xk\beta k))}]*[t^{(p-1)}]$$

Where, h(t) is the hazard function, t=time since onset of observation period, p is the Weibull shape parameter, x_1= covariates for department $_1$, and β_1 is the corresponding covariate effects. The effects of a covariate k on the risk is defined as $\exp(\beta_k)$. Results show that a one unit increase in a given covariate is associated with a $\exp(\beta_k)$ increase in department failure rate. Note that β_k tells us about the magnitude of the shift of the *rate* of closure associated with the covariate. When β_k is negative the covariate decreases the rate of failure and when it is positive it increases it. The theory I propose here predicts that institutionalized fields have longer life spans and hence will have lower failure rates. Thus we expect the coefficients associated with institutionalization to be negative. In the provided results tables, hazard rates are reported instead of coefficients to ease interpretation. Hazard rates are derived with the following: $\exp(\beta_i)$.
I also supply the results of Cox Models. I do this because it places fewer demands on the data, and if we find the same results in the Cox model, the results of the Weibull model are acceptable.

The Cox Model is specified as follows:

$$h(t) = h_0(t) \exp^{(x1\beta1+ \ldots + xk\beta k)}$$

where $h_0(t)$ is the cumulative hazard (not directly estimated), x_1 is a variable for department "1" and β_1 is the corresponding coefficient. The Efron method was used to handle ties, and Cox-Snell analysis shows reasonable proportionality (For more on the model see Appendix 3).

Modeling Results

The following tables show the results of Cox Proportional Hazards Model as well as Accelerated Failure Time models with Weibull distributions performed on four different types of universities (doctoral granting, masters granting, liberal arts colleges, and baccalaureate colleges). Results are presented as Hazard Ratios.[20] Table 7 shows the results of a model that includes the following as terminations: departments that failed, departments that had a discipline dropped from it, and departments that were reduced to program status. The model in Table 8 includes only departments that failed as terminations. Since the results of the Cox Model are essentially the same as a result of the Weibull Model, I will only discuss the results of the Weibull Model below.

[20] Hazard Ratios are derived by taking the antilog of each coefficient $e^{(coeffiecent)}$, and they describe the effect of one unit difference in the associated predictor on raw hazard (Singer and Willett 2003:524).

Table 7

Event History Analysis (Weibull Distribution and Cox Model), Terminations=Failed Depts, Reduced to Program, Dropped From

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	Doctoral	Masters	BA	Doctoral	BA	Doctoral	Masters	BA	Doctoral	BA
Lower Liberal				1.577***	3.127***				1.551***	3.023***
				(0.212)	(0.500)				(0.208)	(0.484)
Higher Practical				3.252***	3.947***				3.026***	3.695***
				(0.375)	(1.275)				(0.348)	(1.195)
Lower Practical				2.930***	5.635***				2.705***	5.071***
				(0.390)	(1.208)				(0.359)	(1.091)
Public vs Private	0.589***	0.668***	0.792	0.576***	0.811	0.595***	0.652***	0.717	0.583***	0.733
	(0.0557)	(0.0688)	(0.174)	(0.0543)	(0.178)	(0.0562)	(0.0675)	(0.157)	(0.0549)	(0.161)
Most Declining	1.462***	1.038	0.797	1.486***	0.758	1.438***	1.070	0.877	1.463***	0.832
Practical	(0.148)	(0.121)	(0.158)	(0.151)	(0.151)	(0.146)	(0.125)	(0.174)	(0.149)	(0.167)
Most Declining	0.588***	0.648***	0.836	0.592***	0.843	0.598***	0.651***	0.837	0.601***	0.844
Liberal	(0.0705)	(0.101)	(0.108)	(0.0710)	(0.108)	(0.0715)	(0.101)	(0.108)	(0.0719)	(0.109)
Small vs Large	1.244***	1.047	2.053**	1.250***	2.076**	1.243***	0.993	1.968**	1.250***	1.981**
	(0.0765)	(0.155)	(0.664)	(0.0771)	(0.674)	(0.0763)	(0.142)	(0.642)	(0.0770)	(0.648)
Practical	2.524***	3.046***	1.958***			2.360***	2.731***	1.822***		
vs Liberal	(0.228)	(0.353)	(0.326)			(0.213)	(0.317)	(0.303)		
Higher	0.931		0.375***			0.941		0.388***		
vs Lower	(0.0807)		(0.0526)			(0.0815)		(0.0546)		
Constant	0.00101***	0.00179***	0.00111***	0.000796***	0.000362***					
	(0.000202)	(0.000458)	(0.000449)	(0.000153)	(0.000155)					
p (slope)	1.507***	1.421***	1.360***	1.510***	1.360***					
	(0.0451)	(0.0506)	(0.0625)	(0.0452)	(0.0625)					
AIC	4892	3127	2198	4882	2195	12640	7531	4970	12629	4967
BIC	4952	3177	2251	4948	2254	12687	7569	5012	12683	5014
Observations	5839	3752	2764	5839	2764	5839	3752	2764	5839	2764
N_fail	792	505	347	792	347	792	505	347	792	347
cmd	weibull	weibull	weibull	weibull	weibull	cox	cox	cox	cox	cox
ll	-2437	-1556	-1090	-2431	-1087	-6313	-3760	-2478	-6307	-2476

Practical versus Liberal: The main question for this paper is whether practical arts departments fail at a higher rate than liberal arts disciplines. This prediction largely holds true across university type, status levels, models, and definitions of termination. For both Table 7 and 8, Columns 1 through 3 describe the main effects of this distinction, while columns 4 through 5 examine the interaction between status and disciplinary type. These last three columns use dummy variables to compare the first three variables (lower status liberal, higher status practical, and lower status practical departments) to the baseline variable of higher status liberal departments.

We can look first at doctoral granting universities in Table 7 with the model that has an expanded definition of terminations. The main effect analysis in column 1 shows that practical arts department failure rates are 2.524 times higher than liberal arts department failure rates during the period between 1975 and 2010 ($p<0.01$). For higher status doctoral granting universities like Yale University, practical arts disciplines fail 2.930 times faster than liberal arts disciplines($p<0.01$). A posttest estimation also shows that the failure rate of practical arts disciplines is higher than liberal arts disciplines also at lower status universities such as the University of Denver ($chi2(1)=34.83$; Prob> $chi2=0.0000$). Table 8 shows the results of the model with the more limited definition of termination. We find the same results as above in the main effect analysis (3.764, $p<0.01$). However the relationship with status is slightly different, an issue that I discuss below.

Table 8

Event History Analysis (Weibull Distribution and Cox Model), Terminations=Failed Depts

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	Doctoral	Masters	BA	Doctoral	BA	Doctoral	Masters	BA	Doctoral	BA
Lower Liberal				1.846***	2.932***				1.805***	2.775***
				(0.420)	(0.807)				(0.410)	(0.764)
Higher Practical				4.217***	5.131***				3.849***	4.622***
				(0.770)	(2.530)				(0.701)	(2.279)
Lower Practical				6.010***	8.065***				5.467***	6.907***
				(1.241)	(2.676)				(1.126)	(2.297)
Public vs Private	0.322***	0.580***	0.423*	0.321***	0.431*	0.327***	0.558***	0.383**	0.325***	0.390**
	(0.0456)	(0.0828)	(0.192)	(0.0452)	(0.196)	(0.0462)	(0.0804)	(0.174)	(0.0459)	(0.177)
Most Declining	1.327*	1.151	0.610*	1.336**	0.587*	1.299*	1.199	0.689	1.307*	0.664
Practical	(0.195)	(0.176)	(0.178)	(0.197)	(0.172)	(0.191)	(0.184)	(0.201)	(0.193)	(0.195)
Most Declining	0.544***	0.402***	0.614**	0.545***	0.619**	0.553***	0.406***	0.616**	0.554***	0.621**
Liberal	(0.111)	(0.112)	(0.142)	(0.111)	(0.143)	(0.112)	(0.113)	(0.142)	(0.112)	(0.143)
Small vs Large	1.111	1.128	0.890	1.113	0.894	1.105	1.057	0.832	1.107	0.833
	(0.112)	(0.235)	(0.609)	(0.112)	(0.613)	(0.111)	(0.209)	(0.572)	(0.112)	(0.574)
	(0.545)	(0.640)	(0.718)			(0.500)	(0.554)	(0.650)		
Higher vs Lower	0.659***		0.402***			0.664***		0.424***		
	(0.0875)		(0.0935)			(0.0881)		(0.0988)		
Constant	0.000808***	0.000998***	0.00108***	0.000489***	0.000378***					
	(0.000235)	(0.000358)	(0.000846)	(0.000141)	(0.000310)					
p (slope)	1.429***	1.352***	1.323***	1.430***	1.323***					
	(0.0644)	(0.0685)	(0.100)	(0.0644)	(0.100)					
Observations	5,839	3,752	2,764	5,839	2,764	5,839	3,752	2,764	5,839	2,764
AIC	2697	1923	1068	2698	1069	5512	3767	1837	5513	1837
BIC	2757	1973	1121	2765	1128	5558	3805	1878	5566	1885
N	5839	3752	2764	5839	2764	5839	3752	2764	5839	2764
N_fail	349	252	128	349	128	349	252	128	349	128
cmd	weibull	weibull	weibull	weibull	weibull	cox	cox	cox	cox	cox
ll	-1339	-953.7	-525.1	-1339	-524.4	-2749	-1878	-911.3	-2748	-910.6

In terms of Masters granting universities, we are only looking at lower status organizations since this sample has no higher status masters granting universities. For the expanded definition of termination in Table 7, the failure rate of practical arts departments is 3.046 times higher than liberal arts departments ($p<0.01$) at places such as Wayne State College, Southern Utah University, and East Carolina University. Results for the more limited definition termination in Table 8 are essentially (3.799, $p<0.01$)

Table 9
Analysis with Tuition Dependence, Terminations=Failed Depts

VARIABLES	All Private	All Public
Brint's Most Declining Practical	0.464***	1.883***
	(0.0812)	(0.249)
Brint's Most Declining Liberal	0.651***	0.346***
	(0.104)	(0.0927)
Small vs Large	1.574*	1.182
	(0.399)	(0.142)
Practical vs Liberal	4.985***	2.666***
	(0.643)	(0.423)
Status Higher vs Lower	0.588***	0.622**
	(0.0861)	(0.118)
Tuition Dependence	0.998	
	(0.00275)	
Tuition Dependence		0.991
		(0.00719)
Constant	0.000716***	0.000475***
	(0.000253)	(0.000150)
p (slope)	1.320***	1.437***
	(0.0584)	(0.0661)
Observations	5,161	5,852
AIC	2838	2566
BIC	2890	2619
N	5161	5852
N_fail	362	317
cmd	weibull	weibull
ll	-1411	-1275

seEform in parentheses *** p<0.01, ** p<0.05, * p<0.1

Moving to baccalaureate universities with the expanded definition termination model, the difference between practical arts departments and liberal arts departments depends on status during the period between 1975 and 2010. For lower status baccalaureate granting universities,

such as Kalamazoo College, we see that practical arts departments fail faster than liberal arts disciplines in the sample (5.635 vs 3.127, in column 6 Table 5). This difference is statistically significant (chi2(1)=12.00; Prob>chi2=0.0005). Results are similar for higher status universities such as Haverford, Amherst, and Bates. The failure rate of practical arts departments 3.947 times higher than higher status liberal departments ($p<0.01$). Status is not however a factor in the model with the more limited definition of termination (Table 8). The failure rates of practical departments at lower status universities are 8.065 times higher than the failure rates of liberal departments at higher status universities and the failure rates of higher status practical departments are 5.131 times higher than the failure rates of liberal departments at higher status universities.

Higher Status versus Lower Status Universities: Next we have the question of whether the differences between practical and liberal failures depend upon status. The last three columns of Tables 7 and 8, above, explore this question. The following Table 9 summarizes these relationships based on the results in Tables 5 and 6.

Table 10
Status Results Summary

Expanded Termination Definition	Doctoral granting	Higher Practical > Lower Practical > Lower Liberal > Higher Liberal
	Baccalaureate granting	Lower Practical > Lower Liberal > Higher Practical > Higher Liberal
Limited Termination Definition	Doctoral granting	Lower Practical > Higher Practical > Lower Liberal > Higher Liberal
	Baccalaureate granting	Lower Practical > Higher Practical > Lower Liberal > Higher Liberal

This Table 10 shows that liberal arts departments at higher status universities have smaller failure rates than all other types of departments. After this, however, the rank order of

failure rates differs by university type. If we first look at the limited termination model, we see that lower status universities do not consistently have the highest failure rates, instead failure rates depend on the difference between practical and liberal departments. Broadly speaking lower status universities do have higher failure rate higher status universities, however this is complicated by the difference between liberal arts and practical arts. Practical departments at higher status universities have higher failure rate than liberal arts departments at lower status universities.

Moving on to the expanded definition model, we can use this table to tell us why the main effect analysis of status shows no statistically significant difference for doctoral granting universities (see column 1 in Table 5). Lower status doctoral schools do not have a consistently higher or lower failure than higher status doctoral granting universities. Instead, of all departments at doctoral granting universities, higher status practical departments had the highest failure rates, while higher status liberal arts departments had the smallest failure rates. As for other university types, I do not have data to explore the question for Masters granting universities, but baccalaureate granting universities do follow Rawlings' position that lower status universities will do close more departments than higher status universities. This is reinforced by the main effect analysis (0.375, $p<0.01$). As a group, lower status universities close more academic departments than higher status universities.

I predicted that there would be no difference or little difference in the closure rates between higher status universities and lower status universities. This is opposite of what Craig Rawlings' predicts and findings are mixed. Lower status baccalaureate universities definitely close more departments than higher status baccalaureate universities. However this might be an apples to oranges comparison since most higher status BA universities are higher status liberal

arts colleges and are fundamentally different from lower status BA institutions. As for doctoral universities, higher status universities have a different pattern than lower status universities but it is not a difference of magnitude. Practical arts departments at doctoral universities are more likely to be closed than all departments at lower status doctoral universities, but liberal arts departments at higher status doctoral universities are more secure than all departments at lower status doctoral universities.

Public versus Private. The above analysis also shows that departments at private universities have higher failure rates than departments at private universities. Looking at the Weibull model in Table 7, private doctoral granting universities close their departments faster than public doctoral granting universities (0.589, $p<0.01$). The same is true for masters granting universities (0.668, $p<0.01$). [21] In the sample, this pattern is also mirrored for the baccalaureate granting universities; however the difference is not statistically significant. Results in Table 8 are similar.

Smaller versus Larger Universities and Tuition Dependence. Doctoral granting universities with less than 5000 incoming enrolled freshman, appear to be slightly more likely to close academic departments than doctoral granting universities with more than 5000 incoming enrolled freshman (1.244, $p<0.01$, Table 7). The same is true for baccalaureate granting universities (2.053, $p<0.01$) but for masters granting universities the difference is not statistically significant.[22] Results for the more limited definition of department terminations are similar, but

[21] A separate analysis found no statistically significant interaction between the variables disciplinary type and institutional type (public versus private). Results are available upon request.

[22] A separate analysis found no statistically significant interaction between the variables disciplinary type (practical versus liberal) and size. Results are available upon request.

results are not significant. In addition, Table 9 shows no evidence that Tuition Dependence shapes rates of department closure.

Most Declining Liberal Departments: This measure tests whether the closure rates of the most declining liberal fields identified by Brint et. al (2012) is higher than all other liberal arts department closures. The fear is that there is some sort of interaction within the liberal arts category and that Brint's most declining liberal fields have a much higher failure rate than other fields in the liberal arts category. Results for the first two types of universities suggest otherwise however. Here we see that all other departments in the sample have a higher closure rate than the most declining liberal departments as identified by Brint et. al (2012) for doctoral granting (0.588, $p<0.01$, Table 7) and for masters granting universities (0.648, $p<0.01$). This suggests that all of the action for department closures exists somewhere else. Baccalaureate granting universities show the same findings in the sample but the results are not significant (0.836, $p> 0.1$). Results for the more limited definition of department terminations are similar (see table 8).

Discussion and Conclusion

Business as usual has been disrupted on most American campuses as the result of rising student debt, falling state funding, increased political scrutiny, and newly emergent online competition. Given such an enormous challenge, scholars have rightfully questioned how universities are responding and in particular, have been interested in understanding what instability in higher education has meant for the various academic disciplines. Such concern is important since the resultant closing of academic programs and departments shapes the type of knowledge taught to students and the type of knowledge created for society (Bastedo & Gumport 2003; Gumport and Snydman 2002). Although coming from different research traditions, most

existing literature believes or implies that the liberal arts disciplines have lost the most classes, programs, faculty, and departments. Both academic capitalism and global new institutionalism, for example, provides suggest theoretical reasons why universities have been more likely to close liberal arts departments than practical arts departments.

To reiterate, I am not arguing that the totality of the practical arts departments are in decline; nor am I saying that the total number of practical arts departments on American universities has gotten smaller over time. In fact, academic capitalism and global new institutionalism still might have important things to say about population shifts. However, distinct from studies of broad population shifts, this study examines academic chopping blocks, a term which describes the activity of universities sitting down and deciding what academic departments to close. After pointing out a number of challenges with the hypotheses suggested by these pre-existing accounts, I provide a *Double-Facing Theory* of university change, which predicts that practical arts disciplines, such as business and engineering, are actually much more likely to be closed than the liberal arts. I argue that all universities are constrained by institutional forces as well as by market forces, such that some parts of the university are institutionalized while others are market-driven. The key dividing line is across disciplines. Some disciplines are shielded by institutional culture while others face market churning. More specifically, practical arts disciplines face market forces while liberal arts disciplines face institutional forces. Consequently practical arts disciplines are much more vulnerable to closure than liberal arts disciplines, since market demand shifts more rapidly than institutional culture. To support this proposition I provide a longitudinal event history analysis of academic departments spanning 1975 to 2010. Looking at roughly 8,000 departments from 276 universities, I find that the closure rate of practical arts departments is roughly 2 times higher

than the closure rate of liberal arts departments. I find that all other departments fail at faster rates than the most declining liberal arts programs as identified by Brint et. al (2012). Such results suggest that low status schools do in fact face institutional forces when it comes to liberal arts departments, and that high status schools face market forces when it comes to practical arts departments.

This paper might have synergies with Peter Eckel's (2002) in depth study of programs at four public universities. The author provides a rich description of various ways that universities "got away" with program termination. In doing so, he does not foreground the practical nature of programs as I do here, however the bulk of program terminations in his sample where practical, and it is possible that "getting away with it" is another way of saying that a program is not shielded from institutional culture. For example, a closed journalism program was seen as "too professional or quasi-commercial". Another faculty member from a group of closed programs that included urban studies, and radio, television and film, stated the following, "We were in a College of Arts and Humanities, that obviously is the cornerstone of this university like ours, but we were a professional program. We were conditional; we weren't English; we weren't history; we weren't art. Parenthetically, the other program that got closed [in the college] was another professional program." (Eckel 2003: 14). My take on the results of this present study of departments is that universities can get away with closing practical departments but places like the NY Times and the Chronicle of Higher Education take note when universities close liberal arts departments.

This paper also has a number of limitations. First, departmental closure is the most extreme measure of disciplinary failure, it is possible that departments are the most institutionalized dimension of universities. Future research must explore the many ways in

which disciplines and their departments can erode prior to department closure (e.q., declining enrollments, budgets, declining number of professors, declining amount of research dollars). Second, the present analysis does not have independent measures of quasi-market forces and institutional forces.[23] Most studies of university change have these limitations, but these are still limitations. The model would also benefit from the inclusion of control variables for the financial health of the institution, the level of state support (for public institutions), student demand for different departments (especially in institutions that allocate resources based on FTE), the gendered mix of students in each department, the number of faculty in each department, the type of budgeting system used by the institution, but unfortunately these data are not available at the moment. Future research is particularly needed that links specific departments with specific quasi-market signals. One could imagine using longitudinal data on employment (either aggregate, or in various fields) to test the quasi-market-pressure argument. In future work, it would also be useful to think about different kinds of markets (e.g., students, politicians, foundations, alumni) and different kinds of institutional supports (e.g., disciplinary associations, journals, number of other universities with like departments).

The data set also has limitations. It is particularly good for studying doctoral and Masters granting universities (see Brint et al. 2012). However, as can be seen in the findings, more

[23] I do not take institutionalization and pervasiveness to be equivalent, a position taken by a number of scholars (see Kraatz and Zajac 1996; Colyvas and Jonsson 2011). I argue that market demand and institutionalization are separate (and sometimes overlapping) forces shaping universities, and that each can potentially explain why some academic fields are widely offered by American universities. A good sign of institutionalization is to watch what occurs to an institutionalized department and a market-facing department that are otherwise equivalent. If both experience drops in student demand but only the market department is closed we would have support for institutionalization. Similarly a very good measure of institutionalization would use a survey to ask whether a given field, like Greek, should continue to exist in the face of declining student interest.

information is needed for lower status baccalaureate granting universities and lower status liberal arts universities. Furthermore the data set contains information on a few hundred universities out of a population of thousands of universities. It also does not have information on community college or for-profit organizations. Unfortunately this is the best data set that we have at the moment.

In terms of model building, the present paper uses discrete variables to distinguish between quasi-market-driven disciplines and institutionally-driven disciplines. Future research must consider the probability that this distinction differs along a spectrum with some quasi-market driven disciplines sitting at the absolute extreme from institutionally driven disciplines and with other quasi-market driven disciplines sitting quite close to institutionally driven disciplines. A closer look at individual disciplines might find a 2x2 relationship where different disciplines having a different relationships to quasi-market forces and institutionalization. Lastly, the binary status variable used in this analysis is imperfect. Future research would benefit from having a more subtle measure of status that considers how status can change over time; however it seems important to keep in mind that the analysis captures substantial differences between highly selective schools and less selective schools. Despite these challenges the above paper addresses a particularly topical question, provides counterintuitive results, and suggests an alternative approach, an approach which shows the utility and limitations of existing accounts of university change. In particular it provides the best data for testing of proposals from academic capitalism about changes to university disciplines and departments since it looks at all disciplines at once across a large sample of universities.

The proposed *Double-Facing* theory of university change implies a number of important consequences for universities that go beyond the present question of which departments are most

likely to close. Indeed it suggests a number of hypotheses that should be studied by future research. For example, many researchers suggest that the biomedical sciences are exceptionally close to quasi-markets. The *Double Facing* theory predicts that universities churn the biomedical science by adding and closing departments and thus have higher failure rates than traditional sciences.[24] The *Double-Facing* theory also suggests that low student enrollment is much more consequential for market churning fields than for institutionalized fields. Consequently, *Double-Facing* theory would be supported if universities close low enrollment practical programs but keep low enrollment liberal arts programs. [25] The proposed theory also suggests that periodicals such as the *Chronicle of Higher Education* will be more likely to report the closing of institutionalized fields than they are to report the closing of fields that face quasi-market churning. Lastly, the present paper only explores which departments are most likely to close and does not address the question of department openings. It would be completely consistent with the *Double-Facing* theory to find that universities are most likely to add practical departments.

[24] The present study is not a good arbitrator of this hypothesis since the College Catalog Study does not include data from medical schools.

[25] At this point no reliable crosswalks exist to link Brint's department data with IPEDs enrollment and completion data. Existing research links specific changes and national student demand with specific changes in the population of university programs and departments (Brint et al 2012; Kraatz and Zajac 1996), but no one has yet linked specific departments or programs to specific market signals.

CHAPTER 2: THE ACADEMIC CHOPPING BLOCK: BIOMEDICAL SCIENCE DEPARTMENT CLOSURES AT THE *DOUBLE FACING* UNIVERSITY (1975-2010)

Introduction

Universities are experiencing "a quiet academic revolution" in the face of political scrutiny, significant budget crises, controversies over student debt, and the growth of online education (Hackett 2014), and consequently, universities across the country have faced the difficult task of closing departments and programs (Flaherty 2014; Rogers 2013; Jaschik 2010). Since department closures radically change the education that universities offer and influence the research pursued by faculty (Bastedo & Gumport 2003; Gumport and Snydman 2002), it is crucial to observe how universities terminate their academic departments, an activity that I label as the academic chopping block.

Which academic fields do universities prefer to close during times of academic retrenchment? Much of the discussion of university restructuring has been about the closing liberal arts and humanities disciplines, but the question of academic science restructuring deserves equal attention for a number of interesting reasons. First, research highlights the termination or decline of traditional sciences, such as botany and zoology (Frank and Gabler 2006; Brint et al 2012). Many of these fields share a common history with the humanities, and the vulnerabilities that these traditional sciences they face are similar to the vulnerabilities that their humanistic counterparts face. Second, in many ways the story of university change since the 1970s is a story of commercialization, and few areas of study are more commercial or have greater entrepreneurial-spirit than the biomedical sciences (Owen-Smith and Powell 2001; Owen-Smith and Powell 2002). Consequently, scholars highlight the strength of these entrepreneurial sciences while implying that the sciences typically associated with the liberal arts

are relatively week and are most likely to lose the most classes, programs, and departments (Frank and Gabler 2006; Slaughter 1993; Brint et al 2012).

Scholars are probably correct that population shifts favor entrepreneurial fields, such as the biomedical sciences. When universities consider adding new science programs and departments, they likely prefer adding programs and departments associated with entrepreneurial fields. At the same time, however, the slightly different but equally important question of disciplinary and department closure must be re-examined. My research suggests a department's entrepreneurial spirit or proximity to quasi-markets might actually be a vulnerability when facing academic chopping blocks (see chapter 1). Consequently, if we want to know which academic sciences are most likely to lose classes, programs, and departments, we should look at the most commercialized scientific fields that have unfavorable market conditions. With this in mind, we must examine what happens when the biomedical sciences face academic chopping blocks. Up until now these set of disciplines have not been examined.

This paper specifically examines the closing of science departments and compares the fate of biomedical departments with the fate of traditional sciences typically housed in colleges of letters and science. I propose that biomedical science departments are not shielded from the whims of quasi-markets by institutional culture. In contrast, traditional sciences are shielded to some extent from quasi-markets by the institutionalized belief that the traditional sciences are a defining characteristics of the university. Consequently, I hypothesize that universities close biomedical science departments at a higher rate than they close traditional science departments, Drawing on a sample of 2280 science departments, I show that the closure rate of biomedical science departments is between 1.7 and 2.2 times higher than L&S science departments. These results challenge many assumptions about the American commercialized university. While many

analysts assume that a turn towards business values has primarily hurt the liberal arts and traditional mainline sciences, this research shows that the opposite is the case.

This paper is also a timely addition to the debate sparked by Bruce Alberts and colleagues about rescuing the biomedical sciences (2014). The findings I present are surprising given that according to many measures the current era is a golden age for biomedical research (Alberts et. al 2014). Even at a time of expansion and growth, we still see substantial numbers of biomedical department closures. The results presented here can help to inform our existing understanding of the organizational status of the biomedical sciences.

In what follows, I describe the three existing empirical and theoretical traditions that have addressed the fate of academic sciences (academic capitalism, new institutionalism, and the empirical studies of Stephen Brint and his colleagues). Next, I outline a *Double-Facing Theory* of university change. Finally, I describe the vulnerabilities of the biomedical sciences in greater detail, and then I provide data analysis showing that biomedical science departments have a higher failure rate than traditional science departments.

Existing Literature

How have universities change and how has this change shaped the sciences? One of the biggest shifts occurring to universities has arguably been a turn away from basic academic interests and shift towards more practical, commercial, and marketable concerns (Gumport 2000; Kirp 2003; Reading 1995; Bok 2007; Geiger 2004; Slaughter and Leslie 1997; Slaughter and Rhoades 2004). This turn has brought about many changes to universities, but some of the biggest and earliest changes came to the academic sciences. This change was particularly pronounced for the biomedical sciences, a group of academic fields that arguably played a large

role in turning towards practical concerns and also appear to benefit from more direct orientation towards commercial and marketable interests. Academic biosciences and industrial life sciences, scholars argue, are no longer two distinct fields. Life science research conducted, particularly in medical centers, is very close to commercial needs and thus contributes to the volume and overall value of university patents (Owen-Smith & Powell 2003). Others argue that medical center faculty are more entrepreneurial, more willing to work in teams, and more open to change and thus could be ambassadors for a more market-driven university (Azziz 2014).

How can we explain the commercialization of the biomedical sciences and as well as the broad turn towards practical interests and how do these changes influence academic chopping blocks? At least three existing research traditions have attempted to answer this question. Each of these approaches assert or imply a similar conclusion. A major result of a turn towards practical interests is that: universities are more likely to close the classes, programs, and departments of traditional mainline science disciplines, those typically associated with the liberal arts and basic scientific interests (see chart below).

So, for example, Stephen Brint and colleagues (2012a) used undergraduate enrollment data from the National Center for Education Statistics to study the most declining *individual* undergraduate *programs* between 1970 and 2006.[26] Their data show that the science programs with the highest rates of absolute and relative decline include botany and zoology, two legacy academic fields that are largely driven by basic scientific interests. The total population of these

[26] They examined absolute decline, which occurs when total population of a given program in 2006 is smaller than the population in 1970, and relative decline, which occurs when the population of a given program does not increase along with the growing population of universities. Concentrating on undergraduate programs that existed at 20% of universities in 1970, the authors identify 15 programs experiencing the most absolute and relative decline.

disciplines shrunk by 50 programs or more between 1970 and 2006. Other sciences demonstrating absolute decline include physics and geography.

Two theoretically driven projects also talk about the turn away from basic scientific interests and imply that traditional sciences typically housed in schools of letters and science are the more vulnerable to academic chopping blocks than more entrepreneurial sciences like the biomedical sciences. For example, scholars from the Global-Culture tradition of New Institutionalism[27] argue that when it comes to the question of what sciences are most vulnerable to closure, university change is primarily shaped by long-term shifts in global culture (Frank & Gabler 2006; Frank, Schofer, & Torres 1994; Gabler & Frank 2005). Universities, they argue, are in the business of methodically discovering and teaching "truths about serious and important things" (Gabler & Frank 2005). Consequently, universities change when we collectively change what we consider to be serious and important things. Disciplines that do not align with shifting global cosmologies about what is serious and important will be vulnerable to termination. Two important cultural shifts have made some scientific disciplines vulnerable to closure. First, according to analysts in this tradition, science has become less interested in sacred origin stories and more interested in evolutionary origin stories. Second, science has been less interested in simply observing nature and more interested in manipulating nature.[28] Consequently these

[27] Scholars from the new institutional tradition argue that organizations strive to appear legitimate by working to satisfy taken for granted norms about what organizations are and how they should behave and consequently come to look alike over time (DiMaggio and Powell 1983; Colyvas and Jonsson 2011). This orientation specifically argues against those who see universities as being shaped by student demand, university resources or market dynamics. Instead universities are shaped by universalized myths about what proper universities look like and consequently posit the same identities, offer the same curriculum, and have similar patterns of enrollment growth (Meyer et al. 2007; Frank and Gabler 2006; Davis and Powell 1992).

[28] According to these authors such changes amount to cosmological shifts in the global myths about what divinities can know and do and what humans can know and do (Frank & Gabler 2006; Frank, Schofer, & Torres 1994; Gabler & Frank 2005). The authors argue, "Instead of passively observing a universe that

authors argue that many traditional sciences do not fit well with new global cosmologies and are thus vulnerable to termination. Scientific disciplines especially susceptible to closure are Astronomy, Botany, and Zoology.[29]

Another group of scholars has a completely different understanding of university change and the turn toward practical interests. These authors argue that universities are increasingly shaped by commercial values and practices and, when faced with severe budget cuts, university administrators have intentionally blurred the lines between the public and private sectors in an effort to establish new connections between business and higher education (Slaughter and Rhoades 2004). In this climate, universities follow quasi-market signals and are biased towards disciplines that are close to quasi-markets.[30] Although their studies examine different measures of university change, their work overall implies that university administrators support those science departments that teach career-oriented curriculum and that research market relevant topics. Disciplines that create jobs, garner large federal grants, maintain relationships with industry, and generate patents are also likely to earn support (Slaughter and Leslie 1997; Slaughter and Rhoades 2004; Slaughter 1993, 1998; Volk et al. 1995). Consequently, those academic programs and departments that can successfully characterize themselves as being

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was created at Genesis and thusly ordered forevermore, individuals are now active participants in a dynamic universe" (Gabler & Frank 2005: 187).

[29] A large empirical study that looked at changing faculty hiring practices found many of the predicted patterns. They found that the percentage of faculty members working in applied natural science fields rose, whereas the corresponding percentage in basic natural science fields fell (Frank and Gabler 2005:69). Changes within the natural sciences also followed specific patterns. Between 1915 and 1935, 2.7% of faculty were botany professors, but by 1995 botany professors only amounted to 1.1% of university faculty. As for other fields, losses in the percentage of faculty followed expectations: (-6%), mathematics (-24%), chemistry, physics, biology, zoology (-54 %), botany, astronomy (-89%).

[3030] The term "quasi-markets" comes in later work involving Sheila Slaughter (Taylor et al. 2013). I use it throughout this paper since it nicely foregrounds the fact that universities face incentives and competition not just from typical markets but also from federal and state governments, among other things.

market relevant are consistently supported by administrators while others are deemphasized or closed (Slaughter 1993; see also Engell and Dangerfield 1998).[31] These scholars argue that the following fields are most likely to grow and are least likely to close: Physical sciences, Computer sciences, Information sciences, and Biomedical sciences (Slaughter 1993).

Table 1:
Predictions and Findings about Scientific Disciplines from the Existing Literature

	Global Culture New Institutionalism	**Academic Capitalism**	**Brint et. al 2012**
Declining Sciences	Basic Natural Sciences, but most importantly: Astronomy, Botany, Zoology	Liberal Arts	*Relative and Absolute Declines:* Zoology, Botany, Crop Science, Physics
Steady/Growing Sciences	Biology, Chemistry, Physics, Geology, Mathematics, Medicine	Physical sciences, Computer sciences, Information sciences, Biomedical sciences	*Relative but not Absolute Declines:* Chemistry, Mathematics, Biology

In total, the existing literature provides the impression that traditional sciences are the most vulnerable to closure on US campuses. Each of prominent approaches to the problem of academic department growth and decline provides important insight into organizational dynamics within American universities; however, each has a number of important limitations, and these necessitate a reexamination of the question of which sciences are most likely to have their courses, programs, and departments closed. First, we have a data limitation. Most of these studies examine a select few scientific disciplines and have not considered the fate of the biomedical sciences. This in and of itself necessitates the reassessment of the question at hand.

[31] Such characterization is not natural; instead Slaughter argues that some disciplines have simply been more successful at rendering themselves as being market relevant

At the same time, however new research raises questions about the accounts provided by global new institutionalism and Sheila Slaughter's academic capitalism[32]. Following this, I put forth an alternative understanding of university change which challenges these two existing accounts and furthermore generates new expectations about what scientific fields are likely to close. I describe this new research below.

The Double-Facing Theory of University Change

Craig Rawlings carefully examined evidence that supports the conflicting positions of global new institutionalism and market accounts of university change. Citing inconsistent evidence for these two positions, he argued that we should not think of universities as *either* being shaped by the market *or* by institutional culture, but that universities are shaped *both* by institutional culture *and* market forces (2012; 2013). Prompted by this work, I propose a *Double-Facing Theory* of university change, which argues that academic disciplines constitute the main dividing line between those parts of the university shielded by institutional culture and those that face the whims of quasi-markets. Some academic disciplines follow the expectations of market accounts and churn by opening and closing departments at a relatively high rate, while other disciplines follow the expectations of new institutional theory and thus are relatively stable and uniform across universities. Churning is a term used in the business literature to describe simultaneous closings and openings. I use it here to help clarify that I'm not arguing that the practical arts and the biomedical sciences are in decline. Instead, I'm arguing that they open and close relatively rapidly.

[32] The term "academic capitalism" was originally coined by Edward Hackett and was subsequently taken up by Shelia Slaughter and her colleagues.

A central assumptions of global new institutional theory is that universities will come to look the same over time and that their offerings of courses, programs, and departments will be uniform or isomorphic (Meyer and Rowan 1977). A look at national program enrollment data[33] suggests that universities do in fact offer a fairly uniform set of programs and departments in the liberal arts. Most universities offer chemistry, philosophy, literature, mathematics, sociology, and physics. In contrast to institutional theory, one of the key expectations of market accounts is that universities will come to offer a diverse selection of programs and departments as they work to satisfy various market niches (Carroll & Swaminathan 2000; Olzak & Kangas 2008; Rawling 2012)[34]. We do find a great deal of diversity when looking at the offerings of practically-oriented degrees and departments such as engineering, business, and education. Flagship state schools often offer mainline engineering programs like civil engineering and mechanical engineering, lower status state schools often offer another selection of practical degrees, and some high status liberal arts schools offer no practical degrees and departments at all. This diversity suggests that, when it comes to practically oriented disciplines, universities adapt to external demands and thus show signs of market influence (see e.g, Hackett 1990; Thompson 1967; Kraatz & Zajac 1996; Furman and MacGravie 2007; Kohler 1982:322). In total, it appears that universities follow institutional culture when it comes to liberal arts programs and departments but follow niche markets when it comes to practical arts degrees.

An important consequence is that liberal arts programs and departments are thus less vulnerable to closure than practical arts programs and departments because liberal arts

[33] *Integrated Postsecondary Education Data System.* U.S. Department of Education. Institute of Education Sciences, National Center for Education Statistics.
[34] Rawlings argues for example that, "lower status institutions compete for more specialized reputational niches by differentiating programs in ways that appear more strategically savvy." (2012:5)

disciplines are supported by institutional culture and thus relatively protected from the vagaries of quasi-markets. Insofar as practically oriented academic departments[35] produce results that are aligned with quasi-market demands, these quasi-market helps bolster these academic fields (Kraatz 1998; D'Aunno, et al. 2000). However, market demand changes can render some academic fields impractical and consequently can lead to reductions or terminations in the number of faculty, programs, and departments offered by American universities. Hence, these disciplines churn by opening and closing departments at a relatively high rate. Home economics and secretarial sciences are two good examples. Both of these fields demonstrated a steady decline as women and society had less and less need for these fields (Brint et al 2012). Furthermore, elsewhere I compare the failure rates of liberal arts departments and practical arts departments and found that practical arts fields, like business and education, have a much higher failure rate than academic departments associated with the liberal arts (see chapter 1). In another study I found that low enrollment engineering programs have a much higher failure rate than low enrollment language programs (see chapter 3). These findings reinforce the idea that the liberal arts are shielded, to some extent, from quasi-market demand by institutionalization. In other words, they are constitutive part of what it means to be a university. In contrast, the practical arts churn in response to market signals by adding and closing departments at a relatively high rate.

[35] Early commentators on the commercialization of universities argued that market proximity was an essential good for any academic discipline (Slaughter 1993, 1998; Volk et. al 2001). University officials, these authors suggest, always bolstered those academic fields and their departments that are close to the market and that offer students practical skills, marketable products, and profitable patents.

Looking at Scientific Disciplines in Light of This New Research

With this new research in mind, we must entertain the possibility that some scientific fields are protected by institutional culture and that other fields face the ups and downs of the quasi-markets, such that failure rates of scientific fields will depend in part on the extent to which they are subject to external pressures[36]. Of course, proximity to quasi-markets does not in and of itself make scientific fields vulnerable to closure. Scientific fields that respond to external demand or satisfy important external constituencies will often continue even when they lack institutionalization. In other words, academic fields do appear on campus that are not central to the very identity of what universities, and these disciplines will continue as long as they satisfy some quasi-market demand. However, fields that are not a part of institutional culture are more vulnerable to external critics and drops in demand than their scientific counterparts that are shielded by institutional culture.

So what scientific fields are close to the market and have faced challenging market conditions? As I have already mentioned many scholars believe that the biomedical sciences are some of the most commercialized sciences on campus and are thus highly influenced by changes in the market. Most of the early university patenting activities of the 1980s occurred in the biomedical sciences, and some have argued, for example, that, "at most universities, life science and particularly biomedical research represent the leading edge of commercialization efforts" (Powell and Owen-Smith 2002:123). Commercialization of the biomedical sciences involved a fundamental shift away from the basic sciences and towards applied sciences. This turn also entails the merging of two previously distinct realms of research. Now, a hybrid technological

[36] For an extended discussion of academic science's dependence on external resources see Hackett (1990).

community exists (Owen-Smith and Powell 2001), where success in one sphere depends upon success in the other (Owen-Smith, 2003), where breakthroughs in basic science often have immediate commercial relevance (Owen-Smith and Powell 2001), and where scientists easily move back and forth between industry and academia (Powell and Owen-Smith 2002).

In sum, the biomedical sciences are exceptionally close to the market. If academic capitalism is correct than a bias towards market relevant fields would shield the biomedical sciences from academic chopping blocks. In contrast the *double facing theory* predicts that biomedical sciences will churn in response to quasi-market changes. If the *double facing theory* is correct, universities will support these disciplines insofar as they continue to satisfy quasi-market demand. However, this characteristic of market proximity can also create a potential vulnerability for biomedical sciences departments within American universities (see chapter 1).

The question remains: what have the quasi-market conditions been for the biomedical sciences over the last 20 years and how has this affected their fate. By most accounts the last two decades have been a Golden Age for the biomedical sciences (Alberts et. al 2014). Relative to other STEM fields, the biomedical sciences have the highest faculty salaries (Stephan 2012: 40), the largest square foot of research facilities (Stephan 2012: 107) and the largest share of federal university research and development funding (Stephan 2012:129). At the same time however, these fields have also faced a number of market challenges. In particular, I argue that the interdisciplinary movement, decrease NIH funding, and increased clinical competition has put pressure on the biomedical sciences and compelled them to open and close their departments. In what follows, I describe these market challenges.

External Factors shaping the Biomedical Sciences

Reduced NIH Funding, Student Demand, and Increased Clinical Competition: The organizational theory I propose suggests that changes in external demand will shape academic disciplines differently. Universities are likely to support institutionalized disciplines and their departments even when they face reduced research funding, reduced demand from students, and external pressure from social movements. We do know that many scientific fields suffered challenging budgetary conditions over the past 20 years, but, if the *double facing theory* is correct, we would expect to find that the consequences of budgetary challenges would be more severe for fields such as the biomedical sciences because they are not shielded by institutionalization. In fact, a major vulnerability faced by the biomedical sciences derives from changing NIH funding. The external constituencies that prop up the biomedical sciences, particularly those departments housed in medical schools, have changed substantially in the last 20 years. Biomedical sciences, particularly those at medical schools, rely heavily on funding from NIH, and since the 1990s NIH funding has flattened or contracted. Writing in the 1990s, many from the community of medical schools complained of reduced NIH funding, and this funding pattern has largely continued into the 2000s (Dorsey et al. 2010). Some writers began to see biomedical sciences as seriously vulnerable to this new reality, and some universities rearranged their basic science departments in an effort to better attract NIH money (Whitcomb 2005; Rajan 2001).

Interest from students is another form of external demand that can shape the biomedical science, and we know that the graduate student interest in pursuing some biomedical sciences has declined substantially. While demand from some biomedical field has grown significantly, the number of anatomy PhDs awarded dropped by 70% between 1985 and 2000 (Mallon and

Bunton 2005). In fact, shifts away from anatomy in the 1980s has created a contemporary shortage of professors that are willing and able to teach anatomy (McCuskey et. al 2005). If the *double facing* theory is correct, reduced student interest will have more severe consequences for market driven fields like the biomedical sciences.

Another source of support for biomedical sciences typically found in medical schools are clinical fees derived from academic hospitals. University hospitals and practitioners charge fees for service and part of these funds are used to support biomedical research. As is the case for NIH funding, these clinical fees shrunk in the 1990s. Following the rise of Health Management Organizations (HMOs), university hospitals faced increasing competition over clinical practice from cheaper community service providers (Cohen 1998; Heinig et al. 1999).[37] Communities increasingly had too many hospital beds (Aaron 2000), and inpatient administrations were down and revenues were flat. Many university hospitals received bond downgrades (Hancock 2013). This situation forced many hospitals to reduce operation costs; consequently, medical schools received fewer funds to subsidize clinical fees and thus reduced money for research and education (Barachi 2000; Rabkin 2008; Korn 1996; Heinig et al. 1999; Cohen 1998; Carlson 1999).[38] The basic sciences continue to rely on clinical fees from academic health centers to subsidize research even when faculty members receive external funding (Dorsey et. al 2009).

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[37] "Although teaching hospitals affiliated with academic medical centers can often boast the most advanced technologies and distinguished physicians, they are often at a price competitive disadvantage with community hospitals, staffed by their graduates, which are not simultaneously sustaining programs of medical education and research and specialized facilities and laboratories, or subsidizing a significant volume of indigent care" (Heinig et al. 1999)

[38] As one article argues: "Academic medical centers attempt to minimize operational costs, control utilization of resources, increase efficiencies, and [thus] curtail the subsidization of activities not directly supportive of patient care. The leadership of these centers imposes increased productivity targets in patient care on physician staff, which reduces the time available for research, teaching, and other academic pursuits" (Heinig et al. 1999).

NIH funding did briefly increase in the 2000s, but concern about funding for the biomedical science has grown louder in recent years. (Teitelbaum 2008; Stephan 2012). Most recently, Bruce Alberts and colleagues published a high profile paper in the *Proceedings of the National Academy of Sciences*. They argue that the demand for research dollars is growing much faster than supply (2014). They assert that universities are simply too ambitious and misread market demand for biomedical sciences. They say, for example, that, "We believe that the root cause of the widespread malaise is a longstanding assumption that the biomedical research system in the United States will expand indefinitely at a substantial rate" (2014). Paula Stephan makes a similar argument, stating that the biomedical sciences misread NIH budget increases in the early 2000s (2012:142, 150).

In total, reduced NIH funding, some reduced student demand, and increased clinical competition have created a destabilizing situation for academic medical schools and the biomedical sciences that depend upon them. In this context, we would expect a great deal of shuffling as medical schools close and open academic departments in an attempt to secure new funding opportunities.

We see discussion of some of this shuffling in *Academic Medicine*, the main trade journal of the Association of American Medical Colleges. One author, for example, complains that universities have attempted to "chase" new NIH funding by closing Anatomy departments and by opening the more "sexy" departments (Rajan 2001). Generally speaking, Anatomy departments are legacy departments[39] that have existed since at least the mid-1910s and that have

[39] Pharmacology, Biochemistry, Microbiology, and Physiology are also legacy departments that existed at most medical school from at least the 1950s. Many of these departments existed as far back as the late 1800s.

experienced substantial change since the mid-1980s (Mallon et. al 2003). Apart from changes in scientific knowledge and practices, such changes were attempts to adapt to external demand, particularly demand from graduate students (McCuskey et. al 2005). [40] I also believe that this constitutes a very important vulnerability for biomedical science departments in general as compared to scientific departments traditionally housed in schools of letters and science.

Interdisciplinary Movement: The *Double-Facing Theory* I propose also suggests that external social movements[41] will shape academic disciplines differently. Academic fields that are institutionalized will be shielded and will be less affected by external social movements than other academic fields. The interdisciplinary movement is a very popular set of views that challenges the existing organization of scientific activities into disciplines and departments, a perspective that is particularly influential among some members of the biomedical community. I argue that these views have helped to create an environment where department structures are not taken for granted and where universities are more likely to consider closing departments.

The interdisciplinary movement comes from federal agencies, academic commentators, and policy advocates and explicitly aims to disrupt academic disciplines and their departments (Jacobs and Frickel 2009). Proponents of this interdisciplinarity argue that the real problems of the day demand collaboration from multiple scientific disciplines (Wilson 1998; Rhoten 2004; Jacobs and Frickel 2009; Klein 1990; Gibbons, et al 1994). Individual disciplines, critics argue, can be too conservative, often privilege disciplinary concerns over social concerns, tend to

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[40] For example, the Indiana University Anatomy Department "officially changed its name to Anatomy and Cell Biology, reflecting … the need to change its profile to better recruit graduate students." (see http://anatomy.medicine.iu.edu/welcome/history/)

[41] Social movements are not typically conceptualized as markets, but in this case, the interdisciplinary movement is an important external factor shaping academic science, and it shapes market demand by advocating for specific ideas about how knowledge should be created.

engender excessive specialization and can ignore important questions (Jacobs and Frickel 2009; Whitley 1984). Instead, science should pursue problems that address social and economic goals rather than disciplinary goals (Klein 1990: 13), problems that quite often lie at the intersection of different disciplines (Brint 2005). So, for example, proponents of interdisciplinary science hope that biologists come to understand enough chemistry to grasp how new chemistry developments can address long standing biological challenges (Alberts 1994).

In order to spur collaboration across departments and disciplines, some scholars have argued that universities must reconsider the institutional configuration of science and should specifically turn away from academic departments as an organizational tool, since academic departments create disincentives for interdisciplinary research (Sa 2008; Klein 1990; Lattuca 2001; Feller 2002). Relatedly, interdisciplinary proponents among the biomedical sciences argue that medical schools, "should be continually reshaped and must evolve with the creation, the solution, merger and separation of its divisions, as dictated by the academic assets and critical masses of each. They cannot be immobilized by tradition, legacy, and assumptions of ownership" (Schafer 2002). Biomedical sciences should either transfer "budgets from the weakest departments to the strongest centers" (Schafer 2002), or they should abandon traditional academic departments in favor of interdisciplinary centers (Brint 2005; Sa 2008). This effort has generated a great deal of support for research centers (Mallon and Bunton 2005) and has led faculty and department chairs to worry about changes to the power, and funding of departments (Ibrahim et al., 2003; Fischman, 1998; Galbreath, 2004).

In total, we can clearly see that critics are openly hostile to the use of departments as an organizing tool for the biomedical sciences, and many universities are willing to try alternative organizational arrangements. There is preliminary evidence that administrators are willing to

spend money on new interdisciplinary programs and funding agencies are interested in funding them at the expense of established fields (see e.q., Klasko et. al 2011; Carlson 1999). Furthermore, the interdisciplinary movement is an explicit attempt to de-institutionalize biomedical departments, and it is plausible that critics who openly question whether the biomedical sciences should be organized into departments have helped to create an unsettled situation where biomedical departments are not taken for granted. This, I believe, constitutes an important potential vulnerability for the biomedical science departments.[42]

Hypotheses: In total, the biomedical science programs face three key vulnerabilities that make them more likely to be closed than traditional science departments typically associated with the liberal arts. First, the biomedical sciences have faced substantial cuts from NIH funding and from reduced clinical fees. Second, the interdisciplinary movement has successfully challenged the very need for biomedical science departments, weakening any institutional protection established biomedical sciences might have had and making them vulnerable to a decline in market demand. Third, the interdisciplinary movement and the situation of reduced funding is particularly problematic since the biomedical sciences most likely lack the institutional support that traditional sciences can rely upon. *Given these three vulnerabilities, I*

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[42] An alternative account might argue that the interdisciplinary movement has not led to a closures among the biomedical sciences. Instead, they might argue, for example, that biomedical sciences have simply migrated from traditional departments into interdisciplinary research centers. It might be the case that the biomedical sciences are alive and well, but they simply do not exist within academic departments. However, research suggests that a migration from departments into research centers is minimal at best. A large-scale study conducted by Association of American Medical Colleges suggests that research centers have proliferated but academic departments continue to have organizational priority. Surveying 761 research directors at roughly 70 universities the authors argues that most centers do not control faculty appointments and contribute little to faculty salaries (Mallon and Bunton 2005). Through the control over faculty appointment, promotion, and tenure decisions, departments continue to shape the cultures, norms and intellectual orientations of the disciplines. Research centers do sometimes provide education but, in this study, 85% of the centers do not grant education degrees. In total it appears that most research centers exist to supplement biomedical departments rather than to replace them. Consequently the closing of academic departments is a meaningful measure of churning for the biomedical sciences.

hypothesize that the biomedical sciences will have similar if not higher closure rate than traditional sciences typically associated with the liberal arts.

One final clarification is needed before I move into the analysis. Throughout this paper I have taken for granted the fact that biomedical scientific knowledge has changed substantially since the 1980s. In fact, some readers might ask whether changes in biomedical scientific knowledge actually offer a better explanation of why biomedical science departments change. Indeed, members of the biomedical community speak about department changes in terms of scientific changes (Rock 2009; Lentz 2011; Rowely 1971; Rose and Bigazzi 1972). However the purpose of this paper is to compare changes among traditional science departments with changes among biomedical science departments, and it's not clear that the biomedical sciences have experienced more scientific change than the traditional sciences. Traditional physics and chemistry departments have made scientific advances since the 1980s, but they demonstrate far fewer changes in department structure. So there is no question that scientific advances shape academic department structure, but this is not the whole story.

Data and Analysis

To test the hypothesis of this paper, I conduct a, longitudinal, multivariate event history analyses of academic science department closures between 1975 and 2010. I use four data sources, two of which were developed by Steven Brint and colleagues: the College Catalog Study (Brint et. al 2011a) and the Institutional Data Archive (Brint et. al 2011b). The College Catalog Study has department level information on 286 four-year colleges and universities. Mergers, closures, and department additions are tracked at five-year intervals between 1975 and 2010, such that we have department status information for the following years: 1975-76, 1980-

81, 1985-86, 1990-91, 1995-96, and 2000-01, 2005-06, and 2010-11. The Institutional Data Archive contains university level characteristics such as membership within the Association of American Universities, and the Baron's Profile of American College Selectivity.

Importantly, the College Catalog Study does not contain department data for science departments housed in medical schools, although it does have information for biomedical departments housed elsewhere in universities, for instance in colleges of arts and science. Thus, I supplement this data with department closure data collected by William Mallon and colleagues at the Association of American Medical Colleges (see Mallon et. al 2003). This data tracks mergers, name changes, splits, and closures at all medical schools between 1980 and 1999. For those universities in the College Catalog Study, I added medical school closures from this data set.

For years after 1999, I supplemented the College Catalogs study data with a dataset constructed from the Association of American Medical Colleges' *Directory of American Medical Education.* These annual directories provide the name and chairs for each department in a given medical school and consequently tell us which departments were offered at medical schools in any given year. I collected data for every medical school associated with a university found within the College Catalog Study.[43] I used the 2010-2011 directory to match with the College Catalog Study. To create a base line, I collected information for each school that had these departments listed in the *Directory of American Medical Education:* development biology,

[43] I specifically excluded clinical science departments such as Anesthesiology, Internal Medicine, and Pediatrics. Following Mallon et. al 2003, I excluded pathology departments from the analyses because of school variation in classifying such departments as clinical or basic science. Some other unique departments were excluded because they were rare or too new to face the risk of closure. Medical humanities departments were excluded since they are not science in the traditional sense of the word.

neuroscience, neurobiology, biomedical sciences, genetics, biochemistry, molecular biology, immunology, genetics, microbiology, cell biology, structural biology, physiology, medical chemistry, medical physics, pharmacology, biophysics, biomedical informatics, biomathematics, biostatistics, epidemiology, health care policy, medical social sciences, and anatomy. To gather closure data, I compared the list of medical school departments in the 2010-2011 directory with the list of medical school departments in the 1999-2000 directory. I also verified Mallon's data by looking at department information in the years 1974-1975, 1979-1980, 1984-1985, and 1989-1990. Since most departmental changes were mergers or name changes, I verified potential department closures with telephone calls to medical schools.

Traditional Science Departments vs. Biomedical Science Departments. All departments in my composite dataset were classified as either traditional science or biomedical science. Traditional science departments include such fields as entomology, zoology, botany, ecology, chemistry, mathematics and statistics, physics, meteorology, atmospheric, marine, and oceanic sciences, environmental science, engineering, toxicology, and health, geology, astronomy, paleontology, and earth sciences. Biomedical science departments are listed above. Table 1 summarizes the total number of departments in the analyses. This includes departments that existed in 1975 or emerged after 1975. Noticeably, the number of traditional science departments in any given cohort that face potential closure is higher than the number of biomedical departments that face the risk of closure.

Renamed Biomedical Departments: There is some question about how to approach medical school departments that change their name but continue to exist.[44] It's not completely

[44] Stephen Brint's College Catalog data makes a point of distinguishing between rebranded departments and departments that dropped a discipline.

clear whether name changes represent a rebranding of the same discipline or a deliberate choice on the part of universities to drop one discipline and to promote another. This is particularly relevant for anatomy departments. Nearly all medical schools had anatomy departments at least since the 1910s, but, during the 1980s, many of these departments added the name cell biology and then eventually dropped the name anatomy all together.[45] There is some evidence these name changes represent a deliberate choice on the part of universities to drop one discipline and to promote another and not a rebranding of the same discipline (Carlson 1999). Cell biology was a distinct discipline by the 1960s with distinctive methods, subjects of interest, and professional societies (Bechtel 2006; Lentz 2011, McCuskey et. al 2005).[46] In fact, growing interest in cell biology arguably contributed to the closing of two anatomy departments in the 1960s, and some commentators actually suggested that all anatomists should become cell biologists or cytologists (Crafts 1965). Contemporary anatomists lament that contemporary anatomy graduate students have more interest in courses on cell biology than traditional courses in anatomy (Carlson 1999). Given this I run a separate analyses that classifies the removal of anatomy from a department as a department failure.

Control Variables

Status: Craig Rawlings (2012) argues that lower status universities are more likely than higher status universities to close courses, programs, and departments. To examine whether this is the case, I control for university status. Following various other studies, I use selectivity as a

[45] Of the 43 departments in the sample with anatomy departments in 1975, 21 of these dropped the name anatomy. We also know that the production of anatomy PhDs has declined while the production of PhDs in cell biology have risen (Mallon and Bunton 2005)

[46] For example, the Indiana University Anatomy Department "officially changed its name to Anatomy and Cell Biology … to reflect the infusion of newer faculty who were using cellular and molecular techniques." (see http://anatomy.medicine.iu.edu/welcome/history/)

proxy for university status under the assumption that highly selective schools are higher status schools and less selective schools are lower status schools (Brint et al. 2012b; Kraatz and Zajac 1996; Jaquette 2011). Here, I use Barron's selectivity index from 2005. Those universities with a selectivity ranking of 1, such as the University of Pennsylvania, or a ranking of 2, such as the University of Michigan-Ann Arbor, are coded as higher status universities. All other universities are coded as lower status. A description of the sample can be seen below in Table 2.

Table 2
Sample Description

Granting	University Type				Departments		Med Schools	
	Higher Status	Lower Status	Private	Public	Biomed	Tradition	Schools With	Schools Without
Masters/BA	32	144	67	109	40	656	8	168
Doctoral	44	41	35	50	255	559	32	54

University Size: Prior organizational literature suggests that organizations with smaller size are more likely to make organizational changes so as to better match their products to the market (Hannan and Freeman, 1977, 1989; Baum and Haveman, 1997). It seems plausible that larger universities will have more resources or greater inertia and thus are less responsive or will be able to better weather various budget crises. Consequently, we might find that larger universities are less likely to close academic departments. One previous study found that this was important for academic programs (Brint et. al 2012). Larger universities were less likely to close several declining academic programs. Consequently, I control for academic size, comparing those universities with fewer than 5000 incoming enrolled freshman with those universities with more than 5000 enrolled freshman.

Public vs. Private Universities: Department failure rates might also differ for public universities and private universities. This is because disparate types of universities have

traditionally relied upon different resources. Public universities typically relied upon funding from the state legislatures, while private universities typically rely upon tuition, endowments and grants (Tolbert 1985). Furthermore, Brint et. al (2012a), for example, found that public universities were more likely to maintain science and technology fields, and also maintained such declining fields as classics and history. Given this, I control for public versus private universities.

University Type: I also control for university type (e.g. doctoral granting vs. masters and bachelor granting) since prior research finds that different types of universities will have different department closure rates. For example, Brint et. al (2012a) found that this was the case in their study of academic program closures. Doctoral granting universities were less likely to drop several basic scientific fields. With this in mind, I control for university type. Drawing on the Carnegie Classification of Universities, I run two separate analyses, one for doctoral granting universities, and one for the combination of masters granting universities and baccalaureate granting colleges.

Descriptive Results

I first use descriptive statistics to identify the most declining departments within the two categories of interest (biomedical vs traditional sciences). Caution must be taken with this table given the small number of department in many of the disciplines.[47]

[47] This chart displays the number of departments with as specific name, therefore some departments are counted more than once. A department of Anatomy and Cell Biology is counted under both "Anatomy" and "Cell Biology". This seems like a better solution than ignoring departments with multiple disciplines, but it also means that this chart cannot be used to count the total number of departments in the sample that face the risk of closures.

Table 3
Number Of Closures Of Departments with the Following Names

Sciences protected by institutional culture				**Sciences facing quasi-markets**			
Closed	*Total*	*% Closed*	*Discipline*	*Closed*	*Total*	*% Closed*	*Discipline*
1	16	6.3	Ecology	0	14	0.0	Neuroscience
17	237	7.2	Biology	1	26	3.8	Molecular Biology
16	201	8.0	Chemistry	1	25	4.0	Genetics
20	217	9.2	Physics	2	41	4.9	Pharmacology
31	317	9.8	Mathematics	4	75	5.3	Cell Biology (Neurobiology)
13	116	11.2	Astronomy	3	32	9.4	Immunology
19	129	14.7	Geology	10	95	10.5	Biochemistry
10	64	15.6	Computer Science (with Math)	6	48	12.5	Physiology
9	52	17.3	Environmental	5	24	20.8	Biophysics
16	51	31.4	Broad Sciences	12	55	21.8	Microbiology
15	40	37.5	Botany and Zoology	7	29	24.1	Anatomy
				2	8	25.0	Biomedical

Results depend upon how we approach the re-naming of anatomy departments. Among the traditional sciences the fields with the highest number of closures includes departments with the names Botany and Zoology, as well as general departments with names like Physical Sciences, Natural Sciences, and Life Sciences. We also see a substantial number of closures in among the biomedical sciences in the following fields: Microbiology, Anatomy, Biophysics and general departments with the name Biomedical Sciences. Column 10 in Table 4 examines the failure rate of these two groups. Results shows no statistically significant difference between these fields, but within the sample the group from the traditional sciences show a slightly higher failure rate than the group from the biomedical sciences. When counting renamed anatomy departments

as dropped, anatomy becomes the most declining science with 50% of anatomy departments in the sample dropping the discipline of anatomy.

Statistical Modeling

For this analysis, I use a Weibull model because I am interested in the time trajectory of department closure and because Weibull model is ideal for capturing the waiting time to closure since it is a flexible monotonic function that is well suited to handle very disparate phenomena involving waiting times. The Weibull distribution is a natural functional form for failures with monotonically increasing or decreasing risk. Each academic department in the data set is assigned various covariates, and each is designated as surviving or closing within the interval 1975 to 2010. STATA estimates hazard ratios (or effects) associated with each covariate. The main model for the hazard of closing of department j is as follows:

$$h(t)=p[e^{(-p(x1\beta1+ \ldots + xk\beta k))}]*[t^{(p-1)}]$$

Where, h(t) is the hazard function, t=time since onset of observation period, p is the Weibull shape parameter, x_1= covariates for department $_1$, and β_1 is the corresponding covariate effects. The effects of a covariate k on the risk is defined as $\exp(\beta_k)$. Results show that a one unit increase in a given covariate is associated with a $\exp(\beta_k)$ increase in department failure rate. Note that β_k tells us about the magnitude of the shift of the *rate* of closure associated with the covariate. When β_k is negative the covariate decreases the rate of failure and when it is positive it increases it. The theory I propose here predicts that institutionalized fields have longer life spans and hence will have lower failure rates. Thus we expect the coefficients associated with institutionalization to be negative. In the provided results tables, hazard rates are reported instead of coefficients to ease interpretation. Hazard rates are derived with the following: $\exp(\beta_i)$.

I also supply the results of Cox Models. I do this because it places fewer demands on the data, and if we find the same results in the Cox model, the results of the Weibull model are acceptable.

The Cox Model is specified as follows:

$$h(t) = h_0(t) \exp^{(x1\beta1+ \ldots + xk\beta k)}$$

where $h_0(t)$ is the cumulative hazard (not directly estimated), x_1 is a variable for department "1" and β_1 is the corresponding coefficient. The Efron method was used to handle ties, and Cox-Snell analysis shows reasonable proportionality (For more on the model see Appendix 3).

Modeling Results

Table 4 shows the results of Cox Proportional Hazards Model as well as Accelerated Failure Time models with Weibull distributions performed on 2 different types of universities (doctoral granting universities and a combination of masters granting, liberal arts colleges, and baccalaureate colleges). Results are Hazard Ratios.[48] Table 5 shows the result of a similar analysis where anatomy renamings are considered department failures. Since the results of the Cox Models are essentially the same as a result of the Weibull Models, I will only discuss the results of the Weibull Models below.

[48] Hazard Ratios are derived by taking the antilog of each coefficient $e^{(coeffiecent)}$, and they describe the effect of one unit difference in the associated predictor on raw hazard (Singer and Willett 2003:524).

Table 4
Event History Analysis (Weibull Distribution and Cox Model)

VARIABLES	(1) Univariate	(2) Everything	(3) Doctoral	(4) Masters & BA	(5) Most Declining	(6) Univariate	(7) Everything	(8) Doctoral	(9) Masters & BA	(10) Most Declining
Biomed vs Traditional	1.458**	1.704***	1.267	2.798***	0.668	1.470**	1.730***	1.298	2.804***	0.640
	(0.165)	(0.297)	(0.256)	(1.060)	(0.193)	(0.243)	(0.301)	(0.263)	(1.067)	(0.184)
High Status vs. Low		0.631***	0.854	0.219***	1.205		0.605***	0.834	0.207***	1.166
		(0.111)	(0.231)	(0.0949)	(0.385)		(0.107)	(0.226)	(0.0896)	(0.371)
Public vs Private		0.676**	0.743	0.553**	0.970		0.672**	0.736	0.561**	0.996
		(0.117)	(0.204)	(0.136)	(0.316)		(0.116)	(0.203)	(0.139)	(0.323)
Small vs Large		1.288	1.274	2.284**	1.273		1.285*	1.261	2.545**	1.274
		(0.199)	(0.216)	(0.879)	(0.320)		(0.195)	(0.211)	(1.003)	(0.316)
Constant						0.000961***	0.00106***	0.000650***	0.000856***	0.00188***
						(0.000296)	(0.000382)	(0.000364)	(0.000523)	(0.00128)
ln_p						1.372***	1.385***	1.533***	1.255**	1.463***
						(0.0881)	(0.0885)	(0.132)	(0.119)	(0.165)
Observations	2,281	2,281	1,174	1,107	326	2,281	2,281	1,174	1,107	326
AIC	2743	2743	2743	2743	2743	1479	1470	801.5	659.8	361.4
BIC	2749	2749	2749	2749	2749	1497	1505	832.0	689.8	384.1
N	2281	2281	1174	1107	326	2281	2281	1174	1107	326
N_fail	187	187	106	81	57	187	187	106	81	57
cmd	cox	cox	cox	cox	cox	weibull	weibull	weibull	weibull	weibull
ll	-1370	-1363	-706.1	-521.9	-302.1	-736.7	-729.2	-394.8	-323.9	-174.7

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5
Event History Analysis (Considers the renaming of Anatomy departments)

VARIABLES	(1) Univariate	(2) Everything	(3) Doctoral	(4) Masters & BA	(5) Most Declining
Biomed vs Traditional	1.934***	2.236***	1.747***	3.158***	0.884
	(0.292)	(0.357)	(0.326)	(1.142)	(0.229)
High Status vs. Low		0.647**	0.894	0.207***	1.292
		(0.110)	(0.232)	(0.0898)	(0.370)
Public vs Private		0.660**	0.711	0.576**	0.914
		(0.112)	(0.185)	(0.141)	(0.267)
Small vs Large		1.273*	1.233	2.600**	1.246
		(0.183)	(0.197)	(1.008)	(0.280)
Constant	0.000799***	0.000886***	0.000476***	0.000813***	0.00132***
	(0.000246)	(0.000314)	(0.000261)	(0.000493)	(0.000847)
ln_p	1.427***	1.438***	1.624***	1.262**	1.586***
	(0.0877)	(0.0879)	(0.130)	(0.119)	(0.159)
Observations	2,294	2,294	1,186	1,108	340
AIC	1539	1531	854.8	663.8	409.6
BIC	1556	1565	885.3	693.9	432.6
N	2294	2294	1186	1108	340
N_fail	202	202	120	82	72
cmd	weibull	weibull	weibull	weibull	weibull
ll	-766.6	-759.3	-421.4	-325.9	-198.8

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Traditional Science versus Biomedical Science: The main question for this paper is whether biomedical departments close at similar or higher rates than traditional science departments, a pattern that is consistent with the proposed *double-facing theory*. As predicted, biomedical department closure rates exceed traditional science department closure rates for each one of the three analyses in the sample. Looking first at the analysis that considers all universities at once (Table 4, column 7), we find that the closure rate for biomedical science departments is 1.730 times higher than the closure rate for traditional science departments ($p<0.01$). This pattern is somewhat similar when we break up all universities into doctoral granting universities and universities that offer masters degrees and baccalaureate degrees. The

closure rate of biomedical science departments is 1.298 times higher than the closure rate of traditional science departments at doctoral granting universities, but this result is not significant ($p=0.197$). The difference between the closure rate of biomedical science departments and traditional science departments is 2.804 at masters and baccalaureate granting universities ($p<0.01$). Results are stronger when we count anatomy renamings as closures, and results for doctoral granting universities are significant (HR=1.730; $p<0.01$).

Higher Status versus Lower Status Universities: Next, we have the question of whether university status shapes the closure of science departments. Research by Rawlings suggests that lower status universities will be more likely to close academic courses, programs, and departments. Results do support this claim for science departments in the sample for all university types. Results are statistically significant at masters granting and baccalaureate granting universities. The closure rate for science departments at lower status universities is slightly higher than for higher status masters and baccalaureate granting universities (HR=0.207; $p<0.01$). Results are the same when we count anatomy renamings as closures (see Table 5). Unfortunately, data limitations make an analysis of the interaction between status and type of science impossible.

Public versus Private. Existing research suggests that public universities are less likely to close departments than private universities (Brint et. al 2012a). The above analysis shows that this pattern also exists for science departments. The results are not statistically significant for doctoral granting universities; however private masters and baccalaureate granting universities do close their departments at higher rates than their public counterparts ($p<0.01$).

Smaller versus Larger Universities. In this sample, doctoral granting universities with less than 5000 incoming enrolled freshmen appear to be slightly more likely to close academic departments than doctoral granting universities with more than 5000 incoming enrolled freshman (HR=1.261). On the other hand, science departments at smaller masters and baccalaureate granting universities have a higher failure rate than larger science departments at larger masters and baccalaureate granting universities (2.545, $p<0.01$). Results are the same when we count anatomy renamings as closures (see Table 5).

Discussion and Conclusion

Collapsing NIH funding, reduced state appropriations, and a lackluster economy suggests that this is period of significant change for American universities. In this context, which academic disciplines are vulnerable to closure and which fields can weather difficult institutional environments? This paper explores the closure rates of one group of programs that are very important to our health and economy: the academic sciences. Although coming from different and sometimes opposing theoretical traditions, existing research suggests that the most vulnerable academic sciences are traditional sciences that are typically associated with the liberal arts. Both new institutionalism and academic capitalism suggests that the liberal arts-related science fields such as botany, astronomy, and zoology are vulnerable to closure.

My research suggests we should return to the question of which academic sciences are most vulnerable to departmental closure. The *Double-Facing Theory* of university change suggests that we need not choose between the research traditions of new institutionalism or academic capitalism. Instead, parts of universities are shaped by quasi-market forces and other parts are shielded, in part, from markets by institutionalism. An important consequence of this

theory is that some academic disciplines are vulnerable to rapid shifts in the market, while other disciplines and their departments are sustained because of institutional culture. I argue that the liberal arts are most shaped by institutional culture, while practical fields such as engineering, business, and nursing are primarily shaped by the market, and I have shown that practical arts departments are more likely to close than liberal arts departments (see chapter 1).

This approach suggests that we should examine the closure rate of the biomedical sciences, one of the most commercialized components of American universities (Owen-Smith and Powell 2001). If my theory is correct, the biomedical sciences will be highly sensitive to market changes, while liberal arts sciences such as physics and chemistry will benefit from institutional culture. This suggests that the biomedical sciences will churn by adding and closing departments in attempt to respond to market changes and so, overall, biomedical departments will tend to be more vulnerable to closure than traditional liberal arts sciences. This is especially the case because the biomedical sciences, particularly those at medical schools, have faced the interdisciplinary movement as well as declining NIH funding and declining clinical research fees.

With these vulnerabilities in mind, the present paper hypothesizes that biomedical science departments will have a higher closure rate than traditional science departments. Using event history analysis, I show that, between 1975 and 2010, the failure rate of biomedical science departments at masters and baccalaureate granting organizations is between 2.8 and 3.1 times higher than the failure rate of traditional science departments (depending upon how we classify the renaming of anatomy departments). Similarly results for the failure rates at doctoral granting universities are between 1.75 and 1.29 times higher for biomedical departments. When ignoring the renaming of anatomy departments, results for doctoral granting universities are insignificant.

Even with this in mind, this paper still provides helpful and new information by showing that the fields that everyone says are closest to the market have similar closures than traditional fields.

This paper contributes to a new understanding of university change. While prior research has debated whether universities follow the market or follow institutional culture, I provide evidence that is consistent with the argument that some disciplines are institutionalized while others are market-driven. Consequently, we should not find the largest number of program and department closures among traditional science departments associated with the liberal arts. Instead, we should find the greatest number of closures among the biomedical sciences, and I would also predict that these small differences between biomedical sciences and traditional sciences would be exaggerated if there were radical changes at NIH.

This paper also adds to the larger discussion of the commercialized biomedical sciences (Owen-Smith and Powell 2001). It suggests that one consequence of commercialization is that disciplines that sit closer to the market are more likely to churn by adding and closing departments. Commercialized disciplines may in fact have close ties with industry, and bring in research dollars, but they are also relatively more vulnerable to closure when this funding recedes. This suggests that universities do not have a bias in favor of market proximate fields as suggested by some authors writing about Academic Capitalism (Slaughter 1993, 1998; Volk et al. 1995). Instead, we should think of market proximity in more traditional market terms whereby organizations or departments face the ups and downs of market demand.

Of course, this work has shortcomings. One weakness is that there is not enough data to compare variation across disciplines within and across the categories biomedical versus traditional sciences. Depending upon how we approach anatomy name changes, data in this

sample suggests that highly closing traditional sciences such as zoology and botany could have a higher failure rate than the most highly closing biomedical sciences such as microbiology, anatomy and biophysics. I would agree with Gabler and Frank (2005) that deinstitutionalization has harmed zoology and botany, but I would argue that shifting market dynamics most likely influence microbiology, anatomy and biophysics. More research is needed to explore whether zoology and botany have a higher closure rate than microbiology, anatomy and biophysics, whether institutionalization shielded the zoology and botany departments from market changes and thus delayed the closing of these departments, and whether universities responded more severely to market changes that potentially occurred to microbiology, anatomy, and biophysics. On the whole, however, universities appear to treat biomedical and traditional sciences differently, a finding that is predicted by the *double facing theory* of university change.

I am also completely aware of possible limitations of my measure of university change. It is possible that one might find different comparative rates depending on outcome when looking, for example, at program growth or contraction, or at faculty salaries. Liberal arts sciences, for example, might be squeezed in different ways at these lower levels. This would not necessarily undermine the proposed account, since a universities department structure is highly visible and department closures tend to receive more scrutiny than program growth or contraction or variations in salaries. One might also argue that that the biomedical sciences are adding and closing departments in response to scientific changes. This is possible but one would need to make the case that stabilized disciplines, like some in the physical sciences, simply have made fewer scientific discoveries during the equal amount of time. Furthermore, in terms of model building, the present paper uses discrete variables to distinguish between market-driven disciplines and institutionally-driven disciplines. Future research must consider the possibility

that this distinction differs along a spectrum with some market driven disciplines sitting at the absolute extreme from institutionally driven disciplines and with other market driven disciplines sitting quite close to institutionally driven disciplines. Additionally, the present analysis does not have independent measures of market forces and institutional forces. Most studies of university change have this limitation, but this is still a limitation. Future research is particularly needed that links specific departments with specific market signals. Evidence for the double-facing theory of university change would be stronger if we can show that traditional science departments stay open despite specific market fluctuations.

CHAPTER 3: THE ACADEMIC CHOPPING BLOCK: LOW ENROLLMENT PROGRAM CLOSURES AT THE *DOUBLE FACING* UNIVERSITY (1984-2012)

Introduction

There is much debate today about how universities are changing, but one thing seems fairly clear: practical fields such as business and computer science have a growing presence on university campuses. Students increasingly study practical fields (Brint et. al 2005), liberal arts colleges have broken with tradition by adding practical academic programs (Kraatz and Zajac 1996), and most newly added academic programs are practical programs (Rawlings 2012). Plus, more and more scientists with commercial research interests have appeared on campus (Owen-Smith and Powell 2001; Owen-Smith and Powell 2002).

What do these and other organizational changes mean for the liberal arts and the humanities? While much previous research has concentrated on population shifts, this paper explores the equally important question of academic chopping blocks, a name that I use to describe the activity of assessing, comparing, and terminating academic programs. Do the liberal arts continue unchanged next to their new partners on campus or are they being pushed out by a bias toward practical fields? More specifically, what does the growth of the practical fields mean when it comes time for universities to restructure and terminate academic programs? Does the growth of practical fields make liberal arts classes, programs, and departments more vulnerable to termination? Are universities more likely to close liberal arts fields than practical arts fields during times of retrenchment and reorganization?

Existing literature offers a number of possible answers to these closely related questions. First, research by one group of scholars suggests that there could be bias against academic programs that serve women and that are distant from quasi-markets (Slaughter 1993, 1998; Volk

et al. 1995). Second, although not explicitly stated by the authors, one study raises the possibility that universities are sensitive to student demand for all academic disciplines and that there is no explicit bias for or against the practical fields (Kraatz and Zajac 1996). A third approach, the double-facing theory, proposes that academic disciplines are broken into those that are shielded by institutional forces and those that are face quasi-markets. Liberal arts disciplines are institutionalized and are thus less vulnerable to closure than practical arts disciplines, such as engineering, which are shaped by market forces (see chapters 1 &2).

To arbitrate between these three competing claims, I provide a comparison between low enrollment language and literature and engineering program closures between 1984 and 2012. Using academic program completions data from the *National Center for Educational Statistics*, I ask whether low enrollment language and literature programs have a higher closure rate than low enrollment engineering programs. By controlling for low enrollment, this study examines whether universities are equally sensitive to student demand for all academic disciplines or whether universities consider demand differently depending on the field for which there is demand. Furthermore, this comparison also examines whether there is a bias towards market proximity since engineering is the quintessentially practical field and language and literature programs are associated with the humanities. Finally, this study examines whether there is a bias towards programs populated by women since engineering graduates are predominantly men and language and literature graduates are predominantly women.

Results show that low enrollment engineering programs have a much higher failure rate than low enrollment language and literature programs. This finding aligns with the proposal that universities are sensitive to external quasi-markets when it comes to the practical fields, but

universities largely follow institutional culture when it comes to liberal arts fields, a prediction made by the *double-facing* theory of university change.

Literature Review and Hypotheses

This paper specifically examines academic chopping blocks, a term which I am using to distinguish my analysis from research that examines population shifts. These are two separate but equally important questions. While many studies investigate how overall population percentages are moving in one direction or another, this analysis of academic chopping blocks studies what happens when universities specifically decide to terminate academic programs. This is my question: when faced with the choice between closing one program over another, what program do universities they choose to close?

Dominant thought about the fate of academic disciplines typically comes in two flavors: academic capitalism and new institutionalism. The former puts forth a critical political argument that says actors within the universities have worked to blur the lines between the public and private sectors (Slaughter and Leslie 1997) and supported those academic fields with close proximity to "the dynamic, high technology, private sector of the market" (Slaughter 1993, 1998; Volk et al. 1995). Thus, the liberal arts, particularly the humanities, far removed from the private sector, are the field most vulnerable to retrenchment. The latter approach of new institutionalism argues that universities work to conform to institutional culture and that this institutional culture is turning away from the liberal arts (Frank & Gabler 2006; Frank, Schofer, & Torres 1994; Gabler & Frank 2005).

I challenge these accounts in two papers by providing evidence that supports a *double facing theory* of university change, a disciplinary-based theory that integrates quasi-market and

institutional explanations (see chapters 1 & 2). Quasi-markets is a term, borrowed from Taylor et al. (2013), that nicely foregrounds the fact that universities face incentives and competition not just from typical markets such as labor markets and student demand. They also face incentives from large donors, federal funding agencies, state governments, social movements (Hackett 1990; Finkelstein et al. 1984; Olzak & Kangas 2008; Sharma et. al 2006; Kraatz and Zajac 1996; Brint et. al. 2012; Rawlings 2012). First, I contend that universities are shaped by *both* institutional culture and quasi-markets, and that quasi-market forces influence some academic disciplines and that institutional culture shapes others. Liberal arts disciplines and their departments, such as history and English, are shaped through university efforts to conform to institutional culture (namely universal ideals of what universities should be and should offer). In contrast, practically oriented disciplines, such as engineering and business, are shaped by quasi-markets. Second, I propose that proponents of academic capitalism are incorrect to suggest that market proximity guarantees the success of practically oriented disciplines. Instead I argue that market proximity means that practically oriented disciplines are vulnerable to the turbulent ups and downs of quasi-market demand. In effect, practical fields churn. They are supported when they satisfy some external demand but they are abandoned when this external demand diminishes. When faced with program closures, institutional culture shields liberal arts disciplines from market changes, while practically oriented disciplines face the whims of quasi-markets. Consequently, liberal arts disciplines and their programs will have a smaller closure rate than practical arts disciplines.

To study this hypothesis, I provided a broad look at the university as a whole by first comparing the fate of liberal arts departments with the fate of practical arts departments. With event history analysis, I showed that practically oriented departments had a higher failure rate

than liberal arts departments at the 286 universities covered by the College Catalog Study. After establishing that finding, I surmised that, if we were to focus on a more specific group of disciplines, we should focus on one of the most entrepreneurial disciplines on campus, those that interact frequently with external markets. According to many scholars the biomedical sciences are some of the most entrepreneurial disciplines on American campuses (Owen-Smith, 2003; Owen-Smith and Powell 2001; Powell and Owen-Smith 2002) and, so I compared the failure rates of biomedical sciences departments with liberal arts science departments. With the assumption that the liberal arts sciences are protected to some extent by institutional culture, I predicted that the biomedical sciences will have a higher failure rate than liberal arts sciences. A study of same 286 universities found that the biomedical sciences indeed have a higher failure rate than liberal arts science departments.

Despite these studies many questions and critiques remain. The first potential critique of my work is methodological. The two preceding studies examined department closures, a measure of change is relatively extreme and rare. Universities are probably more likely to make changes to courses, faculty, and programs before they are willing to close complete departments. Consequently, it is important to study different measures of university change to fully assess the *double facing* theory; changes at the course, faculty, and program level could possibly demonstrate different patterns than changes at the department level. Furthermore, some scholars in the higher education community are suspicious about data contained in the College Catalog Study. Therefore, in order to satisfy some skeptics, it is important to look at another source of data.

There are also two potential theoretical critiques of the *double facing* theory and the two preceding studies that support it. For example, might it be the case that practical arts fields have

a higher failure rate because they experience more severe drops in demand? This is a position implied by Kraatz and Zajac (1996). While the double facing theory critiques new institutionalism by arguing that some academic disciplines face the market and thus churn, Kraatz and Zajac raise the possibility that institutional culture plays a minor role in questions of academic restructuring. They study the growth of business programs at liberal arts colleges, a form of organizational change that explicitly breaks with the purported institutional culture of liberal arts colleges. Against the expectations of new institutionalism, this illegitimate organizational change had no negative effect on liberal arts colleges. Instead, liberal arts colleges freely followed the growing interest among students for earning large amounts of money, even when the broad mission of most liberal arts colleges stands against the idea of universities as job training machines. Consequently, they argue that this correlation between consumer preference and organizational challenges the idea that institutional culture shapes university decision making about academic disciplines. [49]

Although the authors do not explicitly take this position, their work raises the possibility that universities are responding to technical environments for all disciplines and that all disciplines are equally responsive to such things as student demand. Turning to the two previous *double-facing* studies, it might be the case that the liberal arts and practical arts are equally sensitive to drops in student demand, and the higher rates of closure on the part of practical departments in the two previous studies might have been caused by higher drops in student demand (or other forms of market pressure). Consequently, a study must be devised that

[49] My take on this paper is that the authors found signs of market response because they looked at those disciplines that are most responsive to markets.

compares the failure rate of practical and liberal arts field by controlling for student demand and other quasi-market factors.

A completely different group of critics might reasonably raise the issue of gender. This is a part of academic capitalism that I did not address in previous papers. As part of a critical political position, academic capitalism argues that differentials between academic fields within the university are shaped by political economic power, and that this power is patterned by "gender, race, and relations… to federal and corporate research markets, high-end private sector markets for professionals, and the social welfare function of the state." (Volk et. al. 2001:390). Consequently, universities are more likely to change or drop those courses, programs, and faculty members that serve or are run by women (Slaughter 1993; 1998; Volk et. al. 2001). So, for example, Slaughter drew upon of 17 universities, and found that retrenched fields were those that were most likely to provide career opportunities to women, but universities supported fields were those fields were the majority of students were male (Slaughter 1993). Although these authors have studied a different unit of analysis, their work raises the possibility that the failure to control for gender is a substantial problem with the two previous studies of the *double facing* university.

To consider these potential critiques of the preceding studies of the *double-facing* university, I provide an analysis that compares the failure of practical fields and liberal arts fields while controlling for gender and student demand and while using a different measure of university change. I do this by comparing the closure rate of low enrollment language and literature programs to the closure rate of low-enrollment engineering programs. Engineering is the quintessential practical field and language and literature programs are largely associated with the liberal arts and the humanities. A comparison of these two fields provides a broad assessment

of the *double facing* theory, but this comparison also allows us to assess the issues of gender and student demand. Specifically, if low enrollment language and literature programs have a higher failure rate than low enrollment engineering programs, we would have support for Sheila Slaughter's version of academic capitalism, since language programs are predominantly pursued by women[50] and engineering programs are predominantly populated by men. If low enrollment liberal arts fields such as language and literature programs are not shielded by institutional culture, we would expect them to have an equivalent failure rate to low enrollment engineering programs. Such a finding would militate against the *double facing* theory and would lend support to the argument provided by Kraatz and Zajac (1996). In contrast, if liberal arts programs, such as language and literature programs, are shielded by institutional culture, we would expect low enrollment language programs to have a smaller failure rate than low enrollment engineering programs. Such a finding would lend support to the *double facing* theory of university change. The following study investigates these possibilities.

Data and Analysis

To test these hypotheses, I conduct a multivariate, longitudinal, event history analyses of language and engineering program closures between 1984 and 2012. To control for student demand, this analysis only looks at low enrollment language and engineering programs, and, to make data collection more manageable, it only looks at programs that existed between 1984 and 1987. Programs created after 1987 were not considered. To infer potential program closures I

[50] In 2012 there were 15,134 females and 3,827 males undergraduate and graduate completions (Snyder and Dillow 2012: 542) and, in 1989, there were 2791 male and 7393 female undergraduate and graduate completions (Snyder 1989: 228). As for engineering, there were 81,270 males and 17,270 females undergraduate and graduate completions in 2012 (Synder and Dillow 2012:540), and in 1989 there were 82,547 male and 11,250 female undergraduate and graduate completions (Snyder 1989:227).

used completions data provided by the *National Center for Education Statistics Integrated Postsecondary Education Data System* (IPEDS). I was careful to verify that what appears as closures in the IPEDS data are, indeed, genuine failures. Each potential closure was verified via email or telephone confirmation with academic department heads, academic deans, and university institutional research offices. University program websites were also used. Table 1 below outlines this data collection process, but please see Appendix 5 for a detailed definition of a low enrollment program and for an extended discussion of how program terminations were verified.

Table 1
Summary of Data and Data Verification

	Engineer undergrad	*Languages undergrad*	*Engineer grad*	*Languages grad*
High Enrollment Programs Ignored by this Study				
High Enrollment Programs that Potentially Failed	56	23	39	9
High Enrollment Progs. that Survived	1096	361	686	40
Low Enrollment Programs that Survived by Continuing to 2012				
Low Enrollment Progs. that Survived	116	1119	260	264
Data Verification for Potentially Closing Low Enrollment Programs that actually SURVIVED				
Survival Confirmed by Telephone/Email/Web History	10	40	10	7
Survival Confirmed by University Website	6	60	7	5
Survived by Merging or Collapsing into Another Program.	12	18	6	5
Engineering Programs that Survived by Evolving	9		18	
Programs that Survived unchanged but were Reclassified by Institutional Research Office	12	89	5	9
Data Verification for Potentially Closing Low Enrollment Programs that actually FAILED				
Failure Confirmed by Telephone/Email/Web History	77	49	60	21
Failure Confirmed by University Website	80	100	47	3
Language Programs that Failed by Evolving		39		7
Potentially Failing Low Enrollment Programs that could not be Determined				
	12	48	10	4
Final Results				
Failed Programs	157	188	107	31
Survived Programs	165	1326	306	290
Percentage Failed	48.8%	12.4%	25.9%	9.7%

The comparison of low-enrollment language and engineering programs provides a reasonable control for student demand, gender, and for market proximity. Beyond this, I use data from the Institutional Data Archive (Brint et. al 2011b) to control for other variables. Following

Brint et al. (2012b) I use an *organizational status variable* based on three status variables (a) operating budget/student, (b) Barrons' selectivity, and (c) six-year graduation rate. This is an additive, z-scored index. Operating budget/student and six-year graduation rate come from HEGIS/IPEDS.

Table 2 describes the data which includes all low enrollment engineering and language and literature programs that existed or were created between 1984 and 1987. Noticeably, there is only one high status Masters university and few public baccalaureate granting universities with low enrollment language or engineering programs during the period of study. The number of engineering programs at baccalaureate granting institutions is also relatively low, and the overall number of low enrollment engineering programs is lower than the overall number of low enrollment language and literature programs during the period of study.

Table 2
Sample Description (University, Program, and Status Types)

	University Type				Academic Programs	
	Higher Status	Lower Status	Private	Public	Engineering	Language
BA Granting	51	148	188	11	34	461
Masters	1	302	141	162	112	509
Doctoral	52	179	76	155	530	831
Language	484	1317	922	879		
Engineering	128	548	224	452		

I also control for a number of additional variables that previous research demonstrate are important to understanding university change.[51] For example, prior scholarship suggests that organizations with smaller size are more likely to make organizational changes so as to better match their products to the market (Hannan and Freeman, 1977, 1989; Baum and Haveman,

[51] 3.6% of cases were dropped because of missing data (92 out of 2560).

1997). It seems plausible that larger universities will have more resources and thus will be able to better weather various budget crises in a way smaller institutions cannot (see e.g., Brint et. al 2012). Consequently, I control for *University Size*, using a continuous various measure of total enrolled freshman. Prior research also finds that different types of universities will have different department closure rates (see e.g., Brint et. al 2012). With this in mind, I control for *University Type*. Drawing on the 1994 Carnegie Classification of Universities, I run three separate analyses for doctoral granting universities, masters granting universities, and baccalaureate granting colleges. Program failure rates might also differ for Public Universities Versus Private Universities so I control for these characteristics too (Tolbert 1985; Brint et. al 2012). I also run analyses that control for *Tuition Dependence,* which is defined as the percentage of total university revenue that came from tuition in the academic year 1999-2000. Since accounting standards were different for public and private universities these two groups are assessed separately.[52]

Descriptive Results

Before jumping directly into the question of program closures, I want to take a step back and provide some description of general population shifts within language and engineering programs. This background information will provide useful contextualization of academic chopping blocks. Table 3 counts the number of academic programs offered by universities in the sample by discipline, by year, and by university type.

[52] For this analysis of Tuition Dependence, 286 of 1,331 programs at 50 public universities that face potential closure were removed because of parent-child problems in IPEDS (see Jaquette and Parra 2014). Similarly, 27 of 1,146 programs that face potential closure at private universities were removed because of parent-child problems.

Table 3
Population Shifts

Discipline	U Type	1985	1990	1995	2000	2005	2010	2012
Engineering	all types	2367	2469	2634	2732	3059	3225	3267
Languages	all types	2514	2546	2791	2949	3076	3166	3158
Engineering	Doctoral	1998	2094	2230	2340	2535	2637	2663
Languages	Doctoral	1313	1370	1491	1547	1609	1644	1658
Engineering	Masters	300	314	343	377	453	510	525
Languages	Masters	649	625	702	748	762	794	772
Engineering	BA	69	61	61	65	71	78	79
Languages	BA	552	551	598	654	705	728	728

As we can see, the question of academic program closures is happening at a time of expansion for both engineering and language and literature programs. When looking at all university types at once we see that language and literature programs slightly outnumbered engineering programs in 1985 and engineering programs slightly outnumbered language programs by 2000. However, looking at different university types, we can see that engineering programs grew much faster than language programs at doctoral granting universities, but language and literature programs continue to outnumber engineering programs at Masters and baccalaureate granting universities. Overall engineering has grown faster but languages have not been squeezed out.

I next provide descriptive closure results. Table 4 disaggregates language and engineering programs into their respective fields based on IPEDS identification codes (CIP codes). The low enrollment engineering programs that experienced the greatest number of terminations include engineering mechanics, engineering science, industrial engineering, and systems engineering. As for low enrollment language and literature programs, we see a large number of closures in the

fields of German, Russian, Slovak, and various other small language areas such as Arabic, Hebrew, and Native American.

Table 4
Descriptive Results: Program Closures by Field

	CIP Code	Survived	Failed	% Failed
Spanish and Portuguese	160904, 160905	426	22	4.9%
Foreign Languages (General)	160101	64	4	5.9%
Classics/Classical Latin, Ancient/Classical Greek, Latin Language	161200, 161202, 161203	174	14	7.4%
Italian and other Romance	160902, 160999	67	7	9.5%
French	160901	436	60	12.1%
Chinese, Japanese, and East Asian	160301, 160302, 160399	46	7	13.2%
German and Germanic	160501, 160599	274	69	20.1%
Russian and Slavic	16400, 160402, 160499	102	26	20.3%
Various Other Languages	161001, 161011, 1601102, 161103, 161199	27	10	27.0%
Chemical Engineering	140701	53	5	8.6%
Mechanical Engineering	141901	35	7	16.7%
Civil & Environmental Eng.	140801, 141401	67	20	22.9%
Electrical & Computer Eng.	140901, 141001	44	16	26.7%
Engineering Physics	141201	30	15	33.3%
Ceramic, Metallurgical, & Material Engineering	140601, 141801, 142001	63	34	35.1%
Mining and Mineral, Geological, Petroleum Eng.	142101, 142501, 143901	50	30	37.5%
Various Other Engineering	140501, 140401, 142201, 142401,	21	20	48.8%
Nuclear Engineering	142301	17	22	56.4%
Industrial & Systems Eng.	142701, 143501	27	37	57.8%
Engineering Mechanics and Engineering Science	141101, 141301	19	35	64.8%

Modeling

For this analysis, I use a Cox Models because I am interested in the time trajectory of program closure. Each academic program in the data set is assigned various covariates, and each is designated as surviving or closing within the interval 1984-2012. STATA estimates hazard ratios (or effects) associated with each covariate. The main model for the hazard of closing of department j is as follows:

The Cox Model is specified as follows:

$$h(t) = h_0(t) \exp^{(x1\beta1+ \ldots + xk\beta k)}$$

Where $h_0(t)$ is the cumulative hazard (not directly estimated), x_1 is a variable for department "1" and β_1 is the corresponding coefficient. The effects of a covariate k on the risk is defined as $\exp(\beta_k)$. Results show that a one unit increase in a given covariate is associated with a $\exp(\beta_k)$ increase in department failure rate. Note that β_k tells us about the magnitude of the shift of the *rate* of closure associated with the covariate. When β_k is negative the covariate decreases the rate of failure and when it is positive it increases it. The theory I propose here predicts that institutionalized fields have longer life spans and hence will have lower failure rates. Thus we expect the coefficients associated with institutionalization to be negative. In the provided results tables, hazard rates are reported instead of coefficients to ease interpretation. Hazard rates are derived with the following: $\exp(\beta_i)$. The Efron method was used to handle ties, and Cox-Snell analysis shows reasonable proportionality. [53]

[53] For more information please refer to methods Appendix 3.

Modeling Results

The following Table 5 shows the results of Cox Proportional Hazards Model performed on four different types of universities (doctoral granting, masters granting, liberal arts colleges, and baccalaureate colleges). Results are presented as Hazard Ratios. Hazard Ratios are derived by taking the antilog of each coefficient $e^{(coeffiecent)}$, and they describe the effect of one unit difference in the associated predictor on raw hazard (Singer and Willett 2003:524).

Table 5
Cox Model

VARIABLES	(1) Doctoral	(2) Masters	(3) BA	(4) Doctoral	(5) Masters	(6) BA
Lower Status Languages				1.191	0.285	1.504
				(0.304)	(0.289)	(0.508)
Higher Status Engineering				5.832***		22.51***
				(1.421)		(13.61)
Lower Status Engineering				5.929***	1.331	11.45***
				(1.450)	(1.355)	(4.617)
Public vs Private	0.685**	1.302	2.060	0.689**	1.302	2.198
	(0.120)	(0.278)	(1.137)	(0.121)	(0.278)	(1.205)
Smaller vs Larger	1.000	1.000*	0.998***	1.000	1.000*	0.998***
	(2.15e-05)	(7.41e-05)	(0.000666)	(2.15e-05)	(7.41e-05)	(0.000671)
Graduate vs Undergrad	0.527***	0.748		0.530***	0.748	
	(0.0700)	(0.212)		(0.0705)	(0.212)	
Engineering vs Language	5.247***	4.674***	9.180***			
	(0.751)	(0.981)	(2.670)			
Higher Status vs. Lower	0.926	3.510	0.780			
	(0.166)	(3.558)	(0.244)			
Observations	1,361	621	495	1,361	621	495
AIC	3455	1443	790.6	3457	1443	790.3
BIC	3481	1465	807.4	3488	1465	811.3
N	1361	621	495	1361	621	495
N_fail	255	119	69	255	119	69
cmd	cox	cox	cox	cox	cox	cox
ll	-1722	-716.6	-391.3	-1722	-716.6	-390.2

seEform in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 6
Cox Model with Tuition Dependence

VARIABLES	(1) All Private	(2) All Public
Smaller vs Larger	1.000	1.000
	(3.24e-05)	(2.39e-05)
Graduate vs Undergrad	0.963	0.402***
	(0.180)	(0.0672)
Engineering vs Language	5.226***	4.674***
	(0.858)	(0.760)
Higher Status vs. Lower	0.940	1.144
	(0.202)	(0.396)
Tuition Dep Private	1.006	
	(0.00390)	
Tuition Dep Public		1.013
		-0.00944
Observations	1,117	1,045
AIC	2619	2474
BIC	2644	2498
N	1117	1045
N_fail	199	189
cmd	cox	cox
ll	-1305	-1232

Engineering versus Language and Literature: The main question for this paper is whether engineering programs fail at a higher rate than language and literature programs. This prediction largely holds true across university type, and status levels. Columns 1 through 3 describe the main effects of this distinction, while columns 4 through 5 examine the interaction between status and program type. These last three columns use dummy variables to compare the

first three variables (lower status language, higher status engineering, and lower status engineering) to the baseline variable of language programs at higher status universities. Column 1 shows the results for doctoral granting universities. Here, failure rates for low-enrollment engineering programs are 5.24 times higher than language and literature program failure rates during the period between 1984 and 2012 ($p<0.001$). In terms of Masters granting universities, the failure rate of engineering programs is 4.6 times higher than language and literature programs ($p<0.001$). We see a similar pattern when moving to baccalaureate universities. The failure rate of engineering programs is 9.2 times higher than language and literature programs ($p<0.001$).

Higher Status versus Lower Status Universities: Next, we have the question of whether the differences between language and engineering program failures depend upon status. The last three columns of Tables 4 explore this question and show that status and relationship to the market both play an important part of the story. Language programs at higher status universities have smaller failure rates than language programs at lower status universities. This is true for both doctoral and baccalaureate granting universities in the sample; however, the difference between lower status and higher status is not statistically significant for doctoral granting universities. Engineering programs at both higher status and lower status universities have higher failure rates than language programs in general. However, a posttest estimation of the failure rates of engineering programs at higher status universities and lower status universities shows no significant difference. This is true for doctoral granting ($chi2(1)=0.09$; $Prob> chi2=0.758$), and baccalaureate granting universities ($chi2(1)=0.62$; $Prob> chi2=0.430$).

Other Controls. The above analysis also shows that language and engineering programs at private universities have higher failure rates than programs at public universities. Private doctoral granting universities close their academic programs faster than public doctoral granting

universities (0.685, $p<0.01$). In the sample, the reverse is true for masters and baccalaureate granting, but this pattern is not statistically significant. [54] Results show no difference in closure rates between larger and smaller Doctoral or Masters granting universities. Programs at smaller BA granting universities have a higher failure rate than larger BA granting universities. Finally, in the sample, programs art universities with greater tuition dependence had greater failure rates.

Conclusion and Discussion

Much of the previous research has examined population shifts and has found that practical fields play an increasingly large role on American campuses. This paper explores the slightly different but equally important question of academic chopping blocks. Academic chopping blocks is a term that I use to describe activities, on the part of universities, to assess, compare and finally terminate academic programs. This paper explores how the ascendancy of the practical fields might influence the fate of the liberal arts and the associated humanities when these legacy disciplines face the chopping blocks. Are the liberal arts and practical arts equal partners or is there a bias towards practical fields? Importantly, when universities needs to restructure and close academic programs are the liberal arts disadvantaged in comparison to the practical arts?

In this paper, I explore three potential answers this question. The first answer, associated with academic capitalism, suggests that university chopping blocks will demonstrate an explicit bias against programs that serve women and against programs that are quite remote from quasi-markets. The second answer, coming under the name double-facing theory, argues that liberal

[54] A separate analysis found no statistically significant interaction between the variables disciplinary type and institutional type (public versus private). Results are available upon request.

arts fields and their associated humanities are shielded to some extent from quasi-markets by institutional culture, and so university chopping blocks are more likely to terminate practical fields. A third approach raises the possibility that all fields are sensitive to quasi-markets, but university chopping blocks treat all fields relatively equally with no bias for or against one group.

In order to arbitrate between these three different claims I provide an analysis of academic program closures that explicitly controls for market proximity, gender, and student demand. I do this by looking at the potential closure of all low enrollment engineering and language and literature programs that existed or were created between 1984 and 1987. As language and literature programs are predominantly populated by women and engineering programs are predominantly populated by men, this analysis is a good test of the question of whether university chopping blocks demonstrate a bias in favor of male-dominated fields. Similarly, since engineering is a quintessential practical field, this analysis assesses whether university chopping blocks demonstrate bias to or against practical fields. Lastly, by controlling for student demand, we can see whether liberal arts fields as well as practical arts fields equally face quasi-markets.

Results are consistent with the prediction of the double-facing theory. Low enrollment language and literature programs were much more likely than low enrollment engineering programs to survive during the period between 1984-2012. This finding is generally consistent with the idea that practical fields, like engineering, churn in response to fluctuating quasi-markets. Indeed, results for engineering programs are striking. It has been said that universities failures are so rare that it makes little sense to argue that universities participate in market dynamics (Rawlings 2012), but some low enrollment engineering programs lost more than 50%

of their population (see Table 3). This is a pattern observed in more traditional market driven environments. A much larger proportion of low enrollment language and literature programs survive during the period of study, a pattern that is consistent with the idea that institutional culture shields liberal arts programs, to some extent, from quasi-markets. Unlike the two previous predictions about academic chopping blocks, this data suggests that there is not a bias towards practical fields but rather potential bias towards liberal arts fields. By combining these results with my two previous studies on biomedical, liberal arts, practical arts departments and we have a fairly strong evidence for the double-facing theory of university change.

By controlling for student demand, this paper also adds fodder to the debate about ubiquity in higher education (Hearn and Belasco 2015; DiMaggio and Powell 1983; Meyer et al. 2007). Some scholars argue we can use institutional culture to explain why some that programs and departments are ubiquitous. I am more sympathetic to the position that ubiquity can be caused by institutional culture or by large demand from quasi-markets (see Kraatz and Zajac 1996; Colyvas and Jonsson 2011). For example, a good sign of institutionalization is to watch what occurs to two otherwise equivalent and ubiquitous programs. If both experience drops in student demand, but only one program is closed, we would have support for the claim that one of these programs is ubiquitous where there is sufficient student demand and the other is ubiquitous, independent of student demand, because of institutionalization. Although not definitive, this paper suggests that engineering programs are ubiquitous where there is high demand coming from quasi-markets. In contrast, however, language and literature programs are ubiquitous, at least in part, because of institutional culture.

This paper might have synergies with Peter Eckel's (2003) in depth study of programs at four public universities. The author provides a rich description of various ways that universities

"got away" with program termination. In doing so, he does not foreground the practical nature of programs as I do here, however the bulk of program terminations in his sample where practical, and it is possible that "getting away with it" is another way of saying that a program is not shielded from institutional culture. For example, a closed journalism program was seen as “too professional or quasi-commercial”. Another faculty member from a group of closed programs that included urban studies, and radio, television and film, stated the following, “We were in a College of Arts and Humanities, that obviously is the cornerstone of this university like ours, but we were a professional program. We were conditional; we weren’t English; we weren’t history; we weren’t art. Parenthetically, the other program that got closed [in the college] was another professional program.” (Eckel 2003: 14). My take on the results of this present study of departments is that universities can get away with closing practical departments but places like the NY Times and the Chronicle of Higher Education take note when universities close liberal arts departments.

This paper has some obvious limitations. What it provides in broad national patterns, it lacks in rich local detail. Furthermore, it only provides an examination of two groups of fields, and data verification was not possible for computer science programs (see the data collection Appendix 5). Furthermore, there are other forms of quasi-markets besides student demand that might shape these and other fields. Research funding from the federal government might be just as important as student demand for engineering programs. There are other details which might confound this comparison. For example, there are many higher enrollment engineering programs than there are high enrollment language programs, and it is plausible that the existence of high enrollment engineering programs makes low enrollment engineering programs more vulnerable. Second, it is possible that engineering programs cost more to run than language and literature

programs. It might be cheaper to run low enrollment language and literature programs because faculty salaries are lower and because potential faculty are in large supply. In contrast, some engineering courses require expensive equipment, and engineering faculty might be in short supply. Similarly, the cost of accreditation for engineering programs is potentially higher than the cost of accreditation language programs. At the same time language programs often help students satisfy general education requirements. The model would also benefit from the inclusion of control variables for the financial health of the institution, the level of state support (for public institutions), the number of faculty associated with each program,[55] the type of budgeting system used by the institution, but unfortunately these data are not available at the moment. The scope here also excludes community colleges.

In studying the academic chopping block, this paper does not put forth a sanguine view of the long term future of the liberal arts. Even if the failure rate of liberal arts is lower than the failure rate of practical arts, it is not clear if the replacement rate of liberal arts is keeping up with the failure rate. Furthermore, while the failure rate of the practical arts might be high, the replacement rate might be higher. In addition, it is not clear how the political environment might change for universities in the coming years. For instance, activists are pushing universities to think beyond student demand. They want university to consider how academic programs shape student labor market outcomes, a practice already started by some community colleges (Rassen et. el 2014). Furthermore, some state schools are moving away from legacy budgeting, a shift that might further hurt the liberal arts (Jones 2013). For the short term, however, it does

[55] Eckel (2003) found this to be an important finding for program closure in his detailed studies.

appear that universities are more sensitive to quasi-markets when it comes to practical fields, and that the liberal arts are not the most vulnerable.

CONCLUSION AND FUTURE DIRECTIONS

Introduction

In the context of a changing university and a fraught political environment, this dissertation asks whether universities are more likely to shutter liberal arts programs and departments when it comes time to restructure their organizations. In other words, are academic chopping blocks biased against programs and departments of the liberal arts and the humanities? Unlike previous research, this dissertation hypothesizes that the answers this question is no, it goes on to support this answer with three empirical studies. The main findings of the dissertation are:

- Universities were more likely to add practically-oriented departments, such as engineering, business, and biomedicine, than liberal arts programs between 1975 and 2010.
- Conversely, practically-oriented departments such as engineering and business were more likely to close than liberal arts departments between 1975 and 2010.
- Between 1984 and 2012, universities were far more likely to close low-enrollment engineering programs than to close low enrollment language programs.
- Although the biomedical sciences are seen as being some of the most commercially-oriented fields on campuses, I found that biomedical departments have a higher failure rate science programs commonly found in universities' liberal arts colleges.

My dissertation employs sociological theory to help understand and explain these results. With three empirical chapters, I challenge existing scholarship by suggesting that institutional culture shields liberal arts disciplines, while practically oriented disciplines face the whims of the market. This explains my findings that liberal arts departments have a smaller failure rate than practical arts departments. Similarly, the higher failure rate of biomedical science departments is explained by their close proximity to the market and by the institutional protection that most liberal arts sciences rely upon. Finally, my approach suggests that universities are more

comfortable with maintaining low enrollment liberal arts than maintaining practically oriented programs, hence the finding that low-enrollment engineering programs have a higher failure rate than low enrollment language programs.

The findings of this dissertation raise at least two questions that can animate future research on the organization of knowledge production and education. First, there are several ways of improving the measurement of the double facing theory I outlined. Second, this dissertation raises a number of questions for other parts of university life. In what follows, I outline a number of follow-up studies that can improve on this dissertation. I also describe four projects that might examine questions or problems raised by the *double facing* theory of university change.

Follow-Up Studies

In this section, I explore a number of follow-up projects that directly measure the *double facing* theory of university change. I found it best to start measuring the double facing theory by looking at broad patterns that cut across multiple universities. This orientation seemed necessary since critics could easily dismiss case studies of a few universities. Case studies also have a tree versus the forest problem. With case studies it is very difficult to disentangle broad national patterns from local idiosyncratic effects. With this in mind, however, any examination of broad national patterns lacks a certain richness. Furthermore, although the data I presented follows the expectation of the double facing theory, my study still relies upon inference to explain these patterns.

With this is mind, it would be valuable to undertake a number of case studies that control for a wider range of factors. Volk and her colleagues (2001) provide an interesting quantitative

case study of institutional resource allocation, which offers a potential model for future research. These researchers wanted to know if universities were biased towards some disciplines or another so they examined how this university distributed its budget across campus to various disciplines. As such, institutional resource allocation was their outcome variable. They gathered a wide range of potential explanatory variables including department gender composition, diversity, undergraduate courses, assistant professors salary, department size, and grant dollars. Most of this data was available because the university had conducted a university wide assessment of all academic programs and departments. By looking at the effect of these factors on institutional resource allocation, they attempted to make claims about academic capitalism. They found mixed support for academic capitalism, and I speculate that they needed to control for disciplinary orientation (practical vs. liberal). While this study has the shortcoming of a small sample, it clearly was able to control for many other explanatory variables that are not considered by this dissertation.

Future research could do the same analysis at between 4 and 6 representative universities. This, of course, would add the important variable of practical disciplines versus liberal disciplines and could involve interviews. In combining, the results of case studies with the large scale quantitative findings of this dissertation, we could potentially move beyond the problem that case studies have with separating national patterns from local idiosyncratic variation. We could also improve upon the lack of richness contained in large scale quantitative findings.

Beyond case studies, the analyses in this dissertation could be supplemented or improved in a number of ways. Obviously more data for each chapter would be valuable. For example, I would like to supplement the biomedical department chapter with data on the closure of biomedical academic programs. Different measures would also be useful. In addition to

understanding patterns within programs and departments, it would be helpful to know what is happening to faculty and to courses. It seems possible that universities are reducing their liberal arts faculty and courses while maintaining liberal arts programs and departments.

Furthermore, for chapters 1 and 2 that study department closures, it would be very valuable control for student demand. This student demand is available from IPEDS student completions data, however there is no crosswalk that links program data from IPEDS with department data from the College Catalog Study. This is a long-term project that could be used by many higher education researchers. In addition, in collecting data for chapter 3 on language and engineering programs, it is clear that some deans and department heads are willing to describe their take on why programs were closed. I would like to follow up this analysis by asking each respondent to provide three reasons of why a given engineering or language program was closed. This data collection could also set the stage for an examination of how academic departments and programs respond to labor market signals. I describe this project in greater detail below.

Future Directions and New Questions

Beyond follow-up studies that improve the measurement of the question at hand, it is important to understand the challenges and opportunities implicit in the reality of having some disciplines face the market and some face institutional culture. Consequently, this dissertation raises many other questions that can be explored. For example, future research might explore what my findings mean for the scientific knowledge that different fields produce, and what they mean for the lives of scientists and other academics? Are hiring practices different? Are funding practices different? How about teaching? Furthermore, how do organization changes influence

student's job market outcomes? In this section, I provide a number of studies that emerge from the present dissertation.

Impact on students

Future research might examine how the reorganization of American education influences students. University change is a particularly relevant issue for scientific education and underrepresented populations. Many job opportunities can be found in STEM fields with departments that grow and change quickly. However, it is not clear whether the universities that primarily serve students of color and other historically underrepresented populations actually offer these rapidly changing fields. Conversely, more and more scientific disciplines have been interested in recruiting students and faculty of color and of other historically underrepresented populations. Anecdotal reports from the journal *Nature* suggest that the closing of scientific programs and departments around the country have disproportionally occurred at universities that typically serve these populations (Reich 2011). At a time when minority recruitment is ever more important to American science disciplines, one would prefer to find steady or expanding scientific offerings at universities that cater to minority students.

In this context, two issues might be beneficially explored. First, has the growth of STEM fields expanded throughout the system of higher education? Does the expansion of STEM fields (with ample job opportunities) include universities that serve students of color and other underrepresented? Second, have the recent closures of science departments disproportionally impacted some student populations? In particular, are minority-serving universities disproportionately affected by the closing of scientific departments, and how does this affect their students and the university's culture? Such questions have theoretical and practical

importance and may inform future policy. For example, for policy, it seems very important to understand how we might best satisfy the needs of underrepresented populations and the needs of the scientific community during times of academic retrenchment, particularly when underrepresented populations often attend poorly funded low status universities. These questions also have the potential to produce broadly useful knowledge of how education is organized in the United States, as well as how institutional culture replicates and shifts over time.

Other Studies of Market Response

Apart from the immediate question of closure, there are many other studies of market response that should be perused. The biomedical sciences, in particular, face a number of broad organizational challenges that involve issues of meso-level power and challenging questions about how best to manage the American sciences. Although universities do appear to respond to market changes within the biomedical sciences, particularly in regard to academic department structures, it appears that biomedical PhD graduate students are not sensitive enough to dynamics within the faculty labor market. For example, Bruce Alberts and colleagues recently wrote a widely discussed article about the lack of faculty positions for biomedical PhDs (Alberts et. al 2014). Indeed, there appears to be a large misalignment between the faculty ambitions of biomedical graduate students, the production of PhD by departments, and the actual number of available faculty positions for recent PhDs. Furthermore, it appears that many established biomedical faculty thrive on the overproduction of PhDs because there is large group of recent PhDs who can inexpensively staff their labs.

Although particularly acute among biomedical sciences, this problem of labor market misalignments and PhD overproduction is a problem facing many academic disciplines, and so

this is an important issue for knowledge production in general. Consequently, there are many questions to explore. How does PhD overproduction occur and who or what perpetuates the misalignment between career ambitions and market realities? How do students and postdocs come to accept low-wage, high-risk labor prospects, and what do their teachers and mentors tell them about the realities of the job market? Do academic departments perpetuate this misalignment because they have a great need for inexpensive teaching assistants and post-docs? Are PhD students simply unaware or in denial about their faculty prospects? Apart from the students themselves, how has science changed by having a large group of relatively inexpensive scientists with few career prospects? By exploring such questions I hope to offer a greater understanding of knowledge production in the US.

Navigating Rapidly Evolving Market Driven Fields

This dissertation also raises questions about life within market driven fields. For example, if the biomedical sciences lack institutionalization and are changing rapidly in both their names and department structure (in response to market forces), it is important to explore how professors and graduate students navigate these rapidly changing academic landscapes. How do universities identify new PhD students whom they would like to accept and how do graduate students know which potential advisers are appealing? Such questions are a bit easier for institutionalized disciplines such as history since they are often driven by disciplinary identity. New history PhDs know to apply to history departments for faculty positions and history departments nearly always hire history PhDs. This is possible because disciplinary identity is stable for many disciplines. This stability, however, does not exist among the biomedical sciences (and other market driven fields). Instead biomedical departments, department names, and graduate program names change quickly and frequently.

Within this context, it is important for both theory and policy to understand how faculty members and graduate students navigate through these complex organizational environments. I aim to explore these environments with in-depth interviews conducted at major research universities. Such work will, for example, ask graduate students how they know which departments to apply to and which advisers to work with, and will ask departments how they know who to hire. My very preliminary hypothesis is that the biomedical sciences are driven by super-star faculty and not by disciplinary identity as we often see in fields such as philosophy or history. When choosing where to attend graduate school, my proposal is that potential students pay less attention to disciplinary affiliation and department status than students who apply to programs and more institutionalized disciplines such as history and philosophy. Instead, applicants to biomedical graduate programs pay more attention to the prestige of potential graduate advisors. Similarly, since departmental identity is fluid, faculty search committees pay less attention to department status and disciplinary affiliation and pay more attention to the prestige of a candidate's graduate advisor. Such questions have theoretical and practical importance. For policy, this research can help us understand the challenges and burdens that certain scientists face. Broadly, it can also help us gain a better understanding of how knowledge is organized and produced in the United States and will illuminate the different work environments for those sciences that face quasi-markets and those that face institutional culture.

How Do Universities Respond to Labor Markets

There is a lot of discussion today about labor market outcomes of university students. The big question is whether universities successfully prepare students for the contemporary economy. The newly announced College Scorecard appears to be an attempt to push universities to think more about what happens to their students after they leave campus. Conservative pundits also

rail on universities for being out of touch, lazy, and inefficient. Brint et. al 2011 also found little evidence that labor market signals shape changes in the growth and decline of academic fields.

On the other hand, in carrying out my dissertation research, I incidentally collected anecdotal evidence suggesting that universities respond to labor market outcomes in some instances. For example, in collecting data on engineering and literature programs, some email respondents voluntarily linked program closures or program changes with market changes. Some respondents stated that language and literature programs were changed to cultural studies programs because cultural studies programs better prepare students for an international economy. In addition, some respondents said that engineering programs were closed because the students were no longer getting jobs. So, for example, universities in states with steel industries often closed their metallurgical engineering programs when jobs dried up in the steel industries. Similarly universities in states with mining engineering dropped their mineral engineering when their students stopped getting jobs in these industries.

So we still have the question of how universities actually do response to labor market outcomes. On one hand, it might seem that universities do not pay attention to this important detail, but, on the other hand, there is anecdotal evidence that universities do watch to see if their students gets jobs. A more systematic examination of how universities respond to labor markets is very much needed. Doing so might very well help improve the College Scorecard. Similarly, we also should explore how to best use labor market signals alongside other measures of university quality to assess how universities should change and assess the unintended consequences that might follow from the use of the labor market signals.

Explaining Ubiquity

This dissertation has the potential to stimulate debate about the classic question of ubiquity within organizational studies. Scholars have noticed that many organizations end up looking the same over time. In other words, organizations appear to be isomorphic or ubiquitous. This observation in large part spawned an entire genre of research with the title *new institutionalism* (DiMaggio and Powell 1983; Meyer et al. 2007). These scholars set out to explain why a wide variety organizations look the same around the world. In terms of higher education, they note for example that universities around the world are similar along the following dimensions: faculty composition, curricular content, student enrollment, labels, claims about knowledge, and stratification (Meyer et al. 2007). These scholars argue that these practices are ubiquitous because universities are conforming to institutional culture. This is a highly influential idea, and scholars continue to invoke this idea when they find a ubiquitous organizational trait. Just this year, a publication in the *Journal of Higher Education* argued that universities continue to graduate humanities majors and this ubiquity can be explained by deeper institutionalization (see e.q., Hearn and Belasco 2015).

I agree with this argument but I don't think they have data to prove their claim. This is because a different set of scholars argue that an organizational form or practice can be ubiquitous but not necessarily institutionalized (see Kraatz and Zajac 1996; Colyvas and Jonsson 2011). A ubiquitous practice might be caused by high demand or caused by a fad. I am more sympathetic to this position and, although not definitive, this dissertation suggests that engineering programs are ubiquitous where there is high demand coming from quasi-markets. In contrast, however, language and literature programs are ubiquitous, at least in part, because of institutional culture. Additional data and research have the potential to unravel this puzzle in greater detail.

Conclusion

This dissertation puts forth a double facing theory of university change to explain how universities go about closing programs during times of restructuring. I labeled this activity the academic chopping block, a term that conveniently distinguishes the research questions here from questions about total population shifts. Contrary to the findings of much existing literature, the programs and departments of the liberal arts and the associated humanities were not more vulnerable to closure over the last 40 years. An event history analysis of the failure rates of departments in the College Catalog Study data indicates that market proximity does not guarantee the success of practically-oriented disciplines and their departments (as hypothesized by academic capitalism) but rather leaves them vulnerable to the turbulent ups and downs of market demand. In contrast, when faced with department closures, institutional culture shields liberal arts disciplines. Consequently, liberal arts disciplines face *smaller* closure rate than practical disciplines. A study of science departments found similar results. Although considered to be some of the most commercial disciplines on campus, the biomedical sciences show higher failure rates than traditional sciences. Finally an examination of engineering and language and literature programs suggests that higher education leaders may be more interested in conforming to institutional culture than they are in responding to market demand when it comes to the liberal arts.

This dissertation raises important issues for universities in the context of a changing university and a fraught political environment. It also raises some important questions for sociological theory. As I outlined in this concluding chapter, the newly announced College Scorecard reinforces the important question of whether universities do good by students by monitoring and responding to labor market changes. This dissertation suggests that more

research is needed to answer this question. In a similar vein, study is needed of how graduate students monitor and respond to the market opportunities.

APPENDIX 1: PRACTICAL VS. LIBERAL DISCIPLINES

This the classification scheme was used to categorize departments in the CCS data, but it does not reflect the disciplines in the CCS data. (Brint et. al 2005).

TABLE 2
Occupational/Professional and Arts and Sciences Degree Categories

Occupational/Professional	Arts and Sciences
Advertising (Communications)	Area, ethnic and cultural studies
Agricultural business & production	Biological sciences/Life sciences
Agricultural sciences	Communications (except those found under occ./prof.)
Architecture and related programs	English language and literature/letters
Arts management (Visual & Perform. Arts)	Foreign languages and literatures
Broadcast journalism (Communications)	History
Business management & admin. services	Law and legal studies (except those found under occ./prof.)
Clinical psychology (Psychology)	Liberal/general studies & humanities
Communications Technologies (Communications)	Mathematics
Communications, other (Communications)	Multi/Interdisciplinary Studies
Computer & information sciences	Philosophy and religion
Commercial photography (Visual & Perform. Arts)	Physical Sciences
Communications, General	Psychology (except those found under occ./prof.)
Conservation & renew. natural resources	Social Sciences
Construction trades	Visual & performing arts (except those found under occ./prof.)
Counseling psychology (Psychology)	
Education	
Engineering	
Engineering related technologies	
Fashion design (Visual & Perform. Arts)	
Film-video making/cinematography and prod. (Visual & Perform. Arts)	
Graphic design, commercial art and illus. (Visual & Perform. Arts)	
Health professions and related sciences	
Home economics	
Industrial design (Visual & Perform. Arts)	
Interior design (Visual & Perform. Arts)	
Journalism (Communications)	
Law (Law and legal studies)	
Library science	
Marketing opers./market & distribution	
Mechanics and repairers	
Military technologies	
Music bus. management & merchandising (Visual & Perform. Arts)	
Paralegal/legal asst. (Law and legal studies)	
Parks, recreation, leasure & fitness	
Personal & Miscellaneous services	
Precision production trades	
Protective services	
Public administration and services	
Public relations & Organizational comm. (Communications)	
Radio & television broadcasting (Communications)	
School psychology (Psychology)	
Science technologies	
Theological studies/religious vocations	
Transportation & material moving workers	
Vocational home economics	

APPENDIX 2: FIELDS SHOWING GREATEST DECLINE PER YEAR

(Data from Brint et. al 2012a)

Academic fields experiencing relative but not absolute decline between 1970 and 2006

- English
- Chemistry
- Education
- Mathematics
- Biology

Academic fields experiencing both absolute and relative declines between 1970 and 2006:

- Secretarial Sciences (-194 Total Departments)
- Romance Languages (-125)
- Germanic Languages (-181)
- Zoology (-78)
- Library Science (-73)
- Botany (-55)
- Slavic Languages (-48)
- Home Economics (-47)
- Classics (-34)
- Crop Science (-21)
- Sociology (-15)
- Industrial Engineering (-13)
- Geography (-9)
- Economics (-8)
- History (-2)
- Physics (-1)

Fastest Growing Fields between 1980-2000 by degrees awarded

- Computer Engineering
- Women's Studies
- Cognitive Science
- International Business
- Public Health
- Arts, Creative Arts
- Law/Legal Studies
- Computer Science, Information Science
- Ethnic Studies
- International Relations

- Hotel, Restaurant, Hospitality Management
- Recreation, Leisure Studies, And General Studies

APPENDIX 3: EVENT HISTORY METHOD

For this analysis, I use hazard models since they are uniquely suited to handle the occurrence of events over time and handle incomplete observations due to censoring. In this application, for example, a department may not experience a closure event during the period of study because the length of observation time may be shorter than the length of the waiting time to closure. This is a problem that standard logistic regression model cannot handle without cumbersome assumptions. Also hazard models are superior to logistic methods when controlling for differing exposure times.

Of possible hazard models, I use an accelerated failure time hazard model with a Weibull distribution to model the time to closure of departments (although I also provide results of a Cox model as a test, which I discuss below). Unlike Cox models that are agnostic about the time trajectory of the event, in this paper we care about it and need to estimate it from observables. Because a Weibull hazard model is both a proportional hazard and an accelerated failure time model, it is more robust to violations of the assumption of proportionality on which most hazard models rest (For more on event history analysis see (Singer and Willett 2003 or Hosmer, Lemeshow, and May 2008).

One concern with hazard models is whether there are enough failure of events in the model to provide robust results. Hazard models are nonlinear models and so tests of robustness such as R- squared do not apply. Instead the literature generally accepts failure rates of 5% as robust. In the Chapter 1 there are 12,425 departments that face the risk of closure. 13% of departments experienced failure in the first model that combines terminations, dropped from, and reduced to program level. In the model that considers terminations exclusively 5.8% failed. In the Chapter 2 data about the biomedical sciences, 8.2% of departments experienced failure in the

first model that ignores the renaming of anatomy departments. 8.8% of experienced failure in the second model that considers the renaming of anatomy departments. In the Chapter 3 engineering and language data, 18.4% of programs in the sample failed.

To further evaluate this concern of small failure events, I also supply the results of Cox Models in Chapters 1 & 2. I do this because it places fewer demands on the data, and if we find the same results in the Cox model, the results of the Weibull model are acceptable.

The Cox Model is specified as follows:

$$h(t) = h_0(t) \exp^{(x1\beta1+ \ldots + xk\beta k)}$$

where $h_0(t)$ is the cumulative hazard (not directly estimated), x_1 is a variable for department "1" and β_1 is the corresponding coefficient. The Efron method was used to handle ties, and Cox-Snell analysis shows reasonable proportionality.

APPENDIX 4: CHAPTER 1 AND CHAPTER 2 DATA CONSTRUCTION

Departments can evolve in multiple ways and so the College Catalog Data carefully distinguishes between different types of change. For example, departments can maintain their professors and courses and research agenda but change their names. Single departments can also split into two departments. Over multiple generations the courses, professors, and research of a department can slowly evolve. The College Catalog Data designates such changes as reappearing, as splitting, merging, surviving, per unit of time.

For the survival analysis, I coded the following changes as failures: departments coded as failed, departments coded as dropping a discipline, or departments that were reduced to a program. Since I want to distinguish between changes involving evolution and changes involving termination I coded merged, split, reconstituted, and surviving departments as survivals (censored). After a department is split, merged, or added to another department it appears in the next cohort as a new or "birthed" department. Reconstituted[56] departments are coded as new departments in the next cohort as a new or "birthed" department.

In marking a department as "birthed" the data does not distinguish between brand new departments and departments that appear following, for example, a merger. Each cohort has a collection of departments that are brand new as well as a number of departments that appeared as the result of merging and splitting. This has a number of important consequences: It is difficult to study addition of new departments because we don't know if a department marked as "birthed" is a brand new department or whether it originated in a different form in a previous

[56] Reconstituted departments are departments that return to some pre-existing form. For example, two merged departments reappear as distinct departments in subsequent cohorts. These are marked as new departments. Adding reconstituted as a control showed that nonsignificant results and so were removed from the analysis

cohort. Consequently, we can't easily study, for example, the effect of prior merging on closure, and so we don't know if merger is an alternative to closure or whether merging strengthens or weakens departments in the face of a future risk of closure.

APPENDIX 5: CHAPTER 3 DATA COLLECTION AND VERIFICATION

Identifying Potentially Closing Low Enrollment Academic Programs. IPEDS program graduation data were organized as such: First, student graduation data, for each program, between the years 1984-2012, were broken into five year bands: 1984-1987, 1988-1992, 1993-1997, 1998-2002, 2003-2007 and 2008-2012. Second, programs starting after the first year band (1984-1987), and thus lacking graduations in that year band were excluded. Third, year bands per program were classified as low enrollment and high enrollment, where a low enrollment year band is defined as having, on average, ten or less graduations per year. Based on these classifications, programs were defined as low-enrollment programs based on the number low enrollment year bands that a program experienced between 1984-2012. A program was identified as a low enrollment program one of the following conditions were true:

- the academic program graduated students for at least four year bands and had at least four year bands with an average graduations of ten or less.
- The academic program graduated students for less than four year bands and the number of low enrollment year bands was greater than the number of high enrolment year bands

Fourth, the remaining low enrollment programs were divided into those programs that reorted student completions in 2012 and those programs will no reported graduations. Those low enrollment programs that graduated students in 2012 were classified as surviving. Programs that did not graduate students in 2012 were classified as *potentially* closing.

Verifying Potentially Closed Academic Programs: A process was conducted to see if programs that appear as potentially closed actually closed. There are a number of reasons why something that appears as potentially closed might actually not be a genuine termination. Most

importantly, IPEDs data are notoriously messy. Programs that appear as potentially closed in IPEDS data may actually continue to exist under a different IPEDS identification code because of a number of reasons. For example, some programs are simply reclassified by university institutional research offices under a different identification (CIP code). Furthermore, a program might appear under a different identification code because *The National Center for Education Statistics* eliminated a specific program identification code.

Giving the existing state of IPEDS data, extreme caution was taken when asserting that a potentially closed program was actually closed. Most importantly I found secondary sources that could verify the closure of each academic program. Some program closures could be verified by university program histories published on university websites. So, for example, the Mississippi State University Department of Agriculture and Biological Engineering website clearly states that "In 1992, in a university restructuring effort the agricultural engineering curriculum was eliminated." Most potential program closures were confirmed or denied with telephone calls or emails or with university program announcements on websites. Email addresses for academic deans, department heads, or associated institutional research offices were collected for each potentially closed academic program. Respondents were asked to verify whether the program in question was reduced to a minor, merged into a single program, merged into a general program (e.g., general engineering), combined with a different academic program, transformed into a different program (e.g., Industrial Engineering into Operations Research), or reclassified by the institutional research office and reported under a different CIP code.

When email and telephone queries were not successful, I used university websites that tell students about their academic programs. As with the email and telephone queries, I used university websites to assert whether a given program was reduced to minor, merged into a

single program, merged into a general program (e.g., general engineering), combined with a second academic program, or transformed into a different program (e.g., Industrial Engineering into Operations Research). Broadly speaking, universities have an incentive to have accurate websites since most students use these websites to assess what programs to pursue. However there are still potential pitfalls to relying upon university websites. These websites might simply be out of date, programs may have changed their name, or programs in the IPEDs record may have never existed. To assist test the accuracy of using university websites, I took the list of successful email and telephone queries and looked to see if I could have gathered the same information from university program websites. I evaluated the websites of 114 languages. Of these, 103 websites were accurate and informative, 4 were inaccurate, and 7 websites where uninformative. I also evaluated 126 engineering programs by comparing data gathered through emails and telephones to the data that can be gathered from program websites. Of these 112 websites were informative and accurate, 5 were inaccurate, and 9 were ambiguous or uninformative. This leads me to have confidence in the data that was collected from program websites.

Coding Different Organizational Changes as Survivals and Failures In attempting to verify that programs appearing as potentially closed in IPEDS were actual closures it became clear that there are multiple forms of organizational change that must be considered. Some programs are merged or collapsed into another program. For example, Temple reduced its environmental engineering program to an option within civil engineering. These were coded as censored or surviving. Programs that were reduced to minors were deemed closures.

This data is also fraught with a number of ambiguous organizational transitions, where a given program is given a different name but continues to share many of the characteristics of the

original program. In these cases it's not clear whether a program change counts as a closure or has something else. So, for example, many metallurgical, ceramic, and material engineering programs were transformed into material science programs during the period of study. Similarly German, French, and Spanish language and literature programs were broadly transformed into German Studies, Spanish Studies, and French Studies. To bias the analysis against the *double-facing* theory, I coded ambiguous language transitions as closures but coded ambiguous engineering transitions as survivals.

Separate Note on Computer Science Programs It's important to make a special note about Computer Science programs. This group of programs were excluded from this data analysis because the data collection process that I describe above simply does not work. There are 668 potentially closed low enrollment computer science programs in the data between 1984-2012 (CIP codes=110100 thru 119999). Of these, I investigated a convenience sample of 133 and found that 42 were surviving programs and 45 were genuine program terminations. The status of the last 46 could not be determined. Thus there appears to have been a great deal of opening and closing of computer science programs throughout the period of study, however in cases where university may have shut one computer science program and opened another, its next to impossible to rely on a universities website to access whether a potential closure is an actual closure. Contemporary computer science professors often also do not have a grasp on what happened in the 1980s and 1990s, and so they generally were not a useful source of information. The same can be said about people working in institutional research offices. Consequently it is impossible to know, in many cases, whether what looks like a closure in the data is in fact a genuine closure or simply a reclassification on the part of institutional research offices. The irony of this situation is that I would argue that an inability to track names is a sign

of a lack of institutionalization and thus a vulnerability for computer science programs. A more detailed historical analysis will be needed to explore this set of programs.

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