Does Stacking Work?

The Academic Value of Short-Term, Stackable Certificates

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ABSTRACT

Does Stacking Work?

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Community colleges confer professional/technical awards so graduates might attain labor market benefits, including earnings advantages. Short-term certificates, generally defined as academic awards in these fields requiring less than one year of full-time, college-level study, are the quickest-to-the-job-market training solutions among these awards. Empirical studies of short-term certificates, however, show that associated earnings advantages are often small or non-existent. *Stackable* short-term certificates, however, attempt to offer a second benefit in addition to any meager labor market gains. Stackability is the concept that two-year degrees and other longer-to-complete academic awards can be broken into smaller, "stepping stone" awards, increasing the likelihood that a student will progress beyond the first short-term, stackable certificate, where earnings advantages are uncertain or meager, to a long-term certificate or degree where earnings advantages are larger and more certain.

Prior research examines the earnings outcomes and other labor market benefits associated with these awards. The present study focuses on the academic value of short-term, stackable

certificates, defined as their ability to sufficiently attach students to an area or program of study so that they progress beyond the initial short-term certificate toward a two-year degree. The study also considers the earnings benefits of short-term, stackable certificates—largely to establish that certificates examined in this study do not have earnings outcomes that are notably different than those found elsewhere in the literature. This typical lack of earnings benefits is indeed what I find.

Multilevel modeling results of professional/technical students with no prior higher education (N = 3573) who began studies in 2007-08 in Washington State community and technical colleges ($N = 33$) showed that attaining a single short-term, stackable certificate significantly lowered a student's likelihood of earning a two-year degree while attaining two or more short-term, stackable certificates, called *progression stacking* here, more than doubled that likelihood. Based on this finding, a further multi-level model of a subset of students who earned at least one short-term, stackable certificate (n = 567) in the same entry cohort attending the same colleges ($n = 29$) showed that students who earned their first short-term award in Automotive Technologies and Auto Body were significantly more likely to earn the second short-term, stackable certificate in a sequence leading to a degree. No other significant predictors were found.

Short-term, stackable certificates can deliver academic value, but only when a student earns two or more of them. Automotive Technologies and Auto Body are two programs of study where the predicted probabilities of degree completion among all students examined and attainment of two or more short-term, stackable certificates among students who earned at least one were both positive and statistically significant. Potential implications for the design of stackable certificate sequences are discussed.

Key Words: Community colleges, short-term certificates, stacking

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CHAPTER 1: INTRODUCTION

1.1 Problem Statement

Community colleges offer certificate programs—preparing graduates for the labor market in as little as one academic term—in response to demand from students, employers, policy makers, and others seeking quick-to-the-market training options. A closer look at these programs reveals a trade-off. Short-term certificates provide rapid access to the labor market but often fail to result in meaningful wage advantages. Longer-term certificate programs can produce meaningful wage advantages, but are not as rapid in getting trained students into the labor market as some would like (Stevens, Kurlaender, & Grosz, 2015; Bahr, P., et al, 2015; Zumeta & Huntington-Klein, 2015; Xu and Trimble, 2014; Dadgar & Trimble, 2014; Jepsen, Troske, & Coomes, 2014; Carnevale, Jayasundera, & Hanson, 2012; Carnevale, Rose, & Hanson, 2012; Crissey & Bauman, 2010; Dadgar & Weiss, 2012; Bailey, Kienzl, & Marcotte, 2004; Grubb, 1995; Kane & Rouse, 1995). Certificate programs can be quick-to-the-market or they can pay off, but apparently not commonly both. Enter stackable certificates.

"Stacking" is a concept that breaks two-year degrees or other longer-to-complete academic awards into smaller, "stepping stone" awards that allow students to better balance the competing needs of work and school. A single short-term certificate may not deliver much in terms of earnings advantages—no more than the first stepping stone gets you across the river. Accumulating several of them, via stacking, may be the key. And short-term stackable certificates appear to offer other potential advantages. They can be earned quickly, providing opportunities for students who cannot or will not commit to longer courses of study. Ideally, they can be leveraged to some benefit in the labor market, such as an entrance into a desired field, even in the absence of an earnings benefit. As a sequence they can then provide a clear, prescriptive path to returning to school for a greater academic award where earnings advantages appear with greater certainty such as a long-term

certificate, described by Prince & Jenkins (2005) as the "tipping point" to more certain earnings benefits. Short-term certificate coursework can even be delivered during the evenings or weekends or through online or hybrid classes, offering more options for combining work and school.

Community colleges have designed stackable certificate sequences intended to provide these benefits. Are students following these steps far enough to see an earnings benefit? Do these sequences improve the likelihood of earning a degree over traditional, non-stacking coursework? Acknowledging that they are designed to allow students the option to extend their academic careers over time—to stop out for a while but later return without losing a step—what can we learn by examining outcomes after five years? This dissertation uses college transcript and labor-market data from the Washington State Board for Community and Technical Colleges (SBCTC) to examine these questions. Washington has thirty-four community and technical colleges, many of which provide short-term, stackable certificates across a wide variety of programs of study. As such, the data here may have implications for understanding the effects of stackable programs elsewhere in the U.S., a topic of considerable interest nationally.

Certificate conferral has been growing across the nation. In 2012, certificates became the second most commonly awarded postsecondary credential in the U.S., trailing only bachelor degrees (Carnevale, Rose, & Hanson, 2012; Horn, Li, & Weko, 2009). In 2015-16 (the most current year with data available), IPEDS reports sub-baccalaureate certificates as being the third most common award in Washington, nearly equal to associate degrees at 30,591 and 30,831, respectively. Bachelor's degrees are the most common award in the state at 33,598.[1]

[1] Author's calculations using IPEDS data.

1.2 Overview of the Benefits of Short-Term Certificates

Earnings benefits. Prior to the development of stackable certificate sequences, short-term certificates aimed to improve wage and employment prospects in part on the assumption that workers could leverage certificates into entry-level jobs and then "work their way up." The empirical evidence cited above questions this thinking.

In general, research illustrates a positive correlation between academic attainment and earnings. While not universally true, four-year degrees generally correlate with greater earnings than two-year degrees, two-year degrees with greater earnings than long-term certificates, and long-term certificates with greater earnings than a short-term certificate or no award at all. But this is where evidence between academic award attainment and earnings gains appears to end. According to most of the literature, there is no general labor market advantage that short-term certificate holders have over those who start college, earn some credits, and then drop out. The research is mixed but generally indicates that those who have completed at least some college credits do slightly better in the labor market than those who never completed any college at all, and short-term certificate holders appear to have this advantage as well. But there is no evidence that short-term certificate holders do better than those who have "some college" (credits) without earning any award, as illustrated in Exhibit 1.1 (Bahr, Dynarski, Jacob, Kreisman, Sosa & Wiederspan, 2015; Stevens, Kurlaender, & Grosz, 2015; Dadgar & Trimble, 2014; Dadgar & Weiss, 2012; Belfield & Bailey, 2011; Bailey, Kienzl, & Marcotte, 2004).

Exhibit 1.1. *Earnings Value of Academic Awards*

Earnings	Academic Award	
Higher	Four-year degree	
	Two-year degree	
	Long-term certificate (1 year or longer)	
	Short-term certificate (less than 1 year)	Some college
	High School Diploma/GED	
Lower	No High School Diploma/GED	

Research does not indicate that short-term certificate holders do better in the labor market than those who earn college credits without earning an award ("some college").

Academic Benefits. Given the apparent absence of an earnings benefit, the benefit of short-term certificates may lie with their academic value—i.e., their ability to sufficiently attach students to a program of study so that they progress beyond the initial short-term certificate toward a long-term certificate, degree, or other award. Perhaps short-term certificates offer rapid entry into a desired occupation where wage and employment prospects improve with future academic training, such as studies resulting in a long-term certificate or degree, and work experience. Perhaps they make higher education attractive to those who never imagined themselves to be "college material." Perhaps rapid certificate attainment—with a graduation ceremony celebrating college-level achievement early on—motivates low-skill adults to go further in their studies than they otherwise would.

Stackable certificate sequences can also be understood as an alternative to the traditional approach to remedial education, commonly called developmental education. Community colleges and other institutions often use standardized test scores or other placement tools to assess college-readiness, and they place low-scoring students into remedial math and English course sequences—

sometimes lasting several terms—which students must complete before taking the college-level coursework related to their desired areas of study. Bailey, Jeong and Cho (2009) examined nationwide data on community college students collected as part of the Achieving the Dream initiative and found that fewer than half of the students who placed into this type of remedial coursework completed the recommended sequence, and that only about 30% of students even enrolled in any remedial course. Bailey and Cho (2010), examining a similar nationwide data set, found that less than 25% of community college students who enrolled in developmental education completed a degree or certificate within eight years, while almost 40% of community college students who did not enroll in developmental education were able to complete an award.

Short-term, stackable certificate sequences do not, in general, require college-level math and English skills upon entry.[2] As such, these sequences provide an alternative that allows students to engage immediately in coursework related to their chosen field rather than languishing in developmental education. Wang (2015) examined course-taking patterns of community college students in science, math, engineering and technology (STEM) fields, and found evidence that students who enrolled in a college-level STEM course in their first year of study improved their transfer rates to baccalaureate colleges and that the context of the STEM class may have sparked subsequent interest in the required math coursework. Short-term, stackable certificates—which offer subject-matter coursework in the first quarter of study—may offer similar benefits.

The academic benefit of short-term, stackable certificates remains largely unstudied empirically. This dissertation project examines short-term, stackable certificate outcomes in eight programs of study to discern the extent of labor market and academic benefits received by students who entered a community college in Washington with no prior college education. The differences

[2] Long-term certificates and degrees generally require college-level math and English, so short-term certificate holders would eventually need to demonstrate these skills as they progressed along a stackable certificate sequence.

associated with earning a short-term, stackable certificate are estimated among a sample of such students, some of whom earned these types of awards while others did not but wherein all students earned at least fifteen college-level credits, took at least one course in their declared program of study, and attended a college that confers two-year degrees in the program of study (so that stacking toward a degree would at least theoretically be possible). This design provides a reasonable basis for comparing outcomes between short-term certificate holders and students who attained "some college" credits without earning a short-term certificate, where both groups showed some initial attachment to college and a program of study.

1.3 Definitions

This section defines terms associated with short-term certificates and stackable certificate sequences. While the definitions reflect common usage in the field, they are not universal. These definitions inform the research questions at the end of this chapter as well as in subsequent chapters. Many of the studies in the literature review (chapter 2) employ these same definitions, although sometimes with important exceptions. When they occur, those exceptions are noted for clarity.

Certificates. Certificates are nondegree credentials offered by higher education institutions that recognize the completion of academic coursework in a field of study, most often a vocational one. In contrast to an associate's degree, they generally require less than two years of study. While one can usually expect that a degree holder has completed a core of general education courses, individuals who hold certificates as their highest credential may not have done so. As mentioned, entrance requirements (and in some cases, completion requirements) do not necessarily include a college-level math or English course, affording students the opportunity to move straight into coursework specific to the field of interest, even for students who would otherwise place into developmental (remedial) math or English.

In this study, certificates are distinguished from certifications, which are industry credentials conferred by trade groups, companies, and other industry organizations most often based on successfully passing an exam. This dissertation study examines academic certificates, not industry certifications. In 2007-08, public two-year and private, for-profit schools conferred nearly all certificates (both long- and short-term), with less than 5% awarded by private, non-profit institutions (College Complete America, 2010).

Short-term. This study defines "short-term" as certificates that require less than one year of full-time study, in contrast to "long-term" certificates which are those that require at least one year of full-time study (but are generally less than two years). This definition is used by the U.S. Department of Education as part of the Integrated Postsecondary Education Data System (IPEDS) and by Prince & Jenkins in their seminal 2005 examination of the labor-market value of short- and long-term certificates in Washington (Prince & Jenkins, 2005). A number of studies in the literature review (chapter 2) do not distinguish between short- and long-term certificates, a fundamental distinction that is important and that I make in this dissertation.

Stackable. Defining (and subsequently locating) stackability among academic awards was one of the most challenging and critical aspects of this study. Stackability was not defined, and therefore not coded, in the data set. Categories of stacking, therefore, were created using indirect evidence as described in chapter 3. Bailey and Belfield (2017) describe different categories of stacking. This dissertation adopts two definitions coined by Bailey and Belfield—progression stacking and independent stacking. This dissertation also adds a third definition—potential stacking—to describe cases where a student earned a certificate with the "potential" to stack in some way but lacking further evidence to show how the student intended to stack within the five-year period examined (assuming such intention). These three types of stacking are

further defined below. A fourth, type—supplemental stacking—is also discussed due to its prevalence. As noted, however, supplemental stacking falls outside the scope of this work.

Progression stacking. A certificate is defined as progression stacking if there is evidence that the short-term award included credits that could be either immediately or later applied toward a degree. Progression stacking can be understood as the type of stacking intended by the colleges where a sequence of study leading to a degree is broken up into "stepping stone" certificate awards. As such, progression stacking attempts to offer both labor market benefits (opportunities to stop out of studies with an award after a short period of time) and academic benefits (opportunities to continue studying in the same field toward a greater academic award or to stop out and return without losing any credits). Examples of progression stacking include the Automotive Repair Technology sequence from South Seattle College, which is shown in Exhibit 1.2.

Exhibit 1.2. *Automotive Technology Stackable Certificate Sequence from South Seattle College*

Automotive Maintenance & Light Repair

SOUTH SEATTLE COLLEGE
One of the Seattle Colleges

Introduction to Automotive Technology

Jobs & Wages*

Lube Technician
$13-15 / hour

IBEST Training

Introduction to Automotive Technology
17 credits

- Introduction to Automotive Technology I & II
- Introduction to Electricty
- Hands-on, online, classroom experiences

Entry Requirements

- CASAS 220 Listening & Reading
- Instructor Permission

Tire & Brake Technology

Jobs & Wages*

Tire & Break Technician
$14-17/ hour

Training

Steering, Suspension, Brakes
17 credits

- Steering & Suspension
- Tires and wheel alignment
- Basic Brake Systems
- Advanced Brake Systems

Entry Requirements

- Completion of Introduction to Automotive Technology, Math 110
- Instructor Permission

Maintenance & Light Repair Technology

Jobs & Wages*

Maintenance & Light Repair Technician
$17-22/ hour

Training

Engines, transmissions, performance
17 credits

- Automotive Engine Diagnosis/ Remove and Replace
- Automotive Engine Rebuild
- Introduction to Performance
- ASE Student Certification

Entry Requirements

- Completion of Intermediate Manufacturing
- Instructor Permission

Automotive Technology Master Certificate, AAS, AAS-T

Jobs & Wages*

Journeyman/Master Automotive Technician
$22-30/hour

Training

48-73 credits

- Entry-level machinist tasks; program basic machine tools
- Math
- Set up mills and turning tools
- Utilize properties of materials and establish correct speeds and feeds
- Interpret mechanical blueprints
- Use current software
- Apply teamwork, inspection and SPC to manufacturing problems.

Entry Requirements

- Completion of Manufacturing Technology Applications
- Instructor Permission

*Wage information from Career One-Stop, US Department of Labor, as found at www.careerinfonet.org in August 2014.

In this example, a student could earn a Lube Technician certificate in one full-time term, qualify for an entry-level job, and enter (or re-enter) the workforce. Students could also continue their studies, while working or after stopping school for a time, and add Tire and Brake Technology and/or Maintenance and Light Repair Technology to their resume and skill set. Despite the empirical evidence cited earlier, the exhibit presumes wage increases associated with these short-term certificates based on the types of jobs for which the training is designed to prepare students combined with data from the U.S. Department of Labor.[3] The sequence leads to a two-year degree in Automotive Technology and the increased likelihood that a student can attain a wage that might be adequate to support the needs of a family in a given city, county, or other community—a living wage. Policy makers, researchers, workforce investment boards and others describe these sequences as Career Pathways or Career Ladders and invest resources into developing them (Albrecht, 2011; Boston Workforce Development Coalition, 2002; Chrisman & Spangenberg, 2005; Dins, 2005; Bernick, 2005; Fleischer, 2001; Jenkins, 2006; Pleasants & Clagett, 2010; Stephens, 2009; Community Research Partners, 2008).

Similar progression stacking sequences exist in other career and technical programs of study. Some were created explicitly to respond to the policy requirements of federal programs such as Temporary Assistance for Needy Families (TANF), which limit the length of study welfare recipients can undertake.[4] Others were created to respond to the demands of students and employers, both of whom value the idea of quick-to-market training. Some progression stacking

[3] This presumption is driven in part by mandates from technical advisory committees or other governing bodies to demonstrate that professional/technical training program are using wage and other labor market information to design programs that deliver earnings benefits. It is not necessarily supported by evidence in the empirical literature regarding earnings benefits of short-term certificates.

[4] TANF rules vary state by state, with some states providing more opportunity for training than others. Washington offers a mix of "work-first" and "training-first" strategies that are meant to match students to the most appropriate strategy based on individual and family circumstances. However, the overall approach of federal TANF rules embraces a "work-first" approach.

sequences may have been created by colleges to produce more student completions so as to count as a marker of institutional productivity. Career and technical programs at community colleges complain that their measured graduation rates do a disservice to their programs in cases where students gain skills and leave for well-paying jobs before graduation. Short-term certificates thus might increase the number of graduates by giving them awards before they can leave for work.

The Automotive Maintenance and Light Repair sequence from exhibit 1.2 includes a series of short-term certificates that stack toward an associate's degree. This is one model of progression stacking, but it should be noted that other models include long-term certificates in the sequence. Such models progress from a short-term certificate to a long-term certificate to a degree or simply from a long-term certificate to a degree (with no short-term certificate in the sequence). This dissertation focuses on the academic value of short-term certificates, given the general consensus that short-term certificates have little, if any, earnings value. While long-term certificates are not examined here explicitly, some students in my data may have attained long-term certificates either as their final academic award or as a further "stepping stone" on the way to a degree.

Independent Stacking. Independent stacking describes students who earn two or more short-term certificates in programs of study that are "independent" of one another, akin to a double major. While progression stacking can be understood as a design largely intended by the colleges, independent stacking is largely not intended but rather simply is descriptive of certain students' choices.

Independent stacking offers no advantages toward future academic success, such as credit toward a two-year degree. Quite to the contrary, it requires a student to disconnect from one program of study and connect to another, with no evidence that the credits earned in the first certificate provide academic benefit toward the second. Because this dissertation focuses on

understanding any academic benefits of short-term, stackable certificates, efforts are made to avoid instances of independent stacking in the data or—more precisely—efforts are made to identify and focus on instances of progression stacking consistent with the colleges' intended design.

While independent stacking was not of the colleges' design, 13% of all the professional technical awards conferred in 2007-08 were consistent with this student behavior, presenting a need to specifically control for independent stacking when trying to estimate any benefit associated with the intended, progression stacking design. Table 1.1 shows the number and percentage of short-term certificates that were awarded within and outside a student's original program of study in Washington community and technical colleges in 2008, as evidenced by each program's Classification of Instructional Program code (CIP code). CIP codes were developed by the U.S. Department of Education's National Center for Education Statistics to provide a common taxonomy of programs of study, and Washington State's two-year colleges are required to assign a CIP code to each academic award. With exceptions, awards within the same CIP are consistent with progression stacking, and awards outside of the CIP are consistent with independent stacking.

Table 1.1. *Short-Term Certificates Consistent with Progression and Independent Stacking by CIP Code Conferred in Washington in 2007-08*

Total Short-Term Certificates (%)	CIP Codes Consistent with Progression Stacking (%)	CIP Codes Consistent with Independent Stacking (%)
3007	2,612 (86.9%)	395 (13.1%)

Because at least some instances of independent stacking were unavoidable in the data, this type of stacking was coded separately from other types so that the association each category of certificate has on outcomes is estimated separately. Details on how the data was selected, organized, and coded are provided in chapter 3.

Potential Stacking. Potential stacking is a term I have created to describe students who earned only one short-term term certificate that had potential to stack during the five-year period that I examined. These are the students who made it to the first stepping stone, then stopped before completing a second short-term, stackable certificate. They present an interesting case because, unlike others, they were successful in entering a sequence and reaching the first step, but they did not present additional evidence of having earned another award leading to a degree. Further, when considering the academic outcomes examined in this dissertation, it is important to remember that students who were coded as potential stacking earned only one short-term certificate, while students coded either as progression stacking or independent stacking earned at least two.

Supplemental Stacking. Finally, Bailey and Belfield (2017) employ the term supplemental stacking to describe how degree holders sometimes enhance their qualifications by earning a short-term certificate. Carnevale, Rose, and Hanson (2012) discuss this possibility and note that, among those with an associate's degree and a certificate, 31% earned the certificate after the degree. This student strategy is often intended by the colleges and may result in benefits, but it is outside the scope of this dissertation which focuses on credit and degree attainment among adults with no prior higher education experience who are working toward a degree, where the degree is considered the ultimate desired outcome of academic stacking. With that said, it's worth noting that chapter 5 of this dissertation reveals three cases of supplemental stacking in the data—specifically students who started with no prior higher education, earned a degree, and then continued or stopped out and returned to supplement the degree with a short-term certificate. These cases were coded as either progression stacking or no stacking, based on the

student awards prior to earning the degree (and therefore prior to the conferral of the supplemental stacking certificate).

Stopping Out. Stopping out is a term used in this dissertation to describe when students purposefully discontinue studies before reaching a desired academic award in order to address personal barriers (transportation, housing, etc.). Stopping out can be considered an alternative to dropping out for students with known barriers that prevent them from studying uninterrupted toward a desired award, such as a degree. Absent the option to stop out, adults with such barriers might never attempt studies at all, or they might attempt studies but then find they must drop out. Stackable certificate sequences provide stop out points that facilitate the need to temporarily stop studies to address barriers before returning to complete a greater academic award.

1.4 Assumptions

This section delineates certain specific assumptions about short-term certificates and stackable certificate sequences. As with the definitions above, these assumptions inform the research questions at the end of this chapter as well as in subsequent chapters.

Short-term, stackable certificates are designed to be earned in a student's first or second quarter of study. Exhibit 1.2 shows a highly prescriptive map for Automotive Technology students leading from the first short-term, stackable certificate all the way to the degree—including the number of credits earned per quarter. This map, when followed with fidelity by a full-time student, assumes that a student will earn his or her first short-term stackable certificate in the first quarter of study. Chapter 5 analyzes this assumption using student award data and discusses how the lack timely attainment of the first short-term award might signal ineffectiveness of the sequence.

Some students will earn a short-term certificate, stop out, and return to complete the sequence. Short-term certificates are meant to provide students a rapid path to employment with the

option to return to their studies at a future date and pick up where they left off. There is therefore an assumption that some students will need to stop out and that at least some of those who stop out will return. Chapter 5 analyzes this assumption using student transcript records—specific to the case where a student earned at least their first short-term certificate and subsequently stopped out and returned within a five-year period.

1.5 Research questions

This dissertation focuses on a subset of students in programs with evidence of progression stacking sequences. As such, the focus is primarily on finding evidence of the academic value of short-term, stackable certificates for students—some of whom showed no evidence of attempting the stackable certificate sequence (no stacking), some of whom earned one certificate but did not stack a second short-term certificate (potential stacking), and some of who earned two or more short-term, stackable certificates (progression stacking). Specific steps were taken to select data for programs of study and colleges where academic benefits would be expected to be found—among progression stacking sequences—and to minimize or exclude data where academic benefits would not be expected to be found. The definitions and assumptions described above also inform the research.

Academic value is meant to describe a short-term, stackable certificate's ability to sufficiently attach students to a program of study so that they progress beyond the initial short-term certificate toward a long-term certificate, degree, or other award. It is operationalized into two questions:

1) To what degree, if any, is the attainment of a short-term, stackable certificate associated with an increased likelihood of students' attainment of two-year degrees, where labor market value is more certain?

2) To what degree, if any, is the attainment of a short-term, stackable certificate associated with an increase in the number of credits earned by students?

While earnings are not the focus of this dissertation, they are ultimately of interest since the professional/technical programs examined are meant to deliver earnings advantages. Earnings are also examined to confirm that the outcomes for the subset of short-term, stackable certificates examined here are not meaningfully different than the outcomes discovered in other research. Earnings outcomes are operationalized into two questions:

1) To what degree, if any, is the attainment of a short-term, stackable certificate positively associated with inflation-adjusted earnings three quarters following completion?
2) To what degree, if any, is the attainment of a short-term, stackable certificate positively associated with the *difference* (i.e., presumably gains) between inflation-adjusted earnings three quarters prior to the start of studies and three quarters following completion?

Certificate conferral has been growing, and certificate stacking is of interest nationally. Long-term certificates, generally speaking, have shown associations with earnings gains, and short-term certificates, again generally speaking, have not, according to the studies cited above. This dissertation attempts to address a gap in the literature by estimating the academic value to short-term, stackable certificate attainment, where such academic value leads to a higher probability of two-year degree attainment, where wage benefits are more certain.

CHAPTER 2: LITERATURE REVIEW

2.1 Short-Term Certificates, the Labor Market, and the Case for Stacking

Exhibit 2.1 provides a more refined look at the earnings and employment opportunities associated with the various levels of academic awards that was previously provided in exhibit 1.1.

Exhibit 2.1*: Earnings Advantages and Employment Opportunities of Academic Awards*

<table>
<tr><th colspan="2">Academic Award</th><th>Earnings Advantage</th><th>Employment Opportunities</th></tr>
<tr><td colspan="2">Graduate Studies</td><td rowspan="4">Significant[5]</td><td rowspan="2">High-Skill Jobs</td></tr>
<tr><td colspan="2">Four-year degree</td></tr>
<tr><td colspan="2">Two-year degree</td><td rowspan="2">Middle-Skill Jobs</td></tr>
<tr><td colspan="2">Long-term certificate
(1 year or longer)</td></tr>
<tr><td>Short-term certificate
(less than 1 year)</td><td>Some college</td><td></td><td></td></tr>
<tr><td colspan="2">High School Diploma</td><td rowspan="2">Negligible</td><td rowspan="2">Low-Skill Jobs</td></tr>
<tr><td colspan="2">No High School Diploma/GED</td></tr>
</table>

Unlike the earlier table, this table now categorizes earnings advantages and employment opportunities by academic award and shades the level of academic attainment—short-term certificates (on par with "some college" and no award)—examined in this dissertation. It provides a general look at the opportunities short-term certificates offer in the labor market—i.e., on the cusp between low-skill and middle-skill jobs—and illustrates how significant wage advantages are only attained by additional academic achievement beyond short-term certificates—such as via stacking.

[5] In their 2005 study, Prince & Jenkins do not employ statistical modeling. They do, however, cite other researchers who employed such models and ultimately describe the earnings advantage associated with a long-term certificate or higher as "significant." Use of the term significant elsewhere in this dissertation is reserved to describe statistically significant findings.

Section 2.2, immediately below, reviews the literature on earnings benefits associated with various academic awards, affirming the placement of the various academic awards within the table. The literature reviewed includes the limited number of studies that specifically examine short-term certificates. The center column on the table also draws from the literature discussed in section 2.2, but specifically draws from the work of Prince & Jenkins (2005) to illustrate what they call "the tipping point." Prince & Jenkins conducted a longitudinal study of 34,956 students who began studies at Washington State community and technical colleges in 1996-97 and 1997-98, tracking educational progress and wage record data after five years. Among students who started their studies in GED or English as a Second Language coursework, they identified a long-term certificate as the tipping point, as they found annual wage gains of $8500 and $7000 (respectively) among students who earned a long-term certificate, with no mention of meaningful findings among students who earned only a short-term certificate or less. While they do not employ statistical modeling, they cite other studies which employed such modeling to discover similar evidence (some of these studies are included in the review of the literature on earnings in section 2.2, below).[6]

From a policy perspective, the evidence of a tipping point provides a useful minimum benchmark for academic achievement—a wage advantage in the labor market. If we believe that workers, policy makers, and others are interested in academic programs that result in a meaningful wage advantage in the shortest possible time (and if we further believe that the shortest possible time is of particular interest to those considering short-term certificates), this benchmark is critical. The concept of a living wage is perhaps the other most commonly considered benchmark. As discussed in chapter 1, a living wage can be defined as a wage that might be adequate to support the needs of a family in a given city, county, or other community such that the family has no need for

[6] Prince & Jenkins cite Bailey, Kienzl, & Marcotte (2004), Grubb (2002) and Kienzl (2004). More recent studies are included in my literature review, including work from these researchers.

public assistance. Specific calculations of a living wage vary based on how terms such as "needs of the family" and "adequate" are defined as well as the cost of living in a given community. Living wage calculators also sometimes struggle to take into account some strategies that families pursue to mitigate their costs, such as arranging unpaid childcare with a grandparent or other family member, borrowing or sharing a car, or living with a relative. Given the empirical evidence supporting the tipping point and the challenges of defining a living wage, the tipping point is employed as the desired benchmark in this dissertation, while recognizing the importance of a living wage.[7]

After the discussion of the literature on the earnings benefits, section 2.3 discusses the labor market opportunities associated with certificate attainment—the topic shown in the far-right column on the table. It employs the term "middle skill jobs" to describe jobs which require more than a high school diploma but less than a four-year degree. These jobs have received attention in the literature due to the growing number of opportunities at this level (Carnevale, Strohl, Ridley, & Gulish, 2018; Carnevale, Smith, & Strohl, 2010). Middle skill jobs are put on par with long-term certificates due to evidence from the Georgetown Center on Education and the Workforce that these jobs are often associated with living wages (Carnevale, Jayasundera, & Hanson, 2012).

Short-term certificates, however, are difficult to place on the table. They meet the common criteria for middle-skill jobs but often fail to produce significant earnings advantages. Further, as the literature below will show, the earnings advantages are often on par with "some college," which does not meet the criteria for a middle-skill job. This dissertation examines earnings advantages of short-term certificate attainment, including cases where more than one short-term certificate was attained (to estimate any associated advantage over earning just one certificate) to better understand how short-term certificate attainment relates to earnings advantages and job opportunities. Because

[7] Carnevale, Strohl, Ridley, & Gulish (2018) also employ the concept of a "good job" as a benchmark, which they define as a job that pays at least $35,000 for workers age 25 to 44 and $45,000 for workers age 45 to 64.

short-term certificates alone have not been found to increase earnings significantly, this dissertation also examines academic outcomes of these awards to illustrate whether a short-term certificate might increase the likelihood of degree attainment—again to discern the likelihood that a short-term certificate might ultimately lead to more certain wage advantages, although in this case through further, subsequent academic achievement.

Although the long-term certificate has been identified as the tipping point—and therefore might serve as a logical desired outcome—the distinction between short-term and long-term certificates varies in the literature when it exists at all, and in the dataset from Washington State (and in other datasets), the distinction between the two awards might be a small number of credits. For clarity, therefore, the two-year degree is chosen here as the desired outcome of short-term certificate stacking. The distinction between short-term certificates and two-year degrees is clearer and the wage and employment opportunities associated with two-year degrees are even greater than those associated with long-term certificates.

Finally, the last section of the literature review, section 2.4, examines the scant literature on short-term certificate stacking. There is a paucity of literature but the review includes a few studies finding evidence in support of the benefits of certain characteristics of short-term, stackable certificate sequences, although these studies did not examine the concept of stacking per se.

2.2 Earnings Benefits of Short-Term Certificates (and Other Academic Awards)

Research into the earnings benefits of sub-baccalaureate post-secondary awards can be separated by those that use national-level data and those that use state-level data. Grubb (1995), Kane & Rouse (1995), Crissey and Bauman (2010), Belfield & Bailey (2011) and Carnevale, Rose & Hanson (2012) all draw from nationwide data, including the Survey of Income and Program Participation (SIPP) from the U.S. Census Bureau, or from various surveys by the U.S. Department

of Labor's Bureau of Labor Statistics. Bailey, Kienzl, & Marcotte (2004) employ nationwide data sets provided by the National Center for Education Statistics. Marcotte, Bailey, Borkoski, & Kienzl (2005) draw from the National Education Longitudinal Survey. Broadly speaking, these national data sets provide obvious advantages for discovering evidence of earnings benefits based on large, representative data sets that reflect a national scope. The data, however, rely on individuals to self-report their earnings and education, and generally lack information about student credit attainment, specific academic award characteristics (such as distinguishing between short-term and long-term certificates), individual receipt of student aid, and other indicators. It should be noted that many of the studies that employed national datasets are older. Of the six national-level studies included in this dissertation, three are more than twenty years old.

More recently, researchers are examining richer state-level data. Such research obviously does not draw on data sets that are national in scope, and therefore findings are less generalizable across the U.S. These researchers, however, can often crosswalk student-level data points including specific academic awards, fields of study, transcript data, and student demographics (provided by state community and technical college systems) with student-level employment and earnings data (provided by state unemployment insurance offices). The richness of these data sets, while not national in scope, allows researchers to account for a larger number of predictors when making claims, resulting in evidence that more strongly approaches causality. The data also do not rely on the self-reports of survey respondents but draw directly from academic and labor market records. Sanchez & Laanan (1997), Dadgar & Weiss (2012), Xu & Trimble (2014), Jepsen, Troske, & Coomes (2014), Bahr et. al. (2015), and Stevens, Kurlaender, & Grosz (2015) all employ state-level

community college and unemployment insurance data to support their claims.[8] Carnevale, Ridley, & Fasules (2018) examine certificate attainment in Oregon, but unlike others cited here, they do not create a statistical model to compare outcomes of students who attain certificates to a comparison group (such as those who attend college but do not earn certificates). Instead they simply describe earnings histories and other characteristics of certificate holders.

Regardless of the dataset, all the research cited below uses secondary data analysis, presuming relevant confounders are adequately addressed so as to provide some evidence that the degrees, certificates, or other academic attainment, rather than pre-existing differences in the students or other conditions, explain differences in earnings.

Research on national datasets. This review begins with nationwide studies, since the earliest studies used this type of data. Grubb (1995) produced findings that provide a useful framework, including the conclusion that there is essentially no wage benefit to completing an academic program of less than one year, this dissertation's definition of a short-term certificate. Drawing from Survey of Income and Program Participation, or SIPP, data collected by the U.S. Census Bureau in 1984, 1987, and 1990, Grubb employed statistical modelling to compare outcomes of students at various levels of academic achievement, including those who earned associate's degrees and vocational certificates (the author's term, defined further below) as well as those with 4 years, 3 years, 2 years, 1 year and less than 1 year of "some college." In the 1990 data, he found that vocational certificates—which the author describes as most often requiring one year of full-time study (a long-term certificate as defined in this dissertation)—correlated with a 6.3% increase in earnings for men and a 21.9% increase in earnings for women when compared to

[8] This dissertation used a statewide data set provided by the Washington State Board for Community and Technical Colleges that had been cross-matched with Washington State Employment Security Division unemployment insurance records.

those who held only a high school diploma. He found similar positive associations in the 1984 and 1987 datasets. He found that some programs of study and employment fields were associated with higher earnings for certificate holders while others were not. He also found significant correlations associated with student gender and mixed evidence of correlations associated with less than one year, one year, two years, and other levels of "some college" credits with no academic award.

Crissey & Bauman (2010) drew on data from the 2001 and 2004 versions of the Survey of Income and Program Participation. While they note that 15% of their sample held certificates (with no distinction between long- and short-term), they only examined wage outcomes for two-year degrees, distinguishing between professional/technical degrees and transfer degrees. They found statistically significant associated earnings benefits to two-year degree attainment when comparing outcomes to high school graduates and when controlling for student gender, age, race, and part-time employment. Similar to Grubb, they found significant variations by different program of study and differences based on student employment in a field related to their studies.

Kane & Rouse (1995) studied data from the National Longitudinal Study of 1972, which included information on participants up to fourteen years after their high school graduation, and the National Longitudinal Study of Youth, in which participants were surveyed annually between 1979 and 1990. When controlling for student family income, high school class rank, and student test scores (the latter two as a proxy for natural ability) and when comparing to high school graduates, they found that each year of full-time college attendance—which could be conceptualized as different measures of "some college"—correlated with a 4% to 6% increase in earnings. They also found that only one semester of college-level training correlated with small positive returns on earnings compared to those with no college studies at all. Like others, they

also find statistically significant gains associated with two- and four-year degree attainment, but they made no reference to short-term certificates, likely because the Bureau of Labor Statistics data which they used lacked such information.

Marcotte, Bailey, Borkoski, & Kienzl (2005) examined records of 7,021 students from the National Education Longitudinal Survey. These students attended eighth grade in 1988 and provided survey responses in 1990, 1992, 1994, and 2000. Accounting for differences in student test scores (as a proxy for natural ability), student parents' level of education, student parents' income while students were in high school, nesting by high school, student gender, and student race, the researchers found a nearly 40% increase in salary among women who attained an associate's degree compared to those who earned only a high school diploma, although there was no similar statistically significant finding for men. They found no statistically significant association between certificate attainment (without distinguishing between long- and short-term certificates) and earnings gains for men or women.[9]

Bailey, Kienzl, & Marcotte (2004) examined three datasets—the 1989 Beginning Postsecondary Students Longitudinal Study, the 1989 High School and Beyond data, and the 1988 National Education Longitudinal Study—from the National Center for Education Statistics at the U.S. Department of Education. Like Kane & Rouse (1995), they examined certificates without distinguishing between short- and long-term, again most likely because their data lacked the distinction. While they did not find any statistically significant positive correlation in earnings for men who attained certificates compared to high school graduates, women who attained them earned between 15% and 16% more than their high school graduate counterparts

[9] The authors describe a marginally significant correlation between certificate attainment and a 6% increase in earnings for men ($p < .10$). To be consistent with other studies, I only attribute significance to correlations when $p < .05$.

and this difference was statistically significant (p <.05). The researchers discovered no statistical difference in earnings between women who earned a certificate and women who completed a year of postsecondary education without earning a credential, demonstrating, at least for their sample and time period, evidence of an equivalence between the labor market benefit associated with certificate attainment (again without distinction between long- and short-term) and the benefit associated with "some college."

Belfield & Bailey (2011) examined National Longitudinal Survey data from 1972 and 1979 and discerned evidence of a 9% earnings premium for those who earn some college credits without earning a degree compared to those who held no more than a high school diploma. The study does not address outcomes specific to those might have earned a certificate, again likely because such data was not available in the data set. They also find differences in outcomes associated with age, gender, race, immigration status, and area of study, indicating the need to take these demographic and field factors into account.

Carnevale, Rose & Hanson (2012) examined the National Longitudinal Survey of Youth (NLSY) 1997 cohort, and the 2004 and 2008 panels of the Survey of Income and Program Participation. When controlling for student gender and race, they found evidence of a 19% earnings premium among certificate holders (22% for men and 15% for women) when compared to students with no college studies. They also discovered a further premium correlated with employment in field of study. Notably, Carnevale, Rose, & Hanson attribute differences in earnings outcomes to programs of study (i.e., fields), gender and other factors—but not to differences between short-term and long-term certificates.

State-level datasets. Whereas the analytic results from national datasets rely heavily on self-report data, often with fewer covariates to adjust for selection bias and other factors, state-

level datasets draw directly from a given state's community and technical college system and unemployment insurance earnings records, offering greater accuracy and often a wider range of useful covariates. State level-studies can also more precisely measure individual pre- and post-college earnings than their national counterparts, and generally provide for a near-complete universe of students from a particular state and cohort, unlike the national studies which rely on samples. A number of state-level studies indicate that the labor market benefit is tied closely to match between the education attained and the local labor market demand—a notable factor which the national-level studies cited here did not contemplate. Finally, state-level studies often employ "some college" comparison groups as opposed to the high school graduate comparison groups found in many national studies. The "some college" comparison is more rigorous, so earnings gains would not be expected to be quite as large as found with high school graduate comparison groups. I employ the more rigorous "some college" comparison in this dissertation.

Sanchez & Laanan (1997) were among the first to investigate certificate and degree correlations with earnings using state-level data from the California Employment Development Department and the Management Information System of the California Community College System to assess earnings gains of students who left the California system in 1991-92. They examined earnings from the students' last year in college relative to earnings three years later, a comparison that is influenced by the fact that the last year of college attendance would tend to have depressed earnings. (This dissertation compares earnings prior to and post college attendance to avoid this influence.) The researchers draw comparisons among students who earned a two-year degree, a certificate (with no distinction between short- and long-term), and students who earned "some college" credits but no award (with three groups of "some college" credits organized at different thresholds of the number of credits earned). They found earnings

gains for all students, adjusting for inflation, which is perhaps unsurprising given the comparison, with the greatest gains made by those who earned an associate's degree followed by those who earned a certificate, and finally those who left with only "some college" credits. While their findings are consistent with those of others, the timing of the comparison is less so. This dissertation, like other studies, examines differences in earnings before and after college to avoid the influence college attendance has on earnings.

Jacobson & Mokher (2009) considered records held by the state of Florida, representing student-level records that have been linked across multiple databases so as to include high school transcripts, high school attendance and enrollment records, student demographics, college transcripts, college credentials, and quarterly wage records from the Florida unemployment insurance system. The records include students from every public high school or public postsecondary institution in the state from 1995 to 2005, and Florida quarterly wage records for each of these students through 2007. They estimate that the median after-college earnings for certificate-holders in Florida was about $8000 more annually than those who left college without a credential, a benefit that proved even higher than the gains of those who earned an associate degree.[10] They do not distinguish between short-term and long-term certificates, but they do note that students with a C high school GPA are, according to their data, capable of earning certificates and are unlikely to leave college having earned a degree, making certificates a more promising option for this group.

While nearly all of the studies cited thus far fail to distinguish between short- and long-term certificates, more recent works take advantage of better, more recently available data that

[10] The authors do not conclude that the certificate is therefore preferred to the associate degree, since about half of those who earned an associate's degree transferred to a four-year institution and earned a bachelor's degree, which delivered superior earnings.

include this distinction. Dadgar & Weiss (2012), at the Community College Research Center at Columbia University's Teachers College, consider SBCTC data from Washington state (the same source used in this dissertation) on students who started in community college in the 2001-02 academic year. They find that short-term certificates fail to show any wage benefits while some long-term certificates and degrees deliver those benefits, after controlling for socio-economic status, age, gender, and non-white race. Like others before them, Dadgar & Weiss also discover that the associated gains varied across different programs of study.

Stevens, Kurlaender, & Grosz (2015) examined students who earned a certificate or associate's degree between 2003 and 2007 using data from the California Community Colleges system, matching student academic outcomes with employment information from California's unemployment insurance system. Using California's system of academic quarters, they categorized certificates into three groups—short-term (essentially one quarter of full-time study), medium term (at least two quarters), and long-term (at least one year). Similar to Carnevale, Rose & Hanson (2012), they determined that longer-term certificates generally—but not completely consistently—produce higher earnings. They also observe notable variations by program of study.

Dadgar & Trimble (2015) analyzed labor market returns to certificates and degrees in Washington, using SBCTC and Washington unemployment insurance data. They studied 24,221 students with no prior reported post-secondary education who began their studies in 2001-2002. They found that long-term certificates produce earning gains for women—driven mainly by the high wages of women who studied nursing—but no significant gains for men. They found no effect of earning a short-term certificate for men and a slight negative effect for women, as some of the more common short-term awards for women are in fields associated with lower earnings.

This finding illustrates the need for examining the academic benefit of these certificates. If there is no evidence that these certificates are stepping stones to long-term certificates or degrees, then their overall value would appear to be questionable. Dadgar & Trimble, like others, also find that the returns of certificates varies greatly by program of study, and that some short-term certificates do pay off in the labor market.

Xu & Trimble (2014) considered data from North Carolina and Virginia, two neighboring states. The students in North Carolina that they studied began their studies in 2006-2007 and 2007-2008, and the researchers examined earnings data between 2005 and the first quarter of 2012. Students in Virginia began studies in 2006-2007, 2007-2008, and 2008-2009, and the researchers examined their earnings data between 2005 and the first quarter of 2013. The researchers categorized certificates into short- and long-term, defining the former as requiring less than one year of full-time study and the latter as taking a year or more (the same definition used in Washington in the data I examined). They found that certificates, overall, provided a benefit in the labor market with significant differences across programs of study. They also found that the benefits associated with long-term certificates were substantially greater than those associated with short-term awards.

Bahr, Dynarski, Jacob, Kreisman, Sosa & Wiederspan (2015) examined labor market outcomes for first-time community college students in Michigan, considering those who first enrolled in 2003-2004 and looking at academic and labor market outcomes through 2011. They defined short-term certificates more narrowly than described here, as they constrained short-term to those which require only one semester of full-time study and expanded the definition of long-term to include certificates which require more than one semester (whereas the definition in this study is more than one year). They found associated earnings were 33% higher for men who held

long-term certificates but found no statistically significant correlation for women when compared to students who only earned some college credits and when controlling for race, age category, and receipt of a Pell grant (as a proxy for low socioeconomic status). They found no statistically significant association between earnings and attainment of a short-term certificate for either men or women. Like others, they found that student program of study has a statistically significant influence on earnings gain estimates.

Jepsen, Troske, & Coomes (2014), at the Center for Poverty Research at the University of Kentucky, considered data from the Kentucky Community and Technical College system to study outcomes of students who entered Kentucky's community and technical colleges in 2002-2003 and 2003-2004. Examining unemployment insurance earnings data from 2000 through 2008, they concluded that long-term certificates (called "diplomas" in their study and requiring more than the equivalent of one year of full time study) resulted in a $8000 annual earnings premium for women and a $6000 premium for men, controlling for student age, non-white race, and gender and comparing outcomes to students who enrolled but earned no academic award. During the same period, they found that short-term certificates (called "certificates" and requiring less than the equivalent of one year of full-time study) returned roughly a $1200 earnings gain annually for both genders.[11]

Carnevale, Ridley & Fasules (2018) described the rapid growth of certificate conferral in Oregon as well as the 2007 creation of then-new explicit stackable certificate sequences. They examined the earnings history of students who attained certificates in 2007-2011. Without distinguishing between short- and long-term certificate holders, they found a 19% increase in earnings (adjusting for inflation) when comparing earnings four years prior to certificate

[11] The authors describe their findings in terms of quarterly earnings. I have annualized them for clarity.

attainment to four years post-attainment—among certificate holders. The researchers did not compare these gains to any particular comparison group so cannot make a claim of a correlation between certificate attainment and earnings gains.

2.3 Short-term Certificates as Pathways to Middle-Skills Jobs and Living Wages

Middle-skill jobs are posited here as the least desired outcome in the labor market, given the evidence that these jobs are in demand and are associated with living wages. Economists predict growth in future years in middle skill employment (Albrecht, 2011; Carnevale, Smith, & Strohl, 2010; College Complete America, 2010; Holzer & Lerman, 2007). Carnevale, Jayasundera, & Hanson (2012) report projected growth in the number of middle skill jobs, a growing gap between the demand and supply of such workers, and the emerging requirement for postsecondary education for families seeking a place in the U.S. middle class. They caution that many middle-skill jobs do not pay middle class wages, but they note that, the more education workers have, the greater their odds of finding jobs with middle class earning potential.

This reinforces the stackable model, particularly in the case of short-term certificates. While short-term certificates meet the criteria for middle skill employment as defined, the earnings research discussed in section 2.2 reveals variability among the very existence of earnings gains associated with short-term attainment, and where such gains exist, they are small. Long-term certificates and associate's degrees, on the other hand, also meet the criteria for middle skills jobs and come with more certain evidence of a correlation with earnings gains. As such, this dissertation asserts that long-term certificates, associate degrees, or higher academic awards are the goal, and that, with the possible exception of credentials designed to supplement the qualifications of degree holders, short-term certificates should be designed to stack toward such goals.

Policymakers consider such evidence when developing poverty-fighting efforts. A number of scholars see positive results associated with providing educational opportunities to those who receive public assistance, such as Temporary Assistance to Needy Families (welfare) or the Supplemental Nutrition Assistance Program (food stamps) (Belfield & Bailey, 2011; Plimpton & Nightingale, 2000; Gueron & Pauly, 1991; Gueron & Hamilton, 2002; London, 2006).[12] Similarly, Carnevale, Rose, & Hanson (2012), conclude that certificates, being more readily attainable than multi-year degree programs, could add significantly to the postsecondary completion rates of low-income students, who often otherwise do not earn credentials even when they appear to be as prepared academically at entry as their higher-income counterparts.

3.3 The Academic Value of Stacking Certificates

The U.S. Department of Labor is encouraging state and local workforce agencies to "modularize curricula into chunked curriculum" and stackable credentials so under-skilled workers can quickly gain credentials to meet the needs of industry (Albrecht, 2011). The general understanding is that students will have an easier time earning degrees if they are stackable, meaning they are broken into smaller stepping-stone awards, with employability as an option with each award along with the option to return for additional studies (U.S. Department of Education, 2015).

Carey (2017) provides a rare empirical examination of the evidence of this type of certificate stacking and generally finds it wanting. She posits that the ability to stop out and return some time later is a fundamental benefit of stackable certificate sequences, and therefore evidence of students stopping out, returning, and ultimately earning the next stackable credential

[12] It is important to note that the programs that saw the most success in reducing dependency on public assistance offered a mix of education and employment options (Gueron & Hamilton, 2002). Education-only and employment-only programs lagged those which offered a mix of both.

provides a gauge of the value of stacking. She examines 13,880 community college students in Washington State who earned a degree or certificate across all professional/technical programs of study in 2006-07 and finds that only 4% stopped out after earning their award and subsequently returned within five years and earned the next stackable credential on the pathway.[13] The low incidence of stop out/return/completion leads her to conclude that stacking is largely not occurring and that colleges need to ensure these stackable sequences are even viable.

However, the ability to stop out, return, and complete is not the only possible benefit of short-term stackable certificate sequences. Scott-Clayton (2011), for example, argues for greater simplicity and coherence in community colleges, finding that one barrier to completion that students face is simply navigating the complexity and array of options a community college might offer. Stackable certificate sequences prescribe a clear academic pathway leading to greater academic achievement beyond the short-term certificate, often with no opportunity to stray off the career path, and this clarity may result in a greater likelihood of degree attainment among short-term certificate holders.

Others have found that academic outcomes improve when students are rapidly placed into college-level programs of study rather than beginning with remedial, pre-college coursework (Jenkins & Cho, 2012; Bailey T. , 2009; Edgecombe, 2011). Stackable certificate programs often forgo such remedial education and place students directly into the college-level coursework in their program of study.

In conclusion, the literature on the earnings and labor market potential for certificate holders illustrates a need for students to progress (or stack) beyond a single, short-term

[13] Carey does not disaggregate the data by the type of stacking—progression, independent, or supplemental—or describe what credential might be next in the sequence for a student who had already earned an associate degree—commonly considered the terminal degree at community colleges.

certificate—even if they must stop out after earning the first short-term certificate. However, the opportunity to stop out, return, and complete the next award in the sequence is not the only benefit of short-term, stackable certificate sequences. These sequences are prescriptive. They often forgo remedial coursework. As suggested in chapter 1, they might also attract students who are reluctant to make a long-term commitment to education without seeing readily obtainable short-term success. This dissertation attempts to measure any benefit associated with all of these features, even if the limited evidence thus far suggests that vanishingly few students actually take advantage of the option to stop out, return, and complete. I supplement this limited evidence with a study of stacking behavior by a recent cohort of students in the Washington community college system, focusing on programs of study where stacking opportunities are likely to be present.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 Progression Stacking Short-term Certificate Conferral in Washington State

Washington has thirty-four community and technical colleges which provide short-term, stackable certificates across a wide variety of programs of study. As such, the data in this dissertation serve as a possible model for estimated effects of stackable programs in the U.S. The short-term awards in the data include those that appear designed for progression stacking, supplemental stacking (meaning they are meant to enhance the qualifications of people who already hold degrees), and those that may not have been designed to stack at all.

Nowhere in the data was there any indicator of stackability of any kind, nor could progression stacking be directly identified in the data by consulting college Web sites or other materials. Because this dissertation principally sought to examine the potential benefits of progression stacking, steps were taken to indirectly identify and select for examination a subset of programs of study in the data that best represented short-term certificates within progression stacking sequences. Those steps began with a consideration of all awards conferred.

The 2007-08 academic year was selected for examination based on the fact that that year was early enough such that five years of academic and earnings data could be examined but late enough that stacking could be established as a known strategy pursued by community colleges. In 2007-08, the thirty-four colleges within the Washington community and technical college system awarded 22,877 professional/technical degree and certificate awards to 15,112 students. These professional/technical awards prepare students directly for employment, not for transferring to four-year schools.[14] The numbers imply that some students received more than one award, as

[14] A small number of degrees do both, and they are included in the 22,877.

would be expected among students who stacked certificates. The awards are organized by type in Table 3.1:

Table 3.1*: Professional/Technical Awards Conferred by Community and Technical Colleges in Washington in 2007-08 by Type of Award*

Number of Awards	Type of Awards	Years of Full-Time Study
9,079	Two-year professional/technical or general studies degrees not designed for academic transfer; and Two-year degrees designed for either professional/technical or academic transfer	Two
216	Long-term certificates of 90 or more credits	Two or more
4,208	Long-term certificates of 45 to 89 credits	At least one but less than two
9,374	Short-term certificates of 44 or fewer credits	Less than one
22,877	Total	

The table provides an associated length of study for each type of award based on the quarter system used by community colleges in Washington. The model imagines a proto-typical full-time student as taking 15 credits per quarter across the fall, winter and spring quarters and therefore accruing 45 credits per academic year. Forty-one percent of the awards shown above were short-term certificates, the focus of this study. They constitute the plurality of the awards, exceeding the numbers of associate's degrees conferred by about 300.

The short-term certificates can be organized using Classification of Instructional Program codes (CIP codes) to provide a sense of their programs of study. The first two digits of the CIP code identify a broader classification title, such as Health Professions and Related Programs, while the full six digits identify a more specific field, such as Registered Nursing. The 9,374 short-term certificate awards conferred in 2007-08 are organized by the broader 2-digit classification title in Table 3.2, below.

Table 3.2. *Short-Term Certificates in Professional/Technical Programs of Study Conferred by Community and Technical Colleges in Washington in 2007-08 by CIP Classification Title*

CIP Code	Classification Title	Awards
51	Health Professions and Related Programs	2967
52	Business, Management, Marketing and Related Support Services	1503
46	Construction Trades	839
11	Computer and Information Sciences and Support Services	805
49	Transportation and Materials Moving	581
15	Engineering Technologies/Technicians	616
47	Mechanic and Repair Technologies/Technicians	510
48	Precision Production	496
13	Education	294
12	Personal and Culinary Services	281
43	Security and Protective Services	219
01	Agriculture, Agriculture Operations, Related Sciences	130
22	Legal Professions and Studies	52
50	Visual and Performing Arts	14
10	Communications Technologies/Technicians and Support Services	12
45	Social Sciences	10
31	Parks, Recreation, Leisure, and Fitness Studies	7
41	Science Technologies/Technicians	6
03	Natural Resources and Conservation	6
44	Public Administration and Social Service Professions	3
16	Foreign Languages, Literature, and Linguistics	2
19	Family and Consumer Sciences/Human Sciences	2
23	English Language and Literature/Letters	1
--	Undefined/unknown	18
	Total	9374

The awards above represent short-term certificates designed for progression stacking, supplemental stacking or not stacking at all. The steps taken for selecting the subset of programs of study most consistent with progression stacking sequences are described in section 3.2. Once the subset of programs was identified, students within those programs were coded into categories by type of stacking—progression, potential, independent, and no stacking, following the definitions provided in chapter 1. The steps taken to code individual students are described in section 3.3.

3.2 Identifying Progression Stacking Programs of Study

Three steps were taken in the process of examining college award data in order to select a subset of programs of study that best represented short-term certificates within progression stacking sequences. Those steps included excluding student-level cases of supplemental stacking, identifying college-level programs with evidence of progression stacking, and excluding college-level programs of study with competitive admission.

Excluding supplemental stacking. Recall that supplemental stacking describes short-term certificates (and other awards) meant to be earned after a student attains a two- or four-year degree, to supplement that degree. These certificates were not of interest to this dissertation and needed to be removed to the extent possible. To do this, I excluded from both the college-level data and subsequent student-level data all students who indicated they had any prior college experience. This removed nearly all the identified cases of supplemental stacking to the extent that students accurately self-reported any prior college experience. There were three cases in the data where students reported no prior college experience, earned a two-year degree, and then supplemented that degree with a short-term certificate, all within the five-year period examined. These students were retained in the subset of data examined and were coded as "no stacking" since they did not stack toward a degree, but instead supplemented the degree with the short-term certificate.

Identifying programs of study with evidence of progression stacking. Recall the definition of progression stacking provided in chapter 1—short-term certificates that included credits that could be either immediately or later applied *toward a degree*. College-level award data was therefore examined for evidence that programs of study at individual colleges offered progression stacking sequences that led to a two-year degree.

The process began by simply identifying programs of study with relatively high numbers of short-term certificate awards, as illustrated in Table 3.2 above. CIP codes, however, do not precisely reflect how colleges organize programs of study. Some titles in Table 3.2, such as Business, Management, Marketing and Related Support Services (CIP classification title 52), combine three programs that colleges typically organize separately—Accounting, Business Management, and Business IT. Other times, a program that colleges generally identified as a single program of study was coded under more than one CIP classification. Business IT, for example, was coded by some colleges under Business, Management, Marketing and Related Support Services (title 52) and by other colleges under Microcomputer Applications, General (title 11). So while CIP classifications titles were a useful starting point, my final organization of programs of study also considered college award titles, coding practices, and evidence from individual college Web sites to reflect how colleges commonly organized these programs.

Nine programs of study were initially selected for examination based on their relatively high number of short-term certificates awarded and because they represented diverse program areas. These included nursing assistant, computer IT, accounting, business IT, business management, early childhood education, automotive technology, welding, and auto body technology. Nursing assistant was later dropped because of the competitive admission process inherent in many healthcare programs of study—a disqualifying factor which is discussed in more detail below. The nine initial programs of study are shown in Table 3.3.

Table 3.3. *Short-Term Certificates Awarded in Washington in 2007-08 by Programs of Study*

Program of Study	CIP Codes and Titles	Short-Term Certificates
Nursing Assistant	51.1614 Nurse/Nursing Assistant/Aide and Patient Care Assistant 51.3902 Nursing Assistant/Aide	1293
Business IT	52.0401 Administrative Assistant and Secretarial Sciences 52.0408 Office Occupations and Clerical 11.0601 Microcomputer Applications, General	783
Automotive Technology	47.0604 Automobile/Automotive Mechanics Technology/Technician	276
Welding	48.0508 Welding Technology 48.0585 Thermoplastic Welding/Bonding	476
Accounting	52.0302 Accounting Technology and Bookkeeping	376
Early Childhood Education	13.1210 Early Childhood Education and Teaching 13.1501 Teacher Assisting 19.0709 Childcare Provider/Assistant	288
Business Management	52.0201 Business Administration and Management 52.1401 Marketing Management 52.1001 Human Resource Management/Personnel	281
Computer IT	11.0201 Computer Programming 11.0301 Information Processing 11.0802 Data Warehouse and Database Administration 11.0901 Computer System Network/Telecom 11.1003 Computer and Information System Security 11.9901 Technical Support Services 15.0305 Telecommunications Technician	223
Auto Body	47.0603 Autobody/Collision and Repair Technology/Technician	54
	Total	4,050

The table identifies programs of study with the highest number of short-term awards, organized in the manner most often used by the colleges. Next it was critical to examine these programs for evidence of award patterns consistent with progression stacking. The specific evidence sought came from records of colleges that awarded short-term certificates, long-term certificates, and degrees within the same programs of study. While not conclusive, evidence of schools that conferred a high number of short-term certificates and a lesser number of two-year

degrees within a given program of study indicated a likelihood of having progression sequences, since one would expect one or several “stepping-stone” short-term, stackable certificates leading to a degree. Schools that conferred degrees but no short-term certificates were classified as having no stacking.

Recall from chapter 2 that long-term certificates appear among the “stepping stones” in many stackable certificate sequences. The presence of these awards adds to the evidence that a given program of study has progression stacking sequences. As mentioned earlier, however, long-term certificates are not specifically examined in this dissertation for three main reasons. First, unlike two- and four-year degrees, the definition of long- and short-term certificates is not consistent across community college systems—and is sometimes they are not even distinguished. Second, the earnings value of long-term certificates is empirically defined as significantly positive and meaningfully large in a number of studies, whereas the earnings value of a short-term certificate is not consistently found to be positive in empirical studies, and when it is found to be positive, the value is often small. Finally, short-term certificates reflect a specific need of some students and policy makers—academic programs that are quick-to-the-labor-market, and therefore their value was the exclusive focus of this dissertation.

Table 3.4 illustrates award patterns of both stacking and non-stacking certificate sequences—including short-term certificates, long-term certificates, and degrees—in Accounting/Bookkeeping. The data duplicates headcounts for students who earned multiple short-term certificates (so such students show up multiple times). It also duplicated headcounts for students who earned more than one type of award—such as a student who earned both a short-term certificate and a long-term certificate within the same year.

Table 3.4. *Accounting Technology/Technician and Bookkeeping Awards Conferred by Community and Technical Colleges in Washington State in 2007-08*

College	Short-Term Certificate	Long-term Certificate	Two-Year Degree
Bates Technical College	2	0	1
Bellevue College	78	29	26
Bellingham Technical College	0	4	13
Big Bend Community College	5	0	11
Cascadia College	0	0	0
Centralia College	60	3	11
Clark College	0	3	13
Clover Park Technical College	1	0	8
Columbia Basin College	0	11	5
Edmonds Community College	22	16	20
Everett Community College	0	15	15
Grays Harbor College	1	0	4
Green River Community College	59	0	19
Highline Community College	0	8	9
Lake Washington Institute of Technology	7	1	20
Lower Columbia College	3	0	6
North Seattle College	11	15	11
Olympic College	0	13	14
Peninsula College	22	0	3
Pierce College Fort Steilacoom	0	0	7
Pierce College Puyallup	4	0	8
Renton Technical College	2	5	18
Seattle Vocational Institute	0	18	0
Shoreline Community College	21	0	8
Skagit Valley College	8	5	8
South Puget Sound Community College	0	15	17
South Seattle College	0	5	8
Spokane Community College	0	15	21
Spokane Falls Community College	1	0	0
Tacoma Community College	57	10	16
Walla Walla Community College	13	15	11
Wenatchee Valley College	0	6	11
Whatcom Community College	1	3	2
Yakima Valley Community College	0	1	9

Bellevue College, Centralia College, Edmonds College and five other schools awarded both short-term certificates and two-year degrees, with short-term certificates appearing in

greater numbers—the condition most consistent with progression stacking. Bellingham Technical College, Clark College, Columbia Basin College and eight other schools awarded no short-term certificates but conferred two-year degrees—the condition most obviously consistent with no short-term certificate stacking. Eight schools awarded both short-term certificates and two-year degrees, with two-year degrees conferred in equal or greater numbers—a condition that provides evidence of both progression stacking and no stacking possibilities for students. And as mentioned earlier, colleges which conferred two-year degrees without conferring a short-term certificate offer evidence of no stacking. Finally, data from colleges, such as Cascadia College, Spokane Falls Colleges, and Seattle Vocational Institute, were discarded since those institutions did not confer two-year degrees.[15]

Similar award tables were examined for each program of study, clarifying which colleges and programs showed evidence of progression stacking sequences that started with short-term certificates and led to degrees.

Excluding programs with competitive admissions. While nine programs of study were initially identified for examination, nursing assistant/healthcare sequences were dropped. Recall the definition of progression stacking where credits earned within short-term certificates could be *immediately* applied toward a degree. This definition led to the exclusion of nursing assistant from the selected subset of progression stacking short-term certificates, since nursing programs—the field into which nursing assistant stacks—have competitive admission

[15] It could be argued that a student who earned a short-term certificate from a college that did not confer two-year degrees might take the certificate to a different school that does confer the degree and stack in that way. Given the barriers to and small incidence of this behavior, cases of potential stacking across different colleges were excluded when possible. The barriers associated with this behavior include no guarantee, even within the community college system in Washington, that a certificate attained at one college could be applied toward a degree at another college. The incidence of this behavior was also found to be vanishingly small. Of the 3573 student-level records examined in this dissertation, 16 students (0.4%) progression stacked short-term certificates at more than one college. In short, it is assumed that students who do not attend a college that confers a degree do not intend to get the degree, and that the barriers to possibly changing their intention are significant.

requirements for those pursuing degrees. As such, the credits earned in a short-term (overwise) stackable certificate do not immediately qualify a student to continue toward a degree and admission is competitive enough that this is a substantial barrier to such stacking. Exhibit 3, below, illustrates this difference.

Exhibit 3.1: Nursing Stackable Certificate Sequence from South Seattle College

Nursing Career Pathway

SOUTH SEATTLE COLLEGE
One of the Seattle Colleges

HOME CARE AIDE

Jobs & Wages*

Home Health Aide
$9.84 to $14.82 / hour

Training

One quarter certificate
15 credits

- AIDS/HIV Certification
- CPR Certification
- Care Giving in a Home or Family Home setting
- Aging and Disabilities
- Basic Skills in context of Home Care
- All required knowledge and skills for passing state Home Health Aide Exam

Entry Requirements

- CASAS 220 Listening & Reading
- Clear criminal background
- Fitness requirements

NURSING ASSISTANT CERTIFIED

Jobs & Wages*

Nursing Assistant
$8.94 to $17.20 / hour

Training

One quarter certificate
12 credits
50 hours clinical experience

- AIDS/HIV Certification
- Aging and Disabilities
- Monitoring & Maintaining Patient Status
- Providing Care in a Clinical Setting

Entry Requirements

- CPR Certification
- CASAS 235 Reading, 220 Math, 220 Listening
- Clear criminal background
- Fitness requirements
- Immunizations

Healthcare Pathway (bridge program)

Training

Nursing Pre-requisites
2-4 quarters
Academic support class

- Anatomy & Physiology I & II (BIO&241 and BIO&242)
- Microbiology (BIO&260)
- Composition (ENG&101)
- Elementary Statistics (MATH&146)
- Lifespan Psychology (PSYC&200)
- Intro to Chemistry (CHEM&121)

Entry Requirements

- COMPASS 68 Writing, 77 Reading, 71 Algebra
- ENG 101 requires COMPASS Reading 81

LICENSED PRACTICAL NURSE

Jobs & Wages*

Licensed Practical Nurse
$16.85 to $27.82 / hour

Training

One year certificate
4 quarters

- Patient cross-cultural and legal ethical concepts
- Causation of illness and response to treatment
- Body systems
- Medical surgical nursing
- Pharmacology
- Needs of the aging patient
- Pediatric, maternal and infant care

Entry Requirements

- Current NAC Certification
- Application by deadline
- 2 letters of recommendation
- Fitness requirements
- Immunizations
- Nursing pre-requisites with a GPA of 2.5 or higher

REGISTERED NURSE

Jobs & Wages*

Registered Nurse
$24.25 to $47.66 / hour

Training

Associate Degree
LPN plus 3 quarters

- Roles & responsibilities
- Nursing in obstetric and pediatric settings
- Health promotion & wellness
- Legal and ethical issues
- Various healthcare systems
- Psychiatric disorders
- Medical-surgical acute care settings
- Drug therapy, intravenous therapy
- Monitoring patients' conditions
- Leadership in nursing

Entry Requirements

- Current LPN Certification
- LPN coursework with a GPA of 2.5 or higher
- Application by deadline
- 2 letters of recommendation
- Fitness requirements
- Immunizations
- ENG 101 & MAT 107 COMPASS placement

On this nursing career pathway, students can earn two short-term certificates—Home Care Aide and Nursing Assistant—Certified. However, to continue toward a degree, they then must complete nursing pre-requisites and a competitive admissions process. Compare this to Exhibit 1.1, the automotive technology career pathway shown in chapter 1, where no competitive admission criteria exist. In the nursing career pathway, short-term certificate holders must apply for admission; in automotive technology they can *immediately* stack. Competitive admission criteria are common to nursing programs at community and technical colleges in Washington and a confounding factor in studying the effectiveness of short-term certificate stacking in general. As such, nursing assistant—and all healthcare short-term certificates—were excluded. Eight programs of study thus remained.

3.3 Coding students into categories of stacking

Once the programs of study were selected for further examination, student-level data was examined so that students could be coded into three categories of stacking: progression, potential, and independent, along with the residual category of no stacking. Organizing and coding of the data relied on the definitions provided in chapter 1, which are summarized as:

Progression stacking: A student who earned two or more short-term certificates in the same program of study.

Potential stacking: A student who earned one short-term certificate with the potential to progression stack, but who did not stack within five years. The student may have continued in their studies, but he or she did not earn a second short-term certificate during the five-year period.

Independent stacking: A student who earned one short-term certificate in a program of study with potential to stack but who subsequently earned a second certificate in a program of

study different from the first. This definition describes student behavior, not the design objectives of the colleges, and indicates that a student did not follow the intended stacking sequence.

No stacking: A student who earned at least fifteen credits including at least one credit in the declared program of study.

To better ensure a meaningful no stacking comparison group for analytic purposes, no stacking students were included in this study only if they met three criteria—completion of at least 15 credits (the equivalent of a one-quarter, full-time load), a student intent code associated with one of the selected programs of study, and a transcript record showing at least one course with a prefix or title associated with that program of study. For example, students who took courses with prefixes such as ACCT 101 were coded to indicate an accounting program of study (assuming other criteria were met) as were students who took courses with titles such as Introduction to Accounting.

The threshold of one quarter of full-time study is a common approach in community college research in order to remove students who are not "serious" about progressing in their studies. The requirement of a match between a student's intent code and at least one course prefix or title taken was meant to exclude students who provided no evidence that, for example, a purported accounting student even attempted an accounting class.

3.4 Initial Research Questions

Given the paucity of empirical research on the effects of stackable, short-term certificates on students' academic and earnings outcomes, this dissertation used extant data for a 2007-08 cohort of community college students in select programs of study in Washington State to test a series of research questions. The findings on the initial research questions led to a second phase

of analysis where one further research question was examined. The initial research questions and methods are described here and in section 3.5, immediately below. The further research question and methods mirrored the initial ones in many ways, and they are described in section 3.6, below. The initial research focused on one foundational question and two research questions.

1) **Variability**. What is the variation among Washington State community colleges in terms of the previously identified categories of students' degree attainment status, total credits earned, post-college quarterly inflation-adjusted earnings, and difference between quarterly adjusted earnings three quarters prior to starting studies and three quarters after completion of studies, i.e., earnings gains? In other words, do colleges vary significantly in their students' outcomes? This variation provides a foundational, baseline understanding of the variation among one of the most potentially significant predictors—college attended—on outcomes.
2) **Direct associations**. What are the direct associations of categories of short-term stackable certificates and program of study with these outcomes (i.e., without other predictors in the model)? Similarly, what are the direct associations of student demographic characteristics with outcomes? Similar to the estimates of variation among colleges, the estimated direct associations of categories of short-term, stackable certificates and programs of study with outcomes provide a baseline understanding of the association of these core predictors on outcomes.
3) **Unique associations**. What are the unique associations of categories of short-term stackable certificates with outcomes in a multivariate model including student characteristics and college effects? What are the associations after controlling for programs of study and student demographics?

3.5 Initial Methods

Sample

The major aim of the dissertation was to test the association between professional/technical, short-term progression stacking certificate completion, compared to the other categories (potential stacking, independent stacking, and no stacking), and academic and earnings outcomes for students in Washington State's community college system in a single, relatively recent entry cohort. Extant, de-identified student data was provided by the Washington State Board for Community and Technical Colleges (SBCTC) and included the 5-year outcomes for students who began their studies in 2007-08. Combined across the eight programs of study considered, this included N = 4094 students in 33 colleges. After cases with missing predictor data were removed, there were N = 3573 students available to be used for the analytic sample.

Appendix A provides descriptive statistics of the student sample studied in this research. Briefly, the demographic composition of the analytic sample is: 45% female, 31% historically underrepresented students of color, 56% age 25 or older, and 37% students receiving financial aid.

The 5-year mark for follow up of the cohort represents 250% of the normal two-year degree completion period for students who do not require remedial studies. The 5-year mark was selected to recognize that some students who choose stackable studies would need to complete remedial/developmental education studies before earning a degree. Bailey, Jeong, and Cho (2009) note that more than half of community college students enroll in developmental education at some time. Also, the time period is meant to recognize that stackable certificate sequences are designed to provide students an opportunity to stop out of studies in order to work and to rejoin

studies after taking this break. Finally, the 5-year period is also meant to recognize that many such working adults may need to attend school part-time, resulting in a longer completion time.

The entry cohort was chosen from a time current enough to credibly assert that colleges offered stackable pathways. Research shows that various reports describing stackability and stackability-like workforce development strategies—including reports on career ladders, career pathways, "chunking" curriculum, and others—were published between 2001 and 2010 (Albrecht, 2011; Bernick, 2005; Boston Workforce Development Coalition, 2002; Chrisman & Spangenberg, 2005; Community Research Partners, 2008; Dins, 2005; Fleischer, 2001; Jenkins, 2006; Pleasants & Clagett, 2010). This research indicates that stacking was an intentional and discussed strategy before and the 2007-08 cohort year, just as current and previously cited research indicates continuing interest in this strategy today.

Variables

There are four outcomes of interest, one focal predictor (stackable certificate category), and several covariates in my empirical analyses. Below I define these variables.

Outcomes

Degree Attainment Status (binary): This variable is the "ultimate" indicator of academic value. Students were coded 1 (completed) if they attained any two-year degree as indicated in academic award records, including transfer degrees that were attained by (a few) students coded with a professional/technical (non-transfer) intent; students who did not attain a two-year degree within the five-year period were coded 0.

Earned Total Credits (continuous): This variable is another indicator of academic value. It is defined as the amount of college-level and remedial/developmental credit indicated in the student's transcript records. Credit for math and English was restricted to class prefixes 080 or

above (such as ENG 080) to exclude high school completion, GED®, English as a Second Language, and other basic skills coursework.

Post-College Inflation-Adjusted Earnings (continuous): This variable is defined as the amount of (quarterly) dollars a student earned three quarters after completion of studies, adjusted for inflation (2013 dollars), for students who had stopped enrollment anywhere in the community and technical college system, including students who did not obtain any award. Earnings records were drawn from a cross-match of Washington State Employment Security Department Unemployment Insurance (UI) records and SBCTC's records. Such records include only students who have stopped enrollment anywhere in the Washington community and technical college system irrespective of whether or not they obtained an award. Students who continue in further training after completing an academic award, who transfer to another two-year college, or who transfer to a four-year institution within or outside of Washington are not included.

These records have some specific limitations. First, the records do not account for employment outside the UI system, such as self-employment or federal employment or employment across borders in another state. Second, only students who have provided a college with a valid social security number have been tracked. Roughly 5% of students did not provide a valid social security number, and these records were excluded from this analysis. Of N = 3573 students, there were 1653 cases of missing data for this outcome.

Pre- and Post-College Inflation-Adjusted Earnings Difference (continuous). In addition to simply examining earnings three quarters following completion, the difference between these earnings and the earnings three quarters prior to the start of studies is also examined as a separate outcome (again inflation-adjusted to 2013 dollars). These differences were considered only in cases where students have both prior and post-college earnings records. The earnings differences

were collected in the same manner as the adjusted earnings described above, with the same limitations. Of N = 3573 students, there were 2187 cases of missing data for this outcome.

Because the cases included in inflation-adjusted earnings and inflation-adjusted earnings difference are subsets of the population examined in this dissertation, Table 3.5 provides some basic demographic information on each group. More complete demographic information on the complete population, including a breakdown of demographics by program of study, are provided in appendix A.

Table 3.5. *Descriptive Student-Level Demographic Information Among All Students, Students with Inflation-Adjusted Earnings and Students with Pre- and Post-College Inflation Adjusted Earnings Difference*

	All Students	Students With Post-college inflation adjusted earnings	Students With Pre- and post-college inflation adjusted earnings difference
Student cases	3573 (100%)	1920 (100%)	1386 (100%)
Female	1623 (45.4%)	901 (46.9%)	676 (48.8%)
25 Years Old or Older	1998 (55.9%)	993 (51.7%)	746 (53.8%)
Under-represented Minority	1105 (30.9%)	556 (29.0%)	372 (26.8%)
Receipt of Need-Based Aid	1313 (36.7%)	740 (38.5%)	523 (37.7%)

Focal Predictor

Stackable Certificate Category (multi-categorical): Each student's stackable certificate category was categorically coded using a set of k-1 predictors to represent the k number of categories of stacking to be tested (k=4 including the no stacking category). The reference category was the category with the greatest number of students (no stacking). (The definitions of the categories of stacking are described in section 3.3, above.)

Program of Study (multi-categorical): Each student's program of study was categorically coded using a set of k-1 predictors to represent the k number of programs to be tested (k=8). The

reference category was the category with the largest enrollment (i.e., Computer IT).[16] To identify a student's program of study, I first determined what their program of study was by using the last program of study on their record (closest to the end of the five-year period). This is because, although students can change programs throughout their academic careers, a student's last known program of study would logically be the closest to their ultimate academic aspirations. Recall that, by design, all certificates studied here were awarded in the programs of study whose award records were most consistent with progression stacking sequences since progression stacking outcomes are the focus of the study.

Covariate Predictors

Female Status (binary): Students were coded 1 if they self-identified as female, and 0 otherwise. There were 0.9% cases of missing data on this variable. These cases were excluded.

Older Student Age Status (binary): Students who were 25 years old or older on the first day of their first quarter of study, as calculated from the self-identified date of birth, were coded 1. Those who were 18-24 years old were coded 0. There was 0.3% missing data on this variable. These cases were excluded.

Under-Represented Minority Status (binary): Students who self-identified as a non-Caucasian minority race or ethnic heritage were coded 1; all others were coded 0. There was 7.8% missing data on this variable. These cases were excluded.

Financial Aid Status (binary): A student was coded 1 if they ever received need-based financial assistance during the five-year period under study (otherwise coded 0), which can

[16] Computer IT was selected as the reference category in an early analysis that included two entry cohorts, one from 2006-07 and one from 2007-08. When it was determined that one entry cohort was sufficient for the statistical models employed in this dissertation, the earlier cohort was removed from the sample. With the earlier cohort removed, Computer IT became the category with the second largest enrollment (608 students), with three fewer students than the top category, Accounting (611 students). Because the enrollments were so close, Computer IT was retained as the reference category.

include federal, state, or local financial aid, as well as tuition waivers and enrollment in a program designed to support students receiving TANF or Basic Food benefits. There was no missing data on this variable.

Data Analysis Plan

Simple descriptive statistics, including student-level counts, means, and standard deviations, among variables were computed using *IBM SPSS Statistics 24* and are reported and described among the results in the next chapter. I controlled for non-independence in students' outcomes due to their college of attendance using two-level multilevel regression models, with student-level outcomes and predictors at Level 1 (N = 3573), and college-level college of attendance at Level 2 (N = 33).[17]

For the N = 3573 students examined, 66 (under 2%) attended two or more colleges in the five-year period. In these cases, students were assigned to the college where they earned the greater/greatest number of credits overall, or the college where they earned the greater/greatest number of credits in their program of study in cases where students earned the same number of credits at two or more colleges. In the one case where a single student earned both the same number of overall credits and the same number of credits in his/her program of study at two different colleges, I assigned the student to one college using a random method.

For these analyses, categorical predictors (including binary variables) were effect coded and continuous predictors standardized (in z-scores) for ease of coefficient results interpretation. All multilevel models were conducted in *HLM7*. Binary outcome models (i.e., for degree attainment status) were estimated with the nonlinear Bernoulli model (logistic regression), and continuous outcome models (i.e., total credits earned and employment earnings) were estimated

[17] There are 34 community and technical colleges in Washington. One college, Seattle Vocational Institute, was excluded from this study because it does not confer two-year degrees.

with a linear model. The general mixed models corresponding to each of the research questions (using the linear model shown below for simplicity) was as follows.

Research Question 1: Evaluating Variability in Outcomes

Model1 $\text{Outcome}_{ij} = \gamma_{00} + U_{0j} + r_{ij}$.

In the model above, the outcome for *i*th student in the *j*th college is equal to its grand mean (intercept, γ_{00}), plus the residual error between the *j*th college's mean and the grand mean (U_{0j}), and the residual error between the *i*th student's outcome and his/her college's mean (r_{ij}). A significant intercept would indicate that the outcome mean across colleges is greater than zero, and a significant college variance component (U_{0j}'s) indicates that colleges significantly differ from each other on the outcome.

Research Question 2: Evaluating Direct Effects on Outcomes

Model2a $\text{Outcome}_{ij} = \gamma_{00} + \gamma_{10}$*StackableCert1+ …+ γ_{30}*Cert3 + $U_{0j} + r_{ij}$. (no stacking = reference).
Model2b $\text{Outcome}_{ij} = \gamma_{00} + \gamma_{10}$*Prog1 + …+ γ_{70}*Prog7 + $U_{0j} + r_{ij}$ (Prog8 = reference).
Model2c $\text{Outcome}_{ij} = \gamma_{00} + \gamma_{10}$*Female + $U_{0j} + r_{ij}$.
Model2d $\text{Outcome}_{ij} = \gamma_{00} + \gamma_{10}$*OlderStudent + $U_{0j} + r_{ij}$.
Model2e $\text{Outcome}_{ij} = \gamma_{00} + \gamma_{10}$*URM + $U_{0j} + r_{ij}$.
Model2f $\text{Outcome}_{ij} = \gamma_{00} + \gamma_{10}$*FinancialAid + $U_{0j} + r_{ij}$.

In the model above, the outcome for the *i*th student in the *j*th college is equal to the sum of the grand mean (intercept, γ_{00}), the *direct* relationship between the predictor and the outcome (γ_{10}), the between-college residual error (U_{0j}), and the within-college (student) residual error (r_{ij}). A significant slope coefficient for each predictor indicates that a relationship exists between that predictor and the outcome, after taking into account college of attendance dependencies.

Research Question 3: Evaluating Unique (Conditional) Effects on Outcomes

Model3 $\text{Outcome}_{ij} = \gamma_{00}$
+ γ_{10}*StackableCert1+ …+ γ_{30}*Cert3 (no stacking = reference)
+ γ_{20}*Prog1 + …+ γ_{80}*Prog7 (Prog8 = reference)
+ γ_{90}*Female
+ γ_{100}*OlderStudent
+ γ_{110}*URM
+ γ_{120}*FinancialAid + $U_{0j} + r_{ij}$.

While this model is similar to Models 2a-2f, this model tested the unique, conditional effects of each predictor on the outcome, taking into account all other predictor-predictor relationships. In other words, this model tested the relationship between short-term stackable certificate status and each outcome, after controlling for students' program of study, and demographic characteristics.

3.6 Further Research Questions

The unique effect findings for the degree attainment outcome variable led to an examination of a further, final outcome of interest—specifically the attainment of two or more progression stacking certificates among students who earned one. A full discussion of all the findings is provided in chapter 4. The findings for the unique effects of the progression stacking and potential stacking covariates in the analyses on the initial research questions are summarized here to introduce the final outcome examined.

The associations found for degree attainment in the unique effects model (Table 4.2, below) indicate that at the student level, students who earned two or more progression stacking certificates were far more likely to earn a degree than average for the sample while the associated degree attainment benefits for students who earned a single progression stacking certificate were not statistically significant. This led to the decision to examine progression stacking as an outcome—the case where students earned two or more progression stacking certificates—among all students who earned at least one short-term, stackable certificate (progression stacking and potential stacking students). The purpose was to see which program of study or demographic covariates predicted an increased likelihood that someone who earned the first short-term, stackable certificate—where no empirical evidence of academic benefit was found—would earn at least the second certificate—where the empirical evidence of an academic benefit was found and noteworthy. As with the initial research questions, the final question was modeled to

estimate variability in outcomes among the colleges as well as the direct and unique associations between the predictors and the outcome.

1) **Variability.** What is the variation among Washington State community colleges in terms of attainment of two or more short-term, progression stacking certificates? In other words, do colleges vary significantly in their student outcomes?
2) **Direct associations.** What are the direct associations of the program of study and student demographic characteristics with attainment of two or more short-term, progression stacking certificates?
3) **Unique associations.** What are the unique associations of program of study and student demographic characteristics with attainment of two or more short-term, stackable certificates in a multivariate model including college effects?

Sample

The further research question examines the association between completion of a short-term, progression stacking certificate and likelihood of completing a second (or more) short-term, progression stacking certificate within the five-year period examined for students in the previously described 2007-08 entry cohort. Combined across the eight programs of study considered, this included n = 567 students from 29 community and technical colleges. The 567 students represent the subset of students who earned at least one short-term, progression stacking certificate among the N = 3573 students examined initially. The 29 colleges represent the subset of colleges which conferred these short-term, progression stacking certificates among the 33 colleges examined in the initial research questions. There were no missing predictor data, so n = 567 was used for the analytic sample.

Appendix B provides descriptive statistics of the student sample studied, a subset of the sample described in appendix A. Briefly, the demographic composition of the analytic sample is: 45% female, 34% historically underrepresented students of color, 70% age 25 or older, and 37% students receiving financial aid.

Variables

The variables were identical to those used in the initial research questions and are described in section 3.5, above.

Focal Predictor

Progression Stacking Certificate Category (binary): Students were coded 1 if they earned two or more short-term, progression stacking certificates, and 0 otherwise. The analytic sample for these further research questions included only students who earned at least one short-term certificate with the potential to progression stack, so the otherwise in this case are students who earned just the one certificate.

Covariate Predictors

The covariate predictors were *Program of Study (multi-categorical)*, *Female Status (binary)*, *Older Student Age Status (binary)*, *Under-Represented Minority Status (binary)*, and *Received Need-Based Aid (binary)* as defined for the initial research questions in section 3.5, above. The subset contained no missing data.

Data Analysis Plan

Simple descriptive statistics, including student-level counts, means, and standard deviations, among variables were computed using *IBM SPSS Statistics 24* and are reported and described among the results in the next chapter. As with the initial research questions, I controlled for non-independence in students' outcomes due to their college of attendance using

two-level multilevel regression models, with student-level outcomes and predictors at Level 1 (n = 567), and college-level college of attendance at Level 2 (n = 29).

For these analyses, categorical predictors (including binary variables) were effect coded. All multilevel models were conducted in *HLM7*. As a binary outcome, progression stacking certificate category models were estimated with the nonlinear Bernoulli model (logistic regression). The general mixed models corresponding to each of the research questions (using the linear model shown below for simplicity) was as follows below. Again, these are very similar to the models employed for the initial research questions—an intercept-only model, a direct effects model, and a unique (conditional) effects model.

Research Question 1: Evaluating Variability in Outcomes

Model1 $\text{Outcome}_{ij} = \gamma_{00} + U_{0j} + r_{ij}$.

Research Question 2: Evaluating Direct Effects on Outcomes

Model2a $\text{Outcome}_{ij} = \gamma_{00} + \gamma_{10}*\text{Prog1} + \ldots + \gamma_{70}*\text{Prog7} + U_{0j} + r_{ij}$ (Prog8 = reference).
Model2b $\text{Outcome}_{ij} = \gamma_{00} + \gamma_{10}*\text{Female} + U_{0j} + r_{ij}$.
Model2c $\text{Outcome}_{ij} = \gamma_{00} + \gamma_{10}*\text{OlderStudent} + U_{0j} + r_{ij}$.
Model2d $\text{Outcome}_{ij} = \gamma_{00} + \gamma_{10}*\text{URM} + U_{0j} + r_{ij}$.
Model2e $\text{Outcome}_{ij} = \gamma_{00} + \gamma_{10}*\text{FinancialAid} + U_{0j} + r_{ij}$.

Research Question 3: Evaluating Unique (Conditional) Effects on Outcomes

Model3 $\text{Outcome}_{ij} = \gamma_{00} + \gamma_{10}*\text{Prog1} + \ldots + \gamma_{80}*\text{Prog7}$ (Prog8 = reference)
$+ \gamma_{90}*\text{Female}$
$+ \gamma_{100}*\text{OlderStudent}$
$+ \gamma_{110}*\text{URM}$
$+ \gamma_{120}*\text{FinancialAid} + U_{0j} + r_{ij}$.

These models mirror those employed in examining the initial research questions in section 3.5 above, modified by making the progression stacking certificate category as the outcome. Since the outcome is now a specific category of certificate, all certificate predictors were removed from the further research questions, eliminating category of certificate on the

student-level (level 1) and the percentage of students at the college who earned each category of stackable short-term certificate on the college level (level 2).

Limitations. This dissertation, like all of the research cited in chapter 2, uses secondary data analysis. The methods employed here attempt to adequately address relevant confounders so as to provide some evidence that short-term, stackable certificate attainment, rather than pre-existing differences in the students or in other conditions, "explain" (in the loose sense that they are associated within this data set) differences in outcomes. This dissertation presumes that earnings benefits are the ultimate desired outcome of short-term certificate attainment—whether such benefits are delivered directly by the short-term certificates themselves or indirectly by further academic achievement that the short-term certificates presumably enable. While other possible motivations for short-term certificate attainment may help explain differences in outcomes, such as entry into employment that is more aligned with a student's personal interests or employment that offers a favorable work schedule for parents of school-aged children, those (unknown) motivations are not taken into account in this study. This study is limited to the demographic information available in the data set. Certain potentially relevant student characteristics other than those specifically listed above, such as individual student motivation or inherent academic skill, are not taken into account.

CHAPTER 4: RESULTS

4.1 Overview

This chapter presents the estimated effects associated with earning short-term, stackable certificates on two-year college students' academic and employment outcomes. Although prior research has examined the relationship between stackable certificate attainment at two-year colleges and employment outcomes (in certain settings), to date there is no published empirical work on the effects of stackable certificate attainment on academic outcomes, such as the likelihood of attaining a two-year degree. The present study fills this gap and extends the prior research on employment outcomes to the case of the Washington State two-year college system by initially examining student outcomes for the 2007-08 entry cohort of 3573 students enrolled in select programs that offered stackable certificates at 33 Washington State community and technical colleges.[18] The outcomes studied included: 1) degree attainment, 2) credits earned, 3) inflation-adjusted earnings, and 4) inflation-adjusted earnings difference (relative to pre-program earnings).

Upon discovering, in the initial examination, a statistically significant academic benefit correlated with earning two or more short-term certificates but no such advantage to earning only one certificate, a further examination of student outcomes for a subset of 567 students from same 2007-08 cohort was made. The subset consisted of students who earned at least one short-term stackable certificate at 29 Washington State community and technical colleges[19] to examine which covariates indicated statistically significant increased predicted probabilities that students would attain a second (or more) short-term, stackable certificate.

[18] As mentioned in chapter 3, Washington State has 34 community and technical colleges. One college, Seattle Vocational Institute, was excluded from this study because it does not confer two-year degrees.
[19] Of the 33 colleges examined in the original analytic sample, only 29 colleges conferred at least one short-term certificate, and therefore only those 29 were included in the further research questions.

Modeling Approach. Two-level hierarchical linear modeling, also known as multilevel and mixed effects modeling, was employed to test stackable certificate correlations in both the initial and further models. In the initial models, students (N = 3573) were treated as Level 1, and colleges (N = 33) were treated as Level 2 in the multilevel analysis. In the further models, students (n = 567) were treated as Level 1, and colleges (n = 29) were treated as Level 2 in the multilevel analysis. The chosen analytic method specifically treats college of attendance as a random effect (i.e., that predictor variable effects are not assumed to be the same at each college), which controls for non-independence in student outcomes due to college-level differences. Importantly, short-term stackable certificate attainment for this study was differentiated into three categories in addition to a "none" or no certificate earned category: independent, potential, and progression. ***Independent*** stacking was defined as earning more than one short-term, stackable certificate for which one of the certificates was in a separate area of study "independent" of the first. ***Potential*** stacking was defined as earning only one short-term, stackable certificate *with potential to stack* but for which there was no evidence that any other short-term certificate was earned in the five-year period examined. ***Progression*** stacking was defined as earning more than one short-term, stackable certificate in the same area of study. Finally, ***no certificate*** was defined as not earning any short-term, stackable certificates.

Among the certificate categories, ***progression stacking*** represents the intended design of the colleges and the focus of this dissertation. Colleges create progression stacking certificate sequences to facilitate student progress beyond the initial short-term certificate—where empirical evidence of earnings benefits is variable and generally small when present—to a long-term certificate or degree—where empirical evidence of earnings benefits is more consistently found and larger. Progression stacking represents a student who takes at least some steps (two

certificates) along an articulated path toward a higher academic award. Independent stacking represents when a student earns one certificate but then leaves the path and earns a second certificate in a different field, perhaps in an attempt to abandon one program in favor of another, perhaps to combine two short-term certificates on their own from what the colleges see as distinct (independent) programs, or perhaps for another reason altogether.

Models. For each of four outcomes in the initial research questions (two academic and two employment outcomes) and for the single outcome (earning of a second certificate) in the further research questions, I specified three hierarchical models. The first (Model 1) tested the unconditional, or intercept-only model, which provides the mean of each outcome, adjusted for college attended (and, for linear models, Model 1 also provides variance information used to calculate the intraclass correlation, which is the amount of variation in the outcome that college differences account for). The second model (Model 2) tested each predictor variable— certificate category (in the initial questions), program of study, student gender, older student status, and others—in isolation, much like simple correlation analysis, but adjusting for differences associated with the college attended differences. In this way, Model 2 allows us to understand whether a given variable has any relationship to the outcome, irrespective of its overlap with other covariates. Finally, the third model (Model 3) tested the joint effects of all predictor variables entered together, i.e., as in multiple regression analysis. This model enables us to know which predictors have unique, non-redundant effects. All models were specified as linear except for the first outcome, college degree attainment. For this outcome, a hierarchical generalized linear model was used, akin to logistic multiple regression.

Predictors. All predictors were either effect coded or standardized into *z*-scores in order to keep the intercept meaningful and the predictor effects comparable. In the initial research

questions, six student-level variables and three college-level variables were analyzed. The first student-level predictor variable, ***category of certificate***, involved a set of three coded predictors to represent the four categories as described above (no certificate was coded –1 as the reference group). The second predictor variable, ***program of study*** (i.e., field), involved a set of seven coded predictors for which the largest program of study (Computer IT) was coded –1 as the reference group. The final four predictors were control variables and included: ***gender***[20] status (female coded +1, males –1), ***older student*** status (+1 = 25 or more years old, –1 = 24 or less years old), ***under-represented minority*** status (+1 = yes, –1 = no), and ***need-based financial aid*** status as a proxy for socio-economic status (+1 = yes, –1 = no), as described in chapter 3.

Given the focus of this study on stackable certificates, three college-level predictors were created by aggregating student-level data: namely, the ***percentage of students at the college who earned each category of stackable short-term certificate*** (the no-certificate group was not tested to avoid multicollinearity). Including these in Model 3 of the initial research questions allows us to test individual-level certificate effects while also controlling for differences in college-level certificate offerings (whether students have the opportunity to earn a given category of certificate can depend on a particular college's offerings). These aggregate percentages were standardized into *z*-scores for ease of results interpretation.

The further research questions used many of these same predictors. A full description of the outcome, predictors model, and results of the further research questions begins in section 4.3, below, after the discussion of the initial questions.

[20] The SBCTC data provides two self-report options—female and male—for students to use to indicate their gender. The author recognizes the limitations of this convention in accurately representing the gender continuum but it is built into the data set used.

4.2 Initial Research Questions

The initial research questions examine four outcomes (likelihood of degree attainment, credits earned, adjusted earnings, and adjusted earnings differences) among an analytic sample of 3573 students.

Sample Descriptive Statistics for the Initial Research Questions. The sample analyzed consisted of a total of 3573 students who had first enrolled in one of the 33 Washington community and technical colleges in the 2007-08 academic year and who were coded as pursuing studies in one of eight programs of study with award records consistent with short-term stackable certificate sequences, as described in chapter 3. Disaggregated descriptive statistics are shown in Table 4.1.

Table 4.1. *Sample Descriptive Statistics for the Initial Research Questions*

Variable	Mean	(SD)
Level 1 (Student) Predictors		
Cert1 (1=Independent Stacking Certificate)	0.01	(0.10)
Cert2 (1=Potential Stacking Certificate)	0.07	(0.26)
Cert3 (1=Progression Stacking Certificate)	0.09	(0.28)
Cert4 (0=No Stacking)	0.83	(0.37)
Prog1 (1=Accounting)	0.17	(0.38)
Prog2 (1=Business IT)	0.08	(0.27)
Prog3 (1=Business Management)	0.13	(0.33)
Prog4 (1=Early Childhood Education)	0.34	(0.14)
Prog5 (1=Automotive Technology)	0.34	(0.13)
Prog6 (1=Welding)	0.37	(0.16)
Prog7 (1=Auto Body)	0.02	(0.14)
Prog 8 (0=Computer IT)	0.17	(0.38)
Female (1=yes)	0.45	(0.50)
25 Years Old or Older (1=yes)	0.56	(0.50)
Under-Represented Minority (1=yes)	0.31	(0.46)
Receipt of Need-Based Aid (1=yes)	0.37	(0.48)
Outcomes (Student)		
Degree Attainment (1=yes)	0.19	(0.39)
Credits Earned (credits)	83.95	(58.89)
Quarterly Inflation-Adjusted Earnings (dollars)	5903.91	(4611.00)
Quarterly Adjusted-Earnings Difference (dollars)	596.79	(4737.19)

Academic Outcomes

The academic outcomes attempt to capture the academic benefit of progression stacking, where short-term certificates theoretically “attach” a student to a sequence of studies in a field such that the likelihood of subsequent academic award attainment increases. Academic outcomes include two measures: 1) student degree attainment (1 = earned a degree within five academic years from the year of initial enrollment, 0 = otherwise), and 2) student credits earned within five academic years from the year of initial enrollment.

Degree attainment. Table 4.2 displays the multilevel generalized linear model results for degree attainment status. First, Model 1 revealed significant variation among colleges in degree

Table 4.2. *Hierarchical Generalized Linear Model Results for Degree Earned*

	Model 1 Intercept Only					Model 2 Simple Effects					Model 3 Joint Effects				
Fixed Effect	*Coeff*	*(SE)*	*t*	*(df)*	*p*	*Coeff*	*(SE)*	*t*	*(df)*	*p*	*Coeff*	*(SE)*	*t*	*(df)*	*p*
Intercept (Mean)	**-1.44**	**(0.09)**	**-16.11**	**(32)**	**<.001**	--		--	--	--	**-0.98**	**(0.20)**	**-4.88**	**(29)**	**<.001**
Level 2 (College) Predictors															
Z % Cert1 (Independent Stacking)						-0.08	(0.06)	-1.19	(29)	.243	-0.06	(0.07)	-0.82	(29)	.417
Z % Cert2 (Potential Stacking)						0.07	(0.08)	0.82	(29)	.422	0.05	(0.11)	0.43	(29)	.668
Z % Cert3 (Progression Stacking)						0.05	(0.10)	0.44	(29)	.662	**-0.28**	**(0.14)**	**-2.04**	**(29)**	**.050**
Level 1 (Student) Predictors															
Cert1 (1 = Independent Stacking)						-0. 01	(0.36)	-0.02	(3537)	.986	-0.12	(0.40)	-0.29	(3526)	.769
Cert2 (1 = Potential Stacking)						**-0.05**	**(0.23)**	**-1.98**	**(3537)**	**.047**	-0.36	(0.22)	-1.63	(3526)	.104
Cert3 (1 = Progression Stacking)						**1.08**	**(0.18)**	**5.91**	**(3537)**	**<.001**	**1.26**	**(0.17)**	**7.55**	**(3526)**	**<.001**
Prog1 (1=Accounting)						0.25	(0.16)	1.53	(3533)	.126	0.23	(0.19)	1.25	(3526)	.211
Prog2 (1=Business IT)						**-0.93**	**(0.34)**	**-2.69**	**(3533)**	**.007**	**-1.40**	**(0.39)**	**-3.58**	**(3526)**	**<.001**
Prog3 (1=Business Management)						-0.30	(0.21)	-1.44	(3533)	.150	-0.18	(0.22)	-0.80	(3526)	.426
Prog4 (1=Early Childhood Education)						-0.14	(0.18)	-0.77	(3533)	.443	-0.14	(0.20)	-0.68	(3526)	.500
Prog5 (1=Automotive Technology)						**0.40**	**(0.18)**	**2.21**	**(3533)**	**.028**	**0.46**	**(0.18)**	**2.50**	**(3526)**	**.012**
Prog6 (1=Welding)						**-0.53**	**(0.17)**	**-3.08**	**(3533)**	**.002**	**-0.58**	**(0.16)**	**-3.59**	**(3526)**	**.001**
Prog7 (1=Auto Body)						**1.12**	**(0.49)**	**2.29**	**(3533)**	**.022**	**1.32**	**(0.52)**	**2.56**	**(3526)**	**.011**
Female (1=yes)						0.03	(0.06)	0.47	(3539)	.637	0.09	(0.07)	1.37	(3526)	.171
25 Years Old or Older (1=yes)						0.03	(0.06)	0.60	(3539)	.550	0.03	(0.06)	0.52	(3526)	.600
Under-Represented Minority (1=yes)						**-0.10**	**(0.04)**	**-2.49**	**(3539)**	**.013**	**-0.15**	**(0.04)**	**-3.86**	**(3526)**	**<.001**
Received Need-Based Aid (1=yes)						**0.16**	**(0.06)**	**2.73**	**(3539)**	**.006**	**0.17**	**(0.06)**	**2.94**	**(3526)**	**.003**
Random Effect		*Variance*	*Chi*	*(df)*	*p*		*Variance*	*Chi*	*(df)*	*p*		*Variance*	*Chi*	*(df)*	*p*
Colleges		0.18	128.14	(32)	<.001		--	--	--	--		0.17	112.78	(29)	<.001

Note. *N*=3573 students from 33 community colleges. All predictors were effect coded or standardized in *z*-scores. Estimates are in logits.

likelihood (chi-square test $p < .001$). In other words, some colleges have a higher likelihood of student degree attainment than other colleges. Translating the intercept logit value into a predicted probability, Model 1 also shows that the estimated average degree completion rate within five years of enrollment was 19% (adjusted for college attended, but not covariates).[21] Noting that the mean and variance of the logistic distribution are 0 and $\pi^2/3 \approx 3.29$, respectively (Evans, Hastings, & Peacock, 2000), the *approximate* intraclass correlation (ICC) was computed as described in Snijders and Bosker (2012, p. 305) as ICC = $\frac{\tau_0^2}{\tau_0^2+3.29}$, where τ_0^2 is the variance of the college-level fitted values (Level 2 variance component). Using this computation, the approximate ICC, or variance in degree completion likelihood explained by college attended, was 0.18/(0.18+3.29) = 5%.

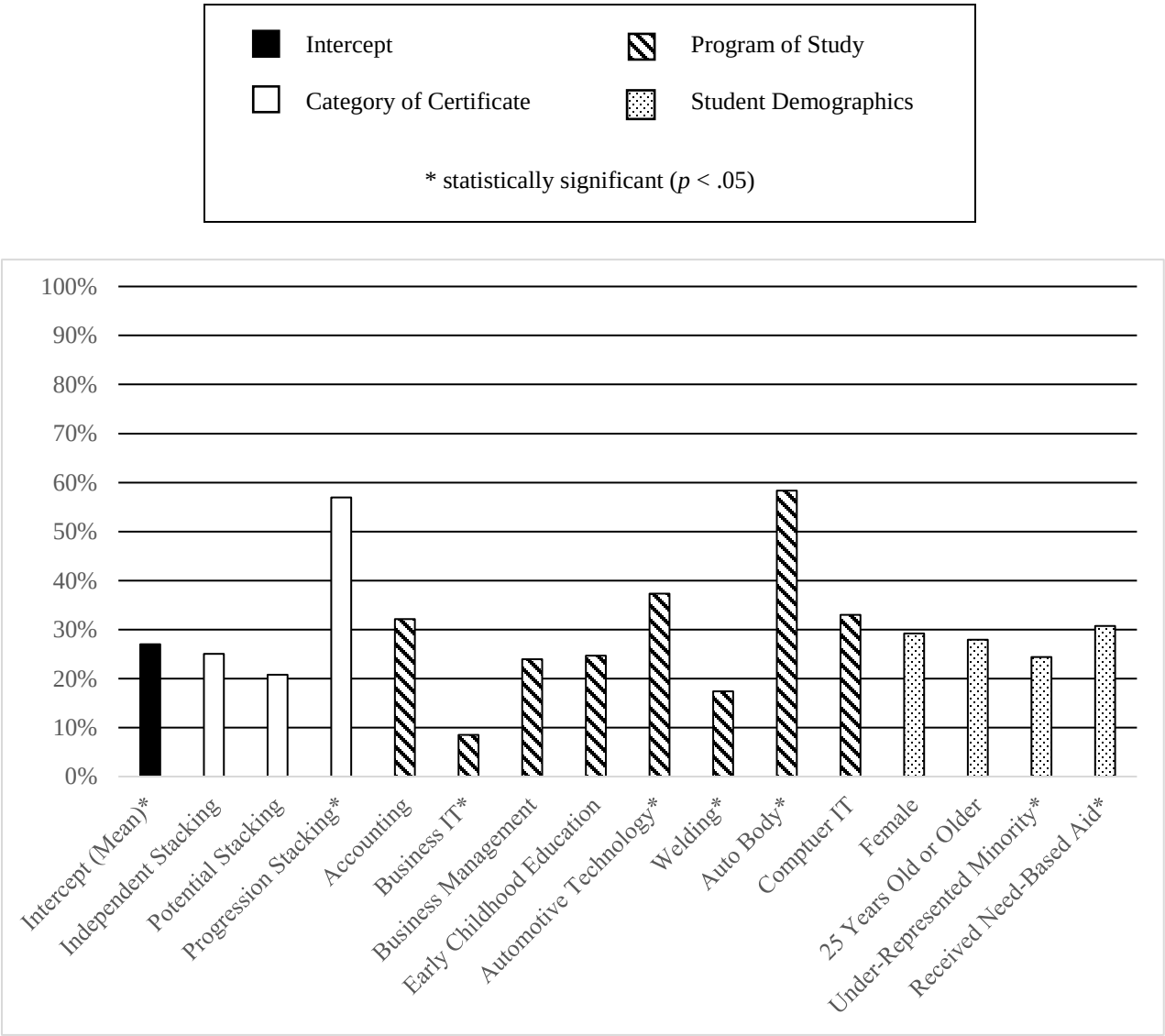
Model 2, which tested simple effects of each predictor variable on the likelihood of earning a degree (the direct relationship, controlling for student's college attended), showed two significant student-level effects of the category of certificate earned (recall that there were three categories and that the "no certificate" category served as the reference group): students who earned just one potential stacking certificate had a lower likelihood of degree attainment whereas students who earned two or more certificates that were progression stacking (i.e., in the same field of study) had a higher predicted likelihood of earning a degree compared to the "no certificate" reference group. Further, four of the program types had a significant effect on student degree completion: business IT and welding programs each had lower likelihoods of degree completion whereas auto technology and auto body programs each had higher likelihoods of completion. Of the four covariates, there were two that had significant effects: under-represented

[21] Recall that the sample includes community college students seeking professional/technical certificates and degrees. The sample excludes students who declared an intent to transfer to a four-year school. Including both student intents would change the estimated average degree completion rate.

minority students were significantly less likely to complete a degree whereas students receiving need-based aid were significantly more likely to complete their degree.

Finally, recall that Model 3 tested the joint effects of all predictors in the model simultaneously – in other words, testing the *unique*, non-overlapping, effects of each predictor variable. Exhibit 4.1 shows the predicted probabilities for degree earned associated with the student-level covariates from this model.

Exhibit 4.1. *Unique Predicted Probabilities of Degree Earned by Student-Level Predictors*



Results from this model showed that the average adjusted (predicted) likelihood of degree attainment in the sample was 27% (by translating the intercept logit value into a probability), taking all predictors into account. Model results also showed one significant college-level predictor. Specifically, a college's having a higher proportion of students earning progression stacking certificates was negatively associated with student degree completion: colleges with +1*SD* higher proportion of students earning progression stacking certificates were predicted, all else held constant, to have students with a 22% likelihood of degree completion (again, translating Model 3 logit values into predicted probabilities), which is 5 percentage points lower than the overall average of 27%.

At the student level, students who earned two or more progression stackable certificates were far more likely to earn a degree than average (57% predicted probability, 30 percentage points more than the overall average). However, in this full model – controlling for program and student covariates, students who earned a potential stacking certificate did not show significant differences from the average probability of completion, holding all else constant.

Student-level program effects observed in the simple effects model held in Model 3: students enrolled in business IT had a predicted degree completion likelihood of 9% (much lower than the 27% overall average) and those in a welding program had a predicted completion of 17% (lower than average). Comparatively, those enrolled in auto technology had a 37% predicted likelihood of degree attainment, and those enrolled in auto body had a 58% predicted likelihood, controlling for all else (both of which are much higher than the overall average completion rate).

Finally, underrepresented minority students had a 24% likelihood of degree completion (3 percentage points lower than average) and students receiving need-based aid had a 31%

predicted probability of completion (4% higher than average), all else constant. Both these differences were statistically significant.

Credits earned. Hierarchical linear model results for the outcome of academic credits earned within five years of enrollment are displayed in Table 4.3. Recall that Model 1 is the intercept-only model that provides the mean credits earned, adjusted for college attended (but not covariates), as well as an indication of the between-college variation. As can be seen, the mean credits earned in the sample was 84.34, adjusting for college attended (but not covariates). Model 1 also shows that there was significant variation among colleges in credits earned. Indeed, the intraclass correlation (ICC), which was computed as between-college variance divided by total variance (between + within college), showed that college attended explained 21% of the variation in student credits earned before covariates were added to the model.

Model 2, which tested the simple effects of each predictor variable (at both levels) on credits earned, showed no significant college-level associations of certificate award mix with credits. However, significant associations for student-level variables certificate category and program of study, and three of the four covariates were found. Specifically, students who earned independent stacking certificates (in different fields) or progression stacking certificates (in the same field) accumulated more credits earned than average, whereas students who earned only a potential stacking certificate earned fewer credits. Auto technology and auto body program students earned significantly more credits than average, whereas students enrolled in business IT, early childhood, and welding earned significantly fewer credits. Finally, females and older students earned significantly fewer credits whereas those with need-based aid earned more credits.

Table 4.3. *Hierarchical Linear Model Results for Earned Credits*

	Model 1 Intercept Only					Model 2 Simple Effects					Model 3 Joint Effects				
Fixed Effect	*Coeff*	*(SE)*	*t*	*(df)*	*p*	*Coeff*	*(SE)*	*t*	*(df)*	*p*	*Coeff*	*(SE)*	*t*	*(df)*	*p*
Intercept (Mean)	**84.34**	**(4.35)**	**19.38**	**(32)**	**<.001**	--		--	--	--	**106.78**	**(4.87)**	**21.91**	**(29)**	**<.001**
Level 2 (College) Predictors															
Z % Cert1 (Independent Stacking)						-0.50	(2.49)	-0.20	(29)	.841	-1.21	(2.70)	-0.45	(29)	.656
Z % Cert2 (Potential Stacking)						-2.89	(3.99)	-0.73	(29)	.474	-2.51	(3.93)	-0.64	(29)	.527
Z % Cert3 (Progression Stacking)						-0.55	(3.55)	-0.16	(29)	.877	-5.30	(3.47)	-1.53	(29)	.137
Level 1 (Student) Predictors															
Cert1 (1 = Independent Stacking)						**26.86**	**(6.44)**	**4.17**	**(3537)**	**<.001**	**26.80**	**(6.66)**	**4.02**	**(3526)**	**<.001**
Cert2 (1 = Potential Stacking)						**-20.49**	**(4.37)**	**-4.69**	**(3537)**	**<.001**	**-16.59**	**(4.25)**	**-3.91**	**(3526)**	**<.001**
Cert3 (1 = Progression Stacking)						**14.56**	**(4.26)**	**3.42**	**(3537)**	**.001**	**13.56**	**(3.52)**	**3.86**	**(3526)**	**<.001**
Prog1 (1=Accounting)						-2.45	(3.41)	-0.72	(3533)	.472	-1.40	(3.44)	-0.41	(3526)	.685
Prog2 (1=Business IT)						**-10.67**	**(4.47)**	**-2.37**	**(3533)**	**.018**	**-12.26**	**(3.73)**	**-3.29**	**(3526)**	**.001**
Prog3 (1=Business Management)						-7.33	(3.89)	-1.89	(3533)	.060	-4.94	(4.11)	-1.20	(3526)	.229
Prog4 (1=Early Childhood Education)						**-12.26**	**(3.47)**	**-3.53**	**(3533)**	**<.001**	**-10.36**	**(3.39)**	**-3.06**	**(3526)**	**.002**
Prog5 (1=Automotive Technology)						**16.28**	**(4.78)**	**3.40**	**(3533)**	**.001**	**12.99**	**(4.81)**	**2.70**	**(3526)**	**.007**
Prog6 (1=Welding)						**-8.69**	**(3.28)**	**-2.65**	**(3533)**	**.008**	**-9.20**	**(2.79)**	**-3.30**	**(3526)**	**.001**
Prog7 (1=Auto Body)						**20.00**	**(9.76)**	**2.05**	**(3533)**	**.041**	17.14	(8.92)	1.92	(3526)	.055
Female (1=yes)						**-3.55**	**(1.46)**	**-2.43**	**(3539)**	**.015**	-0.32	(0.89)	-0.36	(3526)	.716
25 Years Old or Older (1=yes)						**-4.29**	**(1.36)**	**-3.16**	**(3539)**	**<.001**	**-4.36**	**(1.17)**	**-3.71**	**(3526)**	**<.001**
Under-Represented Minority (1=yes)						0.01	(1.19)	0.01	(3539)	.995	-0.51	(1.15)	-0.44	(3526)	.658
Received Need-Based Aid (1=yes)						**3.95**	**(1.21)**	**3.26**	**(3539)**	**.001**	**4.91**	**(1.06)**	**4.62**	**(3526)**	**<.001**
Random Effect	*Variance*		*Chi*	*(df)*	*p*	*Variance*		*Chi*	*(df)*	*p*	*Variance*		*Chi*	*(df)*	*p*
Colleges	582.76		830.90	(32)	<.001	--		--	--	--	481.76		733.62	(29)	<.001
Residual (Students)	2834.32					--					2626.61				

Note. N=3573 students from 33 community colleges. All predictors were effect coded or standardized in *z*-scores. Estimates are in number of credits.

Model 3, which tested the unique effects of each predictor after controlling for all other predictors, showed similar patterns as Model 2, with only the auto body program of study and female student gender moving from significance in the direct effect model to no significance in the joint model. In Model 3, with all predictors taken into account, the intercept, estimating the mean adjusted credits earned, is 106.78. Students who earned independent stackable certificates had 26.80 more credits 5 years after initial college enrollment than this mean, with all other things held constant. Those who earned progression stacking certificates were found to have 13.56 more credits than the overall average, whereas those who earned potential stacking certificates were found to earn 16.59 fewer credits, controlling for all else.

In addition, Model 3 results showed that students in business IT, early childhood education, and welding earned significantly fewer credits (12.26, 10.36, and 9.20 credits less than average, respectively), whereas auto technology students earned 12.99 more credits than average, all else held constant. Finally, only two of the four covariates had significant effects on credits earned once all covariates were taken into account: older students earned 4.36 fewer credits and students receiving need-based aid earned 4.91 credits more. Gender was no longer significant as it was in Model 2. The under-represented minority variable was not significant in either case.

Employment Outcomes

Recall that there were two employment outcomes modeled: 1) student's inflation-adjusted (quarterly) earnings three quarters after completion of studies, and 2) student's adjusted earnings *differences* between pre- and post-college earnings, defined as the difference between quarterly earnings three quarters after completion of studies and quarterly earnings three quarters prior to the start of studies, again adjusted for inflation. The earnings difference measure seeks to

capture the effect of the certificate on earnings. For the first outcome, there was missing data on earnings for 1653 students, or 46.3%, reducing the original sample to a subsample of n = 1920 students.[22] For the second outcome, where both pre- and post-college earnings are required to determine the earnings difference, there was missing data for 2187 students, or 61.2%, reducing the original sample even more to a subsample of n = 1386 students. For the reason mentioned above, adjusted earnings difference is typically preferred over adjusted earnings, since it takes into account earnings before college entry.

Adjusted earnings. Table 4.4 displays results for inflation-adjusted earnings (9 months after completion, of students who completed and for whom a record of earnings could be found). Model 1, the intercept-only model, showed that the inflation-adjusted earning average was $5,752.44 per fiscal quarter (a three-month period), controlling for college variation. As was observed in the prior two outcomes, there was significant college variation in the earnings outcome. Specifically, 27% of students' adjusted earnings were explained by which college the student attended.[23]

Model 2, which tests direct effects of predictor variables on earnings without considering other covariates, revealed that a college's percentage of students awarded potential stackable certificates was positively associated with earnings, as was the student-level program variable *welding* and being an older student; business IT, early childhood education, and auto body programs were negatively associated with earnings, as was being a female student and one's

[22] 78 students in the sample (2.2%) did not provide their college with their social security number, which is not required for enrollment. This accounts for a small portion of the missing data. No employment, self-employment, and employment in the military are among the other reasons why data would be missing, although these and other reasons do not seem to fully account for the difference.
[23] Several aspects of the specific college attended may explain some of these differences in earnings correlations, such as local industries surrounding a given college.

receipt of need-based aid. Importantly, there were no significant certificate category effects on the earnings outcome at the student level.

Model 3, which incorporates all predictors simultaneously, showed that the effects detected in Model 2 generally held up, except for the associations linked to auto body program of study and female gender. More specifically, colleges that awarded relatively high amounts of potentially stackable certificates had students that averaged $754 more in quarterly earnings post-college than the adjusted mean average of $5,588. Welding students were also predicted to have higher earnings ($811 more than average), as were older students ($685), all else held constant. Students in business IT and early childhood education were predicted to earn relatively less, as were students who received need-based aid.

Table 4.4. *Hierarchical Linear Model Results for Adjusted Earnings*

	Model 1 Intercept Only					Model 2 Simple Effects					Model 3 Joint Effects				
Fixed Effect	*Coeff*	*(SE)*	*t*	*(df)*	*p*	*Coeff*	*(SE)*	*t*	*(df)*	*p*	*Coeff*	*(SE)*	*t*	*(df)*	*p*
Intercept (Mean)	**5752.44**	**(238.45)**	**24.12**	**(32)**	**<.001**	--		--	--	--	**5587.62**	**(531.33)**	**10.52**	**(29)**	**<.001**
Level 2 (College) Predictors															
Z % Cert1 (Independent Stacking)						-140.75	(247.88)	-0.57	(29)	.575	-15.48	(242.93)	-0.06	(29)	.950
Z % Cert2 (Potential Stacking)						**782.74**	**(294.42)**	**2.66**	**(29)**	**.013**	**754.08**	**(241.11)**	**3.13**	**(29)**	**.004**
Z % Cert3 (Progression Stacking)						-116.45	(236.18)	-0.49	(29)	.626	-87.82	(226.34)	-0.39	(29)	.701
Level 1 (Student) Predictors															
Cert1 (1 = Independent Stacking)						855.74	(1455.65)	0.59	(1884)	.557	643.75	(1324.57)	0.49	(1873)	.627
Cert2 (1 = Potential Stacking)						-244.15	(582.27)	-0.42	(1884)	.675	-356.42	(538.02)	-0.66	(1873)	.508
Cert3 (1 = Progression Stacking)						-413.72	(474.50)	-0.87	(1884)	.383	-311.04	(429.59)	-0.72	(1873)	.469
Prog1 (1=Accounting)						380.81	(249.53)	1.53	(1880)	.127	199.63	(254.67)	0.78	(1873)	.433
Prog2 (1=Business IT)						**-894.74**	**(304.49)**	**-2.94**	**(1880)**	**.003**	**-1144.27**	**(457.12)**	**-2.50**	**(1873)**	**.012**
Prog3 (1=Business Management)						470.27	(282.90)	1.66	(1880)	.097	402.75	(272.00)	1.48	(1873)	.139
Prog4 (1=Early Childhood Education)						**-1256.17**	**(236.35)**	**-5.32**	**(1880)**	**<.001**	**-1233.74**	**(290.67)**	**-4.24**	**(1873)**	**<.001**
Prog5 (1=Automotive Technology)						68.39	(153.04)	0.45	(1880)	.655	435.81	(259.38)	1.68	(1873)	.093
Prog6 (1=Welding)						**962.66**	**(322.91)**	**2.98**	**(1880)**	**.003**	**810.94**	**(390.54)**	**2.08**	**(1873)**	**.038**
Prog7 (1=Auto Body)						**-632.43**	**(241.01)**	**-2.62**	**(1880)**	**.009**	-235.29	(328.93)	-0.72	(1873)	.474
Female (1=yes)						**-309.48**	**(101.23)**	**-3.06**	**(1886)**	**.002**	-14.60	(143.38)	-0.10	(1873)	.919
25 Years Old or Older (1=yes)						**596.88**	**(181.70)**	**3.29**	**(1886)**	**.001**	**684.70**	**(175.28)**	**3.91**	**(1873)**	**<.001**
Under-Represented Minority (1=yes)						53.41	(102.40)	0.52	(1886)	.602	133.79	(103.28)	1.30	(1873)	.195
Received Need-Based Aid (1=yes)						**-485.47**	**(115.13)**	**-4.22**	**(1886)**	**<.001**	**-586.83**	**(134.99)**	**-4.35**	**(1873)**	**<.001**
Random Effect		*Variance*	*Chi*	*(df)*	*p*		*Variance*	*Chi*	*(df)*	*p*		*Variance*	*Chi*	*(df)*	*p*
Colleges		1190.92	186.71	(32)	<.001		--	--	--	--		600274.55	96.01	(29)	<.001
Residual (Students)		4436.55					--					18615108.97			

Note. N=1920 students from 33 community colleges. All predictors were effect coded or standardized in *z*-scores. Estimates are in dollars.

Adjusted earnings differences (pre-post college difference). Unlike the prior three outcomes, there was little variation among colleges on inflation-adjusted pre-post college earnings differences: Model 1 results, shown in Table 4.5, revealed non-significant between-college variance (ICC was < 1%), perhaps in part because of the missing data.

Model 2 results, testing for direct effects of each predictor variable, showed that two of the college-level certificate category predictors were associated with earnings differences, but that certificate category at the student level had no significant effects. Program of study effects at the student level were also detected for accounting, business IT, business management, auto technology, and auto body, as were effects from each of the four covariates.

Model 3, with all predictors entered, showed that the predicted pre-post college earnings difference of $124 (the intercept) was not significantly different from zero ($p > .05$). Of all the college- and student-level certificate category predictors, only college-level the proportion of independent stacking certificates uniquely predicted earnings differences: colleges with relatively high proportions of students earning independent stackable certificates (+1*SD*) had students that were predicted to have $444.21 more than the average adjusted earnings difference, controlling for all else. In addition, only one program of study uniquely predicted earnings differences: business management students were predicted to have $636 lower than average earnings differences, all else held constant. Finally, two of the control variables, older student status and under-represented minority status, were uniquely related to adjusted earnings differences: older students were predicted to earn far *less* than the average adjusted earnings difference ($1,306 less) whereas under-represented minority students were predicted to earn slightly more than average ($375).

The change in the number of significant predictors between Model 2 and Model 3 indicates that the simple effects can be deceiving when all predictors are taken into account. Model 2 revealed statistically significant effects with eleven covariates, while Model 3 revealed significance with only four.

Table 4.5. *Hierarchical Linear Model Results for Adjusted Earnings Differences (Pre-Post College)*

	Model 1 Intercept Only					Model 2 Simple Effects					Model 3 Joint Effects				
Fixed Effect	*Coeff*	*(SE)*	*t*	*(df)*	*p*	*Coeff*	*(SE)*	*t*	*(df)*	*p*	*Coeff*	*(SE)*	*t*	*(df)*	*p*
Intercept (Mean)	**595.53**	**(128.37)**	**4.64**	**(32)**	**<.001**	--		---		--	123.64	(335.30)	0.37	(29)	.715
Level 2 (College) Predictors															
Z % Cert1 (Independent Stacking)						**397.67**	**(148.35)**	**2.68**	**(29)**	**.012**	**444.21**	**(127.15)**	**3.49**	**(29)**	**.002**
Z % Cert2 (Potential Stacking)						-270.54	(139.84)	-1.94	(29)	.063	-14.73	(154.36)	-0.10	(29)	.925
Z % Cert3 (Progression Stacking)						**-475.40**	**(220.68)**	**-2.15**	**(29)**	**.040**	-230.03	(201.68)	-1.14	(29)	.263
Level 1 (Student) Predictors															
Cert1 (1 = Independent Stacking)						-1651.81	(1062.43)	-1.56	(1350)	.120	-1189.22	(987.91)	-1.20	(1339)	.229
Cert2 (1 = Potential Stacking)						40.42	(596.32)	0.07	(1350)	.946	193.73	(569.58)	0.34	(1339)	.734
Cert3 (1 = Progression Stacking)						360.42	(425.62)	0.85	(1350)	.397	183.89	(401.59)	0.46	(1339)	.647
Prog1 (1=Accounting)						**-666.57**	**(293.74)**	**-2.27**	**(1350)**	**.023**	130.13	(303.64)	0.43	(1339)	.668
Prog2 (1=Business IT)						**-1825.74**	**(422.03)**	**-4.33**	**(1350)**	**<.001**	-710.89	(407.23)	-1.75	(1339)	.081
Prog3 (1=Business Management)						**-776.37**	**(369.57)**	**-2.10**	**(1350)**	**.036**	**-636.21**	**(299.08)**	**-2.13**	**(1339)**	**.034**
Prog4 (1=Early Childhood Education)						150.26	(233.08)	0.65	(1350)	.519	267.66	(279.17)	0.96	(1339)	.338
Prog5 (1=Automotive Technology)						**1173.15**	**(300.28)**	**3.91**	**(1350)**	**<.001**	124.10	(304.68)	0.41	(1339)	.684
Prog6 (1=Welding)						502.03	(309.72)	1.62	(1350)	.105	297.60	(275.90)	1.09	(1339)	.281
Prog7 (1=Auto Body)						**1647.43**	**(559.98)**	**2.94**	**(1350)**	**.003**	569.23	(513.72)	1.11	(1339)	.268
Female (1=yes)						**-618.01**	**(133.19)**	**-4.64**	**(1352)**	**<.001**	-314.67	(170.83)	-1.84	(1339)	.066
25 Years Old or Older (1=yes)						**-1438.64**	**(120.79)**	**-11.91**	**(1352)**	**<.001**	**-1306.40**	**(122.25)**	**-10.69**	**(1339)**	**<.001**
Under-Represented Minority (1=yes)						**353.88**	**(123.17)**	**2.87**	**(1352)**	**.004**	**375.10**	**(138.79)**	**2.70**	**(1339)**	**.007**
Received Need-Based Aid (1=yes)						**-352.88**	**(174.32)**	**-2.02**	**(1352)**	**.043**	-172.75	(139.40)	-1.24	(1339)	.215
Random Effect		*Variance*	*Chi*	*(df)*	*p*		*Variance*	*Chi*	*(df)*	*p*		*Variance*	*Chi*	*(df)*	*p*
Colleges		18562.97	39.43	(32)	.172		--	--	--	--		5636.67	24.13	(29)	>.500
Residual (Students)		22407319.82					--					19853693.83			

Note. N=1386 students from 33 community colleges. All predictors were effect coded or standardized in *z*-scores. Estimates are in dollars.

4.3 Further Research Question

This second part of the findings covers the further research question examining one outcome, the progression stacking certificate category (defined as students who earn two or more progression stacking certificates), among an analytic sample of 567 students.

Recall the associations found for degree attainment (Table 4.2). At the student level, students who earned two or more progression stacking certificates were far more likely to earn a degree than average (57% predicted probability, 30 percentage points more than the overall average) while the associated degree attainment benefits for students who earned a single progression stacking certificate were not statistically significant. This finding informed the decision to add further research questions examining only students who earned at least one short-term stackable certificate (which included both potential and progression stacking students) in order to see which program of study or demographic covariates predicted an increased likelihood that someone who earned one short-term, stackable certificate with the potential to stack—where no empirical evidence of academic benefit was found—would earn at least the second certificate—where the empirical evidence of an academic benefit was both found and notable.

Sample Descriptive Statistics for the Further Research Questions. The subsample analyzed consisted of a total of 567 students who had first enrolled in one of 29 Washington community and technical colleges in the 2007-08 academic year and who were coded as pursuing studies in one of the eight programs of study with award records consistent with short-term stackable certificate sequences, as described in chapter 3. Disaggregated descriptive statistics are shown in Table 4.6.

Table 4.6. *Sample Descriptive Statistics, Students Who Earned At Least One Short-term Stackable Certificate*

Variable	Mean	(SD)
Level 1 (Student) Predictors		
Prog1 (1=Accounting)	0.17	(0.38)
Prog2 (1=Business IT)	0.16	(0.36)
Prog3 (1=Business Management)	0.10	(0.30)
Prog4 (1=Early Childhood Education)	0.13	(0.34)
Prog5 (1=Automotive Technology)	0.12	(0.33)
Prog6 (1=Welding)	0.22	(0.42)
Prog7 (1=Auto Body)	0.02	(0.13)
Prog 8 (0=Computer IT)	0.08	(0.27)
Female (1=yes)	0.48	(0.50)
25 Years Old or Older (1=yes)	0.70	(0.46)
Under-Represented Minority (1=yes)	0.34	(0.47)
Received Need-Based Aid (1=yes)	0.37	(0.48)
Outcome (Student)		
Two or More Short-term Certificates attained (1=yes)	0.54	(0.50)

Outcome: Earned two or more progression stacking certificates. The single outcome examined in the further research question was the progression stacking certificate category. This category was defined as students who attained two or more short-term, progression stacking certificates, and Table 4.7, below, displays the multilevel generalized linear model results for this outcome.

Table 4.7. *Hierarchical Generalized Linear Model Results for Attainment of Two or More Short-Term Progression Stacking Certificates*

	Model 1 Intercept Only					Model 2 Simple Effects					Model 3 Joint Effects				
Fixed Effect	*Coeff*	*(SE)*	*t*	*(df)*	*p*	*Coeff*	*(SE)*	*t*	*(df)*	*p*	*Coeff*	*(SE)*	*t*	*(df)*	*p*
Intercept (Mean)	-0.03	0.23	-0.14	28	.887	--		--	--	--	0.31	0.23	1.38	28	.179
Level 1 (Student) Predictors															
Prog1 (1=Accounting)						**-1.00**	**0.41**	**-2.45**	**537**	**.015**	**-0.97**	**0.40**	**-2.41**	**527**	**.016**
Prog2 (1=Business IT)						-0.54	0.35	-1.55	537	.122	0.09	0.29	0.32	527	.751
Prog3 (1=Business Management)						**-0.99**	**0.19**	**-5.17**	**537**	**<.001**	**-0.90**	**0.42**	**-2.14**	**527**	**.033**
Prog4 (1=Early Childhood Education)						**-1.06**	**0.33**	**-3.25**	**537**	**.001**	**-0.89**	**0.42**	**-2.10**	**527**	**.036**
Prog5 (1=Automotive Technology)						-0.13	0.39	-0.32	537	.749	**0.84**	**0.30**	**2.78**	**527**	**.006**
Prog6 (1=Welding)						**-0.67**	**0.25**	**-2.69**	**537**	**.007**	-0.41	0.26	-1.57	527	.116
Prog7 (1=Auto Body)						**-1.27**	**0.57**	**-2.24**	**537**	**.025**	**1.01**	**0.23**	**4.44**	**527**	**<.001**
Female (1=yes)						**-0.31**	**0.13**	**-2.35**	**537**	**.019**	-0.08	0.15	-0.54	527	.589
25 Years Old or Older (1=yes)						-0.09	0.08	-1.08	537	.281	-0.06	0.08	-0.85	527	.395
Under-Represented Minority (1=yes)						-0.03	0.08	-0.38	537	.706	-0.05	0.08	-0.54	527	.589
Received Need-Based Aid (1=yes)						0.03	0.09	0.31	537	.759	0.04	0.11	0.42	527	.672
Random Effect			*Variance*	*Chi*	*(df)*	*p*		*Variance*	*Chi*	*(df)*	*p*		*Variance*	*Chi*	*(df)*	*p*
Colleges			1.84	151.39	28	**<.001**		--	--	--	--		1.69363	126.64	28	**<.001**

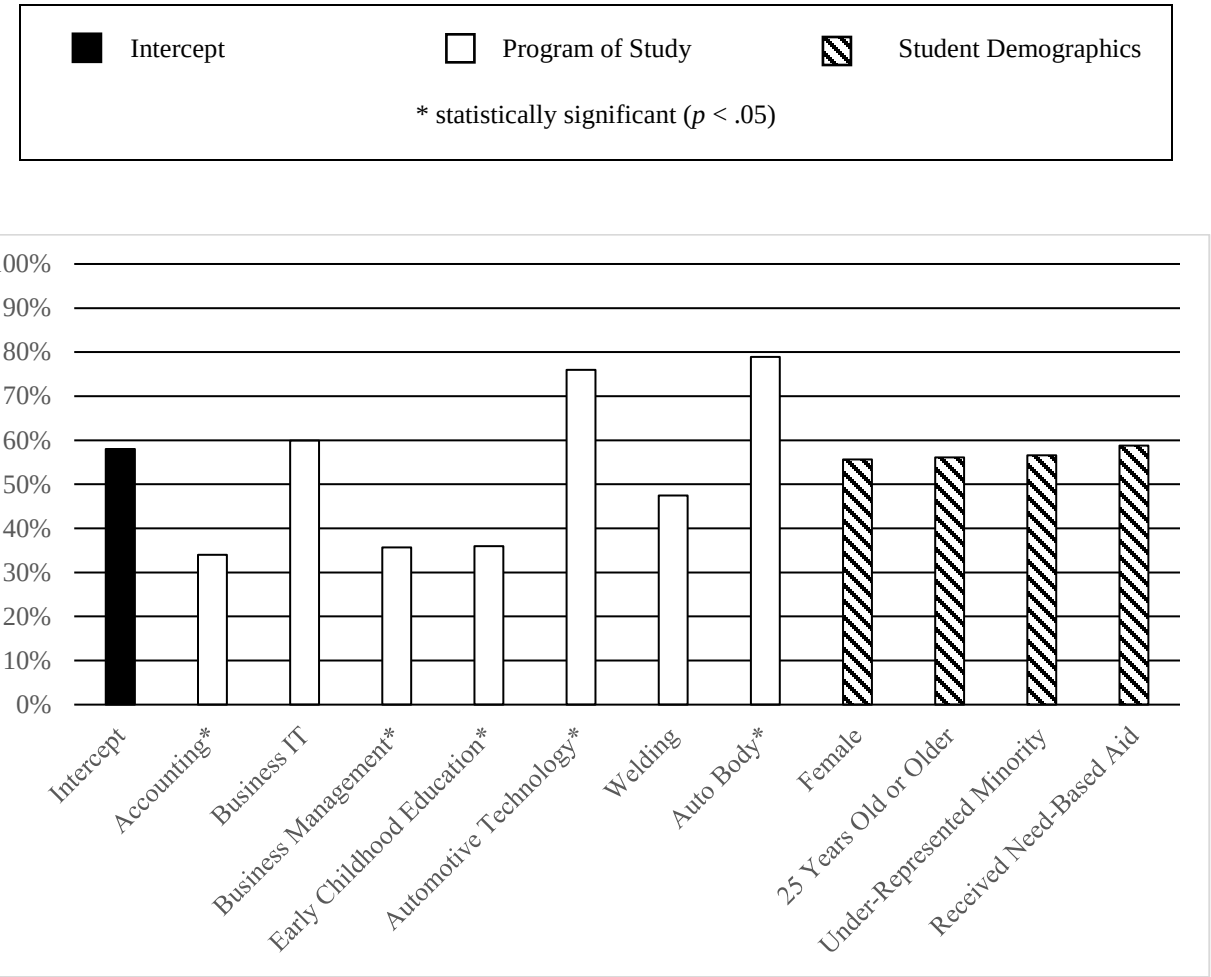
Note. N=567 students from 29 community colleges. All predictors were effect coded.

First, Model 1 revealed no significant variation among colleges in attainment of two or more short-term, progression stacking certificates. In other words, there was no significant indication that some colleges have a higher likelihood of student attainment of two or more short-term, progression stacking certificates than other colleges.

Model 2, which tested simple effects of each predictor variable on the outcome (the direct relationship, controlling only for student's college attended), showed five significant student level effects associated with a student's program of study and one significant effect with female gender, a demographic covariate. Students in the accounting, business management, early childhood education, welding, and auto body programs of study all had lower predicted likelihood of attaining two or more progression stacking certificates compared to the computer IT comparison group. (Recall that Computer IT was the comparison program of study in the earlier models based on student enrollments. It was retained as the comparison group in these models.) Female status was also associated with lower predicted likelihood of the outcome.

Model 3 tested the joint effects of all predictors in the model simultaneously. Exhibit 4.2 shows the predicted probabilities for attainment of two or more short-term, progression stacking certificates associated with the student-level program of study and demographic predictors from this model.

Exhibit 4.2. *Unique Predicted Probabilities of Two or More Short-Term, Progression Stacking Certificates by Student-Level Predictors*



Results from this model showed that the average adjusted (predicted) likelihood of the outcome, represented by the intercept logit value, was 58% but not statistically significant, meaning that associations with college of attendance did not significantly predict attainment of two or more short term, progression certificates, $p = .179$ (taking all predictors into account).

At the student level, the automotive technology and auto body programs of study were both associated with increased predicted probability of the outcome, $p = .006$ and $p < .001$, respectively. From the average adjusted likelihood (intercept) of 58%, a student's having first

earned a certificate in automotive technology increased the likelihood of the outcome by 18 percentage points to 76% and a first certificate in auto body increased the likelihood by 21 percentage points to 79%. Accounting, Early Childhood Education, and Business Management were the other three program of study predictors with statistically significant associations, and the association with all three was a decrease in likelihood of earning the second short-term, progression stacking certificate compared to the Computer IT field. None of the four demographic covariates had statistically significant associations in the joint effects model.

CHAPTER 5: CONCLUSIONS AND IMPLICATIONS

This dissertation examines the academic advantages of short-term certificates, given the research-based consensus that earnings benefits of short-term certificates vary as to whether they exist and are generally small when they are found. Academic value conveys the benefit of stackability to the extent that short-term, stackable certificates may "attach" a student to a sequence of study in order to increase the likelihood of subsequent attainment of a long-term certificate or degree—two awards where empirical research generally finds earnings advantages and where such advantages are generally larger.

The academic value of short-term, stackable certificates is operationalized by colleges in the design of progression stacking sequences. Such sequences are designed so that the credits of a short-term certificate can be applied toward attainment of a long-term certificate or degree. The design of this dissertation included intentional efforts to focus on academic benefits by isolating cases of progression stacking certificates to the extent possible. Programs of study, for example, were selected based on award data consistent with progression stacking (since no direct indicator of which certificates "stack" is available). As such, the sample of students examined here can be accurately described as a subset of the larger population of short-term certificate holders as well as including a comparison group pursuing studies in the same programs, reflecting my focus on examining the academic benefits of progression stacking.

Progression stacking was distinguished from three other categories of stacking: independent, supplemental, and potential. Independent stacking identifies a student's choice to combine short-term certificates from two fields that the colleges consider unrelated. This behavior does not move a student toward a long-term certificate or degree, as the colleges would intend. Supplemental stacking, where a student who already holds a two- or four-year degree and

“supplements” that degree with a short-term certificate, is a separate intended design of the colleges, but these students were excluded from analysis based on the study’s interest in examining students who stack toward a degree. Potential stacking, a term coined herein, identifies cases where a student earned a single short-term certificate with the *potential* to stack, but who did not earn another short-term certificate in the five-year period examined. These students were identified separately in order to estimate any associated advantage of taking “one step” along a progression stacking sequence versus the advantages of taking “two or more steps” (as represented by what I term progression stacking).

Although there was no expectation of finding earnings benefits from short-term certificates, these outcomes were still examined since increasing student earnings is one goal of these programs. This was also done to confirm that the subset of short-term certificate holders selected here did not show associated earnings outcomes that were meaningfully different from the consensus of the literature (or to contemplate implications of such a finding if it arose). By and large, nothing new came up on the earnings dimension. The null earnings effect findings from this study are thus consistent with most previous studies of short-term certificate outcomes.

5.1 Academic Findings

Certificate Category. The academic outcomes for progression stacking students represent the main interest of this study, as these students have taken “two or more” steps along a stackable certificate sequence leading toward a degree (based on the indirect identification of these sequences described in chapter 3). Outcomes for potential stacking students are also of high interest, since these students took “one step” along the sequence but did not earn a second short-term stackable certificate in the five-year period examined. It should be noted, however, that the “second step” of some stackable certificate sequences may have been a long-term

certificate (as illustrated using the Accounting example in table 3.4 in chapter 3). Therefore, the potential stacking category not only includes students who simply stopped after earning one short-term certificate but also students who subsequently earned additional credits with no further award within the study period and students who subsequently earned a greater award such as a long-term certificate or degree. The design of this dissertation focused solely on the academic value of short-term certificates, given the body of empirical evidence that these certificates have little, if any, labor market value. And the central question of this dissertation focused on what value, if any, might be delivered in a short-term certificate program.

On the student level, in my multivariate analysis, reaching the status of progression stacking by earning a second certificate in one's initial program area of study revealed a statistically significant positive difference on both the likelihood of earning a degree and in total credits earned when referenced against the comparison cases where no short-term certificate of any type was earned. Notably, the unique contribution of progression stacking toward the likelihood of earning a degree in the joint effects model was an increase of 30 percentage points. As such, progression stacking more than doubled the intercept likelihood of 27%. The conclusion here is that short-term, stackable certificates are associated with measurable and notable academic value; when a student actually progression stacks at least two certificates, the predicted probability that he or she will earn a two-year degree increases substantially. While the finding validates the concept of progression stacking, it is limited in what it reveals about earning a single short-term, stackable certificate. That question is answered by examining potential stacking.

The empirical findings indicate that potential stacking students—those who earn only one short-term, stackable certificate—actually have *lower* academic outcomes than those with no

certificate at all. In terms of the likelihood of earning a degree, attaining only one potential stacking short-term certificate was not found to be statistically significantly correlated with any change (or increase) in the likelihood of two-year degree attainment in the joint effects model. (In the simple or direct effects model, potential stacking was shown to have a statistically significant *negative* correlation with two-year degree attainment.) In terms of credit attainment, the joint effects model shows that students who earn just one potential stackable short-term certificate earn 16.59 *fewer* credits than students who earn some credits without earning a certificate at all. Findings from both cases may be understood as a sign that some students are presumably seeking only the (perceived) short-term benefit of short-term, stackable certificates in the labor market, not the stackability. The evidence does not support the possibility mentioned above—that many potential stacking students are progressing along the sequence toward the degree by earning a long-term certificate.

In short, the findings about academic benefits for progression and potential stacking—the two types most of interest to this dissertation—indicate that earning two or more short-term certificates (progression stacking) is associated with a more than two-fold increase in the likelihood of degree attainment, while earning just one short-term certificate (potential stacking) is found to have no such statistically significant association. The differences between progression stacking and potential stacking students may not be entirely surprising, given that students who progression stack two or more short-term stackable certificates are almost by definition closer to a degree.

Other academic outcome findings from my analysis confirm expectations. Independent stacking, where students attain two or more short-term certificates from different fields of study, has no statistically significant relationship to degree attainment. This type of stacking would not

be expected to increase the likelihood of degree attainment, and the evidence indicates that it does not. Perhaps the only finding of some interest is that independent stacking is not significantly associated with a reduced likelihood of earning a degree in comparison to those who earn no certificate at all, given that independent stacking can be seen as an intentional choice not to pursue an educational sequence that leads to a degree. Also, cases where students earned two or more certificates—progression and independent stacking—were positively associated with credit attainment and cases where students earned only one certificate—potential stacking—were negatively associated with credits. Again, this fits expectations.

Program of Study. Among programs of study, automotive technology and auto body were both positively and significantly associated with higher probability of degree attainment. It is noteworthy that these account for two of the three programs examined in this study that might be described as "trades" (meaning a field of work that requires specialized skills for a particular occupation), with welding being the third. Welding has a statistically significant negative association with degree attainment probability, a condition which is often attributed to the fact that welding students commonly find and accept high paying jobs in industry before graduating. Evidence that supports this line of thinking appears in the earnings discussion, below. Although welding is an exception, this finding suggests that more investigation of programs in the trades—how the sequences are designed, the relationship of awards to the labor market, or further analysis of these students might reveal the basis for a better understanding of the possibilities for stackable certificate sequences. Additional evidence along the same lines appears in the discussion of the further research questions, below.

Business IT offers the only other statistically significant finding in terms of differential likelihood of degree attainment by program of study. Studies in Business IT are associated with a

19% lower likelihood than the overall average of earning a two-year degree, most likely attributable to the fact that Business IT studies often lead to administrative assistant and other office support occupations that do not require a degree.

5.2 Earnings Findings

The earnings findings in this study are consistent with previous findings in the literature—there is no significant earnings benefit to attaining a short-term certificate over earning some college credits and no academic award. While the finding is unsurprising, it is noteworthy that while previous studies considered short-term certificates broadly this study focused on a subset of short-term certificates that appeared to be progression stacking.

As mentioned, the inflation-adjusted earnings associated with studies in just one field, welding, were statistically significant and positive, with an estimated quarterly earnings benefit of $811 in the joint model. Recall the earlier argument that such earning advantages appear to motivate students to enter the labor market prior to graduation, depressing the likelihood of degree completion. This finding lends credibility to that argument. On the other side of the spectrum, studies in Business IT and Early Childhood Education were found to have statistically significant associations with lower earnings, another commonly recognized reality of the labor market in these fields. No other fields had significant earnings differences.

The case of older students stands out but also confirms expectations. Students who are 25 years old or older have significantly higher earnings but a significantly lower earnings difference relative to their pre-enrollment earnings. In other words, earnings among these students were relatively high but earnings gains after enrollment were relatively low.

While largely consistent with previous studies, the earnings outcomes findings here make one modest new contribution. Recall that previous studies generally find no earnings benefit to

attaining a short-term certificate. One might ask whether earning multiple short-term certificates correlates with labor market value. This study finds no evidence that earning two or more short-term, progression stacking certificates is associated with an earnings benefit. To summarize, there is no evidence of an earnings benefit associated with earning a single short-term certificate, and the findings do not change for those who earn two or more. (The evidence does indicate the promise for *future* increased earnings for students who progress to a long-term certificate or degree, however.)

While this study also estimates earnings outcomes for independent stacking, this evidence should be regarded with caution. The incidence of independent stacking in the sample was roughly 1% and not representative of independent stacking as a phenomenon in the statewide award data for all fields. Steps were taken to exclude programs of study with high incidences of independent stacking from the sample (or, more precisely, to favor programs with strong evidence of progression stacking possibilities), and the remaining cases of independent stacking were coded primarily to separate the findings on academic outcomes for the few independent stacking students found from those for progression and potential stacking. A study making claims on the earnings benefits of independent stacking would need to include a more representative sample across fields, examine patterns in how students combine independent certificates, and undoubtedly take other factors into account.

5.3 Findings Regarding Attainment of Two or More Short-Term Certificates

Given the finding that earning a single short-term certificate in a field where progression stacking was presumed possible was not significantly associated with any benefit toward degree attainment but that earning two or more short-term progression certificates more than doubled that predicted probability, a final series of models was developed to test the likelihood of earning

two or more short-term, progression certificates conditional on earning a first certificate, using program of study and demographic predictors.

Two program of study predictors had statistically significant, positive associations but none of the demographic factors was significant. Automotive technology and auto body both correlated positively in the final model. The likelihood of attainment of two or more short-term certificates increased by 18 percentage points in automotive technology and 21 percentage points in auto body over the mean single-certificate holder likelihood of earning the second certificate of 58%. This was consistent with the findings for likelihood of degree attainment, where automotive technology and auto body were the only two programs of study with positive, statistically significant associations. Of the programs studied, these two programs thus appear to offer the best model for short-term certificate stacking.

5.4 Implications for Designing Stackable Certificate Sequences

The academic outcome findings associated with progression stacking provide evidence supporting stackable certificate sequences, with a major caveat. Stacking works—as evidenced by the more than doubling of the associated likelihood of degree attainment among progression stacking students who have taken two or more steps (i.e. earned two short-term certificates) along an academic path. But it only works when students actually stack—as evidenced by the contrast between the positive findings among progression stacking students who took at least two steps and the negative findings for degree attainment and credits among potential stacking students who took only one.

Revisiting some of the assumptions of short-term certificate sequences helps illustrate dynamics that may explain why earning just one short-term certificate fails to deliver academic

benefits, even—as in the case of this study—when that certificate comes in a field where the academic benefits of stacking seem to be present.

Recall Exhibit 1.1 in chapter 1, which illustrates the stackable certificate sequence in automotive technology at South Seattle College. When adhered to faithfully, full-time students would begin their studies by earning an Introduction to Automotive Technology short-term certificate in their first quarter. One measure of student fidelity to a stackable certificate sequence, then, might the percentage of full-time students who earn the first short-term, stackable certificate in their first (or second) quarter. An examination of the dataset proves inconclusive. Award records, such as conferral of the first, short-term certificate in a sequence, do not appear in the data unless students explicitly apply for conferral—a step that students who intended to continue would likely not take until they were completing or taking a break from studies. An examination of the available data reveals that 23.9% of potential stacking students and 22.4% of progression stacking students show a record of the first short-term certificate conferral in the first two quarters of study.[24] Again, this evidence would only reveal cases where students requested conferral, and therefore it is inconclusive.

In reality some students may discover stackable certificate sequences later in their academic careers—not when they first enroll. The data revealed that some students attempted remedial/developmental education coursework prior to attempting their first short-term, stackable certificate. These students might have struggled in developmental education for a few quarters before switching to a stackable certificate sequence where they would have a chance to bypass developmental education and begin college-level coursework. The data also included cases where students were awarded a short-term certificate after a few years of study, which might suggest that

[24] Author's calculations.

some students “fall back” on a short-term certificate after several quarters of study that failed to lead to a degree or other more robust award. Further examination might reveal whether these behaviors exist and how stackable certificate sequences might be better designed to avoid them.

A second assumption of short-term, stackable certificate sequences is that they offer students an opportunity to take a break from their studies and enter the workforce, knowing that they can return to their studies later at the place they left off. Recall the previous discussion in chapter 2 of a study by Carey (2017) who examined—among other data—cases for 13,880 professional/technical education students at community colleges in Washington state who stopped out of their studies after earning a certificate or degree in the 2006-07 academic year. Carey found that only 4% (576) of these students had returned to studies after five years. That study included all professional/technical education students—including degree earners who would not be expected to return to a community college to progression stack[25] as well as those who independently stacked—while this dissertation looks only at short-term certificate holders and takes measures to exclude cases of independent stacking and those with previous degrees. One would expect a higher rate of returning students among this sample, and this proves to be the case. Tables 5.1 and 5.2 show rates of students returning to studies among this sample’s potential stacking and progression stacking short-term certificate holders.

[25] Such degree-holding students might return to supplemental stack, which helps explain Carey’s decision to examine degree holders.

Table 5.1. *Potential Stacking Short-Term Certificate Holders Who Returned to College After Stopping Out for Two or More Quarters, by Program of Study*

Program of Study	All Students Who Earned a Potential Stacking Short-term Certificate (%)	Certificate Holders Who Stopped Out for Two or More Quarters and Returned to Earn Credits (%)	Certificate Holders Who Stopped Out for Two or More Quarters and Returned to Earn a Degree (%)
Accounting	62 (100.0%)	12 (19.4%)	2 (3.2%)
Business IT	30 (100.0%)	2 (6.7%)	0 (0.0%)
Business Management	35 (100.0%)	3 (8.6%)	1 (2.9%)
Early Childhood Education	53 (100.0%)	19 (35.8%)	3 (5.7%)
Automotive Technology	10 (100.0%)	0 (0.0%)	0 (0.0%)
Welding	64 (100.0%)	13 (20.3%)	0 (0.0%)
Auto Body	1 (100.0%)	1 (100%)	0 (0.0%)
Computer IT	8 (100.0%)	1 (12.5%)	0 (0.0%)
Total	263 (100.0%)	51 (19.4%)	6 (2.3%)

Table 5.2. *Progression Stacking Short-Term Certificate Holders Who Returned to College After Stopping Out for Two or More Quarters, by Program of Study*

Program of Study	All Students Who Earned a Progression Stacking Short-term Certificate (%)	Certificate Holders Who Stopped Out for Two or More Quarters and Returned to Earn Credits (%)	Certificate Holders Who Stopped Out for Two or More Quarters and Returned to Earn a Degree (%)
Accounting	37 (100.0%)	10 (27.0%)	3 (8.1%)
Business IT	58 (100.0%)	7 (12.1%)	3 (5.2%)
Business Management	20 (100.0%)	4 (20.0%)	2 (10.0%)
Early Childhood Education	22 (100.0%)	5 (22.7%)	5 (22.7%)
Automotive Technology	60 (100.0%)	9 (15.0%)	1 (1.7%)
Welding	62 (100.0%)	10 (16.1%)	1 (1.6%)
Auto Body	8 (100.0%)	0 (0.0%)	0 (0.0%)
Computer IT	37 (100.0%)	9 (24.3%)	2 (5.4%)
Total	304 (100.0%)	54 (17.8%)	17 (5.6%)

To confirm, the students described in tables 5.1 and 5.2 earned a short-term certificate before stopping out.[26] The percentages of returners among potential stacking students (19.4%) and progression stacking students (17.8%) suggest that a meaningful number of students are

[26] The students in tables 5.1 and 5.2 also returned to studies prior to earning a degree. Some students return after earning a degree to supplemental stack. These cases were not identified as stop-out-and-return since the degree was defined as the end goal of studies for this dissertation.

attempting this approach in programs of study that seem conducive to stacking. This stands in contrast to Carey's findings among all professional/technical programs, suggesting that the stackable certificate sequences examined in this dissertation may offer a more reasonable opportunity for this behavior. A future study might examine how stopping out after earning a short-term stackable certificate compares to stopping out in general (such as stopping out after earning "some college" credits) or any related concerns. Tables 5.1 and 5.2 simply build on Carey's study to show that stopping out and returning appears to be happening with greater frequency among programs conducive to stacking, providing evidence that students who stop out of stackable certificate sequences show greater attachment to their progressing along an academic pathway than the overall population of professional/technical education students and suggesting that stackability may modestly increase this attachment.

5.5 Conclusion

This dissertation attempts to address a gap in the literature by examining the academic benefits of short-term, stackable certificates. These academic benefits may be the central value of earning such a certificate for students seeking earnings gains, given the scarcity of evidence of earnings benefits without further academic credential attainment. This study finds evidence that stacking short-term certificates delivers compelling academic benefits, but not until students actually stack—meaning not until they earn two or more short-term certificates. Attaining just the first certificate has no statistically significant correlation with the likelihood of earning a two-year degree; attaining the second is associated with a two-fold increase in that likelihood. Upon this discovery, a final model was added to the dissertation to see which covariates predicted attainment of a second short-term stackable certificate among students who attained one.

Not all certificates stack toward a degree. This dissertation examined only 3573 of the 11,851 students who started studies in professional/technical education at Washington state community and technical colleges in 2007-08. The decision to examine a subset was largely due to the large number of short-term certificates in the data that showed no evidence that they stacked toward a degree. Colleges may want to reconsider how they describe the value of such certificates. They may still meet the short-term needs of students, policy makers, employers, and others even if they don't lead to higher earnings. They may still attract otherwise reluctant students and, in cases where the first short-term certificate leads to the second, they may ultimately increase likelihood of subsequent degree attainment. Some certificates that currently do not stack can perhaps be redesigned so that their benefits are enhanced. Carey (2017) notes that a notably small percentage of professional/technical students who stop out after attaining an award ever return. Given the high occurrence of certificates with no academic stacking value, many of the students who stop out may simply have little reason to return.

Attaining two or more short-term stackable certificates is associated with a substantial increase in the likelihood of two-year degree attainment—where empirical literature often finds earnings benefits. Attaining just one short-term stackable certificate has no significant association with either immediate earnings gains or the probability of earning a degree. Short-term certificates may remain the only option for students in need of quick-to-the-market training solutions. A few studies find scant evidence of an earnings value associated with short-term certificates in specific circumstances while most other studies—including this dissertation—find none. This dissertation also finds that a single, short-term certificate fails to deliver academic value resulting in any increased likelihood of degree

attainment. To reach a significant association with either the academic or earnings benefit, progression beyond a short-term certificate seems to be required.

For those who must seek quick-to-the-market training solutions, a single short-term certificate meets the need, although often without earnings benefits. For short-term stackable certificate holders seeking training solutions with the earnings benefits of a two-year degree, the evidence indicates substantial advantages when the first short-term certificate leads to a second in the same field, i.e., progression stacking. For these students, the findings of this dissertation show a need for additional research into understanding what predicts students taking the second step and how they might be encouraged to do so. This dissertation provides some insight into the case when the second step is another short-term certificate and illustrates the need for a fuller study that could better include cases when the second step might be a long-term certificate.

Stackable certificate sequences in the trades may offer the most promising examples. If one accepts that the negative academic outcomes associated with short-term certificates in welding may be an exception due to the high earnings value associated with that program of study, then the three trades programs in this study—welding, automotive technology, and auto body—may merit further study. Setting welding aside as an exception, automotive technology and auto body studies both had statistically significant associations with a higher likelihood of degree attainment (p = .01 in both cases). Studies in automotive technology were positively associated with credit attainment (p = .01) and auto body showed at least a marginal association with this outcome (p = .06). Finally, automotive technology and auto body both correlated positively with the outcome in the final model which tested attainment of two or more short-term certificates among students who earned at least one. The likelihood of attainment of two or more short-term certificates increased by 18 percentage points in automotive technology

and 21 percentage points in auto body over the mean single-certificate holder likelihood of earning the second certificate of 58%.

The role of short-term certificates. The absence of evidence supporting academic benefits for a single short-term certificate raises questions. Should colleges offer short-term certificates at all? If there were no short-term certificates, would fewer reluctant students enroll? If there were no short-term certificates, would colleges offer no option at all then to students, policy makers, and employers seeking quick-to-the-market solutions? If the first rung of the ladder offers no earnings or academic benefit, do you remove it? Or is it enough to give students some semblance of entrance into a desired field?

In 2012, certificates—both long- and short-term—became the second most commonly awarded postsecondary credential in the U.S. after the bachelor's degree (Carnevale, Rose, & Hanson, 2012; Horn, Li, & Weko, 2009). Because of the absence of earnings benefits, the main value of short-term certificates remains tied to stackability—the degree to which short-term awards attach students to a coherent academic pathway that does lead to real subsequent benefits. The finding in this dissertation is that a single short-term certificate may grant students rapid entrance into a desired field, but they must earn at least a second short-term certificate to see any academic benefit that might propel them toward academic awards with meaningful wage benefits such as an associate's degree. Colleges must better understand how these stackable sequences actually work for students and how they can be designed to get students from the first certificate to the second—and beyond.

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Appendix A.1

Table A.1. *Student Demographic Statistics of the Analytic Dataset for the Initial Research Questions by Program of Study*

Program of Study	Total (%)	Female (%)	25 Years Old or Older (%)	Under-Represented Minority (%)	Received Need-Based Aid (%)
Accounting	611 (100%)	485 (79.4%)	432 (70.7%)	180 (29.5%)	257 (42.1%)
Business IT	281 (100%)	182 (64.8%)	215 (76.5%)	75 (26.7%)	96 (34.2%)
Business Management	459 (100%)	273 (59.5%)	228 (49.7%)	137 (29.9%)	155 (33.8%)
Early Childhood Education	491 (100%)	464 (94.5%)	248 (50.5%)	155 (31.6%)	193 (39.3%)
Automotive Technology	478 (100%)	30 (6.3%)	133 (27.8%)	169 (35.4%)	184 (38.5%)
Welding	578 (100%)	50 (8.7%)	339 (58.8%)	164 (28.4%)	186 (32.2%)
Auto Body	67 (100%)	4 (6.0%)	18 (26.9%)	32 (47.8%)	28 (41.8%)
Computer IT	608 (100%)	135 (22.2%)	385 (63.3%)	193 (31.7%)	214 (35.2%)
Total	3573 (100.0%)	1623 (45.4%)	1998 (55.9%)	1105 (30.9%)	1313 (36.7%)

Appendix A.2

Table A.2. *Category of Certificate Conferred for the Initial Research Questions by Program of Study*

Program of Study	Progression	Potential	Independent	No Stacking	Total
Accounting	37 (6.1%)	62 (10.1%)	19 (3.1%)	493 (80.7%)	611 (100%)
Business IT	59 (21.0%)	30 (10.7%)	5 (1.8%)	187 (66.5%)	281 (100%)
Business Management	20 (4.4%)	35 (7.6%)	4 (0.9%)	400 (87.1%)	459 (100%)
Early Childhood Education	23 (4.7%)	53 (10.8%)	0 (0.0%)	415 (84.5%)	491 (100%)
Automotive Technology	60 (12.6%)	10 (2.1%)	1 (<0.1%)	407 (85.1%)	478 (100%)
Welding	61 (10.6%)	64 (11.1%)	5 (0.1%)	448 (77.5%)	578 (100%)
Auto Body	8 (11.9%)	1 (1.5%)	0 (0.0%)	58 (86.6%)	67 (100%)
Computer IT	36 (5.9%)	8 (1.3%)	0 (0.0%)	564 (92.8%)	608 (100%)
Total	304 (8.5%)	263 (7.4%)	34 (1.0%)	2972 (83.2%)	3573 (100%)

Appendix B.1

Table B.1. *Student Demographic Statistics of the Analytic Dataset for the Further Research Questions by Program of Study*

Program of Study	Total (%)	Female (%)	25 Years Old or Older (%)	Under-Represented Minority (%)	Received Need-Based Aid (%)
Accounting	99 (100%)	78 (78.8%)	83 (83.4%)	29 (29.3%)	40 (40.4%)
Business IT	89 (100%)	60 (67.4%)	69 (77.5%)	21 (23.6%)	25 (28.1%)
Business Management	55 (100%)	36 (65.5%)	44 (80.0%)	14 (25.5%)	16 (29.1%)
Early Childhood Education	76 (100%)	72 (94.7%)	52 (68.4%)	40 (52.6%)	24 (31.6%)
Automotive Technology	70 (100%)	3 (4.3%)	27 (38.6%)	36 (51.4%)	31 (44.3%)
Welding	125 (100%)	10 (8.0%)	84 (67.2%)	89 (28.8%)	54 (43.2%)
Auto Body	9 (100%)	0 (0.0%)	2 (22.2%)	4 (44.4%)	3 (33.3%)
Computer IT	44 (100%)	12 (27.3%)	36 (81.8%)	13 (29.6%)	15 (34.1%)
Total	567 (100%)	271 (47.8%)	297 (70.0%)	193 (34.0%)	208 (36.7%)

Appendix B.2

Table B.2. *Category of Certificate Conferred for the Further Research Questions by Program of Study*

Program of Study	Progression	Potential	Total
Accounting	37 (37.4%)	62 (62.6%)	99 (100%)
Business IT	59 (66.3%)	30 (33.7%)	89 (100%)
Business Management	20 (36.4%)	35 (63.6%)	55 (100%)
Early Childhood Education	23 (30.7%)	53 (70.7%)	75 (100%)
Automotive Technology	60 (85.7%)	10 (14.3%)	70 (100%)
Welding	61 (48.8%)	64 (51.2%)	125 (100%)
Auto Body	8 (88.9%)	1 (11.1%)	9 (100%)
Computer IT	36 (81.8%)	8 (18.2%)	44 (100%)
Total	304 (53.6%)	263 (46.4%)	567 (100%)