TWO ESSAYS IN EDUCATION ECONOMICS AND ONE ESSAY IN INTERNATIONAL ECONOMICS

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ABSTRACT

The dissertation comprises of two chapters that use applied econometric techniques to analyze policy related questions that have implications for educational outcomes and one chapter that assesses factors that influence foreign direct investment inflows. In the first chapter I study the impact of equity premiums on the completion numbers of minority students. In the second chapter I assess the impact that state funding cuts for higher education may have on completion numbers across racial and ethnic lines. For the last chapter I study the relationship between intellectual property rights and foreign direct investment

For chapter one, I study the impact that equity premiums inclusion in performance-based funding models have on the completion numbers of minority students. Using a combination of administrative data over the period 2004 to 2018 with two-way fixed effects methods, I investigate the impact of the premiums on completion numbers of Black, Hispanic, and Native American students. My estimates show that in the short run (up to 2 years post-policy) there are no changes in the completion numbers of at-risk students in adopting and non-adopting states. Secondly, there is heterogeneity in policy effects across ethnicity, in particular Hispanic student completion numbers decrease in adopting states. Thirdly, public institutions become more selective in their admissions of at-risk students post-policy, which may lead to the overall null effects I establish.

For chapter two, I investigate whether there exist variations in how state funding cuts for higher education may impact on completion numbers across racial and ethnic lines. Combining administrative data from 1997 to 2018 with two-stage least squares methodology, I test how institutional state funding instrumented by total state funding may

influence completion numbers across racial categories. I find that changes in state funding have no significant impact on the completion numbers for each racial category of students.

For chapter three, I extend Spatz and Nunnenkamp's (2003) analysis by using a panel dataset to determine a causal relationship between intellectual property right (IPR) protections and foreign direct investment (FDI) inflows. Using a fixed-effects Poisson model my results shows that IPR is a causal determinant of FDI within the manufacturing industry. My study concludes that as a country improves their IPR protections, the positive impact on FDI within the manufacturing industry, increases at a decreasing rate.

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CHAPTER 1

THE IMPACT OF EQUITY PREMIUMS ON THE COMPLETION OUTCOMES OF MINORITY STUDENTS

1.1 Introduction

Performance-based funding (PBF) models are an increasingly popular tool utilized by state policymakers to incentivize higher education institutions to improve student outcomes through such measures as enrollment and completion numbers. This study adds to the literature by examining the impact that recent changes in these policies have had on students' completion numbers. Whitford (2020) noted in a report on performance-based funding studies that as of the 2020 fiscal year, PBF policies have been implemented in around 41 states. PBF policies represent a shift from providing state funds based on traditional input-based approaches (such as total enrollments and credit hours) toward funding based on institutional performance metrics (Favero and Rutherford, 2019). This shift in policy over the last several decades is driven by increasing calls from state policymakers for external accountability on public institutions.

Education scholars proposed several reasons for this movement toward PBF policies. First, there have been increasing calls from state policymakers for external accountability on public institutions, given that tuition and fee prices have quadrupled since 1981 (Ma et al., 2016). Second, graduation rates at public institutions have increased at a slower rate than enrollment levels. According to the US Department of Education, only 59% of students complete their bachelor's degree within six years of starting. This estimate includes only first-time, full-time students who make up 47% of all college attendees, suggesting that the actual graduation rate was lower. Third, graduation rates of minority students at public institutions were behind the overall average. For example, according to the National Center for Education Statistics (NCES) for the 2010 cohort of first-time, full-time students attending public institutions, 40% of Black students, 54% of Hispanic students and 36% of Native students graduated within six years of enrolling. By comparison, the six-year graduation rate for all students was 59%, for White students it was 64% and for Asian students it was 72%.

Given the diffusion of performance-based funding policies across the country, many researchers have investigated the effectiveness of these models. The nature of these policies has changed over time and PBF policies can be usefully categorized into two broad groups as the policies emphasize different outcomes. The first iteration of these policies ('PBF 1.0') was implemented by states between 1970 and 2000. During this period policymakers focused exclusively on increasing the enrollment levels of public institutions. The second iteration of these policies were adopted between 2007 and the time of writing ('PBF 2.0'). In developing PBF 2.0 policies, policymakers shifted their focus to increasing the completion numbers at public institutions.[1] Overall, most studies to date have found limited evidence that either type of policy has led to improvements in enrollment or completion numbers (e.g., Shin and Milton, 2004; Hillman et al. 2014; Sandford and Hunter, 2011; Rutherford and Rabovsky, 2014). However, a handful of studies found some evidence that over time, PBF policies may have increased completion numbers (e.g., Hillman and Tandberg 2014; Hillman at al. 2015 and Hillman et al. 2017). For instance, Tandberg and Hillman (2014) found an increase in the number of baccalaureate degrees

[1] Between the period of 2001 and 2006, many states dropped PBF policies and went back to the traditional approach to state funding for public institutions.

for institutions located in states where a PBF 2.0 policy had been in place for seven or more years, suggesting that there may be delayed impacts of the policy.

However, several recent studies have shown that PBF policies may have unintended and negative consequences. Broadly, this set of studies documented that, rather than attempting to improve outcomes for incumbent students, public institutions instead admitted more advantaged students (i.e., cream-skimming). For example, Umbritch et al., (2015), studying the PBF policy in Indiana, found that some public institutions increased their enrollment selectivity (proxied by the number of admissions) in response to PBF policies. Further, McKinney and Hagedorn (2017) found that the amount of funds directed to community colleges within states with a PBF policy in place were a function of students' characteristics who were enrolled. They found that GED holders, Black students, adult students, and part-time students procured less funding for community colleges from the state policymakers, and this may have informed institutions' increased enrollment selectivity.

In response to these findings – limited evidence of policy effectiveness and potential negative and unintended consequences, education scholars have called for PBF policies to be disbanded altogether (Hillman, 2016). On the other hand, Jones (2014) and Tierney (2014) have noted that improving PBF policies, with an eye towards their unintended impacts, is a better route, rather than abandoning the policies altogether. To mitigate unintended and negative policy impacts such as institutions admitting fewer historically underserved students, some states have included premiums into their PBF policy. According to Gandara and Rutherford (2018), PBF policy premiums can be defined as financial bonuses awarded to institutions for the enrollment and completion of a target student population. These premiums focus mainly on at-risk students: ethnic minority students, low-income students, adult students, academically underprepared students, and in a few states, veteran students.[2]

An important gap in the literature to date is a careful study of PBF premiums on completion numbers. My paper seeks to analyze whether the inclusion of the premium policy by certain states has had any impact on the outcomes of at-risk students. Prior research by Kelchen (2017), and Gandara and Rutherford (2017) examined the impact of these policies on enrollment, but not more distal outcomes, such as completion numbers. Moreover, findings are mixed and do not provide a clear picture on the extent to which these policies may impact enrollment. Of note, even if PBF premium policies do not impact enrollment, they may still influence the completion numbers of at-risk students by influencing public institution's retention practices. My contribution to the literature is to assess whether the premium policy caused the completion numbers of minority students to increase. Specifically, this study seeks to answer the research question: Among 4-year public institutions, to what extent does the inclusion of premiums for at-risk or underserved student population affect the completion numbers of these students? By addressing this question, this study shed lights on whether premiums are leading to an increase in minority students completing their bachelor's degrees from public institutions.

Using the two-way fixed effects method with data from the Integrated Post-Secondary Education System (IPEDS) and the Kentucky Center for Poverty Research (UKCPR) my results found no impact from the premium policy on the completion numbers for all minority students in the short run that is, two years after the policy has been in place.

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[2] Ethnic minority includes Black/African American, Hispanic/Latino and Native students. Low-income students are those the receives Pell grants and adult students are those age 25 and older.

After a period of three years, statistically significant impacts began to emerge on the completion numbers of Hispanic students only. My results showed that Hispanic students' completion numbers declined by 11.9% in year three and then by 13.9% in year four after the policy implementation. Lastly, results showed that the completion numbers of Hispanic students attending selective public institutions located in premium policy states declined by 12.7% compared to those located in non-premium states.

The rest of the paper is organized as follows. In Section 2 I discuss previous studies and provide conceptual context. In Section 3, I describe the data sources as well as my methods and identification strategy. I report my principal results showing the impact of the policy on the completion numbers of minority students and run several robustness checks on my results in Section 4. Finally, Section 5 offers a conclusion and discussion.

1.2 Literature and Conceptual Framework

1.2.1 Related Literature

Past research on performance funding policies (PBF 2.0) find either weak evidence of the policy effectiveness or negative unintended consequences. Papers by Hillman et al. (2014), Rutherford and Rabovsky (2014) as well as Tandberg at al. (2014) find no statistical evidence that PBF policies had any impact on total degrees awarded as well as graduation rates. Hillman et al. (2014) find that public institutions in the city of Philadelphia did not outperform public institutions in neighboring states with no performance funding policies. Rutherford and Rabovsky (2014) as well as Tandberg et al. (2014) examining the period 1990 to 2010 find no significant impact of the policy on educational outcomes. These findings fall in line with prior research on the ineffectiveness of PBF 1.0 policy on improving educational outcomes (Sanford and Hunter, 2010; Shin and Milton, 2004). Prior research also find that the policies tend to cause institutions to narrow their mission, meaning increasing focus on recruiting students more likely to graduate (Doughtery and Hong, 2005).

Papers by Hillman and Tandberg (2014), Hillman at al. (2015) and Hillman et al. (2017) were able to find weak evidence of the PBF 2.0 policies positively impacting on educational outcomes. Hillman and Tandberg (2014) analysis found that short run effects were insignificant but after a period of about seven years, significant and positive effects began to emerge. Hillman et al. (2015) found that the policy tends to have no immediate effect on retention rates for public universities but also found that it resulted in community colleges producing more short-term certificates. Hillman et al. (2017) focusing on Ohio and Tennessee, two states with the most robust PBF policies, found positive effects among Tennessee's community colleges with an increase in certificate awards.[3]

As noted earlier, recent research began focusing on the unintended consequences of the policy on institutions and the student body. Both qualitative and quantitative studies have found evidence of 'cream-skimming', as an unintended impact of PBF policies. This cream-skimming practice is where institutions, even those with open-access admissions, focus on recruiting students from wealthier districts as well as more academically prepared students. Qualitative research on PBF policy in Tennessee found some evidence of more attention and efforts being given to groups more likely to affect

[3] According to Snyder (2015), Tennessee and Ohio are two states that adhering closely to best practices with PBF policies as both states have statewide college completion goals and build performance funding into each college's base budget. Also, both states have had the policy in place for a long duration of time.

performance measures while denying service to others (Banta et al., 1996; Colbeck, 2002). By denying services this means institutions restricted admissions by reducing the proportion of students who are less prepared academically and thus, less likely to graduate (Doughtery et al., 2016). A quantitative analysis of public institutions in Indiana, found that some institutions became more selective in their enrollment process compared to private and neighboring public institutions (Umbricht at al., 2015). A few studies found that in the wake of these PBF policies, fewer underrepresented students were enrolled at public institutions. Evidence of increase selectivity in response to performance funding is not new as Kelchen and Stedark (2016) found that PBF 1.0 were providing incentives for schools to strategically allocate aid dollars in enrolling students with a higher likelihood of graduating and excluding those less likely to complete their degree.

Many states began including incentives for institutions as an attempt to mitigate against increase selectivity and curtail the negative consequences impacting on at-risk students. For example, Ness et al., (2015) noted that Tennessee provides an additional 40% of funding for each student who graduates that is either eligible for Pell grants or are adult students. Ohio's Board of Regents' state share of instruction which breaks down the funding formula used for their policy, specifies additional funding for students of color, adult students, and Pell eligible students. According to Lumina Foundation, n.d.; Miller (2016), these premiums for underrepresented students are now best practice for any state adopting PBF 2.0 policy. Despite this, not every state with PBF policy includes premiums for at-risk students (Kelchen, 2016).

Analysis on the impact of these provisions on the enrollment of at-risk students by Kelchen (2017) found either no impact or small positive impact.[4] Specifically analyzing the period of 2004-2005 to 2014-2015 academic years, he found that any equity premium resulted in a large increase in the enrollment of African American students, but this was not the case for the other racial and ethnic minorities or for low-income students. Gandara and Rutherford (2017) analysis for the period of 1993 to 2014 found different results. Their assessment found that premiums increased the enrollment of both Hispanic and low-income students compared to institutions in states with a PBF policy in place without premiums included. They also found negative impacts on Black students and noted that the overall impact of the premium varies depending on type of metrics used and how long the premiums were actively in place.

My research builds on both Kelchen (2017) and Gandara and Rutherford (2017) papers in seeking to analyze the impact of the funding for at-risk students. The main difference is that this paper will be focus on completion outcomes as opposed to enrollment thus assessing whether the policy is doing what policymakers implemented it to do. Following previous research on PBF impact on completion numbers, my paper also seeks to determine whether the impact of the policy changes in the long run specifically, up to four years after the policy has been implemented. I then go a step further and assess if there is any heterogeneity in the impact of the policy based on an institution's selectivity.

[4] Kelchen (2017) defined at-risk students as low income (students receiving Pell Grants), minority (African American, Hispanic, Native American, and multiracial) and adult students (undergraduates aged 25 and older).

1.2.2 Conceptual Framework

According to Ross (1973), the relationship of agency is one of the oldest and most common mode of social interaction. He defined the relationship as one where the agent acts for or on the behalf of the principal. The agent must be willing to enter a contractual relationship with the principal and then both parties will maximize their expected utility (Stiglitz, 2008). With performance funding policies, we can define the principals as state governors, state legislators and state boards of regents while the agents are public colleges and universities enlisted by the state to achieve their higher education goals. As such, we can use principal-agent theory as a lens to examine performance-based funding in higher education.

Eisenhardt (1989) noted that agency theory is concerned with resolving two issues that crop up in the principal and agent relationship, the conflict between the goals of the agent and the principal, and asymmetric information making it difficult for the principal to verify the agent's actions. Kivisto (2008) noted that state legislators tend to have incomplete information when it comes to the actions of college and university administrators. He also noted that in addition to this information asymmetry, issues emerge as both parties seek to maximize their own self-interests such as institutions trying to increase the ranking of their schools while policymakers seek to increase the degree production to benefit the state's economy. Hillman et al., (2018) noted that the decision to move from traditional oversight to a more incentive based model of control such as PBF is informed by the agency theory.[5]

[5] According to Hillman et al. (2018) the traditional role of the state in higher education was to establish a system and then rely on the institutions' administrators to carry out the goals as they saw fit.

Many researchers have stated that PBF policies can be used by policymakers to induce institutions to improve their student outcomes. According to Gandara and Rutherford (2017), inducements are one type of policy instruments used by the state to attain their goals and the inducements can be in the form of rewards or penalties. As such, they conceptualized PBF premiums as specialized inducements given the fact that they are embedded in a policy that is already an inducement itself. Hillman et al., (2018) noted that this decision by policymakers is common in the principal-agent relationship as the principal and agent may have a goal conflict. For example, the college presidents may place a higher priority over completion numbers in total as opposed to completion of 'at-risks' students specifically.

An issue with inducements noted by a few researchers is that incentives are unlikely to create change if agents do not have the resources to implement the principal's agenda.[6] Hillman et al., (2018) noted that institutions might not have the institutional and financial resources to focus on improving student outcomes like completion rates or retention rates. Even in the context of my paper where I am assessing a subset of the total student population, this will still be a difficult task for institutions to undertake. There may also be cases where institutions have the capacity to improve but they fall short of the goal as the factors influencing a student to graduate involves more than financial incentives. Within this conceptual framework of the principal-agent theory, my study examines the effect of premiums on at-risk student populations particularly for racial/ethnic minority students.

[6] Gilmour and Lewis (2008), Moynihan (2008) and Rabovsky (2012) assessed the failings of inducements in the context of higher education.

1.3 Data, Empirical Strategy and Limitations

1.3.1 Data

The empirical analysis for this study focuses on changes in total undergraduate degrees awarded within public institutions between the years of 2004 and 2018. The exact number of states with an active PBF policy is unclear, as Gandara and Rutherford (2017) estimate it to be 26 states while Kelchen (2017) estimates it to be 28 states. To answer my research question on whether the presence of at-risk premium funding influences the completion levels of at-risk students, I combine institutional and state level controls to form a fifteen-year balanced panel dataset. The sample includes only states within mainland of the United States of America.[7]

My primary source of institutional level control variables is obtained from the US Department of Education's Integrated Postsecondary Education System (IPEDS). IPEDS collects data from institutions that are required to report several statistics annually to the Department of Education's National Center for Education Statistics (NCES) to qualify for federally assisted programs.[8] The analysis focuses only on public institutions that grants bachelor's degrees as such, I exclude all institutions that do not award undergraduate degrees or receive state appropriations as determined by the IPEDS dataset. Specifically, any institutions that had no data for the state appropriation variable during my period of study was removed from my sample. I also exclude all two- year public colleges due to the potential bias of these institutions shifting from granting certificates only to

[7] The estimation excludes institutions located in American Samoa, Guam, Puerto Rico, Northern Marinas, Marshall Islands and Virgin Islands

[8] The institutional variables include logged tuition, logged full time enrollment (FTE), percentage of undergraduates enrolled part-time, logged operating expenditures per FTE, logged academic support per FTE, logged institutional per FTE, logged instruction per FTE, logged student services per FTE, percentage of students enrolled that are Black, Hispanic, Native and share of operating expenditure from the state.

granting bachelor's degrees as well during my period of study. The institutional level variables are then combined with state level variables sourced from the University of Kentucky Center for Poverty Research (UKCPR).[9] As several states in my sample have tuition cap or tuition freeze policy which impacts upon tuition and fees of public institutions, I control for this policy by referencing the works of Deming and Walters (2017) and Armstrong et al., (2017). To do this I create an indicator variable to control for tuition caps and freezes. All financial variables have been CPI-adjusted using 2015 dollars.

The number of states with performance-based funding evolves every year with some states currently developing their own PBF policies for implementation. To determine which public institutions were covered by the policy across the states in my sample and during my period of study, I referenced the works of others (Kelchen, 2017; Gandara and Rutherford, 2017; Li, 2018). To answer my research question, I code a binary indicator for whether states attempted to encourage institutions to graduate at-risk students which for my study, at-risk students are defined as low-income and minority students. I define low-income students as all those eligible for Pell grants and minority students as Black, Hispanic, and Native students. I also coded a second binary indicator for states that had the general PBF policy in place without the equity premium to assess if there is any possible difference in the impact of the premium policy when compared to states with zero PBF policy versus those with the general PBF policy (Table A1.1).

1.3.2 Empirical Strategy

To answer my research question my study compares public institutions in premium states (treated group) with those in non-premium states (control group). Given

[9] The state level variables include unemployment rate and the poverty rate.

the nature of the premium policy it is expected that some of the control sates are partially treated. For my main analysis, the partially treated states are grouped into my control group. To assess if these partially treated states affect my results, I control for these states separately as part of my robustness check.

For the estimation I utilized a two-way fixed effects regression to consider the changes in bachelor's degrees awarded to Total, Black, Hispanic, and Native students.[10] The model specification follows the general structure of Tanberg, Hillman and Barakat (2014) and Kelchen (2017),

$$\ln(Y_{s,i,t}) = \beta_0 + \beta_1 (\text{treat*post})_{s,i,t} + \beta_x X_{i,t} + \beta_w W_{s,t} + \eta_t + \delta_i + \varepsilon_{s,i,t}, \qquad (1)$$

where $\ln(Y_{s,i,t})$ is the key dependent variable which include either Black, Hispanic or Native logged completion in each institution (i) located in state (s) for each year (t) and β_0 is the intercept. Due to states implementing the policy at different periods, the (treat*post) interaction is set to equal one for all institutions in the years during and following the adoption of the premium policy. I also include a broad set of institutional observable covariates which influences students' completion of their bachelor's degree. These include logged full-time enrollment, percentage of undergraduates enrolled part-time, logged of share of operating expenses covered by state appropriations, logged operating expenditures (total, academic, student services, institutional), percentage full time enrollment by race (Black, Hispanic, Native) and logged tuition. The institutional variables are logged to prevent outlier variables from being overrepresented in the relationships in my models.

[10] For the papers main analysis, completion numbers are used as the outcome instead of graduation rates because graduation rate data excludes some students that are included in completion numbers. Graduation rates are instead used as an outcome for robustness check.

I then included state level controls such as unemployment and poverty rates as both higher unemployment and poverty rates can have a negative impact on funding for higher education and students' completing their degree. Kelchen (2016) highlighted the importance of controlling for tuition caps as studies have shown that while caps may not be effective in slowing down tuition increases, they are effective in slowing down fee increases. As such I include an indicator variable for whether states had caps or freezes in place for tuition and fees. Lastly, I include year fixed effects (η_t) to account for unobserved factors that affects all states each year such as federal policies, institution fixed effects, (δ_i) to control for unobservable institutional factors that are stable over time such as an institution's academic quality and an error term ($\mathcal{E}_i$) clustered at the state level to adjust for autocorrelation and heteroscedasticity.

The primary focus of my research is to investigate the extent to which premiums for at-risk students affect the completion numbers of Black, Hispanic, and Native students attending public institutions operating under this policy compared to those in institutions operating under zero premium policy. While I cannot know with certainty what would have happened in the absence of these policy premiums, the two-way fixed effects regression is used to consider changes in the completion numbers of minority student groups pre- and post-treatment.

1.4 Empirical Results

1.4.1 Descriptive Statistics

Table 1.1 includes descriptive statistics for all the variables included in my estimation. The variables are separated into three groupings: all states, states with premium policy, states with no premium policy which includes both PBF and non-PBF states. The data shows that in general, non-premium states have a higher operating cost per FTE when compared to institutions in states with premium policy. This may indicate that non-premium states were already allocating significant funds to higher education public institutions which may be the reason why, policy makers deemed premium funding unnecessary. The rest of the institutional financial variables follows the same trend. Other than institutional spending, there is no major difference between the outcome variables and state control variables between the two groups.

Table 1. 1: Descriptive Statistics

	All states	Premium states	Non-premium states
Dependent variables			
Bachelor’s degrees(ln)	6.95	6.79	7.04
Black bachelors(ln)	4.09	4.11	4.08
Hispanic bachelors(ln)	3.72	3.30	3.96
Native bachelors(ln)	1.70	1.66	1.72
Institutional covariates			
FTE enrollment	8,379.55	8,370.65	8,384.77
Percentage part-time enrollment	21.52	22.24	21.09
Share of operating cost from state	-1.23	-1.24	-1.22
Operating cost per FTE	96,669.96	45,905.73	126,469.60
Percentage Black students enrolled	13.75	13.99	13.60
Percentage Hispanic students enrolled	9.35	6.55	10.99
Percentage Native students enrolled	1.71	1.77	1.69
Instruction cost per FTE	22,335.69	12,978.41	27,828.60
Academic cost per FTE	5,210.17	3,165.14	6,410.65

Table 1. 1 continued

Student services cost per FTE	2,748.36	3,165.14	3,097.82
Institution cost per FTE	7,334.46	4,211.09	9,167.95
Tuition and Fees	8.50e+07	8.97e+07	8.23e+07
State-level characteristics			
Unemployment rate	4.47	4.47	4.47
Poverty rate	10.33	10.33	10.33
Observations	**8,070**	**2,985**	**5,085**

1.4.2 Main Findings

Table 1.2 shows the estimated effects of the premium policy on total bachelor's degrees awarded (Column 1), bachelor's degrees awarded to Black students (Column 2), bachelor's degrees awarded to Hispanic students (Column 3) and bachelor's degrees awarded to Native students (Column 4). I estimated three specifications that increasingly provided better controls for omitted variables. Firstly, I estimated the model including institution and year fixed effects to control for differences across institutions and differences over time. The simple conditional model in Column 1 indicates no significant relationship between the premium policy and all four outcomes of interest. I then added a vector of institutional level controls and re-estimated the model which showed no change in the insignificant impact of the policy. Lastly, I included state-level economic controls and state-level policies for my preferred specification. The results of this specification also show no significant impact of the policy however, the inclusion of these additional controls improved the precision of my point estimates.

Table 1. 2: The effects of premium policy on undergraduate completion numbers

	(1)	(2)	(3)
Total Bachelors (ln)	0.003	0.051	0.051
	(0.051)	(0.045)	(0.045)
Black(ln)	0.003	0.034	0.035
	(0.063)	(0.058)	(0.058)
Hispanic(ln)	-0.029	0.012	0.013
	(0.064)	(0.061)	(0.061)
Native(ln)	-0.002	-0.013	-0.013
	(0.059)	(0.050)	(0.049)
Institution & year fixed effects	Yes	Yes	Yes
Institutional demographic controls	No	Yes	Yes
State economic & policy controls	No	No	Yes
N	8,070	8,070	8,070

*p<0.10, **p<0.05, ***p<0.01
The data is derived from a combination of sources such as IPEDS, UKCPR and referenced literature. The dependent variable is defined as the natural log of bachelor's degrees awarded of total Black, Hispanic, and Native students. Institution and year fixed effects are included in all specifications. Standard errors are in parenthesis and are clustered at the institutional level.

To my knowledge, this paper is the first to assess whether the premium policy within the general PBF model has had any impact on students' completion numbers. These results suggest that the premium policy has no impact on the completion numbers of all students and no impact on the completion numbers of Black, Hispanic, and Native students specifically. My results are similar to that of prior research on the impact of general PBF policy on completion outcomes, which was found to be ineffective in the short run. These results imply that the dosage of funding of the premium policy may not be enough to influence institutions' practices in ways which may lead to an increase in the number of minority students completing their bachelor's degrees.

I then compared the presence of the premium policy in a given year to completion numbers in years one, two, three and four after the policy was implemented. This allows the public institutions an opportunity to change their recruitment and retention practices in response to the premium policy. Table 1.3 shows that the policy appears to have an insignificant impact on the completion numbers of all students even after the policy has been in place for four years. Focusing on minority students specifically, the results shows that the policy remains ineffective in influencing the completion numbers of Black and Native students but significantly impacts on the completion numbers of Hispanic students after three years of implementation. The results show that in year 3 (t+3) there is a decline in completion numbers of 11.9% and by year four (t+4) the decline trend continues increasing to 13.9%. These results go against the expectation of the premium policy having a positive impact on completion numbers as well as differing from prior research on the impact on general PBF policy on completion outcomes. Future research is needed to assess why the completion numbers of Hispanic students appear to be more responsive to the premium policy compared to other minority students and why is the impact negative rather than positive.

Table 1. 3: The effects of the premium policy on lagged undergraduate completion numbers

	t+1	t+2	t+3	t+4
Total Bachelors (ln)	-0.007	-0.056	-0.077	-0.100
	(0.061)	(0.036)	(0.055)	(0.073)
Black(ln)	0.017	-0.026	-0.065	-0.091
	(0.047)	(0.045)	(0.052)	(0.062)
Hispanic(ln)	-0.030	-0.074	-0.119*	-0.139*
	(0.054)	(0.057)	(0.060)	(0.070)
Native(ln)	-0.008	-0.020	-0.020	-0.053
	(0.049)	(0.043)	(0.038)	(0.038)
N	8,070	8,070	8,070	8,070

*p<0.10, **p<0.05, ***p<0.01
The data is derived from a combination of sources such as IPEDS, UKCPR and referenced literature. The dependent variable is defined as the natural log of bachelor's degrees awarded for Black, Hispanic, and Native undergraduate students. Institution and year fixed effects are included in all specifications. Standard errors are in parenthesis and are clustered at the institutional level.

1.4.3 Event Study Analysis

The main results for my paper were found using a two-way fixed effects estimation. An event study model is an important extension of this estimation as it allows one to test for and assess the common trends assumption. This assumption is necessary for two-way fixed effects models to recover estimates of causal effects. Specifically, it is assumed that the treated group and the comparison group outcomes would have trended similarly if there was no treatment implemented. To provide some suggestive evidence on this assumption, I estimate an event study model conditioning on covariates as expressed in equation 2,

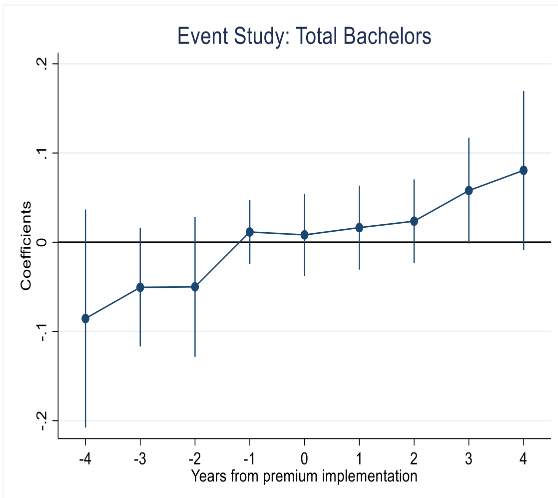
$$\ln(Y_{it}) = \beta_0 + \sum_{k=-5}^{4} \beta^k I[D_{it}^k = 1] + \gamma X_{it} + \eta_t + \delta_i + \varepsilon_{it}\,, \tag{2}$$

where D_{it} is an indicator variable that equals to one when a state implements the premium policy and k is the number of years away from the premium policy year. The first year that the policy is implemented is denoted by k=0. The equation includes 5 leads whose coefficient estimates are used to assess the plausibility of the common trends assumption and 5 lags which allows treatment effects to vary over time in the post-premium years. Each lead and lag represent two years, for example (-5) or the fifth lead represents 10 and 9 years before the policy was implemented and similarly (4) or the fourth lag represents 8 and 7 years after the policy has been implemented. For states that do not implement the premium policy (both PBF states and non-PBF states), I code all the lead and lag variables as zero. I also normalize β^{-5} the last pre-treatment two-year group to zero as such all parameters should be interpreted relative to this two-year period prior to policy implementation. If the lead variables are insignificant and close to zero, then this will provide some suggestive evidence that the parallel trend assumption holds.

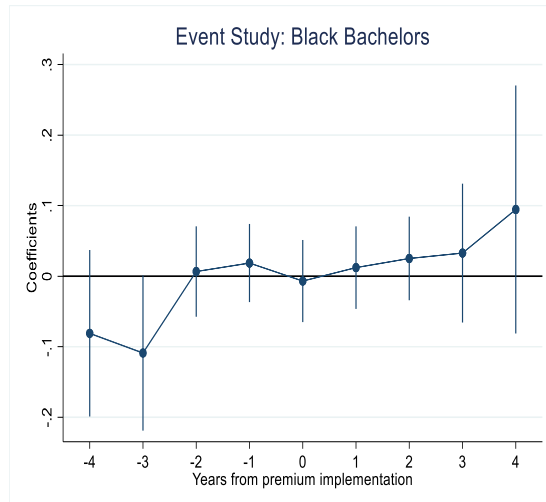
Figure 1.1, panels a to d plot event studies for the four outcome variables comparing institutions in premium states to non-premium states. The x axis shows the normalized time dimensions for all treatment states while the y axis shows the estimated treatment effects. The results suggest that the lead coefficients for all outcomes except for Black student outcomes are jointly indifferent from zero at the 5% level. Thus, the event study results suggest no substantial evidence of differential pre-trends and minimal impact after the policy was implemented which strengths the validity of my two-way fixed effects results.

Figure 1. 1: Event study analysis

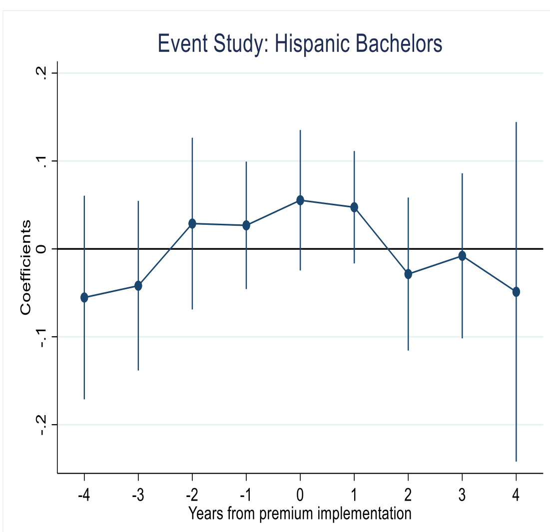
Panel A



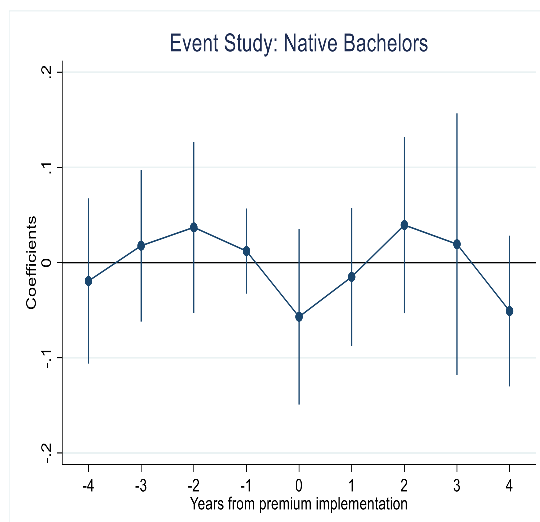
Panel B



Panel C



Panel D



1.4.4 Covariate Test

To explore the extent to which my findings may be vulnerable to potential confounders, I conduct a test of covariate balance following Pei et al. (2019). To do this I place each of the control variables on the left-hand side of the regression instead of the outcome variable and regress the policy indicator on my controls. A zero coefficient on the 'treat' variable would then suggest that there is little correlation between the control variables and the premium policy. Overall, my findings in Table 1.4 indicate little evidence that institutional level demographic and financial variables as well as state-level economic and policy variables predict premium policy implementation. I then re-estimated my model sequentially adding each control variable to investigate the sensitivity of my estimates to confounders. Table 1.5 shows the relevant result which indicates that overall, the magnitude of the coefficient estimates for each model gets bigger as I add controls to the regression model though the 95% confidence intervals overlap.

Table 1. 4: State level correlates of premium policy

Institution demographic variables	
Logged full time enrollment	-0.020*
	(0.017)
Percentage enrolled part time	-0.00048
	(0.608)
Share of expenses covered by state appropriations	-0.004
	(0.041)
Logged operating expenses per FTE	-0.036
	(0.116)
Percentage of Black students	0.407
	(0.438)
Percentage of Native students	-0.059
	(0.251)
Percentage of Hispanic students	-1.299**
	(0.619)
Logged instruction expenses per FTE	0.012
	(0.020)
Logged academic expenses per FTE	-0.007
	(0.047)
Logged student expenses per FTE	-0.18
	(0.020)

Table 1. 4 continued

Logged institution expenses per FTE	-0.087
	(0.078)
Logged tuition	-0.040
	(0.033)
State economic and policy variables	
Unemployment rate	-0.004
	(0.004)
Poverty rate	0.015
	(0.013)
Tuition Cap/Freeze	-0.024
	(0.094)
F-test p-value	11.03
	(0.000)

*p<0.10, **p<0.05, ***p<0.01

The data is derived from a combination of sources such as IPEDS, UKCPR and referenced literature. Institution and year fixed effects are included in all specifications. All models are estimated with the "treat" variable, other institutional characteristics, institution fixed effects and year fixed effects. Standard errors are in parenthesis and are clustered at the state level.

Table 1. 5: Sequentially adding control variables

	Total	Black	Hispanic	Native
Models include fixed effects only	0.003	0.003	-0.029	-0.002
	(0.051)	(0.063)	(0.064)	(0.059)
Institution demographic variables				
Logged full time enrollment	0.044	0.031	0.003	0.003
	(0.045)	(0.062)	(0.065)	(0.057)
Percentage enrolled part time	0.044	0.031	0.003	0.002
	(0.045)	(0.062)	(0.065)	(0.057)
Share of expenses covered by state appropriations	0.044	0.031	0.003	0.003
	(0.045)	(0.060)	(0.065)	(0.056)
Logged operating expenses per FTE	0.044	0.031	0.003	0.003
	(0.044)	(0.60)	(0.065)	(0.056)
Percentage of Black students	0.045	0.030	0.003	0.003
	(0.044)	(0.060)	(0.065)	(0.056)
Percentage of Hispanic students	0.045	0.030	0.003	0.004
	(0.044)	(0.060)	(0.065)	(0.056)
Percentage of Native students	0.047	0.030	0.006	-0.012
	(0.043)	(0.059)	(0.063)	(0.049)
Logged instruction expenses per FTE	0.047	0.030	0.007	-0.012
	(0.044)	(0.059)	(0.063)	(0.049)
Logged academic expenses per FTE	0.047	0.030	0.006	-0.013
	(0.044)	(0.059)	(0.063)	(0.049)
Logged student expenses per FTE	0.047	0.032	0.008	-0.013
	(0.044)	(0.059)	(0.063)	(0.049)
Logged institution expenses per FTE	0.050	0.035	0.012	-0.013
	(0.046)	(0.059)	(0.062)	(0.050)
Logged tuition	0.051	0.034	0.012	-0.013
	(0.045)	(0.058)	(0.061)	(0.050)

Table 1. 5 continued

State economic and policy variables				
Unemployment rate	0.051	0.034	0.012	-0.013
	(0.045)	(0.058)	(0.061)	(0.050)
Poverty rate	0.051	0.034	0.012	-0.012
	(0.045)	(0.058)	(0.061)	(0.050)
Tuition Cap/Freeze	0.051	0.035	0.013	-0.013
	(0.045)	(0.058)	(0.061)	(0.049)
N	8,070	8,070	8,070	8,070

*p<0.10, **p<0.05, ***p<0.01
The data is derived from a combination of sources such as IPEDS, UKCPR and referenced literature. Institution and year fixed effects are included in all specifications. Standard errors are in parenthesis and are clustered at the state

1.5 First stage analysis

The mechanism through which I expect the premium policy to impact the completion numbers is through firstly influencing public institutions' recruitment practices and thus, possibly influencing institutions' enrollment levels. This hypothesis was tested by Kelchen (2017) and Gandara and Rutherford (2017) and their papers showed conflicting results. Specifically, Kelchen (2017) found that the policy had a positive impact on the enrollment of Black students while Gandara and Rutherford (2017) found it to have a negative impact. As such, I reran a modified version of equation (1) to test the hypothesis using my sample for my period of study.

I again estimate three specifications that increasingly provide better controls for omitted variables and the results showed in Table 1.6. For Column (1) I estimated the model including institution and year fixed effects only, then I added institutional level controls for Column (2) and lastly, I added state-level economic and state-level policy controls for Column (3). The results show the policy significantly impacting on total full-time enrollment only. Specifically, it shows that total full-time enrollment of public institutions located in premium states declined by 4.2% when compared to public institutions located in non-premium states. My results differ from both Kelchen (2017) and Gandara and Rutherford (2017) as it shows that when the enrollment numbers disaggregate by race the impact of the policy is not statistically significant. Thus, it is possible that institutions are enrolling less students of other races such as White or Asian students which may account for the minimal decline found in the overall enrollment levels.

Table 1. 6: Impact of the premium policy on full time enrollment at public institutions

	(1)	(2)	(3)
Total FTE (ln)	-0.078**	-0.042**	-0.042*
	(0.028)	(0.021)	(0.020)
Black(ln)	-0.60	-0.036	-0.034
	(0.100)	(0.101)	(0.100)
Hispanic(ln)	-0.110	-0.088	-0.084
	(0.099)	(0.099)	(0.097)
Native(ln)	-0.057	-0.031	-0.033
	(0.103)	(0.101)	(0.101)
Institution & year fixed effects	Yes	Yes	Yes
Institutional demographic controls	No	Yes	Yes
State economic & policy controls	No	No	Yes
N	8,070	8,070	8,070

*p<0.10, **p<0.05, ***p<0.01
The data is derived from a combination of sources such as IPEDS, UKCPR and referenced literature. The dependent variable is defined as the natural log of full-time enrollment of total, Black, Hispanic, and Native. Institution and year fixed effects are included in all specifications. Standard errors are in parenthesis and are clustered at the institutional level.

While the results imply that the policy is not inducing institutions to enroll more minority students, it is possible for the policy to influence institutions' retention practices. It can be further inferred that an increase in student retention is made possible by institutions now having more resources due to the additional funds provided by the premium policy. To test this assumption, I collected retention rate data from College Scorecard dataset and reran the modified equation using retention rates as the outcome of interest. The results in Table 1.7 shows the policy having a minimal negative impact (1.308) on overall retention rates, significant at 5% level.[11] This result is different from the expectation of more funding leading to institutions changing their recruitment practices and possibly retaining more students. This statistically significant impact on

[11] The model was also ran using drop-out data collected from the American Community Survey for individuals between the ages to 16 and 24 to assess any possible impact. The results in Table 9 shows no significant impact on this outcome.

overall retention rates needs further investigation to determine what subgroup of students' retention rates are declining. This is a point for future research as public data for retention rates disaggregated by race is not available currently.

Table 1. 7: Impact of the premium policy on retention rates and drop-out numbers.

	(1)	(2)	(3)
Retention rates	-1.678*	-1.291*	-1.308*
	(0.791)	(0.0743	(0.728)
Drop-out(ln)	-0.016	-0.013	-0.012
	(0.015)	(0.014)	(0.014)
Institution & year fixed effects	Yes	Yes	Yes
Institutional demographic controls	No	Yes	Yes
State economic & policy controls	No	No	Yes
N	8,070	8,070	8,070

*p<0.10, **p<0.05, ***p<0.01
The data is derived from a combination of sources such as IPEDS, UKCPR and referenced literature. The dependent variable is defined as the natural log of full-time enrollment of total, Black, Hispanic, and Native. Institution and year fixed effects are included in all specifications. Standard errors are in parenthesis and are clustered at the institutional level.

1.6 Heterogeneity in premium policy effect by institutions' selectivity

Recent research has noted that state funding of public institutions is influenced by several different factors such as, political factors; state higher education governance structures and individual actors like governors, legislators, and state higher education executive officers (Tandberg and Landerman, 2018). It is to be expected that an institution's selectivity also plays some role in the amount of state funds they receive. This expectation is based on the probability that graduates from more selective institutions are more likely to be in the positions of governors and legislators as opposed to graduates from less selective institutions. Thus, there is a possibility that more selective institutions receive more funds under the premium policy than that of less selective institutions through their closer connections to policymakers. On the other hand, data shows that minority students attend less selective institutions in greater numbers and as such more funds under the premium policy may be directed their way given that their student population will have larger percentages of minority students.

To test which of these assumptions are possibly true, I utilized Baron's Profile of American Colleges (2017) where schools are ranked based on their competitiveness in terms of student applications. Public institutions that made the list formed my 'most' selective sample while those that did not make the list formed my 'less' selective sample. I then reran equation (1) on each of the samples separately to assess any heterogeneity in the impact of the premium policy. The results in Table 1.8 shows that the only difference on the impact of the policy based on institutions' selectivity is on the completion numbers of Hispanic students. It shows that there is a significant negative impact of the policy (12.7%) on the completion numbers of Hispanic students attending 'most' selective public institutions but an insignificant impact on those attending 'less' selective institutions. This result strengthens my conclusion that the completion numbers of Hispanic students appear to be more responsive to the premium policy than that of Black and Native students.

Table 1.8: Heterogeneity by selectivity: Impact of the premium policy on undergraduate completion

	"Most" Selective	"Less" selective
Total Bachelors (ln)	-0.007	0.067
	(0.036)	(0.053)
Black(ln)	-0.028	0.054
	(0.061)	(0.066)
Hispanic(ln)	-0.127*	0.047
	(0.073)	(0.067)
Native(ln)	-0.057	0.002
	(0.103)	(0.044)
N	1,470	6,600

*p<0.10, **p<0.05, ***p<0.01
The data is derived from a combination of sources such as IPEDS, UKCPR and referenced literature. The dependent variable is defined as the natural log of bachelor's degrees awarded for Black, Hispanic and Native undergraduate students. Institution and year fixed effects are included in all specifications. Standard errors are in parenthesis and are clustered at the institutional level.

1.7 Bacon Decomposition

Given the premium policy impact on enrollment findings then it can be stated that the main results of the policy on completion numbers is not being driven by an increase in enrollment of minority students to public institutions. However, it is still important to determine what are the sources of variation driving the results of the estimation. To determine this, I ran a bacon decomposition on my estimation.

By running the bacon-decomposition, I can calculate the components of the DDs and their weights as well as compare the specifications. Knowing the components and the weights of the DDs will then allow me to know how much of the variation in the model is due to the timing of the policy implementation and how much of it is due to the comparisons with untreated observations. Specifically, the bacon-decomposition provides information on which 2*2 DDs coefficients matter the most meaning which ones get the most weights. It also shows which comparisons matter most and how much weight are on each timing group as well as providing information on how the average DDs vary across comparisons.

The decomposition presented in Table 1.9 and in Figure A1.1 in the Appendix shows that the most weight from the estimated DD coefficient comes from the ('Never_v_timing group') which is the two-by-two DD estimate that compares institutions in states where the premium is implemented to those that were never treated. Comparing institutions in states where the premium was implemented earlier to later implementation ('Timing_groups') shows a weight of about 5%. The within variation has a weight of less than 5% which implies that my results are not driven by whether controls are included or not.

Table 1. 9: Bacon Decomposition

Outcome	Weight	Total (1)	Black (2)	Hispanic (3)	Native (4)
Timing_groups	0.104	0.039	0.011	0.087	0.000
Always_vs_timing	0.055	-0.035	0.045	-0.117	0.019
Never_vs_timing	0.793	0.004	0.007	-0.031	-0.002
Always_vs_never	0.000	0.583	0.767	-1.370	-0.280
Within	0.046	1.010	0.647	0.792	-0.349
Premium policy		0.051	0.035	0.013	-0.013
		(0.045)	(0.058)	(0.061)	(0.049)

*p<0.10, **p<0.05, ***p<0.01
The data is derived from a combination of sources such as IPEDS, UKCPR and referenced literature. The dependent variable is defined as the natural log of bachelor's degrees awarded for Black, Hispanic and Native undergraduate students. Institution and year fixed effects are included in all specifications. Standard errors are in parenthesis and are clustered at the institutional level.

1.8 Robustness checks

To ensure that my findings are robust and are not being driven by any particular specification, I perform several robustness checks. Firstly, due to the nature of the policy being assessed I followed the lead of Maclean et al. (2017) by assessing if controlling for the general PBF policy will impact on the robustness of my results. To do this I reran equation (1) using alternative specifications and the results are presented in Table 1.10. Column (1) shows the preferred estimates, for column (2) the 'treat' variable is now an indicator variable for states that have the general PBF policy but do not include the additional premium for at-risk students. Running this estimation allows me to determine if the impact of the premium policy was possibly being muted by the general PBF policy given that the premium policy is a percentage of total funds allocated from the general PBF policy. The results indicate no significant impact of the general PBF policy on all outcomes falling in line with prior research (Hillman et al. 2014). For column (3) I included the general PBF policy indicator variable as a control variable to account for any possible bias arising due to some states being partially treated. The results show no appreciable difference in the estimated coefficients in this column compared to my preferred estimation.

In column (4) the 'treat' variable is equal to 0 for states with no PBF policies, 1 for states with the general PBF policy and 2 for states with the premium policy included in PBF. Then for column (5) an indicator variable for the general PBF policy is also included but it turns off when states implement the premium policy. These specifications were done to account for the partially treated states and like column (3), the results do not contradict the preferred estimation. Finally, I compared institutions in premium states to those in PBF non-premium states only. This allows for me to assess any possible difference in the policy impact when comparing to states that have some PBF policy. The results show no significant impact of the policy for all outcomes.

Table 1. 10: Alternative model specifications

	(1) Preferred	(2) PBF only	(3) Premium & PBF	(4) Level's indicator	(5) Indicators on/off	(6) Pre v Npre
Total Bachelors	0.051	0.012	0.052	0.121	-0.055	0.055
(ln)	(0.045)	(0.034)	(0.044)	(0.074)	(0.071)	(0.044)
Black (ln)	0.035	0.001	0.038	0.040	0.033	0.032
	(0.058)	(0.173)	(0.058)	(0.049)	(0.093)	(0.059)
Hispanic (ln)	0.013	0.038	0.016	0.050	0.061	0.012
	(0.061)	(0.075)	(0.060)	(0.061)	(0.081)	(0.056)
Native (ln)	-0.013	0.111	-0.010	0.066	0.038	0.010
	(0.049)	(0.091)	(0.049)	(0.050)	(0.083)	(0.054)
N	8,070	8,070	8,070	8,070	8,070	6,270

*p<0.10, **p<0.05, ***p<0.01

The data is derived from a combination of sources such as IPEDS, UKCPR and referenced literature. The dependent variable is defined as the natural log of bachelor's degrees awarded of total Black, Hispanic, and Native students. Institution and year fixed effects are included in all specifications. Standard errors are in parenthesis and are clustered at the institutional level.

I then restricted my sample to two different regional groups and reran my original estimation to assess if the findings will change. The first regional group is the Mid-western higher educational compact which is made up of 1,965 observations in total with 1,290 grouped into the premium states, 330 in non-premium PBF states and 345 in non-PBF states.[12] The second regional group is the Southern regional educational board which includes 3,150 of total observations where 1.065 are in the premium states, 1,200 are in the PBF non-premium states and 885 are in non-PBF states.[13] Overall, the findings were similar to the main results (Table 1.11) indicating no significant impact of the policy on all outcomes Thus, when the sample is composed of border states that have similar economic and social characteristics as oppose to a sample of all states, the results validates my main findings.

Table 1. 11: Policy impact focus on border states

	SREB	MWHEC
Total Bachelors (ln)	0.102	0.014
	(0.100)	(0.041)
Black(ln)	0.035	-0.027
	(0.090)	(0.085)
Hispanic(ln)	0.078	-0.074
	(0.115)	(0.098)
Native(ln)	-0.025	-0.065
	(0.076)	(0.038)
N	3,150	1,965

*p<0.10, **p<0.05, ***p<0.01
The data is derived from a combination of sources such as IPEDS, UKCPR and referenced literature. The dependent variable is defined as the natural log of bachelor's degrees of Total, Black, Hispanic, and Native students. The sample is made up of borders states, Mid-Western higher education Compact and Southern regional education board. Institution and year fixed effects are included in all specifications. Standard errors are in parenthesis and are clustered at the institutional level.

[12] Midwestern higher education compact is made up of 12 states which include Ohio, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, and Wisconsin.
[13]The Southern Regional Education Board is made up of states which include, Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia.

For the next test I used graduation rates as the outcome of interest to determine if the impact of the policy will differ from the impact on completion numbers. I chose to analyze graduation rates as a robustness check rather than a main outcome because previous PBF studies noted that graduation rates exclude a portion of the student population that is included in total completion numbers. This includes part-time students, transfer students and students who dropped out of school and then return after a few years (Sanford and Hunter, 2011). The results for the impact on total graduation rates in Table 1.12 shows an insignificant impact of the policy for both comparison groups. It also shows the results for graduation rates outcome disaggregated by race and overall, the impact of the policy is insignificant.

Table 1. 12: Impact of the premium policy on graduation rates

	Coefficients
Graduation rates	12.31
	(32.86)
Black	0.082
	(4.56)
Hispanic	-0.451
	(13.98)
Native	0.002
	(0.244)
N	7,581

*p<0.10, **p<0.05, ***p<0.01
The data is derived from a combination of sources such as IPEDS, UKCPR and referenced literature. The dependent variable is defined as the graduation rates of Total, Black, Hispanic, and Native students. Institution and year fixed effects are included in all specifications. Standard errors are in parenthesis and are clustered at the institutional level.

I then reran the model using the completion numbers of White and Asian students as my outcome of interest. Most of the states specify in their higher education budgets that this premium funding policy is designated for the completion of either minority students, low-income students, or adult students with a few including STEM students. Data shows low-income students and adult students are made up of mostly minority students thus it is expected that this policy should have no impact on White and Asian students. The results in Table 1.13 falls in line with this expectation showing no significant impact of the premium policy on the completion numbers of White and Asian students.

Table 1. 13: Impact of the premium policy on White and Asian students

	Coefficients
White (ln)	0.055
	(0.040)
Asian (ln)	0.008
	(0.039)
N	8,070

*p<0.10, **p<0.05, ***p<0.01
The data is derived from a combination of sources such as IPEDS, UKCPR and referenced literature. The dependent variable is defined as logged bachelor's degrees awarded to White and Asian students. Institution and year fixed effects are included in all specifications. Standard errors are in parenthesis and are clustered at the institutional level.

Lastly, I check the robustness of my results by providing estimates based on a set of alternative weighting schemes, Poisson model and inverse hyperbolic sine function (Table 1.14). Column (1) shows the estimates from the primary analysis. In column (2) I reran the model using an unbalanced panel and obtained larger coefficients, but the impact remained insignificant for all outcomes. For column (3) I ran an inverse hyperbolic sine function to account for the number of zeroes in the logged outcome variables. The results for this estimation were similar to the preferred estimation. In column (4) I accommodate the count nature of the completion data by using Poisson regression. In this specification, I control for exposure using full time enrollment and the results produce smaller estimates. For column (5) I ran a weighted regression using full time enrollment numbers as weight and I got similar results to the preferred estimation.

Table 1. 14: Impact of the policy using alternative specifications

	(1) Preferred	(2) Unbalanced	(3) Arcsinh	(4) Poisson	(5) Weighted
Total Bachelors(ln)	0.051	0.139	0.056	0.014	0.049
	(0.045)	(0.194)	(0.047)	(0.016)	(0.049)
Black (ln)	0.035	0.118	0.048	0.016	0.038
	(0.058)	(0.125)	(0.060)	(0.027)	(0.054)
Hispanic (ln)	0.013	0.094	0.038	0.020	0.034
	(0.061)	(0.103)	(0.060)	(0.049)	(0.053)
Native (ln)	-0.013	-0.007	-0.006	-0.007	-0.019
	(0.049)	(0.049)	(0.056)	(0.061)	(0.066)
N	8,070	8,070	8,070	8,070	8,070

*p<0.10, **p<0.05, ***p<0.01
The data is derived from a combination of sources such as IPEDS, UKCPR and referenced literature. The dependent variable is defined as logged bachelor's degrees awarded to White and Asian students. Institution and year fixed effects are included in all specifications. Standard errors are in parenthesis and are clustered at the institutional level.

1.9 Discussion and Conclusion

Studying policy effectiveness and potential unintended negative consequences is challenging because states have adopted policies in heterogeneous ways and education systems differ in non-trivial ways across states (e.g., states with fewer resources tend to have less generous policies). For instance, in some states the policy applies only to two-year institutions (Virginia and North Carolina) while for others the policy applies only to four-year institutions (Maine and Oregon), and then another group of states where the policy applies to both types of institutions (Ohio and Tennessee). There is immense variation across states in the amount of funding set aside for PBF policies, the student outcomes used as a measure of success, and additional incentives.

There are a few limitations to my study that needs to be taken into consideration. Firstly, I am unable to assess the impact of the policy on other categories of students that are covered by the premium funding umbrella due to a lack of data.[14] Secondly, some states have conflicting measures that may influence the impact of the policy. For instance, Ohio and Tennessee have a dual enrollment policy that may cause an upward bias to my estimation. However, I believe that these effects will be negligible as the dual enrollment program targets a narrow set of high-school seniors and participation is relatively low (Hillman et al., 2017). Lastly, for some states Native students may attend public institutions at no cost or at a discounted price. I choose to still assess the impact of the policy on Native students because (1) less than 50% of states in my sample have these policies, (2) the requirements to qualify for the policies tend to be very stringent and (3) some states discount only room and board and not tuition. Table A1.2 in the Appendix provides more details on these tuition waiver policies across the different states.

[14] A number of states include premium funding for graduating more students who are either adult students, first-generation students, and or students in development education.

The goal of this study was to determine whether premiums for underserved students were effective in increasing the completion numbers of minority students. Based on the theories related to principal-agent relationships and inducements, it is expected that funding incentives towards graduating more minority students would influence institutions' practices and then lead to an increase in minority students completing their degrees. As noted before the mechanism through which the impact occurs is by institutions changing their recruitment and retention practices. Thus, for my first stage analysis I assessed the impact of the policy on enrollment levels of all students and minority students specifically. My results showed statistically significant negative impact of 4.2% on enrollment levels of all students but no significant impact on Black, Hispanic and Native students enrollment levels. The minimal decline in the enrollment of all students may be driven by institutions enrolling less students of other races like White students who on average tends to make up the largest percentage student body at public institutions. It is also possible that while institutions are not enrolling more minority students hence the insignificant impact of the policy, they are reducing the number of minority students dropping out of schools.

My main results show that the immediate impact of the policy does not fall in line with the expectation of the premium funding increasing completion numbers of minority students. The policy was found to be ineffective in impacting on the completion numbers of all students as well as Black, Hispanic, and Native students in the short run. In the long run, some significant impacts began to emerge but only on the completion numbers of Hispanic students. These significant impacts also went against expectation as the results showed, three years after implementation the completion numbers of Hispanic students declined by 11.9% and then it declined to 13.9% after four years. Significant negative effects also emerged when analyzing the impact of the policy on 'most' selective institutions. Again, the completion numbers of Hispanic students were the only one significantly impacted declining by 12.7%. A possible reason for this could be that public institutions' retention practices are either not being influenced by the premium policy or being negatively impacted. Future research should explore the impact of the premium on retention rates disaggregated by race to ascertain whether retaining less students is the foundation upon which the decrease in completion numbers for Hispanic students are being built. This research will also provide more insight into why the completion numbers for Black and Native students are largely unaffected by the policy.

Policy makers and institutions should also consider when designing their premium policies that there is an array of factors that contributes to a student graduating. One of the factors in which institutions have some control, is in creating a conducive academic environment especially for minority students who may enter these institutions with structural disadvantages. As such institutions can use the additional funds provided by the premium policy to create and foster a good academic environment for their minority students which may lead to an increase in the completion numbers of these students. It is also important for policy makers to consider the existing financial base of institutions when assigning funds to avoid widen the unequal access to financial resources between more selective institutions and less selective institutions. This is important as data shows minority students attend less selective institutions in greater numbers and so providing these schools with more funds may improve the effectiveness of the policy.

Lastly, based on the few states that breaks down the performance-based funding policy in their higher education budget on an institutional level, a small number of states assign more than 5% of the general PBF funding toward the premium policy. This may ultimately be the reason why the policy appears to be ineffective in the short run. If policy makers want to influence institution recruitment and retention practices when it comes to minority students, then they will need to provide a larger incentive. Thus, policymakers should increase the dosage of funding towards the premium policy so that public institutions' leaders will be moved to focus on graduating more minority students from their institutions.

CHAPTER 2

THE IMPACT OF HIGHER EDUCATION STATE FUNDING CUTS ON GRADUATION NUMBERS DISAGGREGATED BY RACE

2.1 Introduction

State funding plays a vital role in financing public higher education. Zhao (2018) notes that state appropriations are the largest funding source for public colleges and universities. However, state investment in public higher education has significantly declined in the past recent years. Even before the 2020 pandemic and its ramifications on states' economies, many states funding for higher education is less than their pre-recession levels (Mitchell, Leachman, and Masterson, 2016; State Higher Education Executive Officers Association, 2017). Specifically, state funding for higher education is 9% below pre–Great Recession levels and 18% below the pre 2001 technology bust period (Whitford, 2020). This study adds to the literature by examining the impact of state funding cuts on students' graduation numbers across ethnic lines.

There are many reasons why state funding for higher education has declined in the past recent years such as education funding being crowd out by growing Medicaid spending (Kane, Orszag, and Apostolov, 2005) as well as the channeling of more resources towards unfunded public pension liabilities (Novy-Marx and Rauh, 2014). The Centre on Budget and Public Priorities (2019) data shows that 44 out of 49 states spent less on education in 2017 in comparison to 2008. Table A2.1 in the Appendix shows the change in spending per student from 2008 (pre-recession) to 2018 where some states like Alabama, Illinois, and Pennsylvania experience a decline in spending of 30% or higher.

Webber (2017) notes that there are two ways in which public institutions can deal with the decline in state funding; (1) increase tuition prices or (2) cut spending. Deming and

Walters (2017) in their paper find that cutting spending tends to hurt the educational progress of students more than increasing tuition and fees. Reduction in institutional spending impact on student outcomes in several ways. Firstly, less spending on instruction can result in fewer offered classes, some of which students must take to graduate (Korn and McWhirter, 2017; Lannan, 2017a). Secondly, less spending may lead to lower quality and quantity of teaching faculty and staff (Lannan, 2017a). Webber and Ehrenberg (2010) show that student services and academic support are important determinants of student degree completion. Student services are particularly important for students attending institutions with lower entrance test scores and higher Pell Grant expenditures per student (Zhao 2018).

According to the Organization for Economic Co-operation and Development (2014), the United States has one of the highest college dropout rates in the industrial world. Data from the National Centre for Education Statistics shows that the graduation rates within 4 years of students starting public university is about 35% for the 2010 cohort, the rate within 5 years is about 54% and the rate within 6 years is about 60% for the same cohort.[15] These are worrying statistics given that the goal of higher education is for students to obtain their degrees in an efficient manner and then use their acquired knowledge in the labor market. The graduation rates of minority students are even lower than the general average with 40% for Black students, 54% for Hispanic students and 34% for Native students.[16] This large percentage of non-completion presents potential significant costs for both student and taxpayers.

While previous studies assess the impact of state funding cuts on educational outcomes such as total enrollment and total completion numbers, there is a lack of evidence on the heterogeneity of the impact across racial lines and ethnicity. This paper utilizes an instrumental

[15] The conventional way to measure graduation rates is to examine how many students complete a degree within 150 percent of the expected completion time or within six years for a bachelor's degree and three years for an associate degree.
[16] U.S. Department of Education, Integrated Post-secondary Education Data System (IPEDS), Winter 2016

variable-fixed effects strategy to address potential bias in estimating the impact of institutional level appropriation cuts on the graduation numbers of Black, Hispanic, Native, Asian, and White students. The goal is to assess if state funding cuts may impact groups of students differently. My paper also assesses if the impact may differ across ethnicities for students graduating with a bachelor's degree from 4-year public universities compared to those graduating with an associate degree from 2-year public colleges.

The results of my paper indicate statistically insignificant impact on the graduation numbers of all students across racial and ethnic lines. These results of overall insignificant impacts on graduation numbers are possibly driven by state funding cuts also having no impact on enrollment numbers across each student subgroup. When I truncate the sample, the results find no impact on the graduation numbers of students across racial lines for both 4-year institutions only and 2-year institutions only. I also find that the insignificant impact remains consistent even when analyzing state funding cuts in a given year to graduation numbers at least three years into the future for each subgroup of students.

The rest of the paper proceeds as follows. Section 2.2 assesses the literature on state appropriations and higher education completion rates. Section 2.3 describes the data. Section 2.4 explains the identification strategy and assesses the validity of the methodology. Section 2.5 provides my main results and discusses some policy implications of those results. Section 2.6 concludes the paper.

2.2 Literature Review

Prior research on the impact of state funding cuts on public institutions' expenditures find mixed evidence particularly regarding the impact on instructional and research expenditures (Zhao, 2018). Lowry (2001b) find that public institutions' academic support and student services expenditures fall after states scale back appropriations for higher education and Goodman and Henriques (2015) find that cuts in state appropriations result in an increase percentage of part-time faculty and a lower ratio of full-time faculty to students. In terms of instructional spending, Lowry (2001b) finds a positive relationship with state appropriations but Goodman and Henriques (2015) find no significant effects.

Research also highlights the importance of students accessing specific school resources such as peer advising and financial aid in helping students persist towards completing their degree and graduating. For instance, Barrow et al., (2013) find that performance-based incentive programs tend to increase students' enrollment persistence and performance at community colleges. Bettinger (2011) in his paper run a randomized experiment testing the effectiveness of individualized student coaching and find that treated students are more likely to attend university one year after coaching. The results of these studies highlight that importance of school resources towards students persisting at their education particularly at the college and university level.

According to Bound et al., (2019), cuts in state funding leads to shifts in public universities using tuition prices as their main source of revenues. While selective research universities can moderate cuts in their expenditures by enrolling more out-of-state and international students who can afford to pay full fare and increased tuition prices. For less selective universities these cuts lead to diminished expenditures and increase in-state tuitions. The paper goes on to note that state funding cuts has a negative impact on degree attainment at both the undergraduate and graduate levels. While Perna and Titus (2004) find that cuts led to a higher likelihood of high-school graduates attending out of state schools but not affect the likelihood of attending in-state schools, Toutkoushian and Hillman (2012) find the opposite. In addition, Goodman and Henriques (2015) find that lower state appropriations result in an enrollment shift from public higher education institutions to private for-profit institutions.

Researchers also assess different policies and programs implemented to increase completion at public universities and colleges. Performance-based funding models are an increasingly popular policy that many states use to boost the completion numbers of both public universities and community colleges. These policies are an attempt to improve the efficiency of state funding however, many researchers note that the fluctuation in the funding set aside for the models handicap their effectiveness particularly in increasing completion numbers. Both individual state studies (Hillman et al., 2014; Sandford and Hunter, 2011) and multi-state studies Cheol and Milton, 2009; Tandberg et al., 2014) show that PBF models are either weakly impactful or ineffective in increasing completion numbers.

Deming and Walters (2017) are the first to analyze how price caps and spending cuts influence educational attainment like enrollment and degree attainment. In their paper they find that a 10% increase in spending lead to a 3% increase in current enrollment while the impact on price caps is statistically insignificant. They demonstrate a causal link between institutional spending and degree attainment, building on research by Bound and Turner (2007). They find that in year (t) a 10% increase in total spending leads to a 2% increase in total awards. For year (t+1) the increase is 7.8%, for (t+2) it is 9.4% and for (t+3) it is 6.4% with all the impacts being statistically significant at the 5% level. In conclusion, they note that government programs to reduce college cost through reducing per-student spending will not lead to an increase in degree attainment. In fact, spending cuts affect core instruction and academic support, and this may have downstream impacts on educational attainment levels.

My paper seeks to determine whether the cuts in institutional appropriations have a heterogenous impact on the student population. Some researchers point out that state funding cuts tend to have an uneven impact on public institutions. Where colleges and universities who serve a larger proportion of low-income and minority students are more severely impacted in comparison to flagship universities where a larger number of white students attend (Marcus, 2017). Reasons being that these flagship universities tend to have other sources of revenue to fall back on, such as endowments, research funding, and out-of-state and international students who can afford to pay a premium tuition price. Marcus (2017) notes that regional universities and community colleges are being asked to do more with less resources such as provide remedial education and workforce training to students who typically come from lower performing public schools. This in turn may result in less students persisting towards their degrees particularly minority students who attend these schools in larger numbers. As such, I analyze how state funding cuts may impact on the graduation numbers of Black, Hispanic, Native, Asian, and White students for all public institutions, 4-year public institutions only and then 2-year public institutions.

2.3 Data

The empirical analysis for this study focuses on changes in graduation rates across ethnicities during the sample period of 1997 to 2018. My primary source of institutional level variables comes from the US Department of Education's Integrated Postsecondary Education System (IPEDS). IPEDS collects data from institutions that are required to report several statistics annually to the Department of Education's National Center for Education Statistics (NCES) to qualify for federally assisted programs. IPEDS also collects data at a campus level by using unique longitudinal identifier and this campus level data allows the finance and completion data to be separated for each branch of campuses of university systems. IPEDS define the graduation data as the number of first time, full time students completing their degrees within 150% of normal time.

My state legislative appropriations data comes from Grapevine, which is an annual survey made up of data on state support of higher education and is administered by the State Higher Education Executive Officers Association (SHEEO) as well as the Center for the Study of Education Policy at Illinois State University. Following in Deming and Walters (2017) lead, I account for states that implement either tuition cap of tuition freeze policy to control for states imposing restrictions on the degree to which schools can increase tuition. As such, I reference Deming and Walters (2017) as well as Armstrong et al., (2017) to determine which states had these policies in place and which public institutions were exempted from these policies. I restrict the sample data set to public four-year universities and two-year colleges located with 50 U.S. mainland states.[17] I also exclude observations with missing values for the instrument variable and all the financial data is adjusted for inflation using the Higher Education Price Index.[18]

2.4 Methodology

There are several potential sources of endogeneity which may bias cross-sectional OLS or even fixed effects models when analyzing the relationship between state funding and graduation numbers. Research notes that state funding fluctuations affect public institutions differently based upon the institution's budget sensitivity (Webber, 2017). It also notes that funding fluctuations are partly driven by the fact that state funds are not randomly assigned due to state legislators having the authority to shift funds to schools in financial distress. As such, when analyzing state funding impacts, removing any variation due to the shifting of resources from one campus to another is important. Thus, I use total state appropriations per state level full time enrollment (FTE) as my instrument for institutional appropriations per FTE. This source of variation has been used to account for potential endogeneity bias in recent work on state funding

[17] The estimation excludes institutions located in American Samoa, Guam, Puerto Rico, Northern Marinas, Marshall Islands and Virgin Islands

[18] Higher Education Price Index (HEPI) is an inflation index designed specifically to track the main cost drivers in higher education developed by Commonfund Institute.

(Webber, 2017; Bound, Braga, Khanna, & Turner, 2016; Deming & Walters, 2017). The logic behind this instrument is that it isolates changes in an institution's appropriations which are due to across-the-board state cuts but removes any variation due to a shifting of resources from one campus to another.

2.4.1 Assessing the Validity of the Instrument

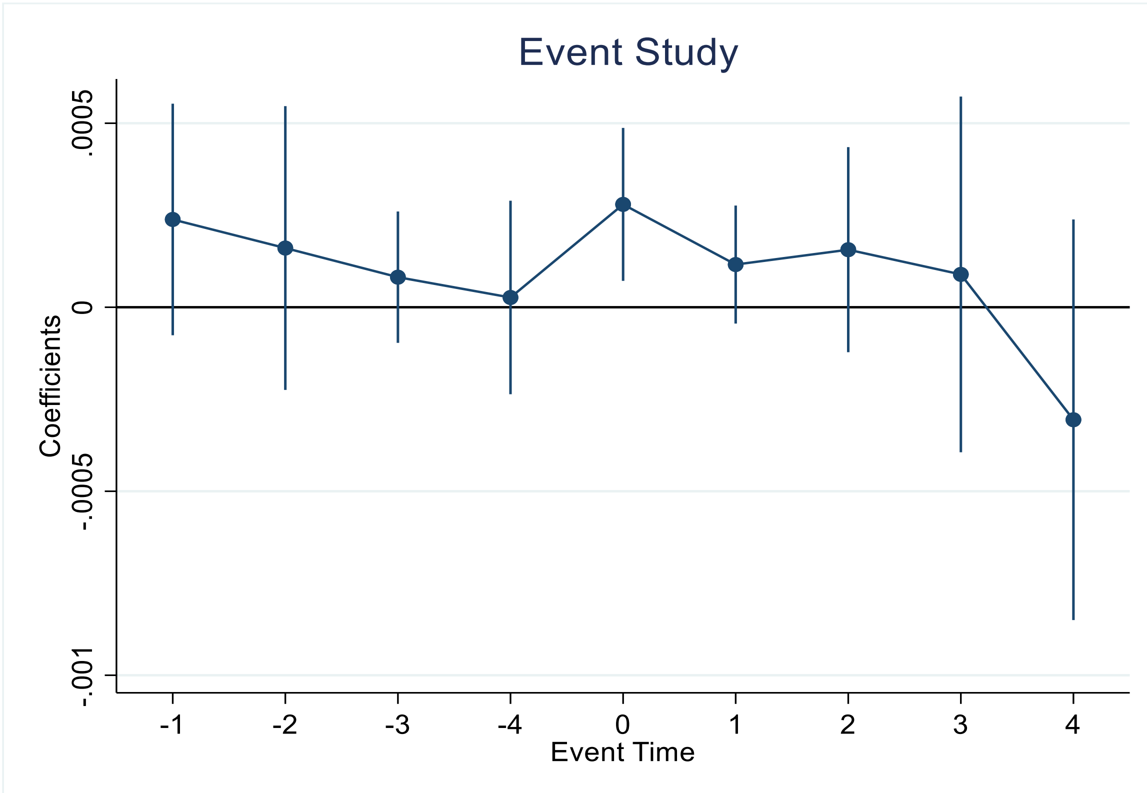
To test the validity of the instrument variable, I estimate the following reduced model.

$$ST_{i,t} = \mu_t + \zeta_i + W_{i,t}\theta + \rho Z_{s,t-1} + v_{i,t.} \quad (1)$$

where $W_{i,t}$ includes tuition cap and tuition max variables to account for tuition state policies that places either a cap or a maximum value on how public institutions may raise their tuition prices. The model also includes institution and year fixed effects. It is common practice to scale the dependent variable to make it more comparable across institutions or states and over time as such, $ST_{i,t}$ is institution (i) appropriation from state sources per full time enrollment (Zhao, 2018). I include four leads and five lags of the instrument variable to check whether there are differential prior trends in outcomes for institutions that may experience differential changes in the instruments. Lastly, I cluster the standard errors at the institutional level.

Figure 2.1 below presents the coefficients and 95 percent confidence intervals for the instrument variable. I find that a $1000 cut in state appropriations leads to an average increase of approximately 0.2% in appropriation per FTE for all public institutions. However, the results also show some evidence of pre-trends as all four pre-trend coefficients are not jointly equal to zero (p=0.003). This implies that my instrument is weak and as such has little explanatory power for the endogenous variable.

Figure 2. 1: Impact of Instrument on Institutional Appropriations



2.4.2 Two Stage Model

To examine the impact of state funding on graduation numbers across ethnicities, I estimate the following two-stage model,

$$ST_{i,t} = \varphi_i + \omega_t + X_{i,t}\lambda + \pi_1 Z_{s,t} + \eta_{i,t.} \qquad (2)$$

In this equation I instrument institution i's appropriation per full time enrollment with total appropriations per state level FTE. Fluctuations in state funding are not the only source of potential bias as endogeneity can also arise due to restrictions that many states impose on tuitions. If this is not addressed, then there will be a downward bias on the estimate as schools in those states are unable to adjust their tuition rates when state funding decreases. To control for state tuition laws, I include two variables created by Deming and Walters (2017).[19] I also control for year fixed effects and institution fixed effects. This equation relates changes in state institutional level

[19] Deming and Walters (2017) collected data on state laws governing tuition freezes and maximum allowable increases.

appropriation per FTE relative to changes in total state appropriations per state level FTE. The second stage then analyzes the impact of changes in institutional level appropriations per FTE on the graduation numbers per 100 FTE for the five subgroups of students.

$$Y_{i,t} = \Phi_i + \Omega t + X_{i,t}\Lambda + \beta_1(ST_{i,t}) + \varepsilon_{i,,t} \qquad (3)$$

where $Y_{i,t}$ is the graduation numbers for Black, Hispanic, Native, Asian, and White students per 100 FTE. The graduation numbers represent students that finish their degree within 150% of normal time. For 4-year institutions 150% of normal time means finishing a degree after 6-years and for 2-year institutions it means finishing after 3 years. The variable of interest ($ST_{i,t}$), is the predicted changes in state appropriation per FTE for each institution and the standard errors are clustered at the institutional level.

2.5 Results

2.5.1 Descriptive Statistics

Table 2.1 includes descriptive statistics for all the variables in my estimation model. I separate the variables into three groupings: all institutions, 4-year institutions and 2-year institutions. The data shows that the institutional level appropriations per FTE for 4-year schools are on average higher than that of 2-year schools which falls in line with expectations. In terms of the dependent variables there is no major difference in the graduation numbers per 100 FTE across institution type.

Table 2. 1: Descriptive Statistics

Variables	All	4-year	2-year
Dependent variables			
Asian_fte	0.657	1.05	1.04
	(1.44)	(0.957)	(2.16)
White_fte	4.87	5.59	9.81
	(13.27)	(5.72)	(21.42)
Black_fte	1.40	1.53	2.91
	(5.63)	(2.42)	(9.36)
Hispanic_fte	0.963	1.13	1.91
	(3.62)	(0.994)	(6.12)
Native_fte	0.574	0.844	0.986
	(1.06)	(0.419)	(1.65)
Independent Variables			
Log Population	10.36	12.36	12.23
	(4.76)	(1.26)	(1.32)
State unemployment rate	5.62	5.58	5.53
	(1.90)	(1.89)	(1.89)
State appropriation per state level FTE	308.92	310.96	311.53
	(133.52)	(138.92)	(138.98)
Institution appropriation per FTE	1,603.39	2078.38	1810.68
	(7252.22)	(5576.16)	(3352.16)
N	25,596	7,664	8,339

2.5.2 Main Results

Table 2.2 reports first-stage impacts of the state appropriations per FTE on institutional level appropriation per FTE along with second stage impacts on graduation numbers per 100 FTE or graduation productivity. The top rows show that the impact of the instrument on institutional level appropriation per FTE is 0.0002. This implies that a $1000 cut in state appropriations per FTE decreases institutional appropriations per student by about 0.2%. The second stage results show that cuts in appropriations have no statistically significant impact on graduation numbers for all students across racial and ethnic lines. Given that prior research finds that cuts in state funding have minimal impact on total graduation numbers, these results are not surprising (Zhao, 2018). On the other hand, the weakness of the instrument must be considered with these results. It is possible that there exists heterogeneity in the impact of state appropriation cuts across racial and ethnic lines, but the weakness of the instrument may not pick up the impact.

Table 2. 2: Fixed Effects IV Estimation Results 1997-2018

	Black	Hispanic	Native	Asian	White
First Stage					
π	0.0002**	0.0002**	0.0002**	0.0002**	0.0002**
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
F-statistic	4.381	4.381	4.381	4.381	4.381
Second stage					
β	0.0004	0.001	0.0001	0.0001	0.0003
	(0.0003)	(0.0005)	(0.0001)	(0.0001)	(0.0007)
N	25,596	25,596	25,596	25,596	25,596

*p<0.10, **p<0.05, ***p<0.01
The data is derived from a combination of sources such as IPEDS, SHEEO, ACS and referenced literature.

Given that I am assessing the more distal outcome of graduation numbers, I expect that cuts in spending will impact on institutions' enrollment practices first. Firstly, funding cuts may induce institutions to enroll more students while keeping tuition prices fixed to fill in the gap in funding. Secondly, institutions may enroll fewer students while increasing tuition prices or even enroll fewer students and raise tuition prices as another way to fill the state funding gap. Using full time enrollment numbers disaggregated across ethnicities as the dependent variable, Table 2.3 shows the results of the impact on cuts in state appropriations. The table highlights that cut in spending has no statistically significant impact on enrollment numbers when broken down into racial categories. Again, due to the weakness of the instrument it cannot be stated conclusively that state funding cuts have no impact on enrollment numbers. As prior research by Webber (2017) notes that cuts in state funding has an average pass-through rate of 25.65% on tuition prices and research shows that increasing tuition prices negatively impact on minority student's enrollment to university.

Table 2. 3: Impact on FTE

	Black	Hispanic	Native	Asian	White
β	0.024	0.053	0.001	0.017	0.035
	(0.015)	(0.037)	(0.002)	(0.011)	(0.038)
N	25,596	25,596	25,596	25,596	25,596

*p<0.10, **p<0.05, ***p<0.01
The data is derived from a combination of sources such as IPEDS, SHEEO, ACS and referenced literature.

To my knowledge, my paper is the first to assess whether cuts in institutional appropriations has a heterogenous impact on the student population base on ethnicity. Base on prior research the expectation is that state funding cuts would have a larger impact on the graduation numbers of minority students (Black, Hispanic, and Native) because they attend regional and community colleges in proportionately larger numbers than that of White students. To test whether my main estimation results remain the same when the sample is made up of only students graduating with only a bachelor's degree or with only a certificate, I divided my sample into 4-year institutions and 2-year institutions. Table 2.4 below highlights the second stage results for both types of institutions. For my sample of 4-year institutions only it shows no statistically significant impact on graduation numbers across all racial categories.

For my sample of 2-year institutions only the results show no statistically significant impact on the graduation numbers of every subgroup of students same as the sample for 4-year institutions only. These results go against my expectations, and this may be due to a few reasons such as the instrument being relatively weak, and that the graduation data tend to exclude subsectors of the student population such as part-time students and students who left school and returned after several years. Even with the weakness of my instrument, my results fall in line with prior research on general state funding policies impact on graduation numbers such as performance-based funding. Majority of the research on these policies find no impact on student completion outcomes both at the 4-year and 2-year institutional level (Hillman et al., 2014).

Table 2. 4: Estimation results for completers within 150% of normal time

	Black	Hispanic	Native	Asian	White
4-year					
β	0.0001	0.0005	0.00001	0.0001	-0.001
	(0.0006)	(0.0004)	(0.0001)	(0.0002)	(0.001)
N	7,664	7,664	7,664	7,664	7,664
2-year					
β	0.001	0.002	0.0003	0.0001	0.0004
	(0.0001)	(0.001)	(0.0002)	(0.0001)	(0.001)
N	8,339	8,339	8,339	8,339	8,339

*p<0.10, **p<0.05, ***p<0.01
The data is derived from a combination of sources such as IPEDS, SHEEO, ACS and referenced literature.

2.6 Robustness Checks

To ensure that my findings are robust, I perform several robustness checks. Firstly, I rerun the estimation using another instrument developed by Deming and Walters (2017). This instrument considers shocks to states' financial budgets. The budget shock instrument isolates change in institutional appropriations to changes in state funding. The instrument is constructed as,

$$Z_{i,t} = (Approp_{i,97} / Rev_{i,97}) * (StApprop_{s(i),t} / Pop_{s(i),t}) ,$$

where, $Approp_{i,97}$ and $Rev_{i,97}$ measure state appropriations and total revenue for institution i in 1997 and $StApprop_{s,t}$ and $Pop_{s,t}$ represent total appropriations and college age population for state (s) in year (t). The results in Table 2.5 below find that the instrument has no impact on the endogenous variable and as such no explanatory power on my outcome variables.

Table 2. 5: Results using budget shock instrument

	Black	Hispanic	Native	Asian	White
First Stage					
α	230.23*	230.23*	230.23*	230.23*	230.23*
	(119.77)	(119.77)	(119.77)	(119.77)	(119.77)
F-statistic	3.695	3.695	3.695	3.695	3.695
Second stage					
β	-3.90e-06	-8.34e-06	-3.72e-06	-0.00001	7.91e-06
	(4.72e-06)	(8.31e-06)	(4.66e-06)	(0.00001)	(0.00001)
N	128	128	128	128	128

*p<0.10, **p<0.05, ***p<0.01
The data is derived from a combination of sources such as IPEDS, SHEEO, ACS and referenced literature.

I then rerun my estimation using first-differences specifications in equations (1) and (2) to focus on the impacts of sharp yearly changes in the instrument on the endogenous variable and outcomes. The first difference model captures causal effect under less restrictive assumptions though it is less efficient than the levels model. My results in Table 2.6 find no statistically significant impact of spending cuts on all my outcomes. Similar to the main estimation results, the instrument in the difference model is weakly identified and as such has little explanatory power.

Table 2. 6: First Difference Results

	Black	Hispanic	Native	Asian	White
β	0.002	-0.0002	-0.0001	0.0001	0.0001
	(0.001)	(0.0004)	(0.0002)	(0.0002)	(0.002)
N	5,020	5,020	5,020	5,020	5,020

*p<0.10, **p<0.05, ***p<0.01
The data is derived from a combination of sources such as IPEDS, SHEEO, ACS and referenced literature.

For my next robustness check, I compare cuts in institutional appropriations in a given year to graduation numbers in years one, two, and three after the cuts are made. This gives the public institutions an opportunity to change their recruitment and retention practices in response to cuts in spending. Table 2.7 below shows no statistically significant impact on the graduation numbers of all racial categories for all three years. As such, it shows that even after cuts have been in place for a while, there is still no impact on graduation numbers.

Table 2. 7: Fixed Effects IV Estimation Results projected three years forward

	T+1	T+2	T+3
Black	0.001	-0.0003	0.008
	(0.004)	(0.007)	(0.028)
Hispanic	-0.005	-0.0005	0.002
	(0.007)	(0.004)	(0.009)
Native	-0.001	-0.0002	0.0006
	(0.001)	(0.001)	(0.002)
Asian	0.0007	-0.0002	-0.0004
	(0.001)	(0.002)	(0.002)
White	0.005	0.020	-0.05
	(0.009)	(0.066)	(0.17)
N	10,833	10,207	9,613

*p<0.10, **p<0.05, ***p<0.01
The data is derived from a combination of sources such as IPEDS, SHEEO, ACS and referenced literature.

Given the data in Table 1 in the Appendix highlighting the sharp differences in state funding for public higher institutions before and after the 2008 Great Recession, I truncate my sample into two groups, sample one for years 1997 to 2008 and sample two for years 2009 to 2018. The assumption that given that state funding cuts were relatively less in the pre-recession period then I expect to see smaller impacts on the graduation numbers during this period as opposed to the post-recession period. The results in table 2.8 follows the same pattern as the main estimation results with no statistically significant impact on the graduation numbers of all students across racial and ethnic lines. Again, these results must be taken in the context of the instrument being relatively weak.

Table 2. 8: Fixed Effects IV Estimation Results

	Black	Hispanic	Native	Asian	White
1997-2008					
β	0.007	-0.002	-0.003	0.001	-0.009
	(0.042)	(0.015)	(0.021)	(0.008)	(0.064)
N	14,393	14,393	14,393	14,393	14,393
2009-2018					
β	0.0001	0.0004	0.0002	0.00001	0.0001
	(0.0003)	(0.0002)	(0.0001)	(0.00004)	(0.0001)
N	11,213	11,213	11,213	11,213	11,213

*p<0.10, **p<0.05, ***p<0.01
The data is derived from a combination of sources such as IPEDS, SHEEO, ACS and referenced literature.

2.6 Conclusion

The impact of cuts in state funding in higher education on U.S. post-secondary attainment has been researched extensively in the education policy community. This paper seeks to make a small contribution to the community by assessing if there is any possible variation in the impact of state funding cuts across racial lines. Firstly, my results appear to show no impact of state funding cuts on students' graduation numbers across racial and ethnic lines. The results also show that the overall insignificant impact continue three years after cuts in funding are made across all racial lines. This pattern remains when the sample consist of only 4-year institutions as well as 2-year institutions. My results are also robust to different instrument specification and estimation model. Lastly, my results show that when the sample is divided into two periods, both pre- and post-recession sample show similar trend of there being no statistically significant impact on the graduation numbers of all students.

Previous research notes that state funding cuts leading to spending cuts may influence persistence and degree completion in both a formal and informal capacity. In regard to the formal capacity, Bound et al., (2012) find that open access institutions in California have turned students away because of overcrowding exacerbated by budget cuts. However, Deming and Walters (2017) note that this mechanism could not fully explain results where there is an increase in the persistence of already enrolled students. The informal capacity constraints of public institutions, which includes large class sizes, reduced course offerings and little to no student guidance is a better possible explanation for cuts in spending leading to a negative impact on student outcomes. However, my paper appears to show that state funding cuts have no impact on students' completion outcomes.

This finding falls in line with previous research by Hillman et al., (2014) as well as Tandberg et al., (2014). Despite the weak instrument, my results reinforce prior conclusions that state funding practices whether it be policies or cuts tend to have no impact on students' completion outcomes. However, more research is needed with stronger instruments to determine whether this conclusion is robust. More research must also be done using completion numbers instead of graduation numbers so that it can incorporate a larger sample of the student population to assess the impact of state funding cuts. Analyzing cuts in institutional appropriations on more targeted student samples is important as it allows policymakers to know which subgroup of students are being most negatively impacted by these funding cuts so that state policy decisions can be better tailored to reduce the negative impacts on already vulnerable student populations.

CHAPTER 3

A CAUSAL DETERMINATION OF INTELLECTUAL PROPERTY RIGHTS AND FOREIGN DIRECT INVESTMENT WITHIN THE MANUFACTURING INDUSTRY

3.1 Introduction

Development of a country's manufacturing sector is an important step in obtaining sustainable growth and development throughout history. It is the defining feature for the rapid development experienced by European countries and the United States in the 18th century as well as by Japan and East Asian Tiger countries in the 20th century and more recently China. For developing countries who are seeking sustainable growth and development, expansion of the manufacturing sector is an important step towards that goal. Braga, Fink & Sepulveda (2000) notes that for industrialized countries, intellectual property rights (IPRs) are a part of the institutional infrastructure that encourages investments into research and development as well as other inventive and creative industries. As such, for developing countries improving IPRs within their manufacturing sectors can be a possible avenue to boost growth and development by attracting more foreign direct investments (FDI). Thus, this paper investigates if there is a possible causal relationship between IPRs and FDI within countries' manufacturing sector.

According to Lall and Narula (2004), the essential role for FDI in economic development has not changed despite the advent of globalization; however, they note that the mechanism and dynamics of FDI-assisted development has. Researchers note that strengthening

IPRs protections is one avenue through countries can induce foreign direct investments. IPRs have been a major global issue since the conclusion of the Uruguay Round of trade agreements where there was an attempt to harmonize protections across countries. Despite all members of the World Trade Organization signing off on the Trade-Related Intellectual Property Rights (TRIPS) agreement in 1995, there are still disputes about the benefits of IPR protections particularly for developing countries.

Advocates of IPRs argue that strengthening protections is beneficial for developed countries who own most of the intellectual property as well as for developing countries in terms of increased FDI inflows, the transfer of technology and increased research and development. According to Adams (2010), an effective IPR regime not only affect knowledge creation and dissemination but more importantly, it may affect the business location decision of firms. Some researchers like Kalande (2002) notes that most multinational companies are more willing to invest in extractive industries or non-manufacturing industries if the country has inadequate IPR protections as opposed to manufacturing industries where IPRs play a more significant role.

Spatz and Nunnenkamp's (SN) 2003 paper is the first to analyze the relationship between IPR and FDI using data disaggregated on a regional and sectoral level, this paper follows their lead. For their paper SN find a positive correlation between IPR and FDI. In this paper I extend their analysis by firstly testing for the stability of their results and then testing for a causal relationship between IPRs and FDI. To do this I create a panel dataset for the period 2003 to 2015 and formulate quantile dummy variables from the IPR index to use as my variables of interest. My goal is to assess if improving IPRs overtime may cause an increase in FDI inflows.[20] To my knowledge, this is the first paper to attempt to find a causal link between IPR protections and FDI using disaggregated data within the manufacturing industry. My results show that IPRs are a

[20] While SN analyzed two different measures for IPR protections, which are the Ginarte-Park (2010) index and the World Economic Forum (WEF) index, only the WEF index is included in this paper.

positive determinant of FDI within the manufacturing industry. Furthermore, I find that as countries improve their IPR protections, the positive impact on FDI increases at a decreasing rate. This result lends credence to the belief that the returns to improving IPR diminishes as a country becomes more economically developed.

The rest of the paper is as follows: Section 2 highlights some important facts about IPR and the TRIPS agreement. Section 3 reviews both theoretical and empirical literature on the relationship between IPR and FDI. Section 4 presents the data and methodological approach that is used for the analysis. Section 5 presents and discusses the results of the study. Section 6 summarizes the paper and provides concluding remarks.

3.2 Literature Review

3.2.1 Intellectual Property Rights: Background

According to Fink (2004), intellectual property rights (IPR) are various instruments that individuals, companies, and countries use to protect creations developed from intellectual activities. These activities may be industrial, scientific, literary, or artistic. The instruments that are used in IPR differ depending on what they are supposed to be protecting, the scope of the protection and how the protection will be utilize. Table A3.1 in the Appendix gives an overview of the different types of IPR and their different applications.

Fink (2004) notes that the administration of IPR is most commonly in the areas of patents, industrial designs, trademarks, and plant breeders' rights. Patents are defined as legal titles granting the owner the exclusive rights to make commercial use of an invention and manufacturing firms use them to protect their inventions. An industrial design according to the World Property Rights Organization (WIPO) is made up of the ornamental or aesthetic aspect of an article and they apply to a wide range of products such as packages, containers, jewelry, textiles, and electronic devices.[21] Trademarks are words, signs or symbols that identify a certain product or company. Trademarks provide the consumers with the assurance that they are buying the good that they intend to, as such almost all companies use trademarks to identify their goods and services. Plant breeder's rights (PBR) are used to protect new plant varieties that are distinct from existing varieties as well as being uniform and stable (Fink, 2004). By obtaining exclusive rights, the owner can exclusively sell and distribute the material for a minimum of 15 years.

Fink (2004) then explains why IPRs are important enough for national governments to extend legal protection by classifying them into two broad categories. The first category involves IPRs that stimulate creative activities such as patent utility models, industrial designs copyright and plant breeder's rights. He points out that these type of IPRs tend to resolve market inefficiency for information and knowledge. This is especially the case for public goods where IPRs like patents and copyrights can prevent free riding by third parties on intellectual assets and thus create an incentive for research and development. These types of IPRs are still considered "second best" instruments of economic policy as they tend to transfer market power to the protected holder of the rights at a cost to society as firms can now charge prices above marginal production costs. The second category are those IPRs that offer information to consumers such as trademarks and geographical indications.

IPRs like patents and copyrights also tend to have both a positive and negative impact on the diffusion of new knowledge and information both nationally and internationally. Focusing on the international impact there are arguments on both sides about the strengthening of a country's IPR protections. Fink (2001) using the example of India for his argument for the benefits of weak IPRs notes that after the country abolish patent protection for pharmaceutical products in the 1970s, they experienced growth in their domestic pharmaceutical industry. He

[21] WIPO is the world's number one source for global intellectual property (patents, industrial designs, copyright, trademarks etc.) information, resources, and services. It was established in 1967 under the WIPO convention.

notes that weak IPR might allow countries to imitate foreign technologies and thus build up their technological capacity, like with India. However, most countries may not have the capability to imitate technology without the participation of the original firm so in most cases it may be best to have strong IPR protections, which then provides an incentive for foreign technology holders to transfer their technology.

3.2.2 TRIPS Agreement

The Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) is one of the three pillar agreements agreed upon during the Uruguay Round on Trade Negotiations (1986-1994).[22] The TRIPS Agreement is applicable to all 147 members of the WTO and binding to every country that becomes a member. While the agreement became applicable to all countries that signed at the beginning of 1996, developing countries and countries in transition were granted a four-year transitional period apart from rules pertaining to national and most favored nation (MFN) treatment.[23] Developing countries were granted an additional five-year transitional period for product patents in the field of technology that were not protected at the date of application for the Agreement. Least Developed countries were granted a ten-year transitional period to comply with the agreement and this period could be extended upon request from the country.

The TRIPS Agreement is the first time there has been international agreement on intellectual property rights. The agreement sets minimum standards of protection for intellectual property such as copyrights, trademarks, industrial designs, patents, trade secrets and more.[24] Fink (2004) notes that between 1996 and 2004 there has been more than 20 TRIPS related disputes between WTO members. He points out that most of these disputes are between developed country

[22] The other two pillar agreements are the Multilateral Agreement on Trade in Goods and the General Agreement on Trade in Services (GATS)

[23] The MFN treatment is a principle whereby under the WTO agreements countries cannot normally discriminate between their trading partners. If one country grants another a special favor such as low custom duty rates, then it must be extended to all WTO members.

[24] TRIPS make references to several of the conventions listed in Table A3.1

members, specifically between the United States and the European Union. The signing of the TRIPS agreement has resulted in many controversies because of the different implications it has for developing countries. Advocates for the policy argue that stronger IPR will stimulate local industries particularly in the creative sectors as well as induce foreign direct investments leading to an overall boost in economic growth for those countries. Since the signing of the TRIPS agreement there has been many studies attempting to pinpoint how improving intellectual property rights may influence the flow of foreign direct investment particularly from developed to developing countries, there has been no consensus thus far.

3.2.3 Previous Research

The literature on the relationship between IPR protections and FDI flows shows mixed results. Lee and Mansfield (1996) find a positive relationship between the strength of a country's IPR protections and the flow of FDI by US multinational enterprises in fourteen developing countries. In contrast to those findings, Ferrantino (1993) and Maskus and Eby-Konan (1994) find that there is no statistically significant relationship between the two factors. According to Spatz and Nunnenkamp (2003), one reason for these mixed results is the fact that previous empirical studies do not account for industry and host country characteristics. SN argue that industry and host country characteristics play an important role in shaping the relationship between IPR protections and FDI, thus using country level data may obscure this relationship.

Focusing on FDI flows towards specific sectors, Maskus (1998) notes that IPR protections are not a major driver of capital flows towards the services sector and towards manufacturing sectors that produce labor intensive and low technology goods. Maskus (1998) notes that FDI in these sectors are more dependent on market opportunities and input costs. For those industries where intellectual property assets are abundant, strengthening IPR protection will most likely lead to an increase in FDI flows. Mansfield (1995) as well as Lee and Mansfield (1996) using survey results also find that the effects of IPR protections on FDI differs considerably across industries. Specifically, they find that the strengthening of IPR protections influence FDI flows more strongly in the chemicals industry and have less of an impact in the metals industry. They then note that the reasons for these differences are industry characteristics such as human capital intensity and research and development intensity.

Studies that allow for industry specific effects of IPR protections on FDI such as Primo Braga & Fink (2000) and Smarzynska (2004) also find conflicting results. For the industry specific coefficients of IPR protection, Primo Braga & Fink (2000) find insignificant impacts for all industries except the chemical industry, which experience a negative relationship on the sales of US affiliates.[25] Smarzynska (2002) in his paper find that IPR protections are negatively related to FDI flows mainly in technology intensive industries that depended heavily on IPR protections. These industries include drugs, cosmetics and health care products, chemicals, machinery and equipment and electrical equipment.

For this paper, I am attempting to update the results found by Spatz and Nunnenkamp 2003 paper. Using sectoral and regionally disaggregated level data, they find that both host country characteristics and industry characteristics have an important influence in determining the relationship between FDI and IPR protections. Regarding host countries' characteristics, they find that IPR protections have weaker effects in countries that have strong market related pull factors for FDI. They find that FDI inflows significantly increased with stronger IPR protections but only in those countries with a moderate level of local imitation capacity. For those countries with either a low or advanced level of local imitation capacity, the impact is insignificant. Given that SN's results are based on data for the year 2000 only, this paper goes on to test the stability of these results by replicating their model for each year from 2003 to 2015.

[25] The results of this paper refer to 1992 only and focuses on only three sectors which are chemicals, machinery and electrical equipment

Focusing on industry characteristics, SN find that the impact of IPR protections is strongest in the machinery and transport equipment industries that are very human capital and technology intensive. On the other hand, IPR protections play an insignificant role in attracting FDI to the food and metal industries, which are more low technology intensive. Further analyzing their estimation results, SN (2003) conclude that by the host countries strengthening their IPR protections they will not only attract more FDI but also derive more benefits from the increasing levels of FDI inflows. SN's results establish that a relationship existed between IPR and FDI, this paper hopes to extend the analysis by determining whether improving IPR protections will result in an increase in FDI inflows.

SN compare two indicators for IPR protections to determine which one is better for empirical analysis. They state that while the Ginarte-Park index (1995) is the more popular index and covers more countries, it has many limitations in comparison to the World Economic Forum (WEF) indicator. The main limitations are that the GP index rely heavily on patents, which only represent one aspect of IPR. In recent years, the Ginarte-Park index has updated to cover more countries as well as to incorporate changes that occurred both nationally and globally due to the TRIPS agreement and revisions in national patent laws.[26] However, since SN find that the WEF index provide statistically significant results as opposed to the Ginarte-Park index in their model, this paper will focus on the WEF index as the main measure of IPR protections. For the model extension, the WEF index will not only be directly included as SN did in their paper, but also binned into equal quarters to form quantile dummy variables. The dummy variables will then be the treatment variables in the extended model testing for causality.

In summary, most of the previous research on IPR protection and FDI focus on the total foreign direct investments flowing into countries and not on sectoral disaggregated data. SN's

[26] Patent laws had to conform to international and regional agreements such as North American free trade agreement (NAFTA), European patent convention (ECP), African Regional Industrial property organization (ARIPO), and Cartagena agreement.

2003 paper is the first to apply sectoral and regional disaggregated data to get a better understanding of the role of IPR protections in influencing FDI inflows. The empirical literature also indicates that the effects of IPR protections on FDI is influenced by observed and unobserved time, industry, and country specifics. Thus, I control for these factors in my analysis of the causal effect of IPR on FDI using panel data over the period 2003-2015.

3.3 Methodology

3.3.1 Data

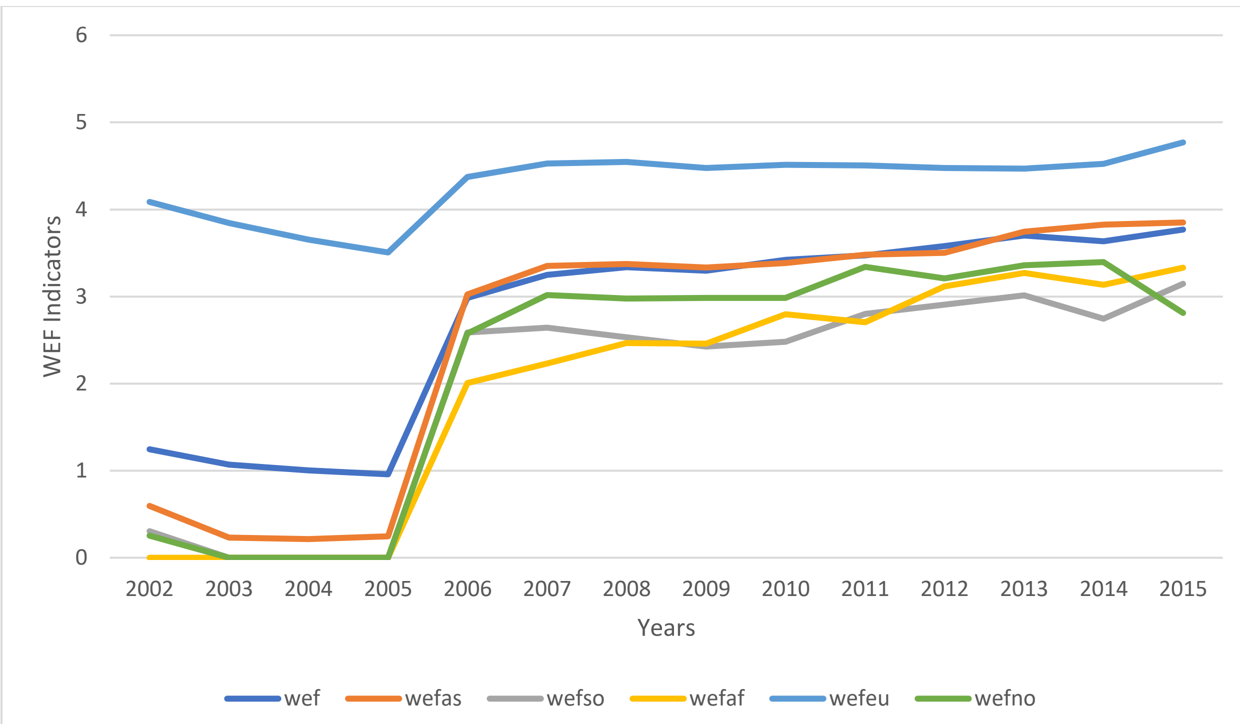
The empirical analysis uses data from a combination of two online databases, the Bureau of Economic Analysis (BEA) (2015) database and the World Bank (2017) database. The BEA provides sectoral disaggregated data on the United States (US) FDI stocks and supplementary information on FDI related economic activities of US affiliates. I collect FDI outflow data from the BEA and country level data (GDP per capita and population) from the World Bank database.[27] The average years of schooling data comes from Barro and Lee (2015) educational attainment dataset and the risk indicator from the PRS index for control of corruption.[28] It must be noted that the risk indicator in this paper is different from the one used by SN (Euromoney dataset).[29] The change in index is necessary due to a lack of access to the Euromoney database.

My variable of interest is an indicator for intellectual property rights which comes from the World Economic Forum. The WEF indicator derives from a survey of 151 countries where a score of one is given if IPR protection is "weak or nonexistent" and a score of seven is given if the protection is "equal to the world's most stringent." Taking a closer look at the WEF index over the period under study shows that the average level of IPR protections for all countries have increased over time. The graph below highlights that each regional grouping followed a

[27] The BEA defined this FDI outflow as US Direct Investment Position Abroad on Historical Cost basis.
[28] Political Risk Service International Country Risk Guide, which consist of 12 components measuring the political and business environment facing firms operating in a country.
[29] The Euromoney country risk index is defined as the risk of non-payment of goods and services and of not servicing loans and other liabilities while the indicator used in this paper is the control of corruption.

similar pattern of IPR index steadily increasing over time with slight dips in the degree of protection. The sharp increase from 2006 to 2008 I must note is mostly due to changes in the WEF methodology and not due to significant changes in global policy.[30] Over these two years, both the structure and the weighting of the WEF Forum model was changed as such this should be taken into consideration when analyzing the empirical results.

Figure 3. 1: IPR protection broken into geographic area from 2001 to 2015



For my empirical analysis, I restrict the sample data to each country's manufacturing sector which is disaggregated into seven industries for years 2001 and 2002 and the eight industries from 2003 and onwards.[31] All observations that are missing due to non-disclosure by individual companies are eliminated from the sample following in the lead of Spatz and Nunnenkamp (2003).

3.3.2 Empirical Strategy

[30] http://km.usaid.gov/esds/

[31] The BEA disaggregated the manufacturing sectors into food, chemicals, metals, machinery, computers, electrical and transportation industries in 2001 and 2002 and then added other manufacturing industry in 2003.

According to Hamermesh (2007), there are three types of replications in economics, pure replication which is the making or doing something the same as before, statistical replication which is the using of a different sample but identical model and population and scientific replication which is the use of a different sample and or population with either a similar or identical model. For this paper, I extend SN analysis by firstly purely replicating their base model and non-linear model for sample period 2002, then re-estimating the models from 2001 to 2015 and lastly creating a panel dataset and quantile dummy variables to investigate a possible causal relationship between IPR and FDI.

As was done by SN, I will utilize a left censored Tobit model to firstly test if there is a correlation between IPR and FDI and then to assess if there is a possible causal relationship. SN's uses a left censored Tobit model to account for the zero and negative observations found in the BEA dataset. Standard errors are adjusted using White's (1980) heteroskedastic-consistent covariance matrix. SN's base model is specified below as,

$$Y_{i,j} = \beta_0 + \beta_1 W_{i,j} + \beta_2 X_{i,j} + \mu_j + \gamma_i + \varepsilon_{i,j}, \qquad (1)$$

where, j signifies an industry in country i; (μ_j) and (γ_i) are the regional and sectoral dummies respectively, $Y_{i,j}$ is logged foreign direct investments, $X_{i,j}$ is a vector of covariates and $\varepsilon_{i,j}$ is the error disturbance term.[32] On the assumption that there may be heterogeneity in the IPRs impact on FDI across countries due to host countries' characteristics, SN test for a possible non-linear relationship between IPR and FDI. The logic for this assumption is that depending on a host country's economic, geographic, or political situation, the impact of IPRs protections on FDI may be stronger or weaker and these innate differences may cause a possible non-linear relationship.[33] To test this hypothesis, SN formula equation (2) where the WEF observations are grouped into

[32] The observable covariates are logged population, logged gross domestic product per capita, risk indicator variable and educational attainment indicator variable.
[33] It is expected that improving IPR protections of stable countries in Asia like Singapore will have a larger impact compared to more politically and economically unstable countries in Africa like Gambia.

geographical regions.[34] As such, interaction terms (W*EU, W*SO, W*NO, W*AF and W*AS) are included into to capture the possible non-linear relationship between IPR and FDI. This new estimation equation is defined as,

$$Y_{i,j} = \beta_0 + \beta_1(W{*}EU)_{i,j} + \beta_2(W{*}SO)_{i,j} + \beta_3(W{*}NO)_{i,j} + \beta_4(W{*}AF)_{i,j} + \beta_5(W{*}AS)_{i,j} + \beta_6 X_{i,j} + \mu_j + \gamma_i + \varepsilon_{i,j} \quad (2)$$

After purely replicating the model, I estimate equations one and two for each year from 2001 to 2015. This allow me to determine if the positive correlation between IPR and FDI found by SN is stable and robust.

Lastly, I extend SN's analysis by formulating an equation to test whether an improvement of a country's IPR protections may lead to an increase in FDI inflows to their manufacturing sector. Past studies have used an ordinary least squares (OLS) regression method to draw an empirical connection between foreign direct investment (FDI) and its determinants (e.g., Chakrabarti, 2001). However, the OLS method may not be appropriate for analyzing the count nature of FDI data, as it assumes that the dependent variable follows a normal distribution. In the case of the count number of FDI, the dependent variable cannot be negative and thus is not normally distributed. Moreover, there may be too many zero counts due to some countries abd by extension some sectors not receiving any FDI at all.

For this analysis I formulate a panel dataset by pooling the data from the sample period 2003 to 2015. To deal with count data, the framework of Poisson regression model has been widely used however this Poisson regression has many drawbacks when dealing with panel data. As such, this paper uses a Fixed-effects Poisson regression to estimate the impacts of improving IPR on FDI inflows. The estimated equation is as follows,

$$Y_{i,j,t} = \beta_0 + \beta_1 W_{i,j,t} + \beta_5 X_{i,j,t} + \tau_t + \varepsilon_{i,j,t} \qquad (3)$$

[34] The geographical groupings are the same as the regional dummies included in the base run model, which is Europe, South America, Rest of America, Africa/Middle East, and Asia/Pacific

where, ij signifies a country-industry matched pair in year t; (τ_t) represents time effects, (α_i) represents industry effects and (η_j) represents country-specific effects. My variable of interest is the IPR indicator ($W_{i,j,t}$) whose variation across, time, country, and industry is what I attempt to exploit and my error term is robust. I also include several observable controls such as population to control for differing market size among countries, GDP per capita to control for differing income levels, indicators for average years of schooling, a risk indicator for differing corruption levels and year fixed effects. Lastly, any observations with missing data for the WEF index, the schooling index and FDI are excluded from the sample.

According to previous research the impact of improving IPRs is not constant. Countries moving from low IPR protections to moderate IPR protections possibly experience a stronger impact on their FDI compared to countries moving from average IPR protections to stringent IPR protections. As such, I bin the IPR index into equal quantiles to assess any possible difference in the impact from one bin to the next. I then formulate dummy variables to represent each bin. The quantile dummies (W1, W2, W3 and W4) are created by binning the WEF variable into quarters where I divide the observations for the WEF variable into four equal parts annually. I must note that due to the reformulation of the index from 2003 to 2005, dummy W1 has 26% of the observations while dummy W4 has 24%.[35] However, I do not expect this to have a significant impact on the overall results given the small difference. For analysis purpose the first bin for the quantiles is dropped as such the interpretation of the coefficients are relative to countries with the lowest level of IPR protections. Lastly, to check if my results are robust, I then re-estimate equation (3) using decile bins as my variables of interest and then I re-run equation using (3) pseudo maximum likelihood instead of fixed-effects Poisson regression.

[35] Table A3.2 in the Appendix shows the frequency and percentage breakdown of the binned data for each year.

3.4 Results Analysis

3.4.1 Pure Replication

Spatz and Nunnenkamp in their original SPSS data file collect data for 126 countries disaggregated into five subsectors under the manufacturing industry that total out to be 630 observations. In their specification, they regress current log FDI stocks onto host countries' log per-capita GDP (GDPPC), log population (POP), log average years in schooling (SCH), country risk (RISK) and the WEF index. Table 3.1 below compares SN results to my replicated results for equation (1). SN do not report the coefficient values for the sectoral and regional dummies they include in their model; as such, I do not report them in my replicated results.

Table 3. 1: Replication of Spatz and Nunnenkamp base run model using the WEF indicator

Coefficients	Spatz and Nunnenkamp (2000)	Replicated Results
Wef	0.58	0.60
	(0.06)	(0.03)
Gdppc	1.67	1.49
	(0.00)	(0.00)
Pop	1.68	1.56
	(0.00)	(0.00)
Sch	1.35	1.29
	(0.08)	(0.04)
Risk	-0.02	-0.02
	(0.38)	(0.41)
Observations	249	249
Uncensored	191	191
Left-censored	58	58
LR chi^2	309.8	317.2
Prob>chi^2	0	0
Pseudo R^2	0.26	0.27

The table shows that my replicated results are not the same as SN's however, the difference is not statistically significant. This difference is driven by a few factors such as difference in data cleaning process. For instance, in my sample dataset I remove any country-industry matched observations that have missing values for WEF index and average schooling variable as well as observations where the FDI variable has negative values. Another potential reason for the difference in the results is that SN report five regions in their appendix, however, in their SPSS dataset; the only regional dummy they include is the Organization for Economic Co-operation and Development (OECD) countries.[36] My results exclude the OECD dummy variable, and if I include it results in statistically significant changes to the coefficient values of each variable as seen in Table A3.3 in the Appendix. This indicates that the model is sensitive to regional dummies, and this may be due to some countries overlapping into different regional groupings.[37]

Table 3.2 compares SN non-linear estimation results with my replicated results for equation (2). As with the replicated base run model, the coefficient values are marginally different however, the coefficient signs are the same.[38] A possible cause for the replicated results of both equations being marginally different from the original results is that SN generate their model using SPSS while my replication is done using STATA.

Table 3. 2: Replication of estimation highlighting host country characteristics

Coefficients	Spatz and Nunnenkamp	Replicated Results
Gddpc	1.49	1.36
	(0.00)	(0.00)
Pop	1.70	1.58
	(0.00)	(0.00)
Sch	1.67	1.71
	(0.04)	(0.01)
Risk	-0.01	-0.02
	(0.64)	(0.35)
Weffeu	0.24	0.41
	(0.47)	(0.16)
Weffso	1.79	1.79
	(0.00)	(0.00)
Weffno	0.35	0.53
	(0.47)	(0.19)
Weffaf	-0.86	-0.58
	(0.24)	(0.40)
Weffas	0.82	0.88
	(0.07)	(0.02)
Observations	249	249
Uncensored	191	191

[36] The regional dummies are Europe, South America, rest of America, Africa and Middle East and Asia and Pacific.
[37] Mexico, Canada, and Japan fell into the OECD grouping as well as the rest of America group and the Asia group.
[38] It should be noted that the difference between the two results is statistically significant.

Left-censored	58	58
LR chi^2	323.9	336.69
Prob>chi^2	0	0
Pseudo R^2	0.27	0.28

3.4.2 Statistical Replication

According to Davis (2013), statistical replication is about testing robustness to the sample and sample period by using the same model and underlying population. Table 3.3 below shows the WEF coefficients values for SN identical base run equation estimated annually from 2001 to 2015. For each year, the result shows that the WEF index had a positive and significant coefficient. These results imply that the positive relationship SN find in their results is stable. The results further shows that the degree of positive influence over the years had a vacillating pattern as the coefficient value declines from 2002 to 2003 but rise sharply in 2004 and then significantly declines again in 2005. Despite this vacillating pattern, the sign of the coefficients remains positive throughout which solidifies SN's results that there is a positive correlation between IPR and FDI.

Table 3. 3: WEF coefficient from 2001 to 2015

Year	WEF Coefficient
2001	1.292 (0.00)
2002	1.202 (0.00)
2003	0.900 (0.04)
2004	2.321 (0.00)
2005	0.989 (0.01)
2006	1.769 (0.00)
2007	2.269 (0.00)
2008	1.562 (0.00)
2009	2.478 (0.00)
2010	1.551 (0.00)
2011	1.186 (0.00)
2012	0.925 (0.00)
2013	1.087 (0.00)
2014	1.296 (0.00)
2015	2.693 (0.00)

To assess the stability of the results in Table 3.2, I re-estimate equation (2) for each year from 2001 to 2015. SN results implies a non-linear relationship between IPR and FDI and my results find that SN's results are stable and hold over time as shown in Table 3.4 below. [39] There are two differences in my updated results from that of SN that needs to be highlighted. Firstly, for my results the Asian and Pacific region on average had the highest statistically significant coefficients while for SN it is the South American region. This departure may be because the host countries located in the Asian and Pacific region imitative capacity grew stronger over the sample period. Secondly, the South American region coefficient being either negative or statistically insignificant reflects a possible contradiction of Maskus (1998, 2000) and SN (2003) conclusions. Both researchers conclude that the impact of IPR protections is stronger in developing countries in comparison to developed countries. The positive coefficients for the South American region fall in line with expectations as this region is made up of only developing countries.

Table 3. 4: Regional WEF coefficient values from 2001 to 2015

Year	W*EU	W*SO	W*NO	W*AF	W*AS
2001	0.93 (0.00)		8.75 (0.00)		8.33 (0.00)
2002	0.31 (0.40)		9.03 (0.00)		8.58 (0.00)
2003	0.13 (0.78)		0.36 (0.17)		3.96 (0.00)
2004	1.89 (0.00)		-0.05 (0.86)		9.15 (0.00)
2005	1.40 (0.00)	0.83 (0.95)	0.84 (0.21)		-0.19 (0.77)
2006	1.77 (0.00)	0.46 (0.54)	1.47 (0.01)	1.65 (0.00)	2.16 (0.00)
2007	2.32 (0.00)	-0.24 (0.74)	2.07 (0.00)	2.67 (0.00)	2.78 (0.00)
2008	1.99 (0.00)	-0.12 (0.89)	1.57 (0.02)	1.43 (0.03)	1.34 (0.00)
2009	2.63 (0.00)	-2.57 (0.05)	2.56 (0.00)	2.54 (0.00)	3.72 (0.00)
2010	1.68 (0.00)	-0.76 (0.44)	1.22 (0.04)	2.35 (0.00)	2.65 (0.00)
2011	1.41 (0.00)	-0.34 (0.67)	1.13 (0.03)	1.33 (0.00)	2.28 (0.00)
2012	1.13 (0.00)	-2.59 (0.00)	0.44 (0.44)	1.38 (0.00)	2.45 (0.00)
2013	1.76 (0.00)	-1.16 (0.11)	0.88 (0.18)	1.50 (0.00)	2.04 (0.00)
2014	1.56 (0.00)	-1.62 (0.23)	1.27 (0.09)	0.87 (0.09)	1.52 (0.00)
2015	2.74 (0.00)	.63 (0.65)	3.40 (0.00)	2.46 (0.09)	2.71 (0.00)

[39] Prior to 2006 due to the WEF forum having limited data, the South American and African region reported no coefficient values.

3.4.3 Scientific Replication

The purpose of this extension is to determine if a causal relationship between IPR protections and FDI exists. In estimating equation (3), I attempt to exploit the variation that occurs when a country moves from a lower bin to a higher bin, which signals an increase in their level of IPR protections. As noted earlier, the WEF index is divided into four equal bins and then quantile dummy variables are created to represent each bin. Bin 1 includes countries with a low level of IPR protections, bin 2 includes those with an average level, bin 3 signals above average and bin 4 include those classified with a high level of IPR protections.

The result in Table 3.5 indicates that IPR is a positive determinant of FDI outflows. The result is significant at the 5% level indicating that firms concentrate on sending FDI to countries and sectors within the manufacturing industry where there IPR protections are high. This result falls in line with SN previous results showing a positive correlation between IPR and FDI within the manufacturing industry using fata from 2002 only.

Table 3. 5: Fixed-effects Poisson estimation results

Coefficients	F-e P
Weff	0.130***
	0.060
GDPPC	1.36e-08**
	5.51e-09
POP	3.81e-09
	2.67e-09
SCH	0.007
	0.078
RISK	-0.409
	0.331
N	4,410

*p<0.10, **p<0.05, ***p<0.01

As IPR protections improve, their impact on FDI outflows may not be constant. To test this assumption, I divide the IPR index into 4 equal quantiles to assess any possible heterogeneity as countries move up in bins indicating an improvement in their IPR protections. Firstly, using bin 1 as the threshold dummy the results in Table 3.6 below indicates that countries in bin 2 receive 34% higher FDI outflows compared to countries in bin 1, countries in bin 3 receive 48% higher while those in bin 4 receive 61%. This implies that as countries improve their IPR protections there is an increase in FDI outflows towards a country's manufacturing industry. As such intellectual property rights can be considered a causal determinant of FDI outflows.

Table 3. 6: Results for quantile dummy variables

Coefficients	W1	W2	W3	W4
W1	-	0.345***	0.488***	0.614***
		0.094	0.129	0.173
W2	-0.345***	-	0.143*	0.269**
	0.094		0.079	0.129
W3	-0.488***	-0.143*	-	0.125
	0.129	0.079		0.096
W4	-0.614***	-0.269**	-0.125	-
	0.173	0.129	0.096	
N	4,410	4,410	4,410	4,410

*p<0.10, **p<0.05, ***p<0.01

Table 3.6 also indicates that there is some heterogeneity in the impact on FDI within the manufacturing industry as countries go up in bins indication an improvement in their IPR protections. The results show that moving from bin 1 to bin 2 has a larger positive impact on FDI outflows (0.345) compared to moving from bin 2 to bin 3 (0.143). It also shows that there is no statistically significant difference in the impact on FDI outflows as a country moves from bin 3 to bin 4. This result falls in line with prior research which states that there are possible diminishing returns from improving IPR protections on FDI outflows. Based on the coefficient values it shows that moving from bin 1 to bin 2 has a larger impact than moving from bin 2 to bin 3 and moving from bin 3 to bin 4. These results provide some support to Asid et. al (2004) conclusion that developing countries experience diminishing returns of IPR protections on FDI inflows.

For my first robust check, I re-estimate equation 3 using decile bins as my variable of interest. The results in Table 3.6 with the decile dummy variables follow a similar pattern to that of the quantile variables. It shows a positive yet uneven impact of FDI outflows as countries move up in bins. It also indicates some diminishing returns on FDI outflows as moving from bin 7, bin 8, and bin 9 up to bin 10 had no statistically significant impact on FDI outflows.

Table 3. 7: Showing the results with the decile dummy variables

	w1	w2	w3	w4	w5	w6	w7	w8	w9	w10
1	-	0.228	0.362**	0.647***	0.561**	0.551**	0.693***	0.775***	0.905***	0.879***
		0.255	0.164	0.196	0.195	0.214	0.212	0.239	0.259	0.265
2	-0.22		0.133	0.419**	0.332**	0.322*	0.464**	0.546**	0.676**	0.651**
	0.25		0.161	0.132	0.139	0.171	0.160	0.191	0.217	0.225
3	-0.06	-0.653***		0.022	0.400**	0.264**	0.284***	0.285***	0.459***	0.557***
	0.09	0.108		0.086	0.088	0.087	0.085	0.087	0.089	0.099
4	-0.08	-0.675***	-0.022	-	0.377**	0.242**	0.262***	0.263***	0.437***	0.535***
	0.08	0.102	0.086		0.080	0.077	0.075	0.077	0.077	0.089
5	-0.46**	-1.05***	-0.40**	-0.377***	-	-0.135*	-0.115	-0.114	0.059	0.157*
	0.09	0.104	0.088	0.080		0.079	0.076	0.077	0.075	0.085
6	-0.33**	-0.918***	-0.26**	-0.242***	0.135*	-	0.020	0.021	0.194**	0.292***
	0.09	0.101	0.087	0.077	0.079		0.071	0.073	0.068	0.078
7	-0.35**	-0.938***	-0.28**	-0.262***	0.115	-0.020	-	0.001	0.174***	0.272***
	0.08	0.102	0.085	0.075	0.076	0.071		0.066	0.061	0.070
8	-0.35**	-0.939***	-0.28**	-0.263***	0.114	-0.021	-0.001	-	0.173***	0.271***
	0.09	0.105	0.087	0.077	0.077	0.073	0.066		0.057	0.064
9	-0.52**	-1.11***	-0.45**	-0.437***	-0.059	-0.19**	-0.174***	-0.173***	-	0.097*
	0.09	0.106	0.089	0.077	0.075	0.068	0.061	0.057		0.050
10	-0.62**	-1.21***	-0.55**	-0.535**	-0.157*	-0.29**	-0.272***	-0.271***	-0.097*	-
	0.10	0.116	0.099	0.089	0.085	0.078	0.070	0.064	0.050	
N	4,410	4,410	4,410	4,410	4,410	4,410	4,410	4,410	4,410	4,410

*p<0.10, **p<0.05, ***p<0.01

I then re-estimate the equation using pseudo-maximum likelihood model. The main advantage of PML estimator is that its consistency does not depend on a particular distribution assumption about the original population unlike that of the fixed-effects Poisson regression. The results in Table 3.7 are similar to that of the main results which indicate that IPR is a positive determinant of FDI within the manufacturing industry.

Table 3. 8: Pseudo-maximum likelihood estimation results

Coefficients	PML
Weff	0.141***
	0.057
GDPPC	3.39e-08***
	6.43e-09
POP	3.90e-09*
	2.25e-09
SCH	0.080
	0.069
RISK	-0.422
	0.353
N	4,410

*p<0.10, **p<0.05, ***p<0.01

3.5 Conclusion

This paper aims to update and expand Spatz and Nunnenkamp's results showing that there is a positive relationship between IPR protections and FDI. Following SN lead, the paper analyses FDI on a sectoral and regionally disaggregated level given that intellectual property rights may depend on host country and industry characteristics. My paper then goes on to replicate SN base run and non-linear models annually from 2001 to 2015 to test the stability of the original results. Lastly, I attempt to determine if a causal relationship exists between IPR protections and FDI inflows by pooling the dataset into a panel format and using the WEF index to create quantile dummy variables in the model.

My empirical findings provide support to Spatz and Nunnenkamp's conclusion, which is that both industry characteristics and host country characteristics have an important role in determining the relationship between IPR protections and FDI. Specifically, the results indicate that IPR protections are an important consideration for US companies in the manufacturing sector when making foreign direct investment decisions. This is an important conclusion especially for developing countries given that developing a strong manufacturing sector is still a necessary step for countries to achieve sustainable economic growth and development.

Base on the results of my extended model it can be concluded that IPR protections is a causal determinant of FDI outflows. The results also show diminishing returns on FDI outflows within the manufacturing industry as countries improve their IPRs overtime. Based on the coefficients it indicates that countries with above average IPR protections that move to excellent IPR protections see no statistically significant impact on FDI outflows however, those moving from low IPR protections to moderate IPR protections see a significant positive impact. This pattern is an indication of the subtle and complex ways in which IPR protections influences FDI inflows (Adams, 2010). While developing countries are likely to benefit from reforming their intellectual property systems, strong IPR protections alone is not a sufficient incentive for foreign firms to invest. This is made clear by the fact that despite China being a developing country with weak IPR systems, it receives the bulk of FDI inflows in recent years. Therefore, according to Dunning and Hamdani (1997), IPR reform cannot stand-alone, and it must be tied with policies to improve the physical, institutional and governance structure of a country as well as the business climate to attract FDI.

The overall results of my study indicate that there are some possible benefits for developing countries improving their IPR protections based IPR being a positive determinant for FDI outflows. However, these countries must be aware that an increase in FDI inflows is just a start; Adams (2010) notes that the bigger challenge is using the FDI to generate sustainable growth. As Asid et al., (2004) point out; the way for these countries to progress is to not just have a more efficient IPR infrastructures but to also intensify their technological research and development.

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APPENDIX A

CHAPTER 1 APPENDIX

Table A1. 1: Summary of PBF policies from 2004 to 2018 affecting public institutions

State	PBF years	Premium years
Arizona	2012--	
Arkansas	2007-2009, 2012--	2013--
Colorado	2004-2006, 2011--	
Florida	2004-2007, 2013	2013--
Georgia	2006-2008, 2015	
Illinois	2013-	2013-
Indiana	2003	2010
Kansas	2004-2008, 2011--	
Louisiana	2014--	
Maine	2013--	2014--
Massachusetts	2014--	
Michigan	2012--	2014
Minnesota	2007-2008, 2011--	2011--
Mississippi	2013--	2013--
Missouri	2013--	2013--
Montana	2013--	
Nevada	2013--	
New Mexico	2004--	2012--
North Carolina	2014--	
North Dakota	2013-	
Ohio	2004--	2010--
Oklahoma	2004--	2012--
Oregon	2007--	
Pennsylvania	2004(PASSHE[40] only)	2011(PASSHE only)
South Dakota	2004--	
Tennessee	2004--	2004--
Utah	2013--	
Virginia	2005--	2014--

Sources: State higher education budget statements; Kelchen (2017); Gandara and Rutherford (2017); Li (2018)

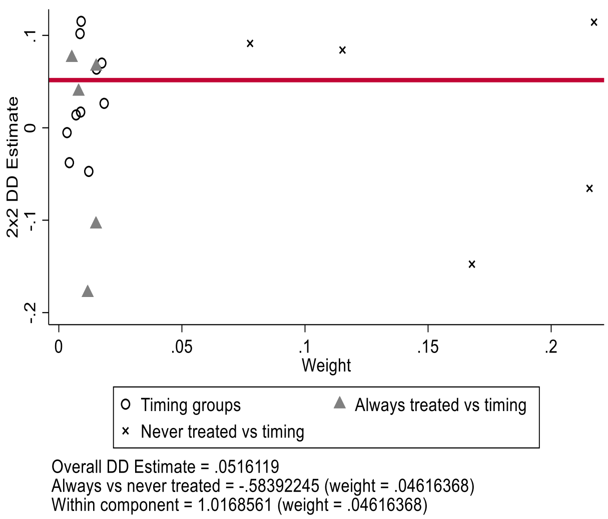
[40]The Pennsylvania State System of Higher Education is a state agency of the Commonwealth of Pennsylvania that oversees 14 state-owned colleges and universities.

Table A1. 2: State level tuition policy for Native students

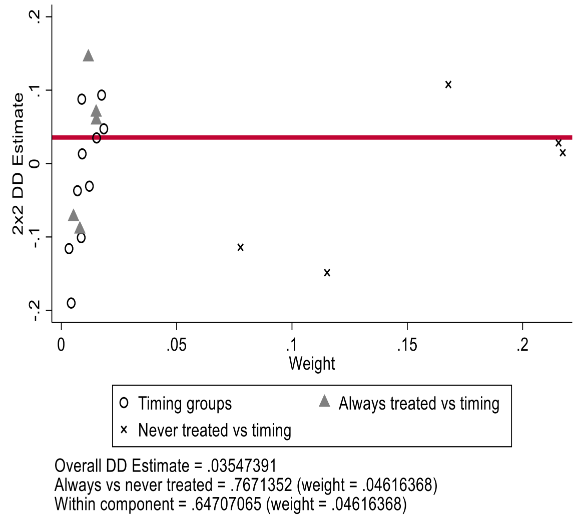
State	Policy
The following states provide in-state tuition rates or tuition waivers to Native American students, with additional requirements such as tribe, state residency or graduation from a BIA high school in that state.	
California	In-state tuition for AI students who graduated from a California BIA high school.
Iowa	In-state tuition for American Indians who have origins in any of the original people of North America and who maintain a cultural identification through tribal affiliation or community recognition with one or more of the tribes or nations connected historically with the present state of Iowa, including the Iowa, Kickapoo, Menominee, Miami, Missouri, Ojibwa (Chippewa), Omaha, Otoe, Ottawa (Odawa), Potawatomi, Sac and Fox (Sauk, Meskwaki), Sioux, and Winnebago (Ho Chunk).
Maine University of Maine	Tuition waiver and scholarship that covers room and board for members of historical tribe of Maine area OR a resident of Maine from any federally recognized or Canadian tribe. Student can be tribally enrolled OR have a parent or grandparent enrolled.
Massachusetts	Tuition waiver for historical Massachusetts area tribes who are Massachusetts residents.
Michigan	Tuition waiver for residents of Michigan enrolled in a Michigan tribe.
Oklahoma (Oklahoma University)	In-state tuition to tribal enrollees.
Utah and Washington	In-state tuition for AI students whose tribes are from the state or neighboring states.
The following colleges offer tuition waiver programs to Native American students from any state	
Colorado	Fort Lewis College at Durango-Student must be 1/4 Native American OR enrolled in a federally recognized tribe OR a direct decedent of a tribal member who lived on a reservation prior to June 1, 1934.
Kansas	Haskell Indian Nations University - Students do not need to be tribally enrolled but must document 1/4 or more tribal descent.
Montana MT University System	Tuition waiver for MT residents enrolled in a federally recognized tribe.
Minnesota	U of MN, Morris -Student must be enrolled in a federally recognized tribe OR a parent OR grandparent must be enrolled.
North Dakota State Colleges and Universities	Search by college under Financial Aid resources or Scholarships for the Diversity Tuition Waiver
Source: www.isd12.org	

Figure A1. 1: Bacon Decomposition Results

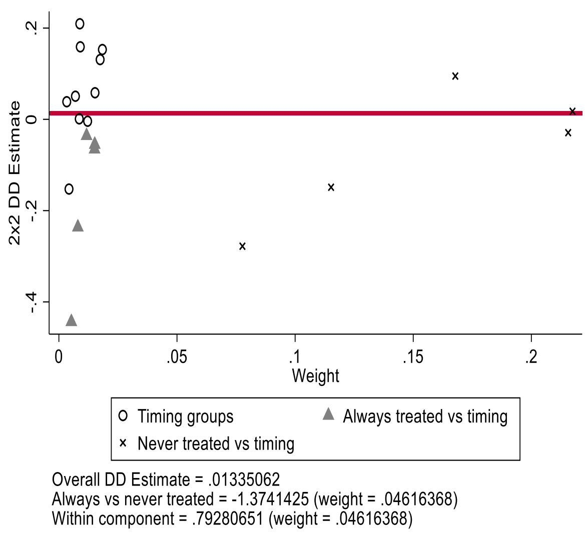
Panel A: Total



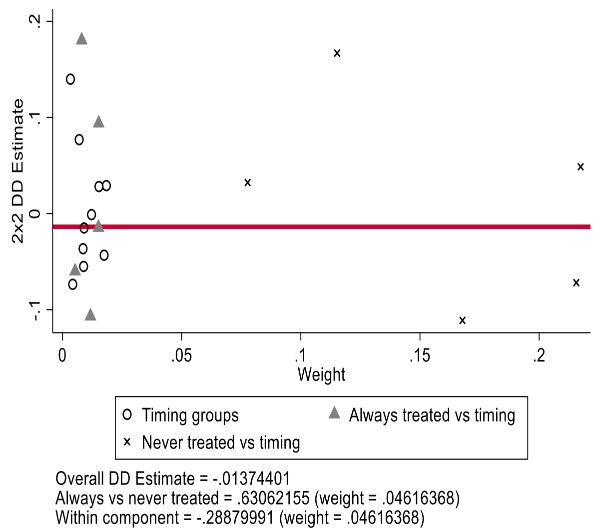
Panel B: Black



Panel C: Hispanic



Panel D: Native



APPENDIX B

CHAPTER 2 APPENDIX

Table A2. 1: Educational Appropriations per FTE (constant adjusted 2018 dollars)

State	FY 2008 $ (pre-recession)	FY 2017 $	FY 2018 $	Change since recession
Alabama	10,772	6,894	6,788	-37.0%
Alaska	15,076	15,003	15,151	0.5%
Arizona	8,493	5,087	5,025	-40.8%
Arkansas	9,389	8,086	7,873	-16.1%
California	7,876	8,355	8,553	8.6%
Colorado	4,724	4,216	4,198	-11.1%
Connecticut	10,703	8,641	8,123	-24.1%
Delaware	6,662	4,976	4,841	-27.3%
Florida	8,556	6,547	7,109	-16.9%
Georgia	10,607	8,841	9,166	-13.6%
Hawaii	11,774	11,664	12,560	6.7%
Idaho	12,142	9,794	9,857	-18.8%
Illinois	11,261	15,869	14,605	29.7%
Indiana	7,070	6,922	6,785	-4.0%
Iowa	7,993	6,187	5,992	-25.0%
Kansas	8,354	6,788	6,885	-17.6%
Kentucky	10,068	7,512	7,514	-25.4%
Louisiana	9,748	5,512	5,876	-39.7%
Maine	7,946	7,749	7,750	-2.5%
Maryland	7,684	7,404	7,426	-3.4%
Massachusetts	8,675	7,540	7,556	-12.9%
Michigan	7,903	6,714	6,773	-14.3%
Minnesota	8,437	7,306	7,758	-8.1%

Table A2. 1 continued

Mississippi	9,889	7,572	6,655	-32.7%
Missouri	9,367	6,857	6,958	-25.7%
Montana				
Nebraska	9,212	9,951	9,699	5.3%
Nevada	11,179	7,681	8,094	-27.6%
New Hampshire	3,918	2,772	2,806	-28.4%
New jersey	8,680	6,529	6,339	-27.0%
New Mexico	11,740	10,496	10,816	-7.9%
New York	8,295	8,430	8,697	4.8%
North Carolina	12,496	10,415	10,429	-16.5%
North Dakota	7,180	9,637	8,273	15.2%
Ohio	7,020	6,389	6,361	-9.4%
Oklahoma	10,001	6,689	6,407	-35.9%
Oregon	6,232	6,057	6,237	0.1%
Pennsylvania	6,629	4,280	4,296	-35.2%
Rhode Island	6,879	5,880	6,061	-11.9%
South Carolina	7,917	5,910	6,053	-23.5%
South Dakota	7,317	6,808	6,378	-12.8%
Tennessee	10,212	8,402	8,774	-14.1%
Texas	9,419	8,024	7,707	-18.2%
Utah	8,651	7,233	7,250	-16.2%
Vermont	3,423	2,787	2,846	-16.9%
Virginia	6,664	5,643	5,420	-18.7%

Table A2. 1 continued

Washington	8,034	7,009	6,966	-13.3%
West Virginia	7,108	4,865	4,723	-33.6%
Wisconsin	8,271	6,335	6,435	-22.2%
Wyoming	17,855	18,451	18,001	0.8%

Source: Center on Budget and Public Priorities 2018

APPENDIX C

CHAPTER 3 APPENDIX

Table A3. 1: IPRs: Instruments, Subject Matter, Fields of Application, and Related International Agreements

Type of IPR	Instruments of Protection	Subject Matter	Main Fields of Application	Major International Agreements
Industrial property	Patents, utility models	New, non-obvious inventions capable of industrial application.	Manufacturing, agriculture	Paris Convention (1883), Patent Cooperation Treaty (1970), Budapest Treaty (1977), Strasbourg Agreement (1971), TRIPS (1996)
	Industrial designs	Ornamental designs	Manufacturing, clothing, automobiles, electronics, etc.	Hague Agreement (1925), Locarno Agreement (1979), TRIPS
	Trademarks	Signs or symbols to identify goods and services	All industries	Madrid Agreement (1891), Nice Agreement (1957), Vienna Agreement (1973), TRIPS
	Geographical indications	Product names related to a specific region or country	Agricultural products, foodstuffs, etc.	Lisbon Agreement (1958), TRIPS
Literary and artistic property	Copyrights and neighboring rights	Original works of authorship	Printing, entertainment (Audio, video, motion pictures), software, broadcasting	Berne Convention (1886), Rome Convention (1961), Geneva Convention (1971), Brussels Convention (1974), WIPO Copyright Treaty (1996), WIPO Performances and Phonograms Treaty (1996), Universal Copyright Convention (1952), TRIPS
Sui generis protection	Plant breeders' rights	New, stable homogenous, distinguishable plant varieties	Agriculture and food industry	Convention of new Varieties of Plants (UPOV, 1961), TRIPS
	Integrated circuits	Original layout designs of semiconductors	Microelectronics industry	Washington Treaty (1989), TRIPS
Trade secrets		Secret business information	All industries	TRIPS

Note: All international treaties except TRIPS and the Universal Copyright Convention are administered by the World Intellectual Property Organization. Years shown refer to the year in which an agreement was first adopted. *Source:* Primo Braga et al. (2000).

Table A3. 2: Breakdown of the cut-off dummy variables for each year

Year	W1	W2	W3	W4
2003	Freq: 70	Freq: 76	Freq: 53	Freq: 61
	Per: **26.92**	**Per: 29.23**	Per: **20.38**	Per: **23.46**
2004	Freq: 72	Freq: 71	Freq: 88	Freq: 48
	Per: **25.81**	**Per: 25.45**	Per: **31.54**	Per: **17.20**
2005	Freq: 81	Freq: 88	Freq: 80	Freq: 72
	Per: **25.23**	**Per: 27.41**	Per: **24.92**	Per: **22.43**
2006	Freq: 217	Freq: 208	Freq: 208	Freq: 208
	Per: **25.80**	**Per: 24.73**	Per: **24.73**	Per: **24.73**
2007	Freq: 226	Freq: 215	Freq: 224	Freq: 216
	Per: **25.65**	**Per: 24.40**	Per: **25.43**	Per: **24.52**
2008	Freq: 233	Freq: 223	Freq: 224	Freq: 224
	Per: **25.77**	**Per: 24.67**	Per: **24.78**	Per: **24.78**
2009	Freq: 233	Freq: 223	Freq: 224	Freq: 223
	Per: **25.80**	Per: **24.70**	Per: **24.81**	Per: **24.70**
2010	Freq: 239	Freq: 231	Freq: 238	Freq: 232
	Per: **25.43**	Per: **24.57**	Per: **25.32**	Per: **24.68**
2011	Freq: 239	Freq: 239	Freq: 246	Freq: 232
	Per: **25.00**	Per: **25.00**	Per: **25.73**	Per: **24.27**
2012	Freq: 247	Freq: 238	Freq: 239	Freq: 240
	Per: **25.62**	Per: **24.69**	Per: **24.79**	Per: **24.90**
2013	Freq: 256	Freq: 247	Freq: 246	Freq: 247
	Per: **25.70**	Per: **24.80**	Per: **24.70**	Per: **24.80**
2014	Freq: 248	Freq: 238	Freq: 240	Freq: 240
	Per: **25.67**	Per: **24.64**	Per: **24.84**	Per: **24.84**
2015	Freq: 247	Freq: 239	Freq: 241	Freq: 240
	Per: **25.54**	Per: **24.72**	Per: **24.92**	Per: **24.82**

Table A3. 3: Replication of Spatz and Nunnenkamp base run model including OECD dummy variable

Coefficients	Spatz and Nunnekamo	Replicated Results	Replicated Results (OECD)
W	0.58	0.60	0.59
	(0.06)	(0.03)	(0.04)
GDPPC	1.67	1.49	1.51
	(0.00)	(0.00)	(0.00)
POP	1.68	1.56	1.57
	(0.00)	(0.00)	(0.00)
SCH	1.35	1.29	1.28
	(0.08)	(0.04)	(0.05)
RISK	-0.02	-0.02	-0.02
	(0.038)	(0.41)	(0.39
Observations	249	249	249
Uncensored	191	191	191
Left-censored	58	58	58
LR chi2	309.8	317.2	317.3
Prob>chi2	0	0	0
Pseudo R2	0.26	0.27	0.27