ESSAYS IN STATE FUNDING FOR HIGHER EDUCATION

A Dissertation

Presented to

The Faculty of the Department

of Economics

University of Houston

In Partial Fulfillment

Of the Requirements for the Degree of

Doctor of Philosophy

By

Senay D. Topal

December, 2013

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Abstract

This thesis is a combination of two papers studying the effect of state funding for higher education on the price of education and student enrollment at institutions. The first paper evaluates the effectiveness of student aid in decreasing the price of higher education by investigating what portion of student aid dollars reach targeted students and what portion are absorbed by the state and universities through decreasing existing aid or increasing tuition. I find no evidence that either the state government or universities absorb student aid funds, suggesting that a dollar in state scholarships reduces a student's price of attending university by that dollar. I also find that state student aid increases resident student enrollment at both public and private universities and crowds non-resident students out of public universities.

While the first paper demonstrates the effectiveness of state funding for higher education, the second paper studies the importance of the format of funding in decreasing students' price of enrollment and increasing enrollment at institutions. States can reduce the price of higher education by funding students directly, or by funding public institutions, which in turn charge lower in-state tuition. I compare funding public institutions to funding student directly and find that the format of funding has an important impact on the price of education and student enrollment across institutions. I find that redistributing state funding from public institutions into the hands of students reduces the price of attending both public and private institutions and increases student enrollment enrollment at private institutions. These findings suggest that funding students is more effective at decreasing the price of higher education and increasing student enrollment at institutions than funding public institutions.

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1. Introduction

State governments fund higher education for several reasons. One is that over the last few decades the return to high school education has dropped sharply relative to the return to higher education. While a typical male high school graduate in 1972 earned $45,000, for example, a similar individual in 2005 earned only $30,000[1] (Deming and Dynarski, 2009). Due to this decline in relative returns, an individual willing to earn the same level of wages may now have to obtain higher education. This has prompted states to introduce funding programs aiming to alleviate credit constraints to college going and promote college enrollment.

Moreover, higher education has broad societal benefits that extend beyond just the returns of college degree-recipients. The wages of non-college educated workers, for example, are positively correlated with the share of college graduates in that labor market (Moretti, 2004). These positive externalities prompt states to subsidize the consumption of higher education, which would be lower than what is socially optimal without state funding.

Funding for higher education not only increases the earnings of state residents, but may also fiscally benefit the state government. Attending college in a state increases the likelihood of being employed in that state after graduation (Groen and White, 2004). University graduates earn higher wages and contribute more in tax revenue to the state economy, which creates the incentive for states to attract and retain university enrollment. There are several types of funding through which states can increase in-state college enrollment.

States fund higher education through transfers to both universities and students. The last few decades have been characterized by a shift from funding institutions to funding

1 In 2003 dollars.

students directly (Rizzo and Ehrenberg, 2004). Although states have traditionally provided aid to students in the form of both merit-based scholarships for high-achieving students and need-based scholarships for low-income students, merit-based aid in particular has greatly increased in popularity. In spite of this long-term trend, the 2008 economic recession has caused several states to scale some of their funding programs down, raising the question of which types of funding should be cut and which should be preserved to best meet the states' objectives.

This thesis studies the effectiveness of state funding in meeting the states' objectives of reducing the price of higher education and increasing college enrollment. The next chapter of the thesis studies state funding to students, showing that a dollar of merit-based student aid in particular decreases students' net price of attending university by that dollar. The following chapter studies the importance of the format of funding by contrasting the effectiveness of funding students versus funding public institutions and shows that funding students is more effective at reducing the price of higher education and increasing college enrollment.

1.1 What is the Incidence of State Student Aid?

The second chapter of this thesis provides a broad look at the incidence of merit-based aid by examining the distribution of student aid dollars among the state, universes, and students, as well as studying the effect of those dollars on the enrollment of students at universities. The paper investigates what portion of student aid funds reaches targeted students and what portion is absorbed by the state and universities using the introduction of a

merit-based student aid program in Tennessee as a natural experiment. The Tennessee Education Lottery Scholarships (TELS) program introduced new merit-based scholarships for Tennessee residents with the goals to incentivize high school achievement, increase access higher education, and retain the best students in the state.

States increase university enrollment by subsidizing students' price of attending university. One of the ways states accomplish this is by disbursing financial aid to students. Not all of the state scholarships disbursed to students, however, induce additional in-state enrollment. Although some of the scholarships are awarded to students who would not have enrolled without them, a large portion of the funds subsidize students who would have enrolled in college anyway. This gives the state and universities the opportunity to absorb funds from students who would have enrolled anyway by decreasing existing student aid or by increasing tuition. Such absorption decreases the effectiveness of student aid in reducing the price of education, and depending on who the state and universities absorb funds from, it could also diminish the effectiveness of student aid in inducing additional university enrollment.

While the state and universities could have absorbed funds by reducing existing student aid or increasing tuition, I conduct a detailed investigation of the Tennessee program and find no evidence of that occurring. The results suggest that a dollar in state scholarships reduced the recipient student's price of attending university in-state by that dollar. The scholarships increased Tennessee resident student enrollment in both public and private universities.

The impact of the Tennessee student aid program extended beyond the boundaries of

the state. According to the framework proposed by Besley and Case (1995), voters in neighboring states may have compared the performance of their legislators to legislators in Tennessee. Such public pressure may have been what prompted legislators in neighboring states to increase funding for higher education a year after the introduction of the program in Tennessee. This increase in funding in turn increased student enrollment in neighboring states relative to other states in the region.

1.2 Does the Format of Funding for Higher Education Matter?

The second chapter of this thesis demonstrates the effectiveness of state funding for higher education by showing that state aid to students reduces students' net price of education and increases university enrollment. The third chapter investigates whether the format through which states fund higher education matters in terms of price and student enrollment at institutions. The two formats I compare are state funding to public institutions, which subsidizes lower in-state tuition, and state funding to students, which subsidizes students directly.

I investigate whether funding students instead of public institutions affects the price and enrollment at institutions by using the introduction of the College Opportunity Funds (COF) program in Colorado as a natural experiment. The COF program took a portion of funding away from public institutions and redistributed it to students in the form of vouchers. One of the goals of the program was to promote the enrollment of state resident students at in-state institutions.

It is unclear how public universities respond to a loss of funding from the state. Although public institutions responded by increasing their prices in order to recoup lost revenue from the state, they may not have increased their prices by the size of the new vouchers. The decision of how much to increase attending price may depend on what other sources of funding institutions have and on what portion of the lost funding was devoted to subsidizing in-state tuition. In addition, the price increase may be diminished if institutions prefer to respond by decreasing expenditure rather than maintaining revenue. After conducting a detailed investigation, I find that public institutions responded to the loss of revenue from the state by increasing prices by less than the size of the student vouchers.

The introduction of the vouchers also gave private institutions the opportunity to absorb voucher funds by increasing their prices. I find no conclusive evidence that private institutions absorbed voucher funds, which is consistent with the findings in the second chapter. This suggests that a dollar in vouchers decreased a student's price of attending a public institution by less than a dollar, but decreased the price of attending a private institution by that dollar.

The vouchers increased student enrollment only in private institutions where the net decrease in price caused by the vouchers was largest. The lack of redistribution of enrollment from public to private institutions in spite of the relative change in prices implies that the increase in student enrollment in private institutions may not have consisted of students who would have enrolled in public institutions. This leaves out students who would not have enrolled in college altogether or students who would have enrolled in college out-of-state.

1.3 Comparison of the Tennessee and Colorado Programs

The thesis answers the questions posed above by examining two policy experiments introduced in two different states. I study the incidence of state student aid dollars by examining the Tennessee Education Lottery Scholarships program introduced in 2004 and I study the importance of format in state funding for higher education by examining Colorado's College Opportunity Fund program introduced in 2005.

Both programs were introduced with similar intent. The main goals of the programs were to increase state resident students' access to higher education and to retain the best students in the state. Naturally, this raises the question of which program is more effective at accomplishing those goals.

Both programs were introduced within the same recent time period, so the the response of institutions and students to each program is unlikely to be different due to changes in education production technology or student preferences for education. Both programs were also introduced in relative isolation to other states in their respective geographical region, making institutions in surrounding states a natural comparison group for institutions in the program states.

The main difference in the two programs was that the Tennessee program introduced additional funds to higher education funding, while the Colorado program redistributed existing funding from public institutions to state resident students. Another potentially important difference, possibly relevant to student ability at institutions, is that student aid in the Tennessee program had merit-based qualification requirements, while the Colorado

program did not. These differences in the program provisions caused important variation in how the two programs affected the price of education and student enrollment across institutions.

1.4 Comparison of the Tennessee and Colorado Program Outcomes

Although the introduction of additional student aid dollars in the market for higher education gives institutions the opportunity to absorb those additional funds, I find no strong evidence of additional fund absorption in either Tennessee or Colorado. The behavior of institutions in response to additional student aid funds from the state was consistent across the two programs. The student aid introduced in Tennessee represented additional funds in both public and private institutions, but due to the decrease in state funding to public institutions, the student aid introduced in Colorado represented additional funds only in private institutions. The additional funds introduced by the Tennessee program were not absorbed, but rather reduced students' price of attending university dollar for dollar. The additional funds in private institutions introduced by the Colorado program were not absorbed either and also reduced students' price of attending private institutions dollar for dollar.

While a dollar in Tennessee student aid decreased the price of attending public and private institutions by exactly a dollar, a dollar in Colorado student aid caused a smaller decrease in the price of attending public institutions. This price distortion caused by the Colorado program created the potential for redistribution of student enrollment away from

public and intro private institutions in the program state.

The Tennessee program scholarships, which reduced the price of attending public and private institutions by the same amount, increased enrollment in both public and private institutions. The Colorado scholarships, which reduced the the price of enrollment in private institutions more on the other hand, increased enrollment in only private institutions. It is interesting to note that the change in relative prices of attending public and private institutions did not redistribute enrollment from public to private institutions. The increase in private institution enrollment was likely composed of students who would not have enrolled in college altogether or of students who would have enrolled out-of-state.

Cornwell et al.(2006) find that Tennessee-style merit-based programs increase admission test scores at institutions, while the Colorado program which did not have merit-based requirements had no significant impact on admission test scores. This suggests that the increase in test scores may have been due to students meeting scholarship eligibility requirements rather than due to meeting university admission criteria.

1.5 Implications for State Higher Education Funding Policy

The above differences in the effect of the Tennessee and Colorado programs present an opportunity to propose policy recommendations for achieving specific state objectives. Both policies reduce the price of education faced by students, but a Tennessee-style program is more effective at subsidizing students and reduces aid-receiving students' price of attending college by the amount of the scholarship. The merit-based aspect of the Tennessee

program, however, prevents some students from qualifying for the scholarships. The choice between the two programs, therefore, presents a tradeoff between the effective size of the subsidies and the number of students receiving the subsidies.

Both programs also increase aggregate student enrollment in the state. While the Colorado program increases enrollment only in private institutions, the Tennessee program increases student enrollment at both public and private institutions. The Tennessee program is therefore more effective in increasing aggregate college enrollment in the program state.

Previous research has found that Tennessee-style merit-based aid increases the admission test scores of students enrolled at institutions (Cornwell et al., 2006). Chapter three of this dissertation finds no persisting effect of redistributing funding from institutions to students on student test scores, which is likely due to the lack of GPA or admission test score requirements in the awarded scholarships. Merit-based aid may therefore be better at increasing student ability at in-state institutions.

Although a Tennessee-style program that introduces additional funds for higher education is more effective in subsidizing students, increasing enrollment, and increasing student ability at institutions, implementing a Colorado-style redistribution of funds does not cost the state additional resources. This suggests that the two programs can be implemented simultaneously to further reduce the price of education and increase student enrollment at no additional cost to the state.

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2. The Incidence of State Student Aid:

Evidence from the Tennessee Education Lottery Scholarships

Abstract: This paper investigates the distribution of student aid funds among the state, universities, and students. Using a merit-based aid program introduced in Tennessee as a natural experiment, I find no evidence that the state absorbed aid program funds by decreasing funding to students or universities. I also find no evidence that universities absorbed program funds by decreasing student aid or increasing tuition, suggesting that the aid program scholarships were a dollar for dollar reduction in students' net price of attending university. I find that this reduction increased Tennessee resident student enrollment. Moreover, using a difference-in-differences strategy with universities further from Tennessee as a comparison group yields enrollment effects up to three times the size of the largest found by comparable studies. This suggests that the response in non-program states may have caused previous difference-in-differences studies to underestimate the effect of student aid on university enrollment.

2.1 Introduction

The two main types of student aid awarded by state governments are need-based aid for low-income students and merit-based aid for students meeting GPA and test score requirements. This study focuses on merit-based student aid which has been increasing over the last two decades relative to other types of funding. Most previous studies on merit-based aid have examined its effect on students and institutions in the market for higher education in isolation. Kane (2003), Dynarski (2000, 2002, 2003, 2004), Cornwell et al. (2006), and others find that merit-based aid increases student enrollment**.** These partial equilibrium studies, however, ignore potential market-wide changes that may affect the accuracy and interpretation of their estimates. One example of such general equilibrium changes is Long (2004)'s finding that some institutions responded to a merit-based aid program in Georgia by increasing tuition and decreasing student aid, which resulted in a lower than intended reduction in students' price of attending university.

This paper provides a broader look at the incidence of state merit-based aid by considering its impact on various parties in the market for higher education together. I study the program effect on both program-targeted state resident students as well as the state government, universities, and non-resident students. Furthermore, I expand the analysis beyond the program state by investigating the program impact in non-program states in the same region. Although the incidence of the aid dollars is the main focus of the paper, I also match the amount of aid that reaches targeted students to the number of program-targeted and not targeted students enrolled at universities. This lets me estimate the price elasticities of

demand for student enrollment at different types of universities.

I investigate whether TELS (Tennessee Education Lottery Scholarships program) incidence fell on the state government due to absorbing TELS funds by reducing other aid to students or by reducing funding to universities. I also investigate whether TELS incidence fell on universities due to increased tuition or decreased aid to students. After finding the TELS effect on the net price of enrollment, I also estimate the effect on student enrollment at different types of universities. In sum, the previously unexplored aspects of merit-based aid I study are whether the state absorbed program funds by substituting between new and existing funding to students**,** how aid-ineligible non-resident students were affected by the program, whether the program response was different in research and teaching universities, and what the response to the program in non-program states was.

Studying the Tennessee program enables me to circumvent the endogeneity of student aid by using the introduction of the program in 2004 as a natural experiment. The endogeneity problem arises because states determine funding for higher education with formulas based on outcomes such as tuition, enrollment, and other state funding. TELS offers a unique dataset that enables me to examine more channels through which program fund spillover can occur, such as substitution between new and old student aid by the state. The data also allows me to more narrowly identify the students targeted by the aid program in institutions. While other studies have investigated the effect of merit-based aid on total student enrollment (Cornwell et al., 2006; Singell et al., 2006**)**, this study differentiates between the effects on state resident[2] students and non-resident students who were ineligible

2 67% of state resident students attended a public institution on a TELS scholarship during the first year of the program.

to receive the program scholarships**.** Following Cornwell et al. (2006), I focus on 4-year public and private universities[3].

Although this is not the first paper to study TELS, to my knowledge, it is the first to investigate the institutional response to the program. Pallais (2009) as well as Bruce and Carruthers (2013) study the program's impact on students' college preferences and college enrollment, while this study focuses primarily on the program's impact on the pricing behavior of institutions. The pricing behavior of universities in response to merit aid has become especially relevant due to the proliferation of merit-based aid programs.

Over the last two decades, merit-based aid has been gaining popularity in state funding for higher education with increasing number of states adopting this type of program. Since the introduction of the Arkansas and Georgia merit-based programs, which have served as the model for other programs to follow, numerous states, including Florida, Kentucky, Louisiana, Michigan, New Mexico, Nevada, South Carolina, West Virginia, and Tennessee, have adopted similar large student aid programs (National Association of State Student Grant and Aid Programs). States' commitment to student aid varies, but the programs can get as large as $436.4 million for Georgia and $333.8 million for Florida in 2011-2012 (NASSGAP).

Student aid programs increase the provision of higher education by subsidizing students' cost of enrollment. Spillovers of the subsidy benefits, however, can diminish their effectiveness in reducing the price of attending university. There are various channels through which these spillovers can occur. A student aid program may impact not only

3 Cornwell (2006) also studies the effect of the Georgia HOPE program in 2-year public institutions, but finds that the enrollment effects of the program are concentrated in 4-year institutions.

targeted award-receiving state resident students, but may also affect the state government, universities, and non-resident students. Because of the potential responses of the other parties in the market, not all of the economic benefit of the program may reach its intended recipients. In addition, the interests of state resident students may differ from the interests of the other parties, which may lead to some program funding not serving its intended purpose.

While one portion of the aid program funds serves its intended purpose of inducing additional university enrollment by targeting resident students who would not have enrolled without it, a large portion of the funds is a transfer to resident students who would have enrolled anyway. Studying the Georgia HOPE program, Dynarski (2000) concludes that 20% of that program's funds induced students who would not have enrolled without it to enroll in college, while 80% of the program funds subsidized students who would have enrolled anyway. This gives the state and universities an opportunity to absorb program funds from aid-receiving students without necessarily reducing total student enrollment.

Although states have the opportunity to absorb funds, the decision to do so depends on how they perceive the program. If they perceive the program funds as additional revenue, states may absorb funds in order to reoptimize public spending across different categories. This is especially relevant for many recently implemented merit-based aid programs that are funded through channels independent of state tax revenue such as state-ran lotteries. Two possible channels through which states can absorb program funds are by reducing other aid to students, which has not been previously explored, or by reducing funding to universities. After checking both mechanisms of absorption, I find no evidence that the state absorbed aid program funds.

The behavior of universities will likely vary by university type. In models of university behavior, prestige-maximizing universities compete in resources in order to increase their attractiveness to potential students (Epple et al., 2006; Epple et al., 2013). Universities can absorb program funds from award-receiving students in order to increase revenue and resources by either increasing tuition or decreasing university aid. Universities' ability to absorb funds by adjusting tuition independently of the state could differ by whether they are public or private. Their capacity to absorb program funds, on the other hand, depends on the number of award-receiving resident students they attract. It has been suggested that academic research activity may be a signal for university quality (Siow, 1997), in which case research universities may attract more high ability students that are merit-based aid recipients. This could concentrate the program's enrollment effects in research universities and/or increase research universities' capacity to absorb program funds. If universities do in fact absorb funds, what they are spent on might also differ by how they prioritize academic activities such as research and teaching.

Long (2004) analyzes the Georgia HOPE program and finds some evidence that universities absorbed funds in response to the introduction of a merit-based aid program by increasing tuition or decreasing university aid and that on average they did not spend the absorbed funds on instruction expenditure. In addition to investigating differences in absorption and spending between public and private universities, I also investigate differences in absorption and spending between research and teaching universities, which has not been studied. Unlike Long (2004), I find no strong evidence of program fund absorption by universities after using an alternative method for inference with difference-in-differences

and a small number of clusters.

The lack of absorption by the state and universities suggests that TELS subsidized scholarship-receiving students' price of attending university in-state. However, the program may have also indirectly impacted the enrollment of non-resident students. Non-resident students are ineligible to receive program scholarships, but they can still be affected through the behavior of scholarship-receiving students and program-participating universities. The impact on non-resident students will likely also differ across university types. Public universities, for example, give priority admission to resident students, while private universities do not (Groen and White, 2004). This may cause scholarship-recipients to crowd non-resident students out of public universities. On the other hand, a crowd-out may be diminished by how public universities value tuition revenue (due to a non-resident student in a Tennessee public university paying three times the resident tuition rate). Because on average non-resident students in public universities have higher admission test scores than resident students, selective public research universities, which may place more value on admission test scores relative to students' residence, may not even experience a crowd-out.

These theoretical considerations make the impact of aid to resident students on non-resident student enrollment at universities difficult to predict. Cornwell et al. (2006) investigate a merit-based aid program's effect on aggregate state-level non-resident student enrollment, but do not study the effect of the program on the distribution of non-resident student enrollment within the program state. I find that TELS increased resident student enrollment at universities, but that it had no statistically significant effect on the enrollment of non-resident students in Tennessee.

The merit-based aspect of the student aid program would suggest that the increase in resident student enrollment in Tennessee likely consisted of higher ability students. Previous papers find positive peer effects on student achievement (Carrell et al., 2009; Lyle, 2007; Sacerdote, 2001; Zimmerman, 2003); therefore, a change in student ability at universities may also affect the production of education at institutions. Models of university behavior suggest that universities admit students in declining order of ability (Groen and White, 2004) or according to a minimum ability threshold (Epple et al., 2006; Epple et al., 2013). Merit aid recipients are likely of higher ability than universities' admission threshold and also likely increase student ability at the universities they enroll in. Models of university behavior also suggest that private universities may absorb and reallocate student aid funds to attract higher ability students (Epple et al., 2006; Epple et al., 2013). Studies of merit-based student aid find a positive effect on admission test scores, but they do not account for the possible response in neighboring states, which may bias the estimated effect. (Cornwell et al. 2006; Palais, 2009). Using a comparison group that I argue to be less contaminated by the effect of TELS, I explore whether the format of funding affects student ability across institutions by estimating the effect of TELS on ACT test scores in public and private universities and find that TELS increased ACT test scores in private universities.

In addition to affecting the state market for higher education, state spending can also influence spending patterns in other states in the region. Various studies have demonstrated the interdependence of sub-national government spending. Case and Rosen (1993) and Baicker (2005) in particular have shown that spending at the state level affects the spending of neighboring states. Testing for a response to TELS in neighboring states, I find that states

bordering Tennessee increased funding to public universities and students enrolled in them relative to other states in the region. This in turn increased student enrollment in public universities bordering Tennessee relative to other public universities in the region. Correcting for this response in the control group by using only universities in states further from Tennessee as a comparison group as much as doubles some of the estimated aid program effects on enrollment.

The rest of this paper is organized as follows. Section 2.2 describes relevant details about the implementation of the TELS program. Section 2.3 outlines the empirical strategy and the additional checks that were performed. Section 2.4 describes the university-level data employed in the empirical analysis. Section 2.5 presents the main results of the study. Section 2.6 presents robustness checks. Section 2.7 concludes with implications for economic research and public policy.

2.2 Background of The Tennessee Education Lottery Scholarships

The purpose of the Tennessee Education Lottery Scholarships program was to incentivize high school achievement, promote access to higher education, and retain the best students in the state. The funding for the scholarship program was approved by a referendum that passed in November 2002 with the lottery funds being earmarked for scholarships for higher education. House bill 787, enacting the Tennessee Education Lottery Scholarships program, was signed into law in June 2003 and the scholarship program itself became effective the academic year of 2004-2005. Surprisingly, there is nothing in House bill 787

enacting TELS that prevents the state government from recouping funds by reducing existing funding for higher education or prevents universities from absorbing aid program funds by adjusting their attending price.

The potential for TELS fund absorption by the state and universities depends on how large the amount of TELS scholarships[4] disbursed to students is. The HOPE scholarship and its supplements made up by far the largest portion of all scholarships awarded and all dollars disbursed with 31,272 out of a total of 40,195 scholarships awarded and $86,650,189 out of a total of $93,416,022 disbursed in the first program year[5]. The average dollar amount of HOPE scholarships disbursed in a public university at the program introduction in the Fall semester of 2004 was $3,419,894, while the average number of first-time full-time[6] students in a public university was 2,216 students. This translates to an average of $1,595 of real TELS funds per first-time full-time[7] student disbursed in public universities.

How much of those funds can be recouped by the state depends on the levels of existing state funding to universities and students. The average real state funds to students in public universities in academic year 2003-2004 before the introduction of the program were $292 per full-time student, while the average real funds to public universities were $7,018 per full-time student. The state can absorb 18% of the TELS funds by reducing funding to

4 The TELS program includes several scholarships with different award sizes and qualification requirements, but the two scholarships that can be used in 4-year universities are the HOPE scholarship and the HOPE Access Grant. To qualify for either scholarship, a high school student must have been a Tennessee resident for at least a year prior to the scholarship application deadline and must enroll in a program-participating Tennessee institution of higher education within 16 months of graduating a Tennessee high school. To qualify for the base HOPE scholarship award of $3,000, a high school student must have a 3.0 GPA or a 19 ACT score. A HOPE scholarship recipient can qualify for a $1,000 merit-based supplement if he has 3.75 GPA or a 29 ACT score or qualify for a $1,000 need-based supplement if his household income is lower than $36,000. To qualify for the HOPE access grant award of $2,000, a high school student must have a 2.75-2.99 GPA and an 18 ACT score, as well as household income lower than $36,000.

5 The numbers of awards and dollars disbursed include 2-year institutions.

6 An undergraduate student is considered to be enrolled full-time if taking 12 credit hours.

7 Converted to 2005 dollars using the GDP implicit price deflator from the Bureau of Economic Analysis.

students and it can absorb the full $1,595 per full-time student of TELS funds disbursed in public universities by reducing funding to public universities.

The TELS fund absorption capacity of the public universities in Tennessee depends on the flexibility in adjusting resident student tuition and the level of institutional aid awarded to students. Tuition levels have high public exposure, so universities may be apprehensive in absorbing funds through tuition increases. The average real institutional aid in academic year 2003-2004 before the introduction of the program was $1,043 per full-time student, giving public universities the ability to absorb 36% of the TELS funds by decreasing institutional aid to students[8].

The potential for TELS fund absorption from scholarship recipients in private universities depends on the amount of dollars disbursed in the private sector. The Tennessee Student Assistance Corporation reports that the average amount of HOPE dollars disbursed in a private university at the program introduction in the Fall semester of 2004 was was $502, 915. The average number of first-time full-time students in a private university was 292 students. This means that an average of $1,780 of real TELS funds per first-time full-time student were disbursed in private universities.

The average real state funds to students in private universities in academic year 2003-2004 before the introduction of the program were $292 per full-time student. This means that the state is able to absorb about 16% of TELS funds disbursed in private universities by reducing existing funding to students. Private universities can also absorb program funds by increasing tuition charges or decreasing university aid to students. Average real institutional

8 If the existing institutional aid to students was received by TELS-eligible students, universities can absorb the funds from TELS recipients. If the existing institutional aid was awarded primarily to TELS non-recipients, universities can absorb funds from non-recipients and simply substitute between the enrollment of new TELS-receiving students and old institutional aid-receiving students.

aid in academic year 2003-2004 before the introduction of the program was 5,092 per full-time student, giving private universities the ability to absorb the full amount of TELS funds by decreasing institutional aid to students.

The 19 ACT score requirement to receive the base scholarship was well above the ACT 25th percentile scores at universities in Tennessee before the program introduction. The average ACT Math and ACT English 25th percentile scores in public universities were 17.08 and 18.04, while the average ACT Math and ACT English 25th percentile scores in private universities were 16.61 and 17.74. If universities admit students in declining order of ability or according to a minimum ability threshold, then an influx of scholarship-receiving students with high ACT scores should raise the test scores of students in Tennessee universities.

Although no new student aid programs were introduced in surrounding states within the studied time interval[9], neighboring states can still respond to the Tennessee program by adjusting existing higher education funding. States neighboring Tennessee had higher levels of funding to public universities with average revenue from the state in Tennessee and neighboring-state public universities being $7,273 and $10,288, respectively. Therefore, any funding decrease in Tennessee can be fully mimicked by neighboring states.

2.3 Empirical Framework

I employ a difference-in-differences identification strategy to estimate the reduced form effect of the TELS program at the university level. The strategy compares university outcomes in Tennessee before and after the program introduction to university outcomes in

9 Years 1999-2000 through 2006-2007.

surrounding states before and after the program introduction to weed out any secular time trends in the examined outcome variables.

I investigate the distribution of the TELS funds by state government, universities, and students. I identify the program funds absorbed by the state government as a negative effect of the TELS program introduction on state funding to universities or a negative effect on state aid to students. I define funds absorbed by universities as a positive effect of the program introduction on tuition and a negative effect on aid to students. I consider any TELS funds not absorbed by the state or by universities to have subsidized scholarship-recipients' price of attending university. In addition, I estimate the effect of the TELS introduction on student enrollment and ACT test scores at universities.

The main specification for university i in state s in year t is

$$Y_{ist} = \alpha + \beta(Tennessee_s * After_t) + \gamma_i + \delta_t + \varepsilon X'_{st} + e_{ist} \quad (2.1)$$

where Y_{ist} is the university-level outcome variable such as revenue from the state, number of students receiving state aid, tuition, university aid, or student enrollment. $Tennessee_s$ is a dummy variable taking value one for universities in Tennessee, $After_t$ is a dummy variable taking value one for years after the introduction of the program, and β is the reduced form difference-in-differences estimate of the effect of TELS on the outcome variable. γ_i are university dummies accounting for time-invariant university effects, δ_t are year dummies accounting for general year effects, while X'_{st} is a set of state-level economic and demographic covariates accounting for the possibility that states with differing economic and

demographic characteristics related to the outcome variable may have different tastes for state-funded student aid.

An assumption necessary for the control group to be valid is that there was no response to TELS in the comparison group. I check this by testing whether there was a response in states bordering Tennessee due to the closer geographic proximity and higher competitive pressure from program-participating universities. Studies find that a $1 increase in state spending increases the spending of neighboring states by $0.50 to $0.90 (Case and Rosen, 1993; Baicker, 2005), which suggests that a program response in states further from Tennessee will be diluted. Moreover, neighboring states may respond with a time delay, which suggests that the response in states further from Tennessee will be delayed more. This makes universities in states further from Tennessee a better comparison group. The second specification, studying the effect of TELS in neighboring states, compares university outcomes in states bordering Tennessee before and after the introduction of TELS to university outcomes in states further from Tennessee before and after the introduction of TELS. The specification for university i in state s in year t is

$$Y_{ist} = \alpha + \beta(Border\ state_s * After_t) + \gamma_i + \delta_t + \varepsilon X'_{st} + e_{ist} \quad (2.2)$$

where Border state$_s$ takes value one for universities in states bordering Tennessee. I estimate a significant response in states neighboring Tennessee relative to states further from Tennessee, showing that universities in states further from Tennessee should be used as a comparison group in specification (2.1).

Bertrand et al. (2004) point out that using conventional standard errors in difference-

in-differences studies may lead to constructing wide confidence intervals and estimating significant coefficients in the absence of actual treatment effects. Following Bertrand et al. (2004), I collapse the panel of data into one pre-treatment and one post-treatment periods to correct the standard errors for serial correlation. The authors show that this yields the correct rate of committing a Type I error even when the number of states in the sample is small. Inference with this correction leads to different conclusions than those of studies using more conventional methods, implying that those studies may have estimated significant coefficients in the absence of real program effects.

One of the underlying assumptions necessary to interpret the difference-in-differences estimate as the causal effect of TELS is that any discontinuous change in the studied outcome is due to the program introduction. I check this by examining whether the timing of discontinuities in the outcome variable is consistent with the timing of the program introduction. Another necessary assumption is that universities in Tennessee and universities in the control states would have continued on the same parallel trends had the program not been introduced. I check this by testing whether universities in Tennessee and the control states had parallel trends in the studied outcomes before the program introduction. These assumptions are tested using the specification for university i in state s in year t

$$Y_{ist} = \alpha + \beta_1(Tennessee_s * year2001_t) + \ldots + \beta_6(Tennessee_s * year2006_t) + \gamma_i + \delta_t + \varepsilon X'_{st} + e_{ist} \quad (2.3)$$

where the base year 2000 is excluded[10]. The interaction terms are interpreted as the

10 The actual base year and beginning interaction term included in the regression depends on what the first year of available data is.

differences between the difference from base year in Tennessee and the difference from base year in the comparison states.

The last specification, which checks for a difference in the program response of research and teaching universities, due to the possibility of research universities attracting more award-recipients, is

$$Y_{ist} = \alpha + \beta_1(Research_i * After_t) + \beta_2(Tennessee_s * After_t) + \beta_3(Research_i * Tennessee_s * After_t) + \gamma_i + \delta_t + \varepsilon X'_{st} + e_{ist} \quad (2.4)$$

where $Research_i$ is a dummy variable taking value one for universities classified as research institutions by the Carnegie Foundation in 2005, β_2 is the general reduced form difference-in-differences estimate of the program effect, and β_3 is the difference of the program effect between research and teaching universities.

2.4 Data

The study is conducted on a balanced panel of degree-granting 4-year public and 4-year not-for-profit private universities in Tennessee and its surrounding states studied over the years ranging from 1999 through 2006. This gives me a maximum of five pre-program introduction years and three post-program introduction years. The choice of control states and years is determined by the absence of other major state aid programs being introduced in

the region[11] and data availability limitations[12]. The set of control universities in the sample is made up of institutions in Tennessee's eight bordering states of Alabama, Arkansas, Georgia, Kentucky, Mississippi, Missouri, North Carolina, and Virginia and the ten non-bordering states in the same region of Florida, Illinois, Indiana, Iowa, Kansas, Louisiana, Nebraska, Ohio, Oklahoma, and West Virginia. The sample excludes universities in South Carolina, which introduced a large state-funded student aid program in 2003[13].

The university-level data used in the study comes from the various survey components of the Integrated Postsecondary Education Data System[14] from the National Center of Education Statistics. The variables used to determine whether the state government absorbed program funds by reducing already existing funding to students are the number of first-time full-time undergraduates receiving state aid and the number of first-time undergraduates receiving a TELS scholarship[15]. The variable used to determine whether the Tennessee government absorbed TELS funds by reducing funding to public universities is the real revenue from state appropriations per full-time student[16]. The variables used to determine

11 States that introduced a program awarding more than a total of $10 million in scholarships are excluded from the sample. In academic year 2007-2008 Missouri introduced a $72 million program and North Carolina introduced a $35 million program.

12 Annual enrollment data for public and private universities from the Residence and Migration of First-time Freshmen component of the Enrollments survey in IPEDS is available only after year 2000. In fiscal year 2001-2002 IPEDS introduced a change in the financial data reporting standard making previously reported data not directly comparable.

13 The South Carolina program targeted only 2-year colleges, but the state is excluded in case the program shifted the distribution of students between 2-year colleges and 4-year universities, which can pollute my estimates.

14 Due to the difficulty of obtaining a sizable overlap of universities responding to all of the different IPEDS survey components, the study is conducted on four overlapping samples. Those are the university finances, attendance price, enrollments, and test scores samples as described in Table 2.1.

15 Although part-time students are eligible to receive TELS scholarships, most TELS scholarship recipients enrolled full-time. For example, only 2% of TELS scholarship recipients in 2010 were part-time students (Tennessee Higher Education Commission). Data on the dollar amount of TELS scholarships disbursed in individual institutions is not available from the Tennessee Higher Education Commission, therefore the paper examines whether the state reduced existing funding to students by comparing the number of students receiving state aid to the number of students receiving a TELS scholarship.

16 These are funds disbursed from the state to public universities and do not include state student aid.

whether universities absorbed TELS funds by increasing tuition charges or decreasing university aid to students are the real published resident and non-resident tuition and fees for first-time full-time undergraduates and the real institutional aid per full-time first-time undergraduate student. The variables used to determine the reduced form enrollment effect on resident and non-resident students are the number of resident first-time undergraduate students and the number of non-resident first-time undergraduate students[17]. The variables used to determine whether TELS had an effect on student ability are the ACT Math 25th percentile score and ACT English 25th percentile score at universities. If universities admit students in declining order of ability or according to a minimum ability threshold, then the lower percentile test scores should be closer to the test scores of the marginal student. This lets me compare the test scores of the marginal students across universities, as proxied by the 25th percentile scores.

All dollar-unit variables are converted to 2005 dollars using the GDP implicit price deflator from the Bureau of Economic Analysis. The state-level economic and demographic covariates accounting for different state tastes for student aid are the state median household income from the U.S. Bureau of Census, the average annual unemployment rate from the Bureau of Labor Statistics, and the share of 18 to 24 year-old state population from the U.S. Bureau of Census. Summary statistics of the data before the program introduction are presented in Table 2.1.

2.5 Results

17 IPEDS identifies a non-resident student as one who is not a legal resident of the state in which he attends school.

Tables 2.2 through 2.5 investigate the effect of TELS on university outcomes in Tennessee. Each row presents estimates from a separate regression. The reported coefficient is from estimating specification (2.1) as described in the empirical framework section. The reported coefficients are the average difference-in-differences in the outcome of universities in Tennessee and states in the region that do not border Tennessee. The comparison group is made up of universities further from Tennessee to reduce the TELS effect contamination to the comparison universities. The data has been collapsed into one pre-TELS period and one post-TELS period following Bertrand et el. (2004) to correct for serial correlation. The accuracy of the point estimates is examined further in Section 2.6.

2.5.1 TELS Fund Absorption by the State

Table 2.2 presents the results investigating whether the Tennessee state government absorbed new TELS funds in response to the introduction of the program. The first and second rows inspect whether the state absorbed funds by decreasing other funding to students. To determine whether the state substituted between new and existing funding to students with the intent to recoup program dollars, I compare the TELS-induced increase in the number of students receiving any state scholarships to the increase in the number of students receiving TELS scholarships. The dependent variables in this case are in levels for the increases in numbers to be directly comparable.

The first row of Table 2.2 shows that on average TELS increased the number of

freshmen receiving state aid for each public university in Tennessee by 1,351 students. According to this estimate, 77% of state resident students in public universities enrolled on a state scholarship after the program introduction. For comparison, that share before TELS was 20%.

I determined that TELS caused a large increase in the number of students receiving state aid. Next, I determine what portion of that increase consisted of TELS scholarships. The dependent variable in the next column is the number of freshmen receiving a TELS scholarship in public universities. The difference-in-differences estimate from specification (2.1) shows that on average 1,432 freshmen in a public university attended on a TELS scholarship.

The results indicate that on average 1,432 freshmen in a university received TELS scholarships, but the number of freshmen receiving state aid increased by only 1,351 students. This implies that the state may have responded by reducing the number of students receiving aid by the difference of 81 students. This 81 student difference, however, is not statistically different than zero. I find no evidence that the state absorbed TELS funds by reducing other funding to students.

State student aid levels may have been under high public exposure during the introduction of the program, forcing the state to absorb funds through a less visible channel. The last row of Table 2.2 investigates whether the state absorbed funds by reducing existing funding to universities. The dependent variable is the log of revenue from the state at public universities. The coefficient 0.114 is positive and significant at the 90% level indicating that on average the state may have increased funding to public universities by 12%[18]. This is an

18 The exact percent change implied by the coefficient is $e^{0.114} - 1 = 0.12$

$873 per enrolled student increase in funding from the state. The possible increase in funding to universities suggests that the state may have bolstered the new TELS scholarships for students with additional funding to universities, rather than attempting to recoup money by reducing other sources of funding. This finding is consistent with Long (2004) who also finds that funding to universities may be complementing rather than substituting merit-based student aid.

2.5.2 TELS Fund Absorption by Universities

Although universities did not have to compensate for a decrease in funding from the state, they could have still chosen to absorb funds with the goal of increasing institutional resources. Table 2.3 presents the results from the regressions exploring whether universities in Tennessee absorbed aid funds in response to the introduction of the program by increasing tuition or by decreasing university aid. Results are presented for both public and private universities.

The results of the regressions investigating the effect of TELS on public university tuition present no strong evidence in favor of absorption. Public universities may not have been able to increase tuition due to various reason such as public exposure or state government pressure, but they may have absorbed aid funds by decreasing university aid to students, which receives less public attention. However, the estimated coefficient in the last column of Table 2.3 is not significantly different than zero. I find no evidence that public universities absorbed TELS funds by decreasing student aid, which would have been the less

visible channel through which this could have been accomplished.

While public universities may have been under government pressure to maintain their existing price of attendance, private universities enjoy more autonomy in their pricing decisions. On the other hand, they also operate under competitive pressure from public universities which did not adjust their attending price. None of the estimated coefficients in any of the regression investigating the TELS effect on tuition and institutional aid in private universities are statistically significant, suggesting that similarly to public institutions, private universities did not adjust their attending price.

These results contradict Long (2004) who finds that private universities increased their price of attendance in response to a similar merit-based program. The author's finding is based on clustering the standard errors, which may produce excessively low standard errors with a small number of clusters (Bertrand et al. 2004).

2.5.3 TELS-induced Enrollment at Universities

The results so far present no compelling proof that the state or universities absorbed TELS program funds by increasing scholarship recipients' price of attending university. This implies that one dollar of TELS scholarships reduced the scholarship recipient's net price of enrolling in both public and private universities by that dollar. However, because tuition in private universities in Tennessee is approximately three times the tuition in public universities, a dollar in scholarships represents a larger percentage reduction in public university students' price of attendance. Table 2.4 explores how the student aid program

affected student enrollment at public and private universities.

The difference-in-differences estimate 0.439 in the first row of Table 2.4 shows that on average TELS increased the number of resident freshmen students in every Tennessee public university by 55%. Public universities also gained in total student enrollment. The 0.343 difference-in-differences estimate in the last row of Table 2.4 shows that on average TELS increased total freshman enrollment in Tennessee public universities by 41%. The program did not have a statistically significant impact on non-resident student enrollment at public universities.

Gains in resident student enrollment may have been smaller in private universities because the scholarships constitute a smaller percentage change in attending price. The 0.176 coefficient in the first row of Table 2.4 shows that on average TELS increased resident student enrollment in private universities by 19%. The increase in total freshman enrollment, however, was not statistically significant than zero.

Unlike Cornwell et al. (2006), who find that another merit aid program increased student enrollment in private universities more, I find that TELS increased student enrollment at public universities by a larger proportion. Cornwell's estimates for public universities are sensitive to the comparison group and suggest that comparing the effect on universities in the program state to universities in states further from the program state would have yielded larger coefficients that are closer in size to mine.

2.5.4 TELS Impact on Test Scores at Universities

The TELS scholarships had test score requirements that were higher than the lowest quartile ACT score before the program introduction in both public and private universities. TELS also increased resident student enrollment in both public and private universities. This suggests that the program should have increased student ability in both. Table 2.5 explores whether that was the case. TELS had no significant effect on test scores in public universities, but did increase both ACT Math and English test scores in private universities. TELS increased Math scores by 1 point while increasing English scores by 0.6 points. It is somewhat surprising that private universities received more higher ability applicants although student enrollment increased by more in public universities.

2.6 Robustness Checks

2.6.1 Response in Neighboring States

Tables 2.6 through 2.9 report the estimated response to TELS in universities in bordering states relative to other universities in the region. Any response to TELS in the comparison group will bias the estimates of the effect of TELS in Tennessee. A response that is in the same direction but smaller in magnitude will bias the estimates downward. Below I demonstrate the importance of using different comparison groups by showing that a response in surrounding states occurred. The response to TELS in surrounding states is likely stronger in states that are closer and experience higher competitive pressure from universities in Tennessee. The “treatment” group used to test for a response in surrounding states includes

universities in states bordering Tennessee, while the comparison group includes universities in other states in the region. Universities in Tennessee are excluded. These regressions are also performed on a collapsed panel of one pre-TELS and one post-TELS periods to correct for serial correlation. The regression coefficients are estimated using specification (2.2) described in the empirical framework section.

2.6.1.a. Funding Response of Neighboring States

The new student aid program introduction in Tennessee may have prompted governments in neighboring states to respond in turn by increasing funding for higher education. Given that the new funds in Tennessee were in the form of student aid, neighboring states may have preferred to increase funding in a comparable format. The coefficient 151 from the freshmen receiving state aid regression in the first row of Table 2.6 is significant at the 99% level, showing that on average the number of students receiving state aid in a public university in a state bordering Tennessee increased relative to other public universities in the region.

In addition to increasing student aid, bordering states may have responded to TELS by increasing funding to public universities. The statistically significant 0.074 coefficient in the last row of Table 2.6 shows that was indeed the case and states bordering Tennessee increased support to public universities relative to other states in the region[19]. Bordering states responded to the introduction of the program in Tennessee by increasing funding to

19 Checking the timing of the response in states bordering Tennessee, which is not reported in the tables, reveals that bordering states significantly increased support to public universities relative to other states in the region a year after the introduction of the program in Tennessee.

both public university students and public universities.

2.6.1.b. Pricing Response of Neighboring-state Universities

The increases in state aid for public university students in bordering states gave those universities the opportunity to absorb aid funds by increasing tuition or decreasing student aid. It is possible that universities in Tennessee did not absorb funds due to receiving high public attention because of the introduction of a major student aid program. No high profile program, however, was introduced in bordering states, giving their universities the ability to absorb funds while being under less public scrutiny. Unlike universities in Tennessee, universities in neighboring states do seem to have responded to the increase in funding from the state by increasing their attending prices. Table 2.7 shows that public universities decreased student aid, while private universities increased tuition charges.

2.6.1.c. Enrollment Response at Neighboring-state Universities

In spite of increasing their price of attendance, public universities also managed to increase student enrollment. The coefficient 0.163 from the first row of Table 2.8 is significant at the 99% level, meaning that public universities in neighboring states increased resident student enrollment in response to the introduction of the program in Tennessee. The positive and significant coefficient from the total freshman enrollment regression in Table 2.8 reveals that the increase in the resident student enrollment of private institutions in bordering

states was large enough to significantly affect total freshman enrollment. This large increase in enrollment is surprising given that only 151 students more received state aid and universities absorbed some funding by increasing their attending price. This implies that the additional funding from the state may have also been used to increase student enrollment, possibly through increasing university capacity.

2.6.1.d. TELS Impact on Test Scores at Neighboring-state Universities

Although student enrollment in public universities in neighboring states increased, this increase may or may not have been induced through merit-based aid as in Tennessee. Therefore, the increase in student enrollment may have had less of an effect on student test scores than it did in Tennessee. Table 2.9 presenting the estimates of the TELS effect on ACT test scores in neighboring state universities and shows no significant effect on test scores.

2.6.2 Timing of the TELS Effect in Tennessee

Tables 2.10 through 2.13 investigate the effect of TELS on the outcome variables using specification (2.3) from the empirical framework section. Each column presents estimates from a separate regression. The coefficients reported in the first column of every pair are the yearly difference-in-differences in the outcome between universities in Tennessee and universities in states further from Tennessee. The coefficient for each year is the average difference between the difference from base year in Tennessee and the difference from base

year in the control states. Attributing any changes in the outcome variable to TELS, requires the timing of the changes in the outcome variable to match the timing of the TELS introduction. That would be indicated by sizable, significant, and persisting coefficients after year 2004.

Estimating the size of the TELS effect on the outcome variable accurately, also requires parallel pre-TELS trends in the outcome in universities in Tennessee and the surrounding states. That would be indicated by individually and jointly insignificant coefficients before the introduction of the program in 2004. The reduced form effect of TELS on the outcome variable is reported in the second column of each pair.

In general, the significant estimates from the results section exhibit yearly difference-in-differences with size and significance that match the introduction of TELS in 2004. Because clustered standard errors, which are used for this specification, may be biased when the number of clusters is small, some of the regressions estimate significant coefficients that do not match the timing of the program introduction. Those coefficients likely capture random variation, showing the need to correct for serial correlation by collapsing the data as in Section 2.5. On the other hand, collapsing the data may deteriorate the accuracy of the point estimates, because of which I compare the point estimates on collapsed data from Section 2.5 to the point estimates on not collapsed data in the second column of each pair of Tables 2.10 through 2.13.

The significant coefficients estimated in section 2.5 are generally similar in size to the corresponding point estimates in the second column of each pair from Tables 2.10 through 2.13. The point estimates of the effect of TELS on resident and total freshman enrollment in

Tennessee public universities, however, are likely more accurate than the ones estimated in section 2.5. Columns 2 and 6 of Table 2.12 yield coefficients 0.365 and 0.279 indicating that on average TELS increased resident freshman enrollment in public universities by 44% and total freshman enrollment in public universities by 32%.

2.6.3 TELS Effect in Research and Teaching Universities

Tables 2.A.1 through 2.A.4 in the Appendix report the results from using specification (2.4), which allows for heterogeneity in the effect of TELS in research and teaching universities. The results in Table 2.A.1 show that research institutions did not attract more scholarship recipients, but distributed between research and teaching institutions rather evenly. The rest of the results allowing for heterogeneity do not present strong evidence for a differential effect of TELS in research and teaching universities.

2.7 Conclusion

The paper contributes to the literature studying state merit-based student aid by conducting a broader study of the incidence of a state aid program that has been relatively less studied. I find little evidence of aid program fund absorption by the state or by universities, which implies that a TELS scholarship awarded to a state resident student reduced her cost of attending university in Tennessee by the dollar amount of the scholarship. These results differ from previous studies that do find evidence of absorption, possibly due to

understated standard errors in difference-in-differences regressions with a small number of states.

I also find much larger effects of the student aid program on student enrollment compared to previous studies that also used a difference-in-differences empirical strategy. After accounting for the response in states where the program was not introduced, my estimates triple in size for public universities compared to the largest estimates of previous studies. States bordering Tennessee, which may be under stronger competitive pressure from universities in Tennessee due to their closer geographic proximity, responded more strongly relative to states further from Tennessee. Bordering states responded to the introduction of TELS by increasing support to public university students and public universities relative to other states in the region. In turn, public universities in states closer to Tennessee increased resident and total frshman enrollment relative to other public universities in the region.

The effect of TELS in Tennessee was an increase in resident student enrollment. On average, TELS increased resident freshman enrollment in Tennessee public universities by 44% or more, while increasing total freshman enrollment by 19% or more. TELS also increased first-time full-time resident student enrollment in private universities by about 19%. Although student enrollment increased in public universities by more, the ACT score data suggests that merit-aid receiving students preferred to apply to private universities. The higher education subsidy increased the supply of state resident university students in Tennessee, but neither public nor private universities responded by adjusting the price of attending university. This implies that both public and private universities in Tennessee have close to perfectly elastic demand for state resident students[20].

20 Assuming that there was no redistribution of institutional aid between resident and non-resident students.

Who benefited from the new student aid program? The state government did not absorb program funds. Assuming that the state values satisfying the preferences of its constituents, the government still benefited by subsidizing higher education for state residents without incurring a cost in terms of tax revenue. Universities did not absorb program funds either, but public universities grew in terms of enrollment, while private universities attracted higher ability students. The program did not affect universities' total expenditure per student, or instruction expenditure per student, so it is unclear whether it affected instruction quality. As intended by the aid program, TELS subsidized in-state higher education for state resident students by the full amount of the scholarship received.

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Figure 2.1: TELS Program and Comparison States.

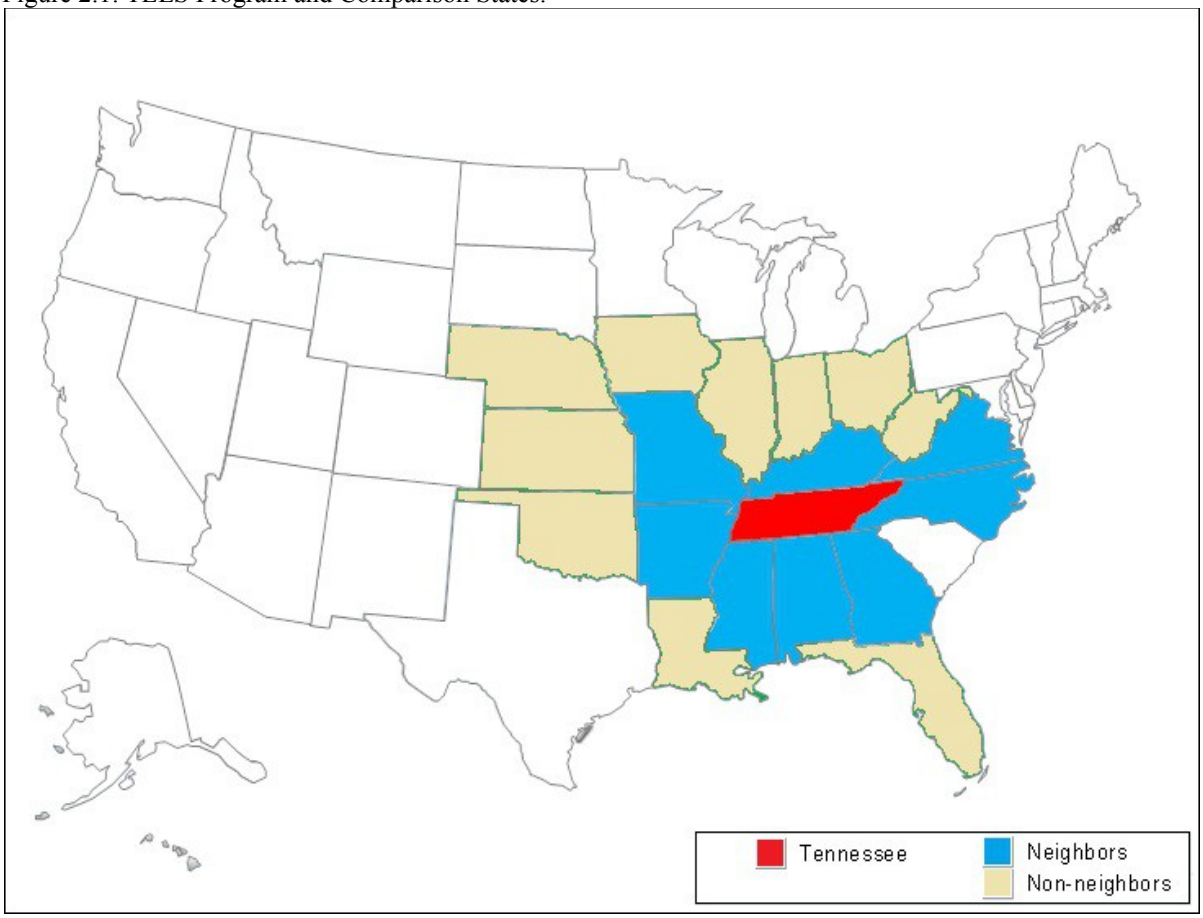

Figure 2.2: Average Freshmen receiving State aid in Public 4-year universities.

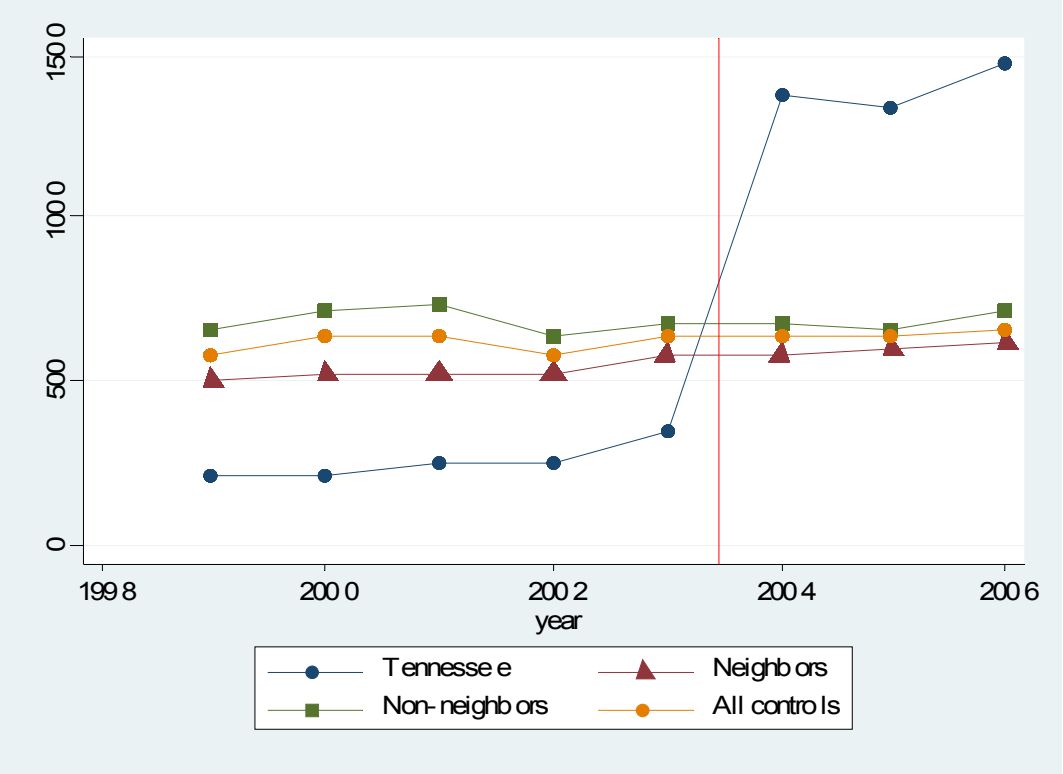

Figure 2.3: Average Freshmen receiving a TELS scholarship in Public 4-year universities.

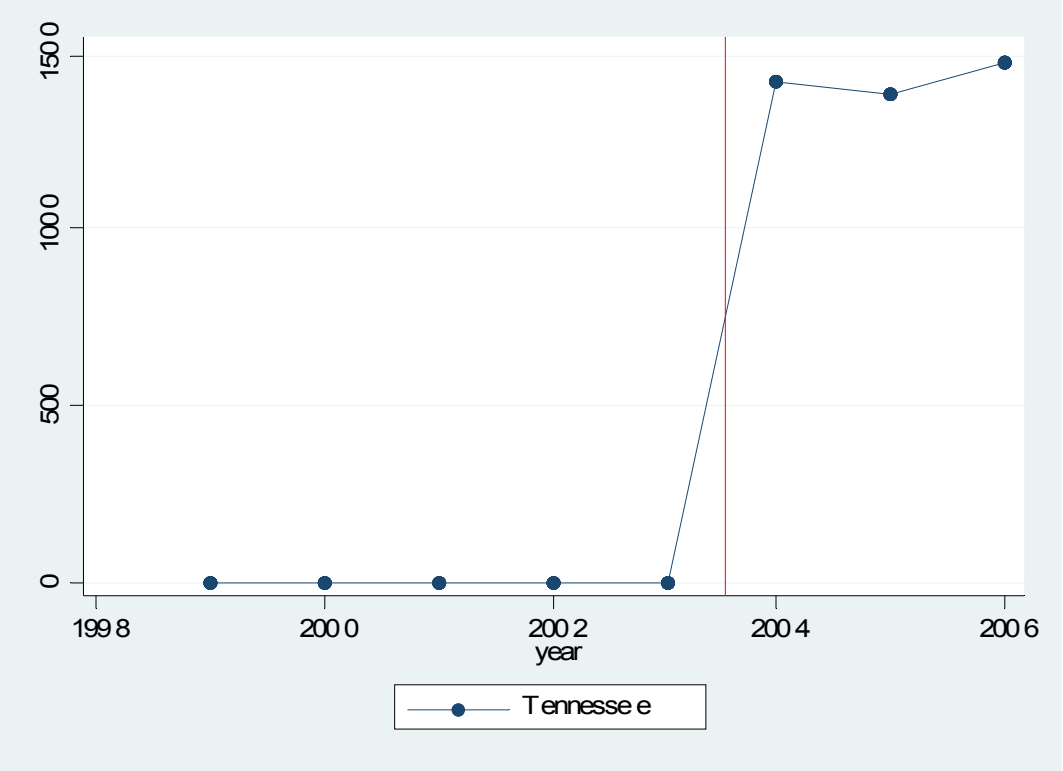

Figure 2.4: Average Revenue from the state per student in Public 4-year universities.

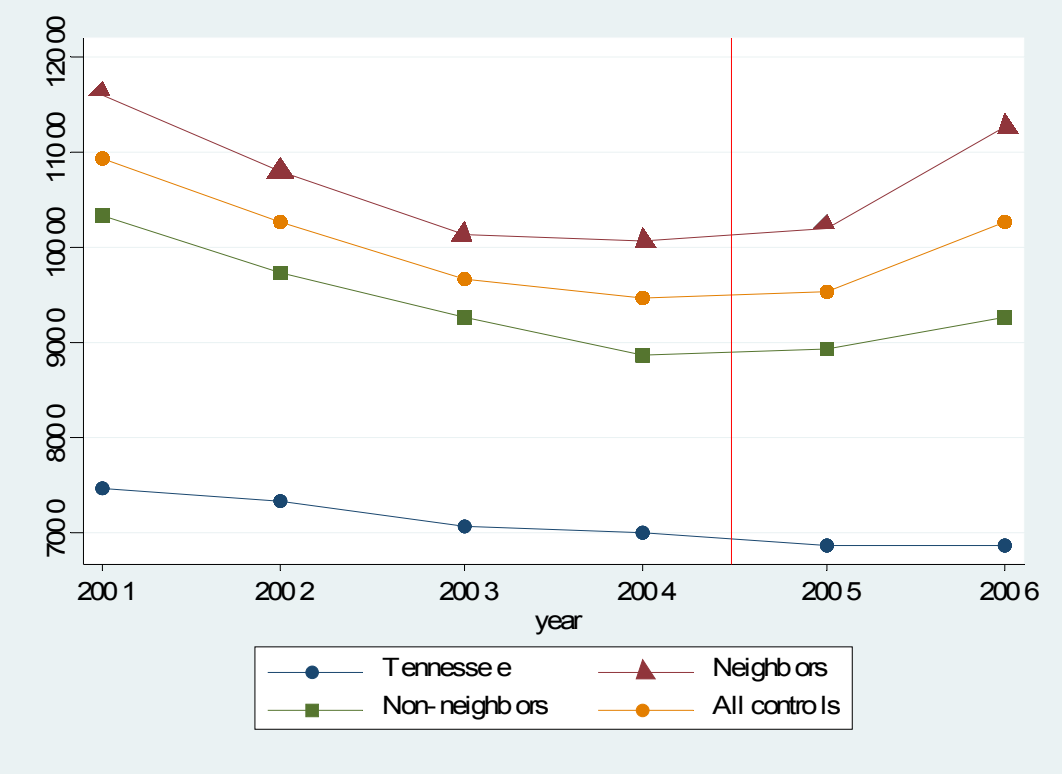

Figure 2.5: Average Resident Tuition and fees in Public 4-year universities

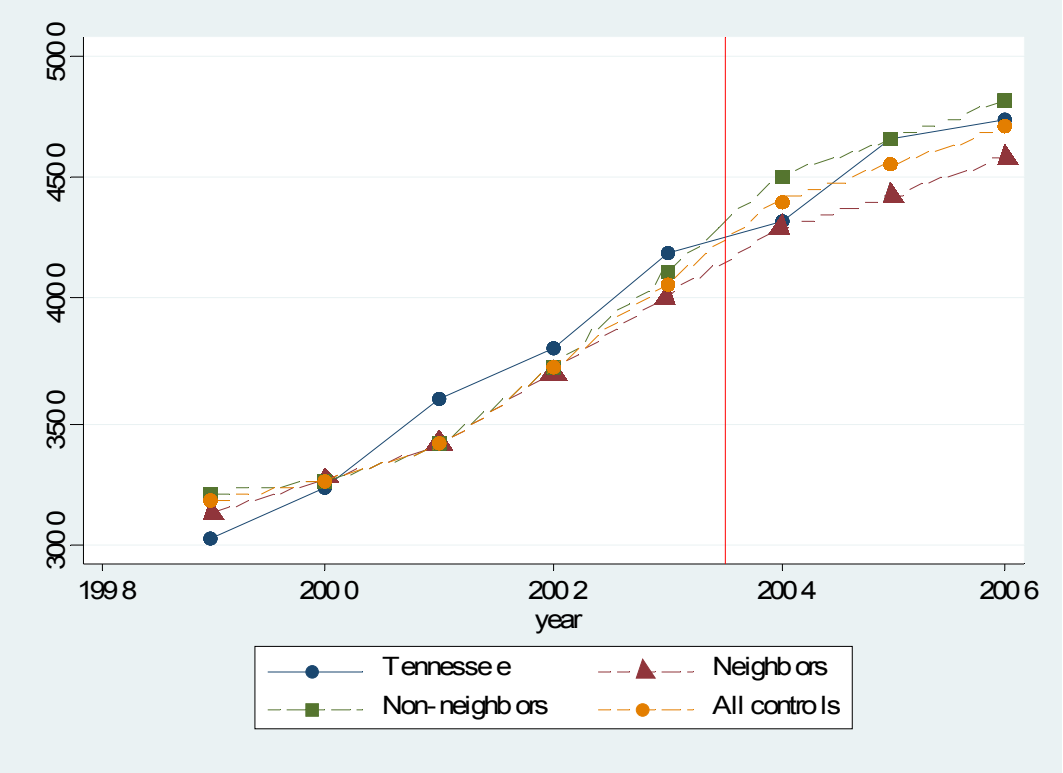

Figure 2.6: Average Non-resident Tuition and fees in Public 4-year universities.

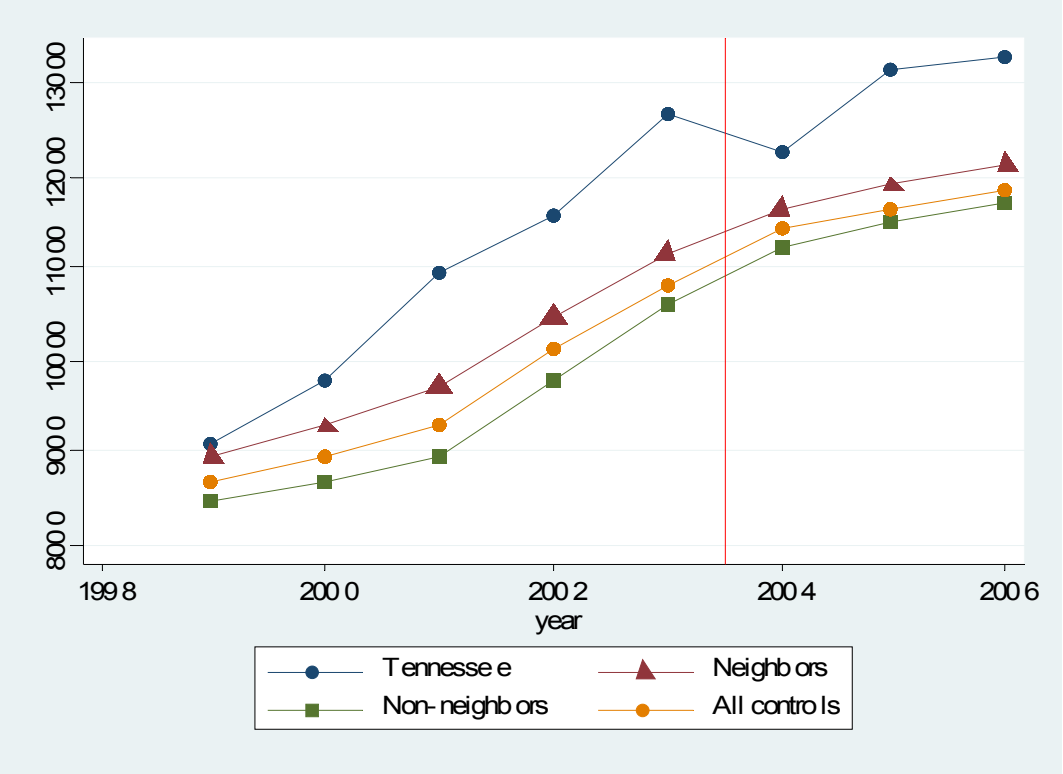

Figure 2.7: Average Institutional aid in Public 4-year universities.

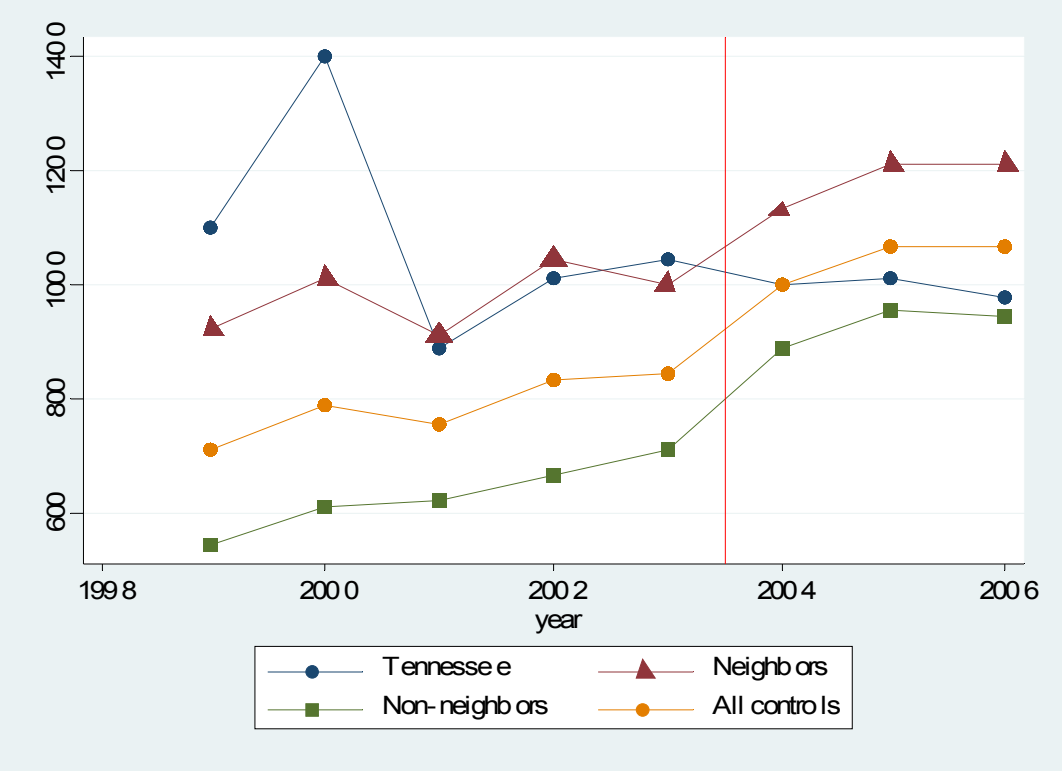

Figure 2.8: Average Tuition and fees in Private 4-year universities.

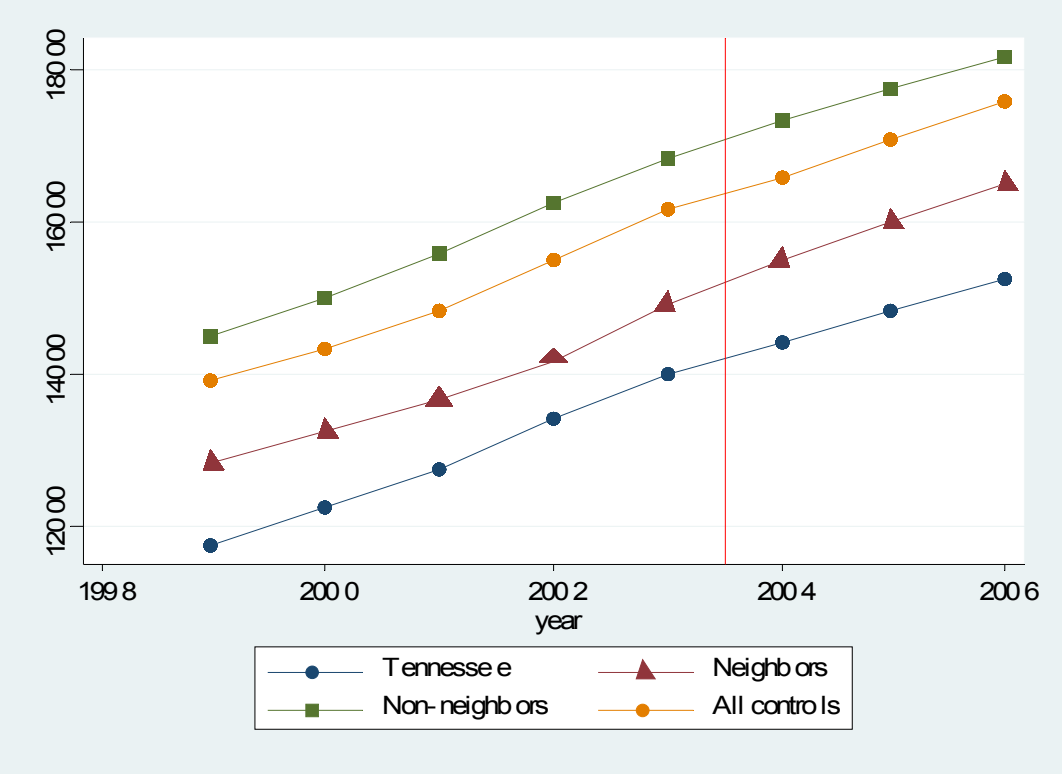

Figure 2.9: Average Institutional aid in Private 4-year universities.

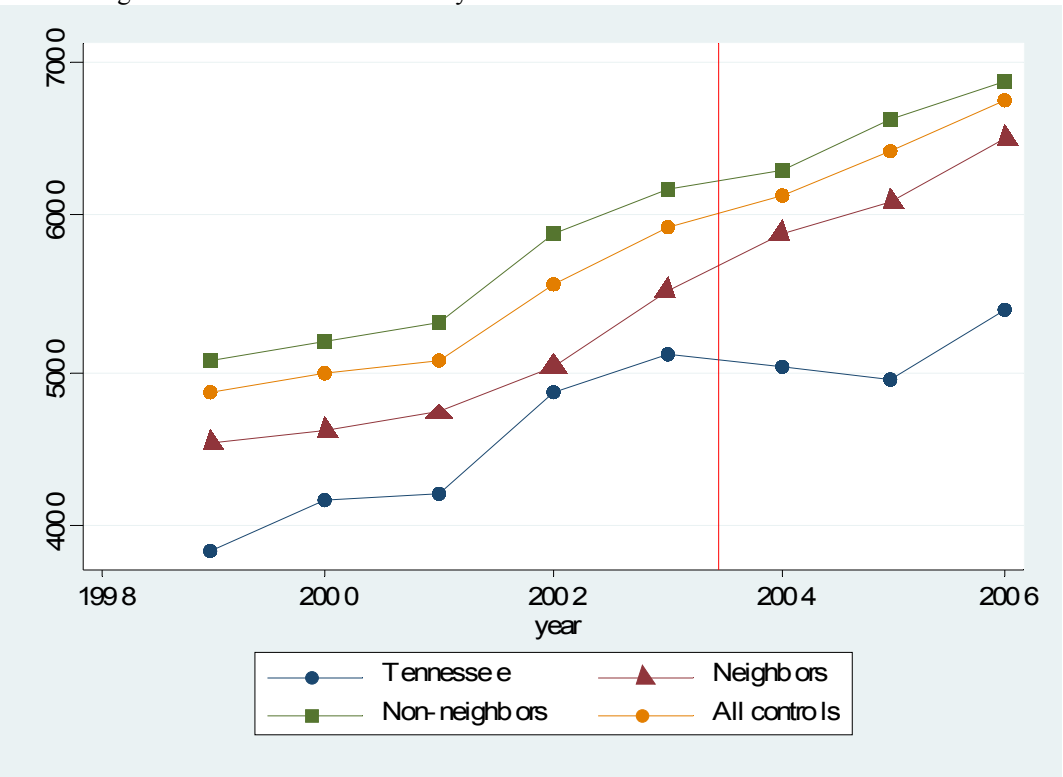

Figure 2.10: Average Resident Freshmen in Public 4-year universities.

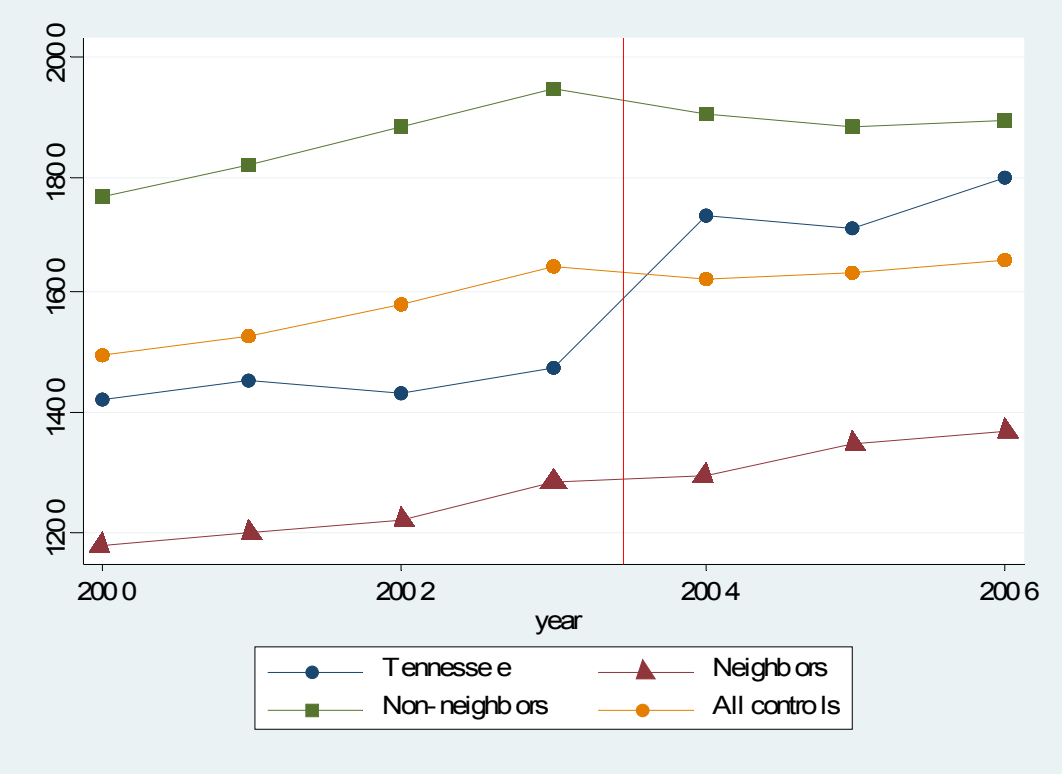

Figure 2.11: Average Non-resident Freshmen in Public 4-year universities.

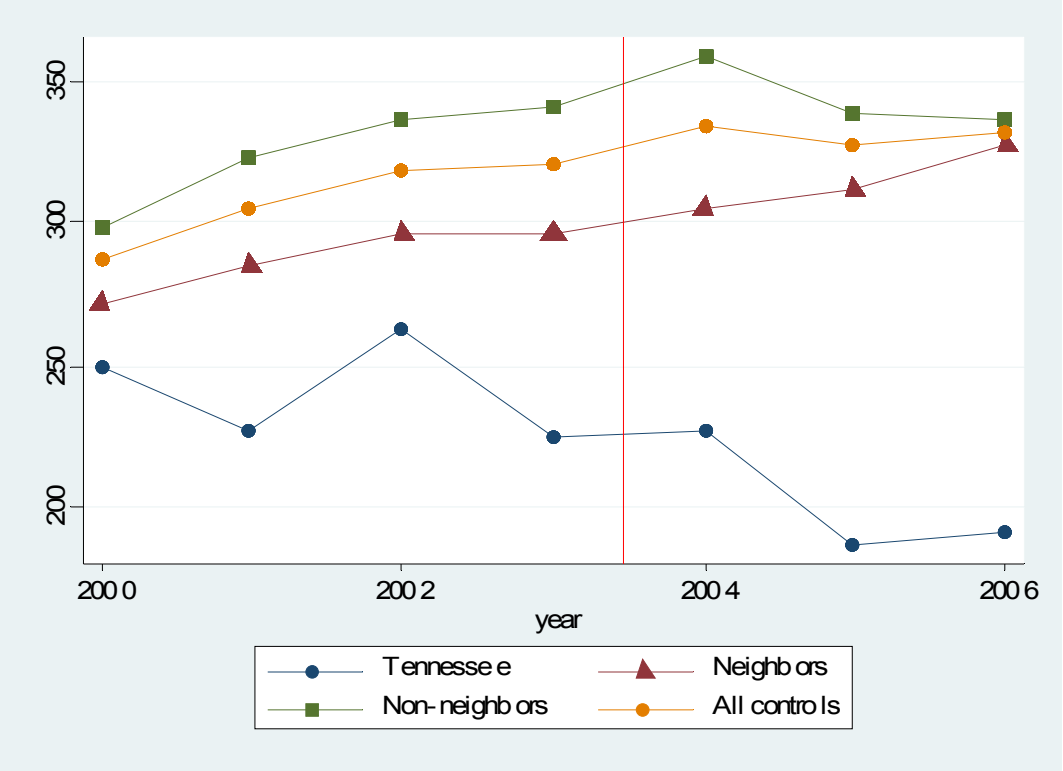

Figure 2.12: Average Total Freshmen in Public 4-year universities.

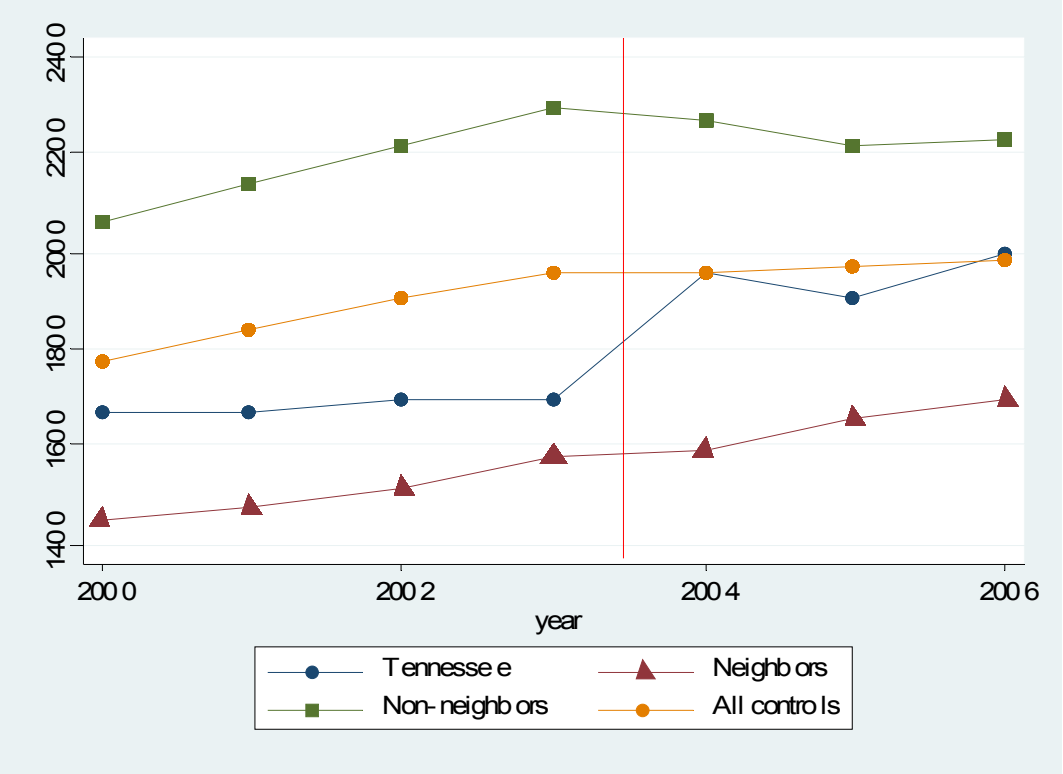

Figure 2.13: Average Resident Freshmen in Private 4-year universities.

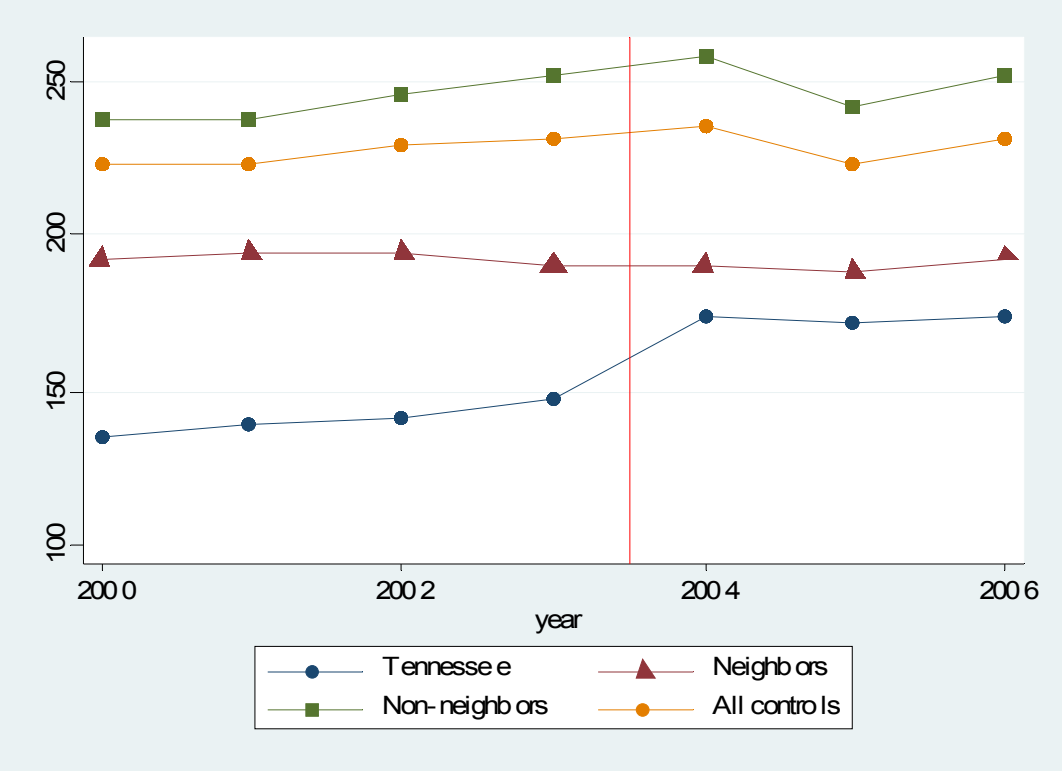

Figure 2.14: Average Non-resident Freshmen in Private 4-year universities.

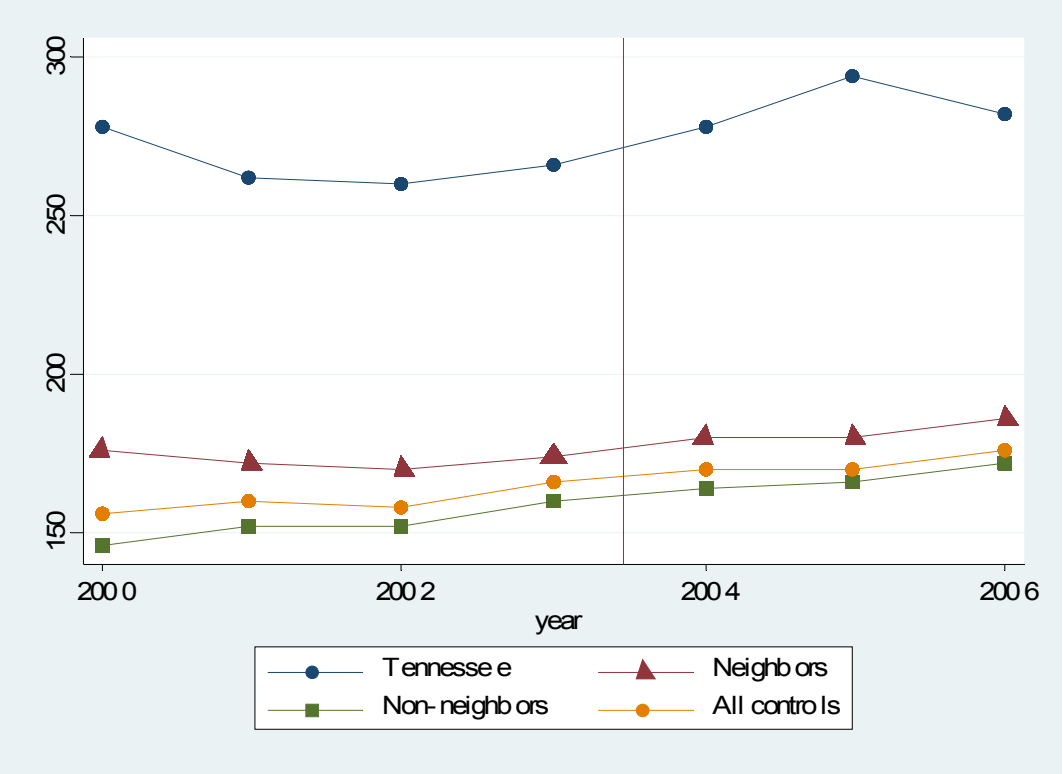

Figure 2.15: Average Total Freshmen in Private 4-year universities.

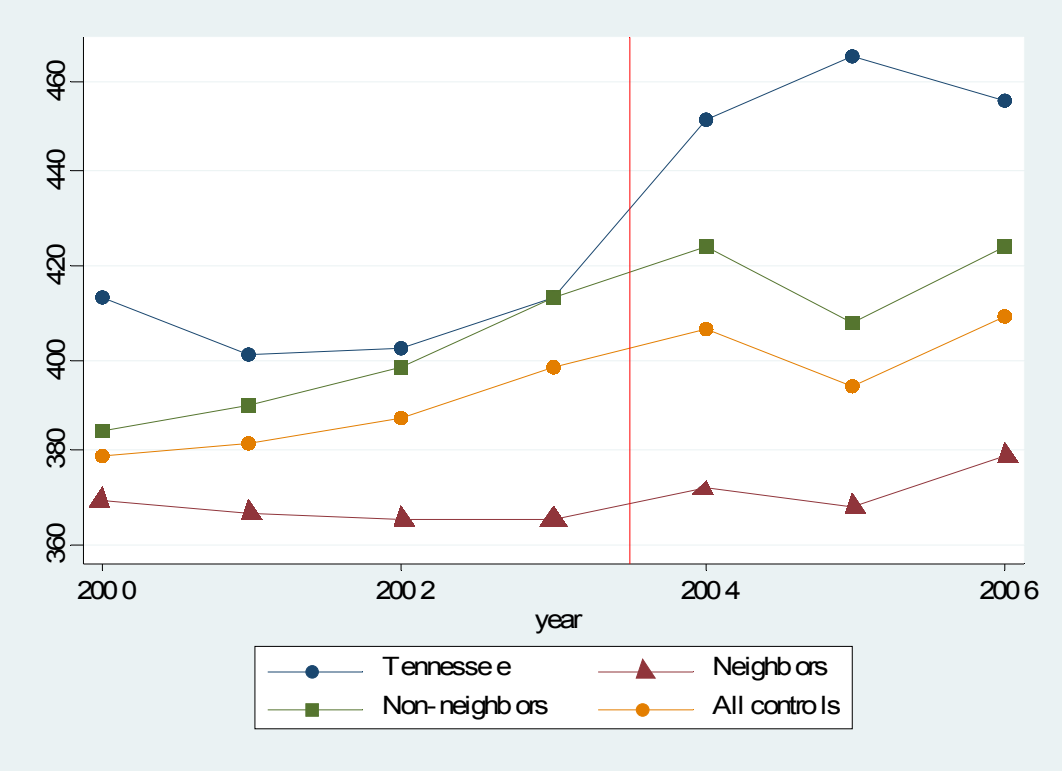

Figure 2.16: ACT Math 25th percentile score in Public 4-year universities.

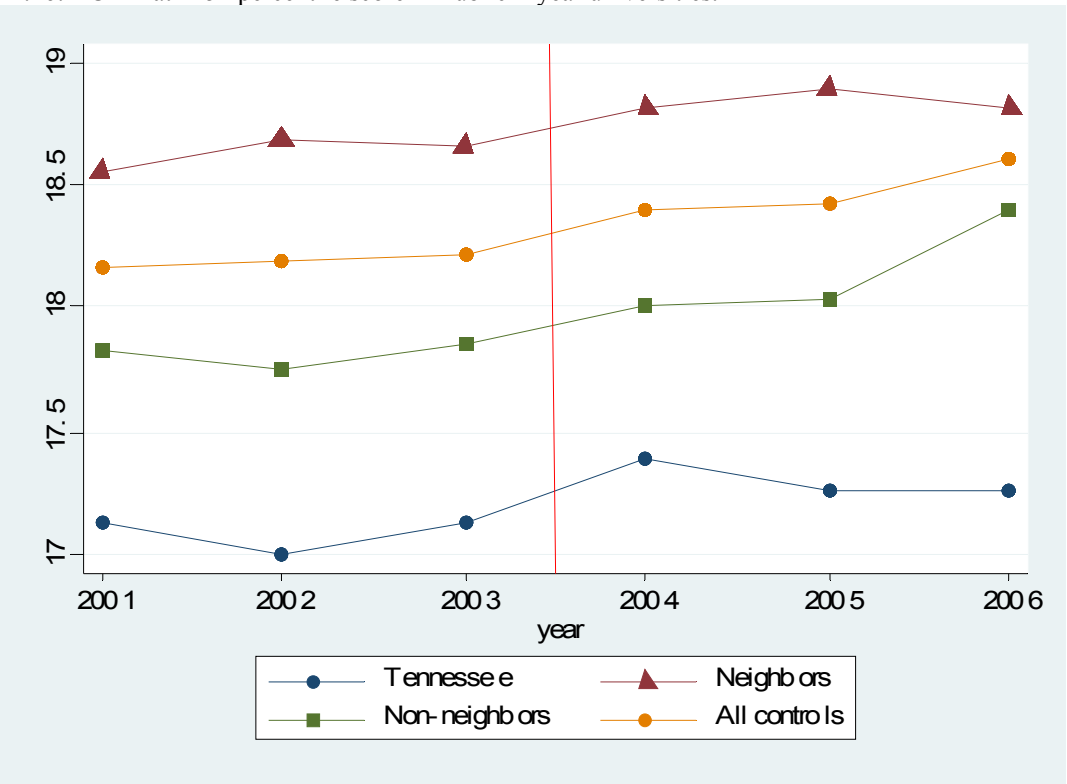

Figure 2.17: ACT English 25th percentile score in Public 4-year universities.

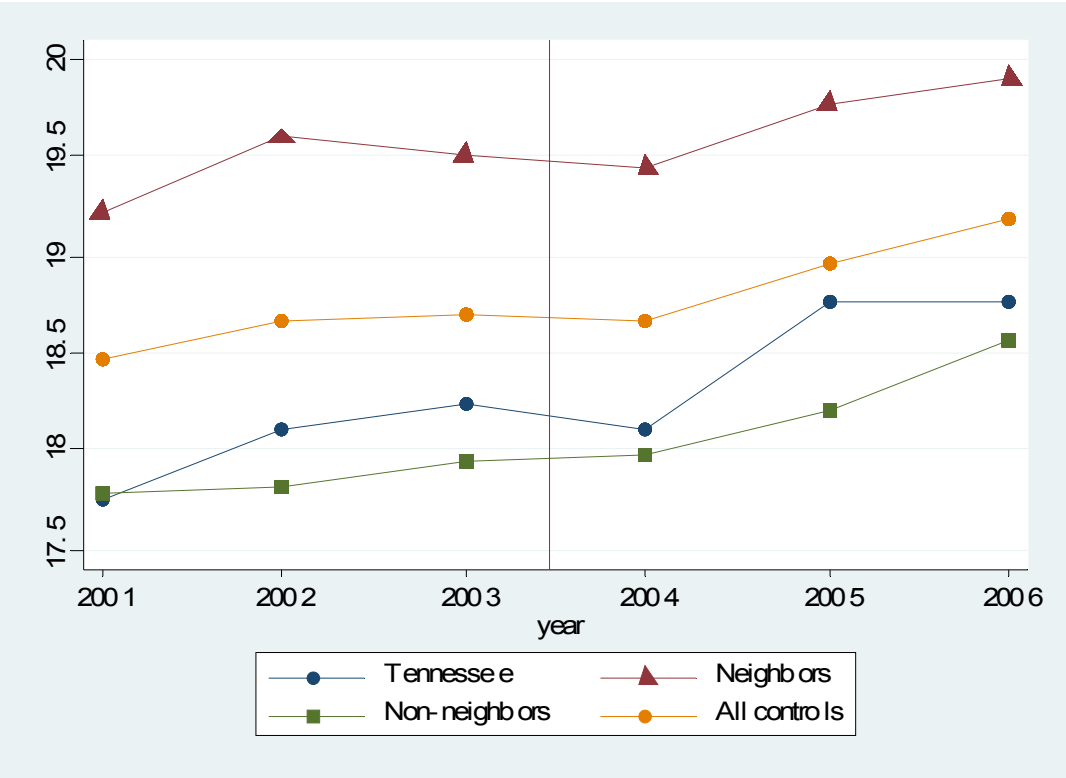

Figure 2.18: ACT Math 25th percentile score in Private 4-year universities.

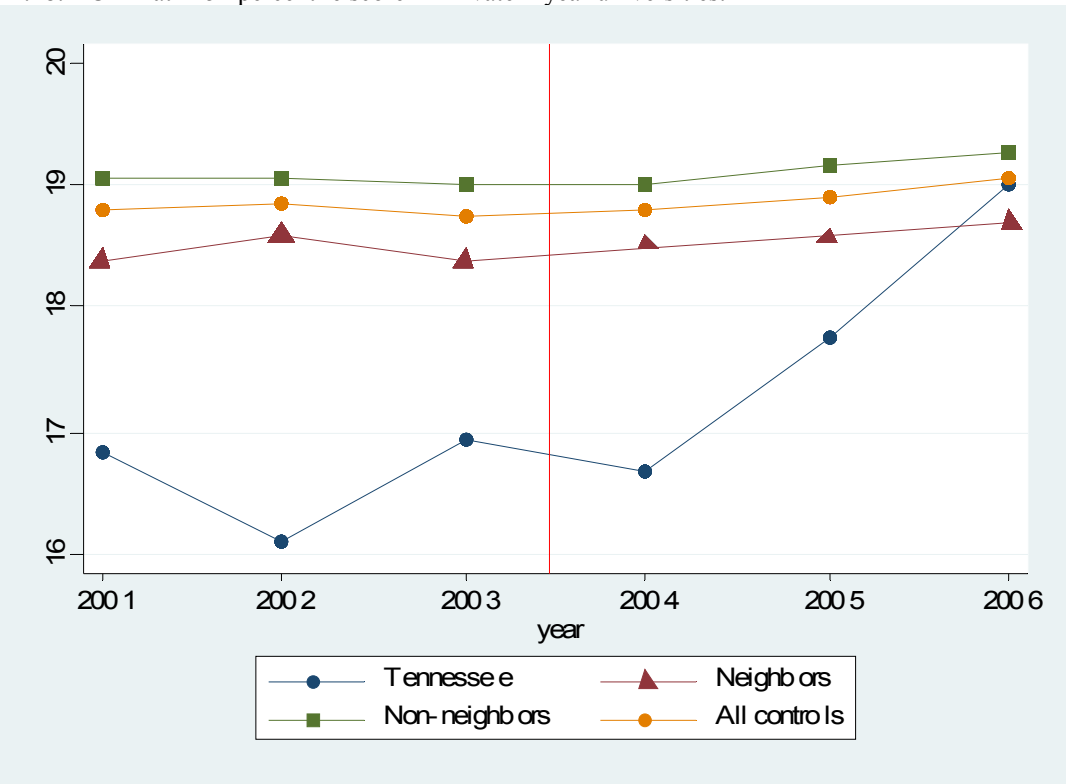

Figure 2.19: ACT English 25th percentile score in Private 4-year universities.

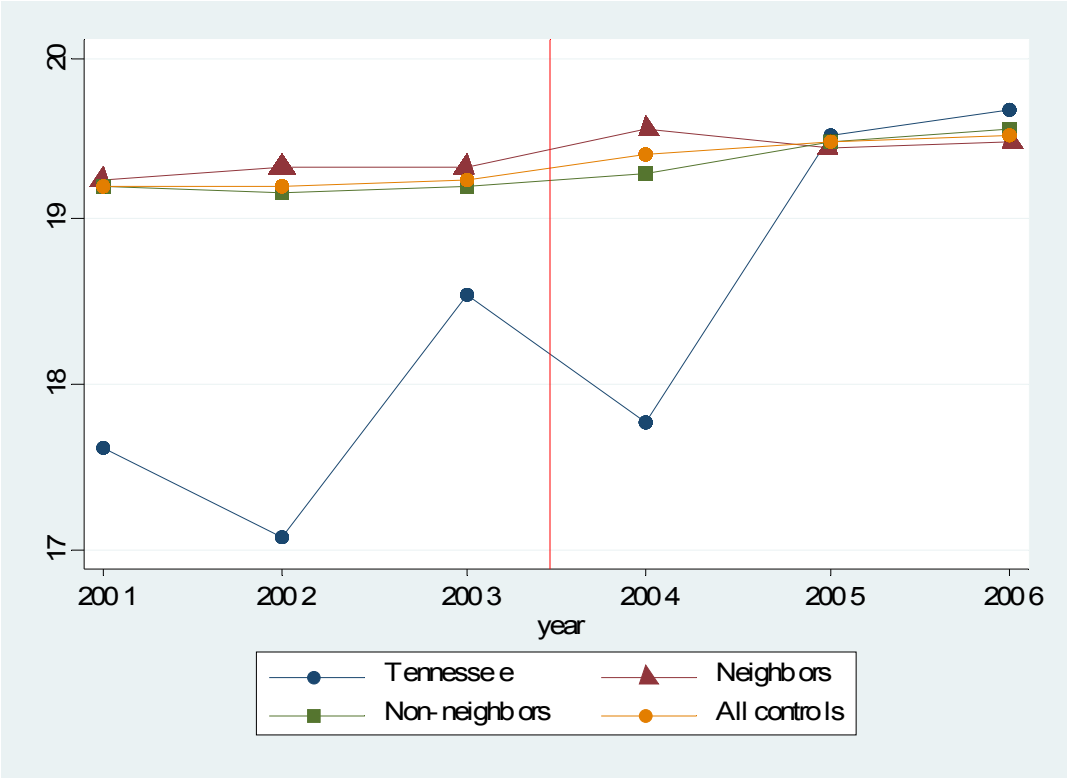

Table 2.1
Pre-TELS Sample Means

	Tennessee		Surrounding states	
	All	Research	All	Research
University finances				
Public 4-year Universities				
University revenue from the state	7,272.58	8,250.05	10,287.57	10,018.88
	(1,541.91)	(1,486.10)	(9,813.62)	(3,423.12)
Number of universities	6	3	186	69
Number of observations	36	18	1116	414
Attending price				
Public 4-year Universities				
State aid per student	292.34	284.21	785.34	971.07
	(237.73)	(263.34)	(734.79)	(847.75)
Freshmen receiving any state aid	255.64	322.30	614.96	1,228.24
	(168.74)	(223.19)	(841.35)	(1,193.26)
Resident tuition and fees	3,573.14	3,670.36	3,526.60	4,310.40
	(483.37)	(533.91)	(1,215.40)	(1,367.48)
Non-resident tuition and fees	10,810.77	11,105.14	9,576.22	12,225.63
	(1,439.33)	(1,586.56)	(3,317.72)	(3,110.06)
Institutional aid	1,086.13	1,217.53	787.06	1,122.39
	(1,189.94)	(1,266.75)	(714.90)	(762.95)
Number of universities	9	4	218	70
Number of observations	72	32	1744	560
Private 4-year Universities				
Tuition and fees	12,860.94	19,987.61	14,952.10	21,665.78
	(5,165.39)	(8,374.52)	(5,405.53)	(5,728.55)
Institutional aid	4,437.23	7,234.59	5,277.40	7,660.13
	(2,977.71)	(3,050.87)	(3,406.46)	(2,660.77)
Number of universities	31	2	359	22
Number of observations	248	16	2872	176
Enrollments				
Public 4-year Universities				
Resident freshman undergraduates	1,442.79	2,148.00	1,561.20	2,522.27
	(702.75)	(848.74)	(1,345.79)	(1,305.09)
Non-resident freshman undergraduates	241.16	507.12	307.34	540.27
	(273.38)	(342.02)	(307.34)	(426.14)
Total freshman undergraduates	1,683.95	2,655.12	1,868.54	3,062.55
	(966.93)	(1,189.77)	(1,552.85)	(1,507.03)
Number of universities	6	2	137	47
Number of observations	42	14	959	329
Private 4-year Universities				
Resident freshman undergraduates	140.64	220.25	226.21	424.82
	(77.68)	(4.42)	(230.02)	(397.28)
Non-resident freshman undergraduates	266.42	1,361.00	160.18	700.54
	(338.29)	(41.20)	(246.88)	(507.51)
Total freshman undergraduates	407.07	1,581.25	386.40	1,125.36
	(369.93)	(43.39)	(383.59)	(667.98)
Number of universities	14	1	210	17
Number of observations	98	7	1470	119
Test scores				
Public 4-year Universities				
ACT Math 25th percentile	17.08	16.55	18.18	19.8
	(0.65)	(0.52)	(2.60)	(2.47)
ACT English 25th percentile	18.04	17.44	18.59	20.2
	(1.36)	(1.94)	(2.79)	(2.24)
Number of universities	8	3	72	30
Number of observations	48	18	432	180
Private 4-year Universities				
ACT Math 25th percentile	16.61	17	18.79	23.33
	(3.04)	(0)	(2.54)	(3.54)
ACT English 25th percentile	17.74	18	19.23	23.6
	(3.75)	(0)	(2.76)	(2.85)
Number of universities	13	1	130	10
Number of observations	78	6	780	60
State characteristics				
Median household income	39,990.20		44,233.32	
	(1,188.63)		(5,379.92)	
Annual unemployment rate	4.76		4.66	
	(0.66)		(1.09)	
Share of 18 to 24 year-olds in the state	9.67		9.88	
	(0.11)		(0.65)	

Notes: The balanced panel of 4-year universities includes institutions in Tennessee and its surrounding states of Alabama, Arkansas, Georgia, Kentucky, Mississippi, Missouri, North Carolina, Virginia, Florida, Illinois, Indiana, Iowa, Kansas, Louisiana, Nebraska, Ohio, Oklahoma, and West Virginia. The maximum year range is 1999-2006. The actual year range depends on data availability. The standard deviations are reported in parentheses. All monetary variables are in 2005 dollars. The source of the university-level data is the Integrated Postsecondary Education Data System from the National Center for Education Statistics. The source of the state characteristics data are the US Bureau of Census and the Bureau of Labor Statistics.

Table 2.2
TELS Fund Absorption by the State

Dependent variable	Public Universities		
	TN*After	number of observations	number of universities
Freshmen receiving any state aid	1,351***	256	128
	(144)		
Freshmen receiving TELS aid	1,432***	256	128
	(93)		
University revenue from the state	0.114*	202	101
	(0.063)		

Notes: Each row reports coefficients from a separate regression of specification (1). The regressions are on a collapsed panel of one pre-TELS and one post-TELS periods to correct the standard errors for serial correlation. The standard errors are reported in parentheses. *** , **, * indicate significance at the 99%, 95%, 90% levels, respectively. The dependent variables in the students receiving aid regressions are in levels to keep the coefficients comparable across regressions. Observations for freshmen receiving TELS scholarships exist only after their introduction in 2004. The dependent variable in the university revenue from the state regression is in logs. Each regression includes real median household income, average annual unemployment rate, and share of 18-24 year-olds of state population as control variables, as well as university and year dummies. The comparison universities are in Florida, Illinois, Indiana, Iowa, Kansas, Louisiana, Nebraska, Ohio, Oklahoma, and West Virginia The year range is 1999-2006 for the number of students receiving aid regressions and 2001-2006 for the university revenue from the state regressions.

Table 2.3
TELS Fund Absorption by Universities

Dependent variable	Public Universities			Private Universities		
	TN*After	number of observations	number of universities	TN*After	number of observations	number of universities
Resident tuition and fees	0	256	128	0.036	510	255
	(0.046)			(0.023)		
Non-resident tuition and fees	-0.028	256	128	0.036	510	255
	(0.064)			(0.023)		
Institutional aid	-0.07	256	128	-0.032	510	255
	(0.188)			(0.084)		

Notes: Each row reports coefficients from a separate regression of specification (1). The regressions are on a collapsed panel of one pre-TELS and one post-TELS periods to correct the standard errors for serial correlation. The standard errors are reported in parentheses. *** , **, * indicate significance at the 99%, 95%, 90% levels, respectively. The dependent variables are in logs. Each regression includes real median household income, average annual unemployment rate, and share of 18-24 year-olds of state population as control variables, as well as university and year dummies. The comparison universities are in Florida, Illinois, Indiana, Iowa, Kansas, Louisiana, Nebraska, Ohio, Oklahoma, and West Virginia. The year range is 1999-2006.

Table 2.4
TELS-induced Enrollment at Universities

Dependent variable	Public Universities			Private Universities		
	TN*After	number of observations	number of universities	TN*After	number of observations	number of universities
Resident freshman undergraduates	0.439***	160	80	0.176**	308	154
	(0.103)			(0.082)		
Non-resident freshman undergraduates	-0.356	160	80	0.028	308	154
	(0.256)			(0.109)		
Total freshman undergraduates	0.343***	160	80	0.076	308	154
	(0.090)			(0.072)		

Notes: Each row reports coefficients from a separate regression of specification (1). The regressions are on a collapsed panel of one pre-TELS and one post-TELS periods to correct the standard errors for serial correlation. The standard errors are reported in parentheses. *** , **, * indicate significance at the 99%, 95%, 90% levels, respectively. The dependent variables are in logs. Each regression includes real median household income, average annual unemployment rate, and share of 18-24 year-olds of state population as control variables, as well as university and year dummies. The comparison universities are in Florida, Illinois, Indiana, Iowa, Kansas, Louisiana, Nebraska, Ohio, Oklahoma, and West Virginia. The year range is 2000-2006.

Table 2.5
TELS effect on Admission Test Scores

Dependent variable	Public Universities			Private Universities		
	TN*After	number of observations	number of universities	TN*After	number of observations	number of universities
ACT Math, 25th percentile	-0.058	92	46	1.044***	180	90
	(0.321)			(0.366)		
ACT English, 25th percentile	0.367	92	46	0.590*	180	90
	(0.360)			(0.339)		

Notes: Each row reports coefficients from a separate regression of specification (1). The regressions are on a collapsed panel of one pre-TELS and one post-TELS periods to correct the standard errors for serial correlation. The standard errors are reported in parentheses. *** , **, * indicate significance at the 99%, 95%, 90% levels, respectively. The dependent variables are in logs. Each regression includes real median household income, average annual unemployment rate, and share of 18-24 year-olds of state population as control variables, as well as university and year dummies. The comparison universities are in Florida, Illinois, Indiana, Iowa, Kansas, Louisiana, Nebraska, Ohio, Oklahoma, and West Virginia. The year range is 2000-2006.

Table 2.6
Funding Response of Neighboring States

Dependent variable	Public Universities		
	Border* After	number of observations	number of universities
Freshmen receiving any state aid	151***	436	218
	(41)		
University revenue from the state	0.074***	372	186
	(0.021)		

Notes: Each row reports coefficients from a separate regression of specification (2). The regressions are on a collapsed panel of one pre-TELS and one post-TELS periods to correct the standard errors for serial correlation. The standard errors are reported in parentheses. *** , **, * indicate significance at the 99%, 95%, 90% levels, respectively. The dependent variable in the students receiving aid regression is in levels. The dependent variable in the university revenue from the state regression is in logs. Each regression includes real median household income, average annual unemployment rate, and share of 18-24 year-olds of state population as control variables, as well as university and year dummies. The border state universities are in Alabama, Arkansas, Georgia, Kentucky, Mississippi, Missouri, North Carolina, Virginia, while the comparison universities are in Florida, Illinois, Indiana, Iowa, Kansas, Louisiana, Nebraska, Ohio, Oklahoma, West Virginia. The year range is 1999-2006 for the number of students receiving aid regressions and 2001-2006 for the university revenue from the state regressions.

Table 2.7
Pricing Response of Neighboring-state Universities

Dependent variable	Public Universities			Private Universities		
	Border* After	number of observations	number of universities	Border* After	number of observations	number of universities
Resident tuition and fees	-0.025	1744	218	0.056**	718	359
	(0.018)			(0.025)		
Non-resident tuition and fees	-0.012	1744	218	--	718	359
	(0.019)			--		
Institutional aid	-0.140*	1744	218	0.055	718	359
	(0.072)			(0.048)		

Notes: Each row reports coefficients from a separate regression of specification (2). The regressions are on a collapsed panel of one pre-TELS and one post-TELS periods to correct the standard errors for serial correlation. The standard errors are reported in parentheses. *** , **, * indicate significance at the 99%, 95%, 90% levels, respectively. The dependent variables are in logs. Each regression includes real median household income, average annual unemployment rate, and share of 18-24 year-olds of state population as control variables, as well as university and year dummies. The border state universities are in Alabama, Arkansas, Georgia, Kentucky, Mississippi, Missouri, North Carolina, Virginia, while the comparison universities are in Florida, Illinois, Indiana, Iowa, Kansas, Louisiana, Nebraska, Ohio, Oklahoma, West Virginia. The year range is 1999-2006.

Table 2.8
Enrollment Response at Neighboring-state Universities

Dependent variable	Public Universities			Private Universities		
	Border* After	number of observations	number of universities	Border* After	number of observations	number of universities
Resident freshman undergraduates	0.163***	274	137	-0.061	420	210
	(0.045)			(0.039)		
Non-resident freshman undergraduates	-0.026	274	137	-0.067	420	210
	(0.099)			(0.053)		
Total freshman undergraduates	0.125***	274	137	-0.071**	420	210
	(0.042)			(0.034)		

Notes: Each row reports coefficients from a separate regression of specification (2). The regressions are on a collapsed panel of one pre-TELS and one post-TELS periods to correct the standard errors for serial correlation. The standard errors are reported in parentheses. *** , **, * indicate significance at the 99%, 95%, 90% levels, respectively. The dependent variables are in logs. Each regression includes real median household income, average annual unemployment rate, and share of 18-24 year-olds of state population as control variables, as well as university and year dummies. The border state universities are in Alabama, Arkansas, Georgia, Kentucky, Mississippi, Missouri, North Carolina, Virginia, while the comparison universities are in Florida, Illinois, Indiana, Iowa, Kansas, Louisiana, Nebraska, Ohio, Oklahoma, West Virginia. The year range is 2000-2006.

Table 2.9
TELS effect on Admission Test Scores at Neighboring-state Universities

	Public Universities			Private Universities		
Dependent variable	Border* After	number of observations	number of universities	Border* After	number of observations	number of universities
ACT Math, 25th percentile	-0.245	144	72	0.006	260	130
	(0.173)			(0.167)		
ACT English, 25th percentile	-0.173	144	72	-0.142	260	130
	(0.199)			(0.170)		

Notes: Each row reports coefficients from a separate regression of specification (2). The regressions are on a collapsed panel of one pre-TELS and one post-TELS periods to correct the standard errors for serial correlation. The standard errors are reported in parentheses. *** , **, * indicate significance at the 99%, 95%, 90% levels, respectively. The dependent variables are in logs. Each regression includes real median household income, average annual unemployment rate, and share of 18-24 year-olds of state population as control variables, as well as university and year dummies. The border state universities are in Alabama, Arkansas, Georgia, Kentucky, Mississippi, Missouri, North Carolina, Virginia, while the comparison universities are in Florida, Illinois, Indiana, Iowa, Kansas, Louisiana, Nebraska, Ohio, Oklahoma, West Virginia. The year range is 2001-2006.

Table 2.10
TELS Fund Absorption by the State

	Public Universities					
	Freshmen receiving any state aid		Freshmen receiving TELS aid		University revenue from the state	
	(1)	(2)	(3)	(4)	(5)	(6)
TN*After		1,347***		1,431***		0.086**
		(102)		(2)		(0.032)
TN*2000	-64		--			
	(45)		--			
TN*2001	-6		--			
	(44)		--			
TN*2002	85		--		0.047	
	(107)		--		(0.028)	
TN*2003	228*		--		0.079*	
	(108)		--		(0.039)	
TN*2004	1,301***		1,426***		0.147*	
	(102)		(0)		(0.068)	
TN*2005	1,359***		1,392***		0.122**	
	(127)		(0)		(0.040)	
TN*2006	1,571***		1,478***		0.120**	
	(162)		(0)		(0.050)	
Pre-TELS coefficients F test	6.30***		--		2.13	
Number of observations	1024	1024	1024	1024	606	606
Number of institutions	128	128	128	128	101	101

Notes: The first column of each pair reports coefficients from a regression of specification (3), while the second column of each pair reports coefficients from specification (1). Standard errors clustered by state are reported in parentheses. *** , **, * indicate significance at the 99%, 95%, 90% levels, respectively. The dependent variables in the students receiving aid regressions are in levels to keep the coefficients comparable across regressions. Observations for freshmen receiving TELS scholarships exist only after their introduction in 2004. The dependent variable in the university revenue from the state regression is in logs. Each regression includes real median household income, average annual unemployment rate, and share of 18-24 year-olds of state population as control variables, as well as university and year dummies. The comparison universities are in Alabama, Arkansas, Georgia, Kentucky, Mississippi, Missouri, North Carolina, Virginia, Florida, Illinois, Indiana, Iowa, Kansas, Louisiana, Nebraska, Ohio, Oklahoma, and West Virginia. The year range is 1999-2006 for the number of students receiving aid regressions and 2001-2006 for the university revenue from the state regressions.

Table 2.11
TELS Fund Absorption by Universities

	Public Universities						Private Universities			
	Resident tuition and fees		Non-resident tuition and fees		Institutional aid		Tuition and fees		Institutional aid	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
TN*After		-0.002		-0.045*		-0.035		0.030***		-0.027
		(0.019)		(0.024)		(0.053)		(0.008)		(0.036)
TN*2000	0.022		0.04		-0.201**		0.025***		0.174***	
	(0.018)		(0.025)		(0.078)		(0.005)		(0.039)	
TN*2001	0.096***		0.119***		-0.329***		0.022***		0.144***	
	(0.013)		(0.014)		(0.085)		(0.005)		(0.044)	
TN*2002	0.091***		0.109***		-0.06		0.022**		0.213***	
	(0.011)		(0.012)		(0.083)		(0.008)		(0.028)	
TN*2003	0.089***		0.137***		0.018		0.035***		0.191***	
	(0.010)		(0.012)		(0.042)		(0.008)		(0.046)	
TN*2004	0.045**		-0.002		-0.132**		0.045***		0.182***	
	(0.014)		(0.018)		(0.054)		(0.009)		(0.038)	
TN*2005	0.074***		0.051**		-0.11		0.051***		0.106**	
	(0.021)		(0.021)		(0.068)		(0.007)		(0.036)	
TN*2006	0.059*		0.069**		-0.183***		0.062***		0.06	
	(0.028)		(0.024)		(0.052)		(0.009)		(0.063)	
Pre-TELS coefficients F test	115.05***		334.84***		41.82***		50.18***		44.29***	
Number of observations	1024	1024	1024	1024	1024	1024	2040	2040	2040	2040
Number of institutions	128	128	128	128	128	128	255	255	255	255

Notes: The first column of each pair reports coefficients from a regression of specification (3), while the second column of each pair reports coefficients from specification (1). Standard errors clustered by state are reported in parentheses. *** , **, * indicate significance at the 99%, 95%, 90% levels, respectively. The dependent variables are in logs. Each regression includes real median household income, average annual unemployment rate, and share of 18-24 year-olds of state population as control variables, as well as university and year dummies. The comparison universities are in Alabama, Arkansas, Georgia, Kentucky, Mississippi, Missouri, North Carolina, Virginia, Florida, Illinois, Indiana, Iowa, Kansas, Louisiana, Nebraska, Ohio, Oklahoma, and West Virginia. The year range is 1999-2006.

Table 2.12
TELS-induced Enrollment at Universities

	Public Universities						Private Universities					
	Resident freshman undergraduates		Non-resident freshman undergraduates		Total freshman undergraduates		Resident freshman undergraduates		Non-resident freshman undergraduates		Total freshman undergraduates	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
TN*After		0.365***		-0.300***		0.279***		0.131***		0.042		0.068**
		(0.095)		(0.067)		(0.083)		(0.028)		(0.037)		(0.024)
TN*2001	0.062		-0.176***		0.024		0.009		-0.118***		-0.021	
	(0.034)		(0.023)		(0.029)		(0.014)		(0.031)		(0.014)	
TN*2002	0.107		0.08		0.086		0.055**		-0.094*		-0.040*	
	(0.078)		(0.066)		(0.068)		(0.021)		(0.046)		(0.021)	
TN*2003	0.178		-0.263**		0.117		0.035		-0.232***		-0.058*	
	(0.107)		(0.093)		(0.095)		(0.032)		(0.056)		(0.031)	
TN*2004	0.380**		-0.374**		0.281**		0.098**		-0.131**		-0.005	
	(0.125)		(0.125)		(0.114)		(0.040)		(0.051)		(0.037)	
TN*2005	0.464**		-0.457***		0.337**		0.196***		-0.017		0.081**	
	(0.146)		(0.109)		(0.129)		(0.033)		(0.056)		(0.033)	
TN*2006	0.592***		-0.384***		0.452**		0.205***		-0.127*		0.022	
	(0.172)		(0.105)		(0.151)		(0.047)		(0.061)		(0.049)	
Pre-TELS coefficients F test	1.45		56.75***		1.64		5.44**		12.65***		1.79	
Number of observations	560	560	560	560	560	560	1078	1078	1078	1078	1078	1078
Number of institutions	80	80	80	80	80	80	154	154	154	154	154	154

Notes: The first column of each pair reports coefficients from a regression of specification (3), while the second column of each pair reports coefficients from specification (1). Standard errors clustered by state are reported in parentheses. *** , **, * indicate significance at the 99%, 95%, 90% levels, respectively. The dependent variables are in logs. Each regression includes real median household income, average annual unemployment rate, and share of 18-24 year-olds of state population as control variables, as well as university and year dummies. The comparison universities are in Alabama, Arkansas, Georgia, Kentucky, Mississippi, Missouri, North Carolina, Virginia, Florida, Illinois, Indiana, Iowa, Kansas, Louisiana, Nebraska, Ohio, Oklahoma, and West Virginia. The year range is 2000-2006.

Table 2.13
TELS effect on Admission Test Scores

	Public Universities				Private Universities			
	ACT Math, 25th percentile		ACT English, 25th percentile		ACT Math, 25th percentile		ACT English, 25th percentile	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TN*After		-0.023		0.214		0.827**		0.508*
		(0.178)		(0.350)		(0.261)		(0.239)
TN*2002	0.01		0.356*		-0.921***		-0.726**	
	(0.133)		(0.181)		(0.226)		(0.305)	
TN*2003	0.043		0.404		-0.062		0.536	
	(0.191)		(0.242)		(0.252)		(0.315)	
TN*2004	0.13		0.256		-0.352		-0.441	
	(0.230)		(0.313)		(0.337)		(0.414)	
TN*2005	0.022		0.735		0.646**		1.170***	
	(0.326)		(0.530)		(0.271)		(0.333)	
TN*2006	-0.271		0.645		1.743***		1.122**	
	(0.460)		(0.600)		(0.417)		(0.370)	
Pre-TELS coefficients F test	0.17		2.07		79.36***		25.41***	
Number of observations	276	276	276	276	540	540	540	540
Number of institutions	46	46	46	46	90	90	90	90

Notes: The first column of each pair reports coefficients from a regression of specification (3), while the second column of each pair reports coefficients from specification (1). Standard errors clustered by state are reported in parentheses. *** , **, * indicate significance at the 99%, 95%, 90% levels, respectively. The dependent variables are in logs. Each regression includes real median household income, average annual unemployment rate, and share of 18-24 year-olds of state population as control variables, as well as university and year dummies. The comparison universities are in Alabama, Arkansas, Georgia, Kentucky, Mississippi, Missouri, North Carolina, Virginia, Florida, Illinois, Indiana, Iowa, Kansas, Louisiana, Nebraska, Ohio, Oklahoma, and West Virginia. The year range is 2001-2006.

2.9 Appendix

Table 2.A.1
TELS Fund Absorption by the State

	Public Universities			
Dependent variable	TN*After	TN*After*Research	number of observations	number of universities
Freshmen receiving any state aid	1,354***	37	256	128
	(184)	(265)		
Freshmen receiving TELS aid	1,319***	254	256	128
	(119)	(171)		
University revenue from the state	0.075	0.065	202	101
	(0.084)	(0.115)		

Notes: Each row reports coefficients from a separate regression of specification (4). The regressions are on a collapsed panel of one pre-TELS and one post-TELS periods to correct the standard errors for serial correlation. The standard errors are reported in parentheses. *** , **, * indicate significance at the 99%, 95%, 90% levels, respectively. The dependent variables in the students receiving aid regressions are in levels to keep the coefficients comparable across regressions. The dependent variable in the university revenue from the state regression is in logs. Each regression includes real median household income, average annual unemployment rate, and share of 18-24 year-olds of state population as control variables, as well as university and year dummies. The comparison universities are in Florida, Illinois, Indiana, Iowa, Kansas, Louisiana, Nebraska, Ohio, Oklahoma, and West Virginia The year range is 1999-2006 for the number of students receiving aid regressions and 2001-2006 for the university revenue from the state regressions.

Table 2.A.2
TELS Fund Absorption by Universities

	Public Universities				Private Universities			
Dependent variable	TN*After	TN*After*Research	number of observations	number of universities	TN*After	TN*After*Research	number of observations	number of universities
Resident tuition and fees	0.005	-0.031	256	128	0.038	-0.042	510	255
	(0.059)	(0.085)			(0.024)	(0.077)		
Non-resident tuition and fees	0.108	-0.337***	256	128	0.038	-0.042	510	255
	(0.079)	(0.114)			(0.024)	(0.077)		
Institutional aid	0.053	-0.327	256	128	-0.004	-0.427	510	255
	(0.241)	(0.348)			(0.086)	(0.280)		

Notes: Each row reports coefficients from a separate regression of specification (4). The regressions are on a collapsed panel of one pre-TELS and one post-TELS periods to correct the standard errors for serial correlation. The standard errors are reported in parentheses. *** , **, * indicate significance at the 99%, 95%, 90% levels, respectively. The dependent variables are in logs. Each regression includes real median household income, average annual unemployment rate, and share of 18-24 year-olds of state population as control variables, as well as university and year dummies. The comparison universities are in Florida, Illinois, Indiana, Iowa, Kansas, Louisiana, Nebraska, Ohio, Oklahoma, and West Virginia. The year range is 1999-2006.

Table 2.A.3
TELS-induced Enrollment at Universities

Dependent variable	Public Universities				Private Universities			
	TN*After	TN*After*Research	number of observations	number of universities	TN*After	TN*After*Research	number of observations	number of universities
Resident freshman undergraduates	0.473***	-0.108	160	80	0.187**	-0.131	308	154
	(0.119)	(0.178)			(0.085)	(0.254)		
Non-resident freshman undergraduates	-0.414	0.191	160	80	0.034	-0.073	308	154
	(0.297)	(0.445)			(0.113)	(0.339)		
Total freshman undergraduates	0.374***	-0.092	160	80	0.088	-0.165	308	154
	(0.104)	(0.156)			(0.074)	(0.222)		

Notes: Each row reports coefficients from a separate regression of specification (4). The regressions are on a collapsed panel of one pre-TELS and one post-TELS periods to correct the standard errors for serial correlation. The standard errors are reported in parentheses. *** , **, * indicate significance at the 99%, 95%, 90% levels, respectively. The dependent variables are in logs. Each regression includes real median household income, average annual unemployment rate, and share of 18-24 year-olds of state population as control variables, as well as university and year dummies. The comparison universities are in Florida, Illinois, Indiana, Iowa, Kansas, Louisiana, Nebraska, Ohio, Oklahoma, and West Virginia. The year range is 2000-2006.

Table 2.A.4
TELS effect on Admission Test Scores

Dependent variable	Public Universities				Private Universities			
	TN*After	TN*After*Research	number of observations	number of universities	TN*After	TN*After*Research	number of observations	number of universities
ACT Math, 25th percentile	0.252	-0.746	92	46	1.158***	-1.417	180	90
	(0.377)	(0.501)			(0.378)	(1.099)		
ACT English, 25th percentile	0.686	-0.748	92	46	0.682*	-1.007	180	90
	(0.423)	(0.562)			(0.350)	(1.017)		

Notes: Each row reports coefficients from a separate regression of specification (4). The regressions are on a collapsed panel of one pre-TELS and one post-TELS periods to correct the standard errors for serial correlation. The standard errors are reported in parentheses. *** , **, * indicate significance at the 99%, 95%, 90% levels, respectively. The dependent variables are in logs. Each regression includes real median household income, average annual unemployment rate, and share of 18-24 year-olds of state population as control variables, as well as university and year dummies. The comparison universities are in Florida, Illinois, Indiana, Iowa, Kansas, Louisiana, Nebraska, Ohio, Oklahoma, and West Virginia. The year range is 2000-2006.

3. Does the Format of State Funding for Higher Education Matter? Evidence from the Colorado College Opportunity Fund

Abstract: This paper investigates the importance of format in state funding for higher education. I compare indirect funding through state-subsidized tuition to direct funding through student vouchers. I examine the effect of a partial shift from indirect to direct funding on the price of enrollment and on student enrollment across different types of institutions. While previous research has estimated the effect of direct funding on student and institutional behavior, overcoming the endogeneity of state funding to public institutions has been empirically challenging. This study addresses this endogeneity by using the introduction of the Colorado College Opportunity Fund program in 2005 as a natural experiment. I find that the shift from indirect to direct funding increased student enrollment at program-eligible private 4-year universities in Colorado. Contrary to the predictions of previous research, the enrollment increase in private institutions did not occur at the expense of enrollment in public institutions. I find evidence that the increase in private 4-year university enrollment in Colorado occurred at the expense of public 4-year universities in neighboring states.

3.1 Introduction

State governments fund higher education through monetary transfers to both institutions and students. The general trend in state funding for higher education over the last few decades has been characterized by decreasing funding to public institutions and increasing funding to students. Because funding from the state constitutes as much as two fifths of public institutions' revenue, this trend has forced public colleges and universities to rely on other sources of funding such as tuition revenue. The propose of this study is to uncover if a change in whether public institutions or students receive state support has an effect on the price of education and student enrollment at public and private institutions.

Long (2004a) explores the question by investigating the effect of funding format on students' preferences for universities. This study, on the other hand, investigates the general equilibrium effects of funding format by also examining the effect on institutions' pricing behavior. While recent research on state funding to college students has been extensive, less attention has been devoted to state-financed in-state tuition in public institutions. Direct funding to students has been shown to increase student enrollment (Cornwell et al.,2006; Dynarski 2000; Dynarski 2002; Dynarski 2003; Dynarski 2004; Kane, 2003), but the effect of a shift from funding institutions to funding students on the price of enrollment and on student enrollment is unknown due to the unclear effect of funding to institutions. Estimating this effect has been problematic because state governments determine the levels of funding with formulas based on tuition and enrollment at those institutions. Previous studies have attempted to address this endogeneity by using instrumental variable strategies with

debatable exclusion restrictions (Koshal and Koshal, 2000)

I control for the endogeneity of state funding to institutions, which may bias the estimates of previous papers investigating the importance of format (Long, 2004a), by using the introduction of Colorado's College Opportunity Fund (COF) program in 2005 as a natural experiment. This program unprecedentedly shifted a portion of state funding away from public institutions to state resident students in the form of tuition vouchers. State resident students were eligible to receive COF vouchers and redeem them in both public and eligible private institutions in the state. Using differences-in-differences with institution-level data, I estimate the reduced form effect of the program's introduction on the price of enrollment and on student enrollment across public 2-year, public 4-year, and eligible private 4-year institutions. Because any redistribution of students across institutions may also affect student ability in those institutions, I also check whether the program had an effect on ACT test scores across institutions.

Arguably, state funding to public institutions and state funding to students both increase the provision of higher education. While funding to a student reduces her cost of enrolling in any college within the state, funding to an institution subsidizes in-state tuition only in that particular institution. Thus, the choice of funding will likely impact various types of institutions differently. While state funding to institutions subsidizes in-state tuition only in public colleges and universities, for example, vouchers to students can be spent in both public and private institutions. A shift from one format of funding to the other has the potential to change the distribution of student enrollment across public and private institutions in the state. Moreover, public 2-year and 4-year institutions fulfill different

academic functions and likely devote different portions of received state funds to subsidizing resident student tuition. A decrease in state funding brought about by a change in funding format may affect the relative prices of attending public 2-year and 4-year institutions and cause a redistribution of student enrollment. Still, each format of funding may not translate into a decrease in the net price of enrollment for students. The size of the actual reduction depends on the pricing responses of institutions. The pricing responses may reduce the effectiveness of each format in lowering the net price of enrollment, which may in turn also affect student enrollment.

There are various ways the format of funding can affect price, enrollment, and average student ability. A number of models of university behavior have proposed a framework of prestige-maximizing universities competing in amassing resources in order to increase their attractiveness to potential students (Epple et al., 2006; Epple et al., 2013). Such models would predict that a loss of revenue from the state would cause public institutions to increase tuition while attempting to maintain expenditures per student. The COF program caused public institutions to lose revenue from the state and to compensate by increasing resident tuition, which is consistent with what the theoretical models would predict. The tuition increase was lower than the size of a COF voucher, which decreased voucher-receiving resident students' net price of enrollment in public institutions. The pricing response of private institutions, however, may have been different.

Private institutions experienced an influx of COF voucher recipients and no loss in revenue since they receive little state funding to begin with. Although they did not have to respond in a way that compensates for a loss of revenue, they may still have had an incentive

to increase their price of enrollment. While one portion of the COF vouchers may have been received by students who would not have enrolled in private institutions without them, a large portion was received by students who would have enrolled in private universities anyway. This gives those institutions the opportunity to absorb voucher funds from students who would have enrolled anyway by increasing tuition or by decreasing financial aid. The models of university behavior would predict that the absorbed funds would be spent on increasing expenditures per student in order to increase attractiveness to potential students. This would further widen the gap in resources between public and private institutions. While some evidence of student aid absorption by private institutions exists (Long 2004b), my results support Topal (2013), who finds no evidence of student aid absorption by private universities.

Any changes in the net price of enrollment across different types of institutions may also cause changes in the distribution of student enrollment across those institutions. Changes in enrollment may occur due to both the behavior of students and the behavior of institutions. Because students now receive fungible funds that reduce their cost of enrollment in institutions of their choice, rather than only in public institutions, a relative decrease in the net price of attending private universities may redistribute students away from public and into private institutions. In addition, a reduction in the net price of enrollment in private institutions may cause students who would not have enrolled in college at all or students who would have enrolled out-of-state to enroll in Colorado private universities. Indeed, I find that COF had an important impact on the distribution of students across institutions. I find that the shift in funding increased student enrollment in private universities. The increase did not

occur at the expense of public institutions as predicted by Long (2004a) and likely consisted of students who would not have enrolled in Colorado without the program. I also find a program-induced decrease in enrollment in public universities in neighboring states, suggesting a redistribution of enrollment from neighboring states into the program state.

As mentioned earlier, COF voucher absorption and redistribution into expenditure can affect education production at institutions. But a COF-induced redistribution may affect education production due to reasons other than institutional resources. Previous papers find positive peer effects on student achievement (Sacerdote, 2001; Zimmerman, 2003; Lyle, 2007; Carrell et al., 2009); therefore, a redistribution of students by ability may also affect the production of education across institutions. A change in student ability may occur with or without a change in enrollment levels, so a redistribution will not necessarily be reflected in the enrollment data. Studies of merit-based student aid find a positive effect on admission test scores (Cornwell et al. 2006; Palais, 2009), but this may not necessarily be the case for aid that does not have test score eligibility requirements. On the other hand, models of university behavior suggest that private universities may absorb and reallocate voucher funds to attract higher ability students (Epple et al., 2013). I explore whether the format of funding affects student ability across institutions by estimating the effect of COF on ACT test scores in public 4-year and program-eligible private 4-year universities and find no strong evidence that the format of higher education funding affects student ability across institutions.

Section 3.2 of this paper presents relevant details about the implementation of the COF program. Section 3.3 describes the difference-in-differences empirical strategy employed to estimate the reduced form effect of COF at the institutional level and the

robustness checks that were included. Section 3.4 describes the sources of data and the institutions comprising the treatment and comparison groups in the difference-in-differences regressions. Section 3.5 presents the main results. Section 3.6 reports robustness checks of the main results. Section 3.7 summarizes and concludes.

3.2 Background of The College Opportunity Fund Program

The COF program was introduced in 2005 as a step towards deregulating public colleges and universities and moving towards a more market-driven system of higher education finance. Funding students rather than institutions meant to force public institutions to become more disciplined and efficient in their operations and to promote the admission and enrollment of state resident students. One year before the introduction of the program, $2.83 billion of Colorado's $35.6 billion public expenditure was devoted to higher education. On average, those funds made up 31% of public 2-year institutions' revenue and 13% of public 4-year institutions' revenue.

The program did not change total state funding for higher education, but rather split old funding to public institutions between public institutions and state resident students[21]. On average, nearly half of the old state funding to public 4-year institutions was converted into vouchers[22]. The introduction of the vouchers in public institutions was paired with a program-

21 Funding to institutions was not completely removed, but reduced and replaced by fee-for-service and performance contracts. The fee-for-service contracts were concentrated in 4-year universities with graduate programs, while the vouchers were intended to fund undergraduate programs. While the initial intent of the performance contracts was to tie institutional funding to specific performance objectives, the actual purpose the funds served was to compensate public institutions for part of the lost revenue from the state (Western Interstate Commission for Higher Education).

dictated increase in resident student tuition by the amount of the voucher[23]. This placed the entire incidence of the voucher funds disbursed in the public sector on institutions and should have left public college students' net price of enrollment unaffected. Depending on the pricing response of private institutions, this may have resulted in a narrowing in the price gap between public and private institutions.

Total state funding for higher education did not change and because some of the voucher-receiving students enrolled in private universities, some public institutions were not able to recover all of the lost state appropriation revenue by absorbing voucher funds through tuition increases. It is interesting to see whether public institutions compensated for that loss by further increasing their price of enrollment and narrowing the price gap between public and private institutions[24], or whether they responded by decreasing expenditures and widening the gap in resources between public and private institutions.

In private institutions the COF voucher worked much like traditional student aid. Unlike public institutions, who experienced a program-mandated tuition increase, private institutions were free to adjust tuition up to their discretion. At the introduction of the COF program in 2005, the size of the voucher received by eligible state resident students enrolled in eligible private institutions was $1,200 per academic year. Whether the vouchers reduced

22 To qualify for a COF voucher, a student must be enrolled in a program-eligible institution in Colorado and be classified as a Colorado resident for tuition purposes. The student must not have exceeded 145 of earned credit hours in her lifetime. Students enrolling in eligible private 4-year universities must in addition demonstrate financial need by showing eligibility for the Federal Pell grant. The size of the COF voucher at the time of the program introduction was $2,400 per academic year in public institutions and $1,200 per academic year in private institutions.

23 In-state tuition was split into the already existing student's share and a state's share which was paid by the COF voucher. A student qualifying for in-state tuition, but choosing not to apply for a COF voucher was responsible for paying not only the student's share but also the state's share of in-state tuition.

24 Although the statute enacting the COF program prohibited public institutions from raising resident tuition by more than the value of a voucher, they may still have increased their net price of enrollment by decreasing student aid.

the cost of enrollment in private institutions by $1,200, however, is not obvious. Private institutions have the ability to absorb COF stipends by increasing tuition or by decreasing student aid and the effect of the vouchers on the net price of enrollment in private universities depends on their pricing response.

None of the neighboring states introduced major policy changes in funding for higher education within the studied time interval of 1999-2006, presenting the opportunity to use institutions in those states as a comparison group for the program-affected institutions in Colorado. Although previous studies have demonstrated the interdependence of neighboring states' spending levels (Case and Rosen, 1993; Baicker, 2005), total spending in Colorado did not change; therefore, the program should not have prompted a funding response in neighboring states. It is however, possible that neighboring states mimicked Colorado and introduced a change in their format of funding as well. The empirical section below describes checks of whether a response in surrounding states occurred.

Regardless of whether the program accomplished its intended goal of adopting a more market-driven approach of higher education funding or not, COF presents a unique natural experiment allowing me to study the effect of a change in funding format on the price of enrollment, student enrollment, and average student ability across institutions. The particular details of the program implementation enable me to estimate the effect of a change in funding format to which public universities respond by increasing tuition to recover lost revenue from the state.

3.3 Empirical Framework

The study employs a difference-in-differences identification strategy to estimate the reduced form effect of the COF program at the institutional level. The treatment group includes 2-year public, 4-year public, and 4-year private program-eligible institutional in Colorado, while the control group includes 2-year public, 4-year public, and 4-year private institutions in states in the same region. The strategy compares institutional outcomes in the treatment group before and after the program introduction to institutional outcomes in the comparison group before and after the program introduction to weed out any secular time trends in the examined outcome variables.

Since institutions that lost revenue from the state may have compensated by increasing their net price of enrollment, I estimate the effect of the program introduction on tuition and institutional aid to students in institutions. I also estimate the effect of COF on the net price of attending private universities, which may have increased tuition or decreased student aid in order to absorb voucher funds. I check whether the vouchers to students and the changes in the price of attending public and private institutions had an effect on the enrollment of students by estimating the impact of the program introduction on freshman enrollment and total undergraduate enrollment at public and private institutions. I also check whether COF affected student ability at institutions by estimating the effect of the program introduction on students' ACT test scores.

The main specification for institution i in state s in year t is

$$Y_{ist} = \alpha + \beta(Colorado_s * After_t) + \gamma_i + \delta_t + \varepsilon X'_{st} + e_{ist} \quad (3.1)$$

where Y_{ist} is the institution-level outcome variable, $Colorado_s$ is a dummy variable taking value one for institutions in Colorado, $After_t$ is a dummy variable taking value one for years after the introduction of the program, and β is the reduced form difference-in-differences estimate of the effect of COF on the outcome variable. γ_i are institution dummies accounting for time-invariant institutional effects, δ_t are year dummies accounting for general year effects, and X'_{st} is a set of state-level economic and demographic covariates accounting for the possibility that states with differing economic and demographic characteristics related to the outcome variable may have different tastes for state funding for higher education.

One of the underlying assumptions necessary to interpret the difference-in-differences estimate as the causal effect of COF is that any discontinuous change in the studied outcome is due to the program introduction. I check this by breaking the difference-in-differences down by year and examining whether the timing of discontinuities in the outcome variable is consistent with the timing of the program introduction. Another necessary assumption is that institutions in Colorado and institutions in the control states would have continued on the same parallel trends had the program not been introduced. I check this by testing whether institutions in Colorado and the control states had parallel trends in the studied outcomes before the program introduction. I also check whether the estimated effects are due to the program introduction or due to something unobserved by estimating my specifications with and without state-specific year trends controlling for unobserved trends in factors correlated with the introduction of COF and the outcome variable.

Bertrand et al. (2004) point out that conventionally used standard errors in difference-in-differences studies may lead to constructing wide confidence intervals and estimating

significant effects in the absence of actual treatment effects. I check whether the confidence intervals I use are correct by re-estimating my specifications using a correction proposed by Bertrand et al. (2004), which collapses the panel of data into one pre-treatment and one post-treatment periods.

An assumption necessary for the control group to be valid is that there was no response to COF in the control states. I check this by testing whether there was a response in states bordering Colorado due to the closer geographic proximity and higher competitive pressure from program-eligible institutions in Colorado relative to the other states in the region. I do this by excluding institutions in Colorado from the sample and using institutions in states bordering Colorado as the treatment group and institutions in other states as the comparison group. Because any response in surrounding states can bias my estimates from the main specification, I also re-estimate the main specification using only institutions in states further from Colorado as a comparison group.

3.4 Data

The study is conducted on a balanced panel of degree-granting 2-year public, 4-year public, and 4-year not-for-profit private institutions in Colorado and its surrounding states studied over the years 1999 through 2006. The COF program was introduced in 2005, giving me six pre-program introduction years and two post-program introduction years[25][26]. The set

25 Except for ACT score data from the Admissions survey in IPEDS, which is available only after year 2001. This yields four pre-program years and two post-program years of test score data.

26 Due to the partial federal government shutdown in October 2013, the institutional data collected by the NCES was not accessible and the study was conducted on partially available data. The next iteration of this manuscript will include more post-program years of data.

of control institutions in the sample is made up of institutions in Colorado's seven bordering states of Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Wyoming, and Utah and nine non-bordering states of Arkansas, California, Idaho, Iowa, Missouri, Montana, Nevada, South Dakota, and Texas. This distinction is used in determining whether institutions closer to and experiencing higher competitive pressure from institutions in Colorado responded to the introduction of the program relative to other institutions in the region.

The institution-level data used in the study comes from the various survey components of the Integrated Postsecondary Education Data System[27] (IPEDS) from the National Center of Education Statistics. The variables used to determine whether universities absorbed voucher funds by increasing tuition charges or decreasing university aid to students are the real published resident tuition and fees for first-time full-time undergraduates[28] and the real institutional aid per full-time first-time undergraduate student. The variables used to determine the program effect on student enrollment are the number of first-time full-time undergraduate students and the number of total full-time undergraduate students. Because non-freshman students were also eligible to receive the COF vouchers, the study looks for a COF effect on both freshman and total undergraduates who may have transferred to different institutions.

The variables used to determine whether COF had an effect on student ability are the ACT Math 25th percentile score and ACT English 25th percentile score of students. If universities admit students in declining order of ability, as proposed by the earlier mentioned

27 Due to the difficulty of obtaining a sizable overlap of institutions responding to all of the different IPEDS survey components used in the paper, the study is conducted on three overlapping samples. Those are the attending price, enrollments, and admission test scores samples as described in Table 3.1.

28 The tuition and fee rates of public institutions in Colorado were transformed to include the COF-mandated increase in tuition.

models of university behavior, then the lower percentile test scores should be closer to the test score of the marginal student.

All dollar-unit variables are converted to 2005 dollars using the GDP implicit price deflator from the Bureau of Economic Analysis. The state-level economic and demographic covariates accounting for different state tastes for student aid are the state median household income from the U.S. Bureau of Census, the average annual unemployment rate from the Bureau of Labor Statistics, and the share of 18 to 24 year-old state population from the U.S. Bureau of Census. Summary statistics of the data before the program introduction are presented in Table 3.1.

3.5 Results

I employ the difference-in-differences strategy with the institution-level data to investigate the impact of a change in the format of state funding for higher education on the price of attending public 2-year, public 4-year, and private 4-year institutions. I examine the effect of the COF program introduction on tuition and student aid charged and disbursed at institutions. I define funds absorbed by universities as a positive TELS effect on tuition and a negative effect on aid to students.

Table 3.2 investigates the effect of COF on the pricing variables mentioned above. Each column presents estimates from a separate regression. The coefficients reported in the first column of every pair are the yearly difference-in-differences in the outcome between institutions in Colorado and the surrounding states. The coefficient for each year is the

average difference between the difference from base year in Colorado and the difference from base year in the surrounding states. Attributing any changes in the outcome variable to COF requires the timing of the changes in the outcome variable to match the timing of the COF introduction. That would be indicated by sizable, significant, and persisting coefficients after year 2005.

Estimating the size of the COF effect on the outcome variable accurately, also requires that institutions in Colorado and the surrounding states would have continued on to parallel trends without the introduction of the program. Although I cannot test that exact assumption, I can check for the existence of parallel trends before the program introduction. Pre-COF parallel trends in outcomes would be indicated by individually and jointly insignificant coefficients before the introduction of the program in 2005. The reduced form effect of COF on the outcome variable is reported in the second column of each pair.

3.5.1 COF Impact on Attending Price

Table 3.2 presents the main results investigating whether COF changed the prices charged by institutions in Colorado. Columns 1 through 4 describe the pricing response of public 2-year colleges, columns 5 through 8 describe the response of public 4-year universities, while columns 9 through 12 inspect whether private 4-year universities absorbed voucher funds by increasing their prices.

The results indicate that tuition in Colorado public 2-year colleges increased relative to tuition in other colleges. This is due to an attempt to absorb voucher funds and recover lost

revenue from the state. The increase in tuition described by the 0.620 coefficient recovered $1,713 of the $2,400 voucher disbursed in public colleges. Still, colleges may have also recovered funds by decreasing student aid.

Posted tuition levels are highly visible to the public and colleges may have been apprehensive of openly increasing their prices. Student aid disbursed by institutions, on the other hand, receives less public exposure. An institution willing to absorb voucher funds through less visible means may have decreased student aid in response to the introduction of the program. Columns 3 and 4 of Table 3.2, however, present no evidence that colleges recovered revenue lost from the state by decreasing student aid. This suggests that on average, Colorado resident students' net price of attending a public 2-year college decreased by $687. Full voucher fund absorption may not have occurred due to voucher-recipients choosing to attend 4-year universities rather than 2-year colleges, which may have reduced 2-year colleges capacity for fund absorption.

Columns 5 through 8 of Table 3.2 examine whether public 4-year universities responded to the program by changing their price of enrollment. Columns 5 and 6 present evidence for a 57% increase in tuition[29]. The results from Columns 7 and 8, however show that public universities increased institutional aid instead of decreasing it to absorb voucher funds. The size and the significance of the yearly difference-in-differences in Column 7 increases dramatically in 2005 and persists after the introduction of the program. The main specification coefficient 0.522 in Column 8 is significant at the 99% level and suggests that on average COF increased institutional aid in every public institution in Colorado by 69%. Compared to pre-COF levels, this translates into a net $1,505 increase in the price of

29 The coefficient 0.452 in Column 6 of Table 3.2 translates into a $e^{0.452}-1 = 0.57$ proportional change.

attending public universities. The results imply that Colorado resident students' net price of attending public universities may have decreased by $896 due to receiving the COF vouchers[30]. One possible explanation for this result is that public institutions did not fully absorb the COF vouchers in order to keep their prices competitive with those of private institutions.

Private universities operate under larger autonomy from the state government when it comes to pricing decisions. Although public institutions may have been under government pressure to maintain prices affordable, private universities likely had more discretion in adjusting their tuition and student aid. None of the coefficients reported in Columns 9 and 10 investigating a COF impact on tuition are statistically different than zero. The results from Columns 11 and 12, however show that private universities may have absorbed voucher funds by decreasing student aid[31]. The -0.295 coefficient in Column 12 would suggest that on average COF decreased institutional aid in program-eligible private universities by 26%. In dollar terms, this converts to a $2,060 per student decrease in aid, which is sufficient to absorb the $1,200 per eligible student of COF stipends received in program-eligible private institutions.

3.5.2 COF-induced Enrollment at Institutions

The results presented up to this point show some evidence of a COF voucher-induced reduction in the price of attending public institutions. Moreover, the price of attending public

30 Depending on whether state resident or non-resident students are awarded the additional institutional aid.

31 The largest in size and most statistically significant coefficients in Column 11 are -0.309 for year 2005 and -0.279 for year 2006. This describes a discontinuity in institutional aid to students which matches the introduction of the program.

4-year universities may have decreased by more, which may have redistributed student enrollment from public 2-year colleges to 4-year universities. Enrollment concentration in public 4-year universities may have also occurred due to the possible voucher fund absorption by private universities. In addition, the voucher size in private institutions was only half the size of the voucher size in public institutions. Table 3.3 investigates the COF impact on enrollment at institutions. Every Colorado resident student who has earned fewer than 145 lifetime credit hours was eligible to receive the COF vouchers; therefore, the vouchers may have affected both first-time enrollment and transfer enrollment in institutions. In this section I investigate both.

Columns 1 through 4 of Table 3.3 investigates COF-induced enrollment changes in public colleges. The results do not present strong proof that the yearly changes in student enrollment occurred due to COF[32]. The increase in the price charged by public colleges and the absence of changes in student enrollment suggest that colleges may not have been able to recover all lost revenue from the state by absorbing voucher funds due to recipients enrolling in other institutions. Although the majority of Colorado residents in 2-year colleges received vouchers, additional voucher-recipient enrollment may have increased colleges' capacity for absorption.

Some of the other institutions that voucher-recipients may have enrolled in instead are public 4-year universities. This prediction is reasonable considering that the voucher size was the same in public 2-year and 4-year institutions, but the voucher translated into a larger decrease in the price of attending 4-year universities. The results from Columns 5 through 6,

32 Although the coefficients from the main specification reported in Columns 2 and 4 are significant, the yearly changes reported in Columns 1 and 3 do not exhibit a pattern matching the program introduction in 2005. The pre-COF coefficients are also jointly significant, indicating that the main specification coefficients in Columns 2 and 4 also capture pre-program differences in enrollment.

however, provide little evidence that COF affected student enrollment in public universities. None of the difference-in-differences coefficients from the main specification are statistically significant. This is surprising considering that public universities decreased their net prices by increasing institutional aid. This implies that the decrease in price charged by public universities may have been paired with a change in the composition of student enrollment rather than a change in total student enrollment.

The COF program does not seem to have induced additional student enrollment in public institutions. The results presented earlier suggest that private universities may have absorbed voucher funds by decreasing student aid. This may have decreased the effectiveness of the vouchers in reducing students' cost of attending private institutions. Columns 9 through 12 present the results investigating for COF-induced enrollment at private universities. The timing of the relative changes in enrollment reported in Columns 9 and 11 show the coefficients for freshman enrollment roughly double in size after the program introduction in 2005[33]. Although the main specification coefficient reported in Column 10 is positive, large, and significant, its size should be interpreted with caution because it also captures differences in pre-program freshman enrollment. Although COF likely increased freshman enrollment in voucher-eligible private universities, the size of the increase in is less than what is indicated by the coefficient reported in Column 2.

3.5.3 COF Impact on Test Scores at Institutions

33 Although the results are noisy, the post-program coefficients of 0.791 and 0.795 are persistently larger in size than the pre-program coefficients.

If universities value student quality and admit students in declining order of ability, as proposed by some models of university behavior (Epple et al, 2006; Epple et al, 2013), The increase in freshman enrollment in private universities should have also increased student ability. If I use the ACT test score in the 25th percentile as a proxy for the marginal test score of the admitted student, the increase in freshman enrollment in private universities should have also increased ACT test scores in the 25th percentile. Table 3.4 presents the results investigating the COF impact on ACT test scores in public and private universities.

Although enrollment levels in public universities did not change, the increase in institutional aid may have occurred due to universities trying to attract particular types of students, resulting in a change in the composition of student enrollment. Columns 1 and 3 of Table 3.4 do not report statistically significant yearly difference-in-differences of ACT scores in public universities in Colorado and the surrounding states that match the program introduction in 2005. On average, COF does not seem to have had an effect on ACT scores in public universities in Colorado[34]. Any compositional change that may have occurred due to COF does not seem to have changed student composition by ability.

Columns 5 and 8 of Table 3.4 show that the increase in freshman student enrollment in private universities was paired with an increase in both ACT Math and English scores in the first year of the program. Strangely, the increases in test scores did not persist in the second year of the program and on average the COF impact on ACT test scores was not statistically different than zero.

34 The statistically significant coefficient in Column 2 captures the difference in pre-program trends in ACT scores of public universities in Colorado and the surrounding states.

3.6 Robustness Checks

Table 3.5 reports the results of additional checks on the accuracy and interpretation of the main estimates. The dependent variables are in rows. Each coefficient is from a separate regression. Column 1 controls for unobserved trends correlated with the outcome and the introduction of COF to check whether the change in the outcome variable is due to the introduction of COF or due to something unobserved. Column 2 corrects the standard errors for serial correlation by ignoring the time dimension of the data. As proposed by Bertrand et al. (2004), the main specification is re-estimated on a panel that has been collapsed into one pre-TELS and one post-TELS periods, which they demonstrate to work even with a small number of states. Column 3 reports the estimated response to TELS in universities in bordering states relative to other universities in the region. The treatment group in these regressions includes institutions in states bordering Colorado, while the comparison group includes institutions in other states in the region. Institutions in Colorado are excluded. These regressions are also performed on a collapsed panel of one pre-COF and one post-COF periods to correct the standard errors for serial correlation.

Any response to COF in the control group will bias the estimates from the main specification. A response that is in the same direction but smaller in magnitude will bias the estimates downward. The response to COF in surrounding states is likely stronger in states that are closer and experience higher competitive pressure from institutions in Colorado. To reduce any response to COF in the control group, the main specification is re-estimated in Column 4 using a comparison group including only institutions in surrounding states that do

not share a border with Colorado.

3.6.1 COF Impact on Attending Price

The statistically significant changes in tuition charged by public 2-year colleges estimated in the previous section did not exactly match the timing of the COF program introduction and could have been partially due to something other than COF. The regression of tuition controlling for state-specific year trends in Column 1 of Table 3.5 yields a coefficient 0.749 which maintains the direction, size, and significance of the original coefficient. The COF effect on tuition re-estimated with corrected errors in Column 2 is also sizable and significant, further confirming that the change in tuition was due to COF.

Controlling for state-specific year trends in the institutional aid regression in Column 1 of Table 3.5 removes the significance of the coefficient, but preserves its sign. Although the coefficient drops in size from 0.522 to 0.258, unobserved trends correlated with institutional aid do not explain all of the COF effect on aid. The new coefficient is likely not significant due to including more right-hand-side variables in the regression. COF likely increased institutional aid in public universities by 29% to 69%.

Although the main results present evidence that private universities decreased institutional aid to students, re-estimating the main specification with corrected standard errors in Column 2 removes the significance of the coefficient. I find no statistically significant effect of COF on the price of attending a private university in Colorado.

3.6.2 COF-induced Enrollment at Institutions

Reestimating the COF effect on freshman enrollment at public colleges with corrected standard errors does not yield a significant coefficient. This further weakens any evidence of a pricing response by public colleges. I find no strong evidence that public colleges experienced a COF-induced change in student enrollment.

Checking for a response in the freshman enrollment of bordering state universities with public 4-year universities in states bordering Colorado as the treatment group and other public 4-year universities in the region as the control group yields a coefficient of -0.104. This reveals that public universities in bordering states experienced a decrease in freshman enrollment relative to other public universities in the region. It is possible that the COF program induced Colorado residents who would have enrolled in public universities out-of-state to enroll in private universities in Colorado instead.

Reestimatnig the freshman enrollment regression with state-specific year trends reduces the size of the coefficient from 0.471 to 0.098. As expected, not all of the previously-estimated change can be attributed to COF. The sign of the coefficient, however, is preserved and a sizable portion of the previously-estimated effect is not accounted for by unobserved trends correlated with freshman enrollment. Re-estimating the main specification with corrected errors also preserves the significance of the coefficient. The COF program likely increased freshman enrollment in program-eligible private institutions in Colorado.

3.6.3 COF Impact on Test Scores at Institutions

The additional checks performed for both public and private universities fail to uncover a significant effect of COF on student ability. Although the results provide some evidence of a COF effect on student enrollment in surrounding states, that does not seem to have translated into a change in admission test scores.

3.7 Conclusion

This paper contributes to the literature on funding for higher education by investigating the importance of funding format. The study compares state subsidized in-state tuition in public institutions to state-funded fungible student aid redeemable in both public and private institutions. The paper avoids endogeneity problems by using the introduction of Colorado's COF program in 2005 as a natural experiment. The results suggest that public institutions responded to the loss of subsidies from the state by increasing tuition and only partially absorbing the new vouchers disbursed to students. Private institutions did not have a statistically significant pricing response to the program, which meant that the net price of attending university decreased the most in private institutions.

The results also suggest that private universities may have increased freshman student enrollment in response to the program. Unlike other research studying the effect of funding format (Long, 2004a), I do not find that the increase in student enrollment in private institutions occurred at the expense of student enrollment in public institutions in Colorado. This suggests that the increase may have consisted of students who would not have enrolled

in college at all or of students who would have enrolled in college out-of-state. The results provide some evidence of this since freshman enrollment in public 4-year universities in states bordering Colorado decreased relative to other universities.

The increase in freshman enrollment in Colorado private 4-year universities was likely composed of voucher-receiving Colorado residents. The increase in enrollment without a change in the price charged by private institutions is consistent with Topal (2013)'s finding that private universities may have close to perfectly elastic demand for resident student enrollment.

Who did the change from funding public institutions to funding resident students benefit? The total state funding level for higher education was maintained, so the state governments was unaffected in terms expenditures[35]. Some of the total state higher education spending was diverted from public to private institutions in the form of vouchers. This implies that public institutions lost revenue from the state which they were not able to recover by absorbing voucher funds. The loss in revenue did not affect instruction expenditure in public institutions, so it unclear whether the program affected instruction quality[36].

Voucher-receiving Colorado resident students benefited in terms of a lower price of attending both public and private institutions. The loss of revenue in public institutions, however, may have caused other compensating behavior that affected resident students in public institutions in other ways. The clear beneficiary of the change in funding format seems to have been program-eligible private institutions. Although private universities did not

35 Results for state-level higher education spending are provided in the appendix.
36 Results available upon request.

absorb program funds, their enrollment growth was paid by old funding to public institutions.

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Figure 3.1: Average Tuition and fees in Public 2-year colleges.

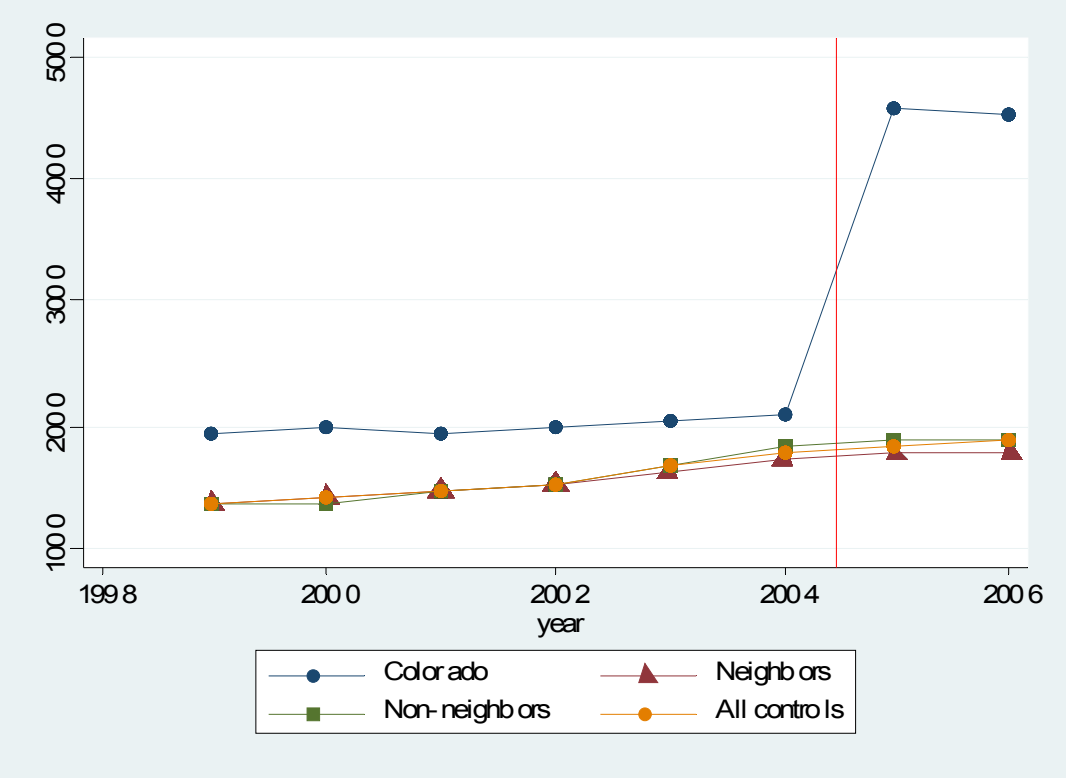

Figure 3.2: Average Institutional aid in Public 2-year colleges.

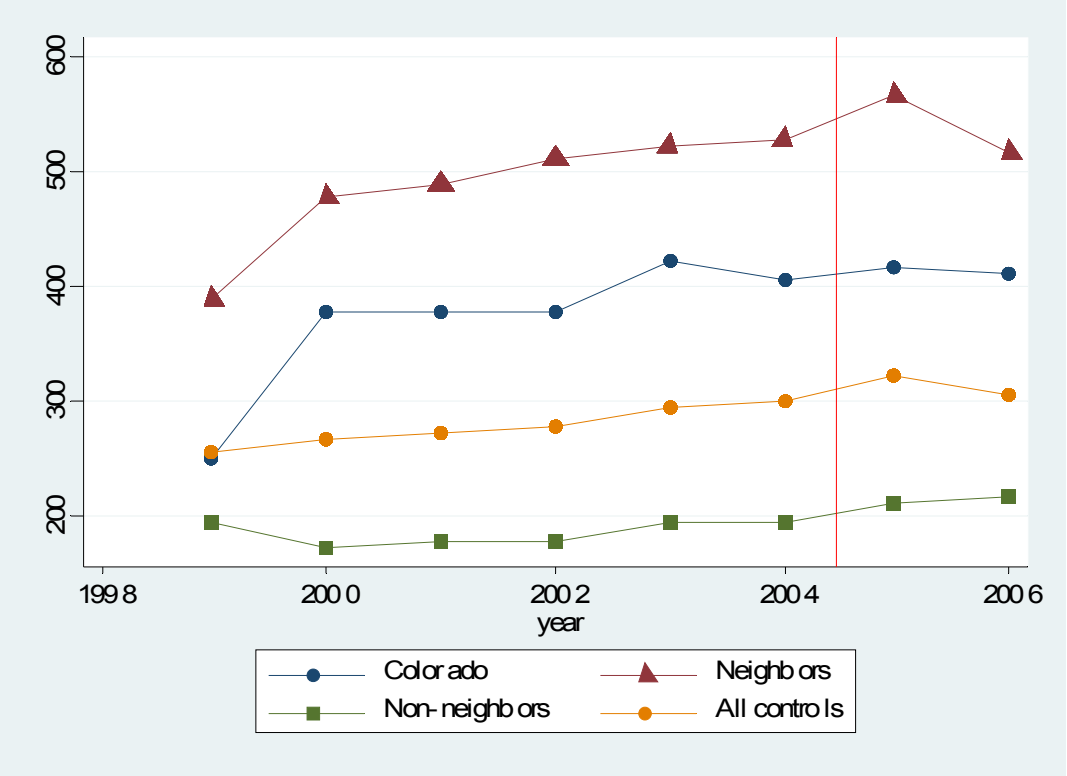

Figure 3.3: Average Tuition and fees in Public 4-year universities.

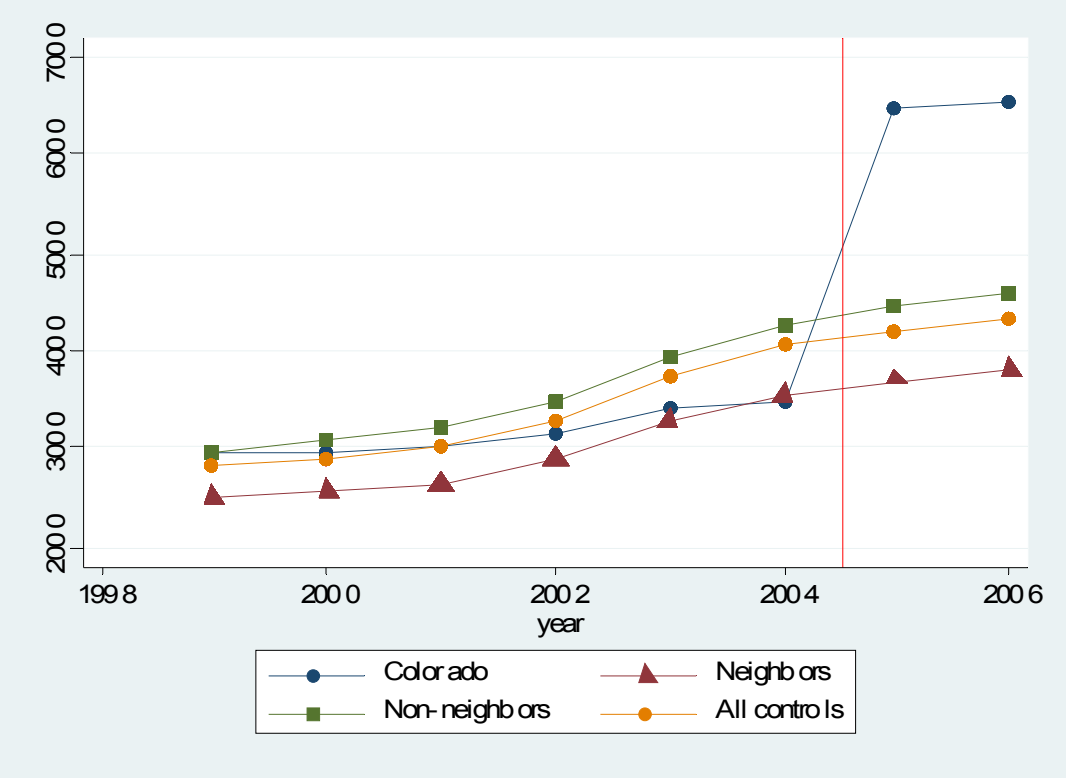

Figure 3.4: Average Institutional aid in Public 4-year universities.

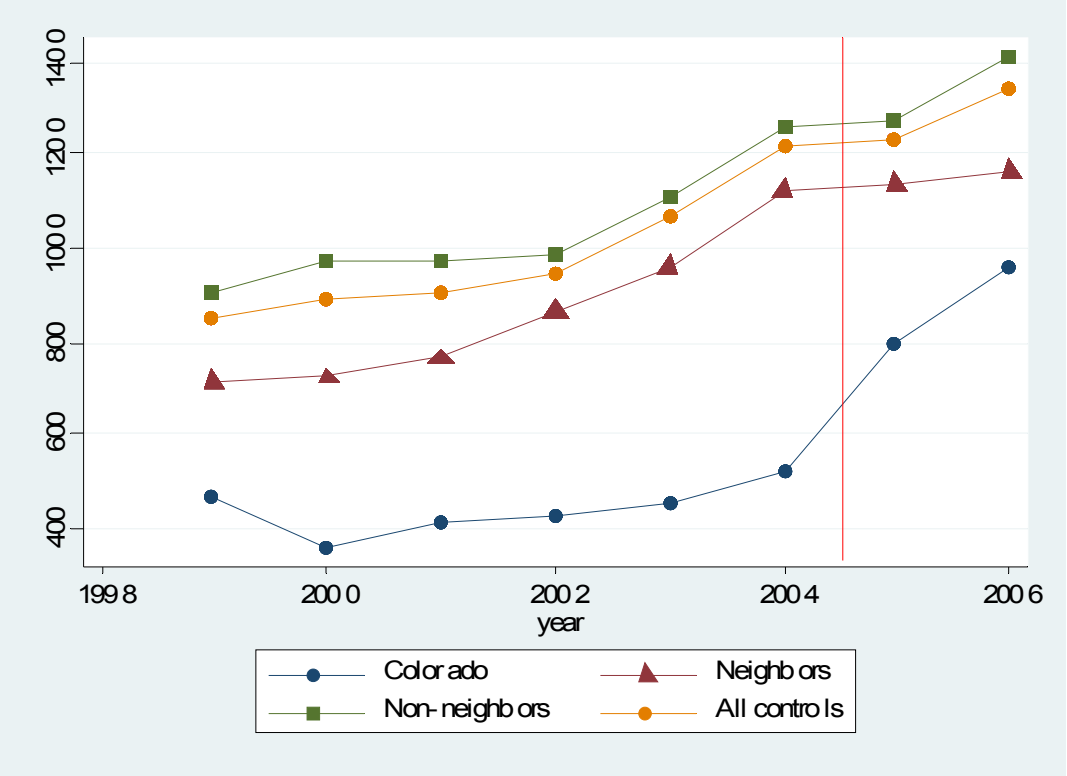

Figure 3.5: Average Tuition and fees in Private 4-year universities.

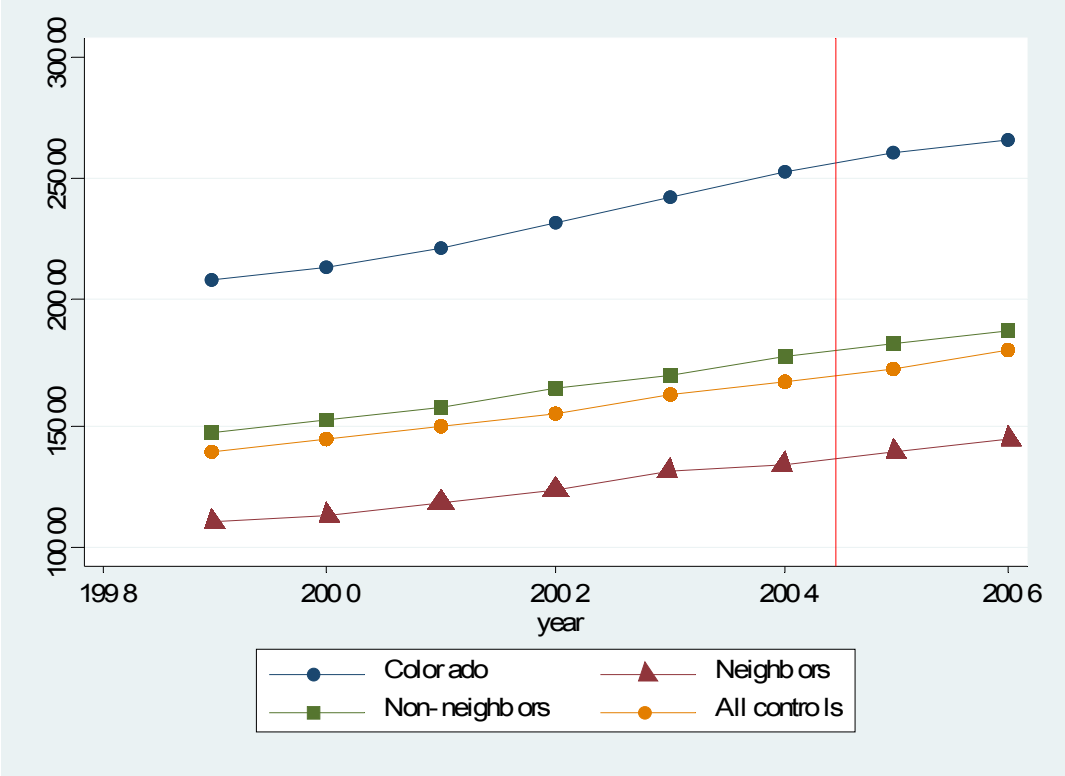

Figure 3.6: Average Institutional aid in Private 4-year universities.

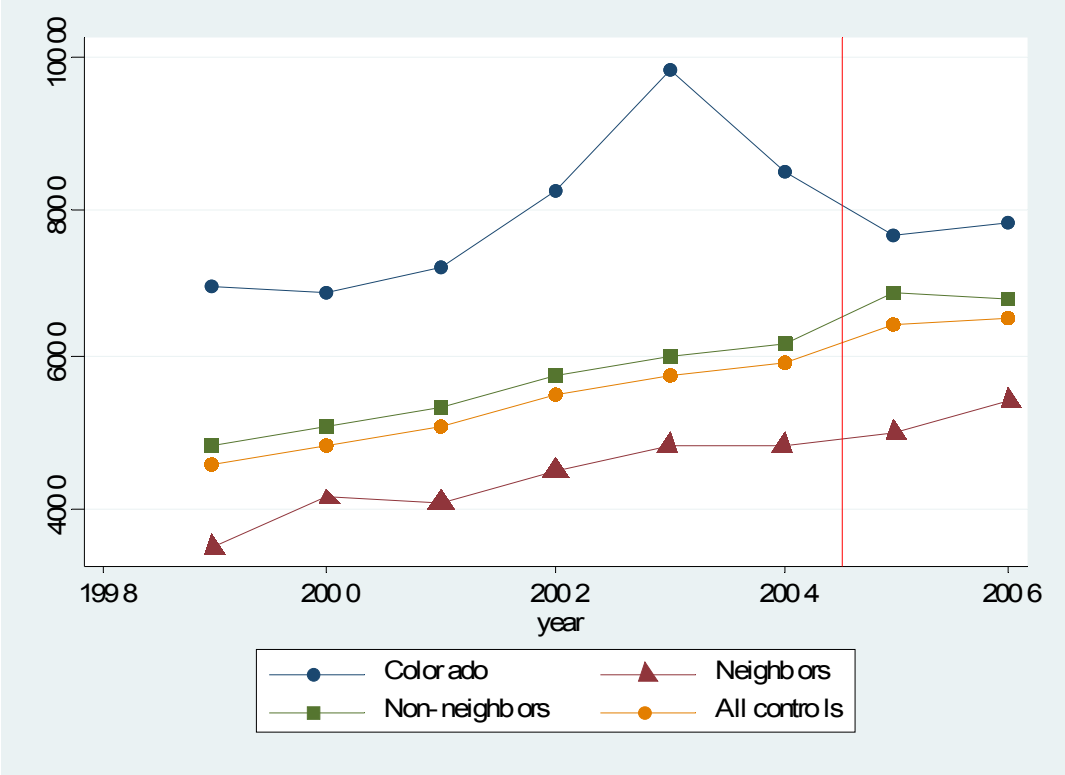

Figure 3.7: Average Freshman undergraduates in Public 2-year colleges.

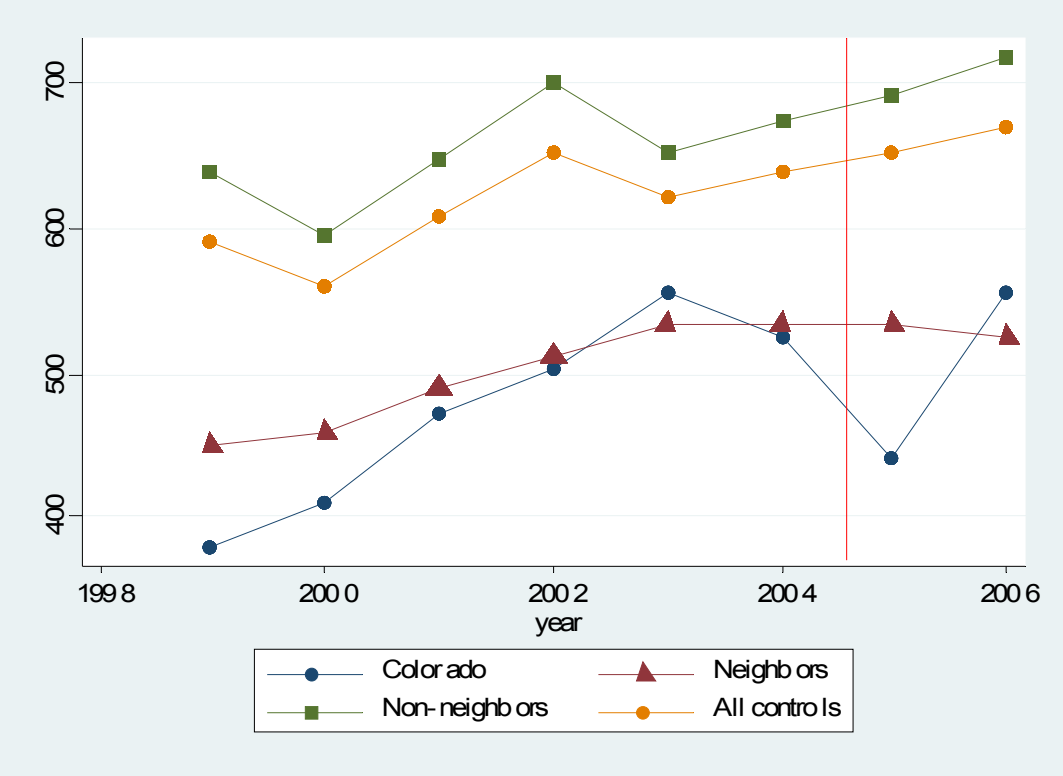

Figure 3.8: Average Total undergraduates in Public 2-year colleges.

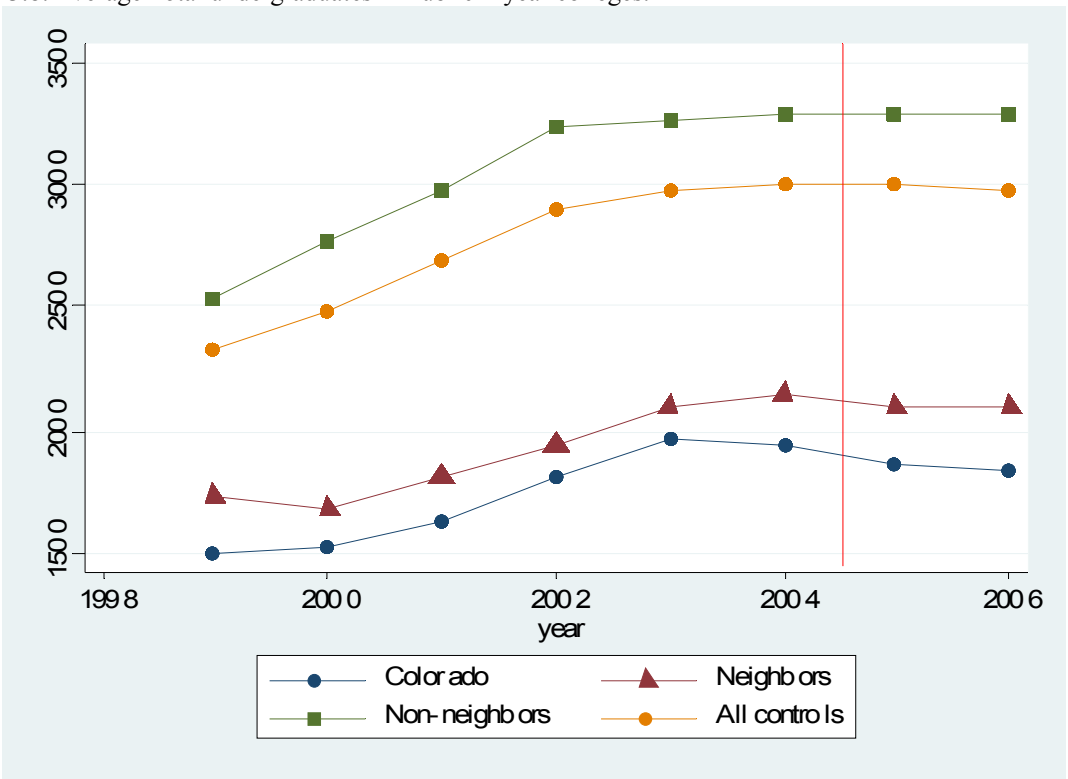

Figure 3.9: Average Freshman undergraduates in Public 4-year universities.

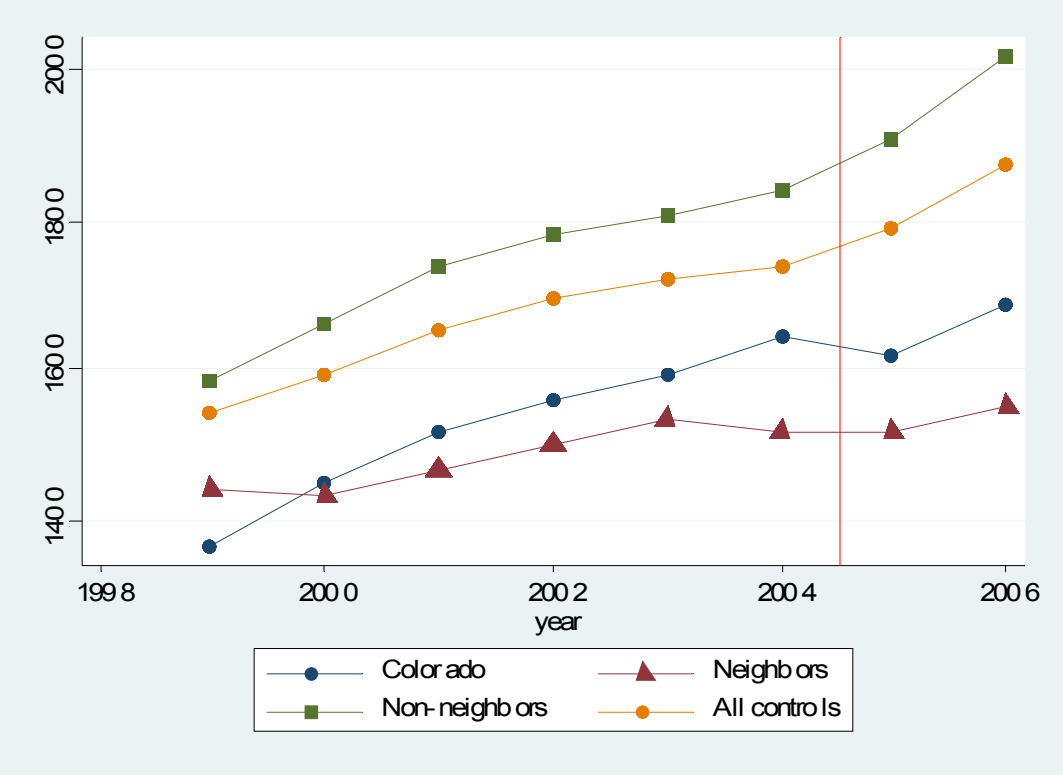

Figure 3.10: Average Total undergraduates in Public 4-year universities.

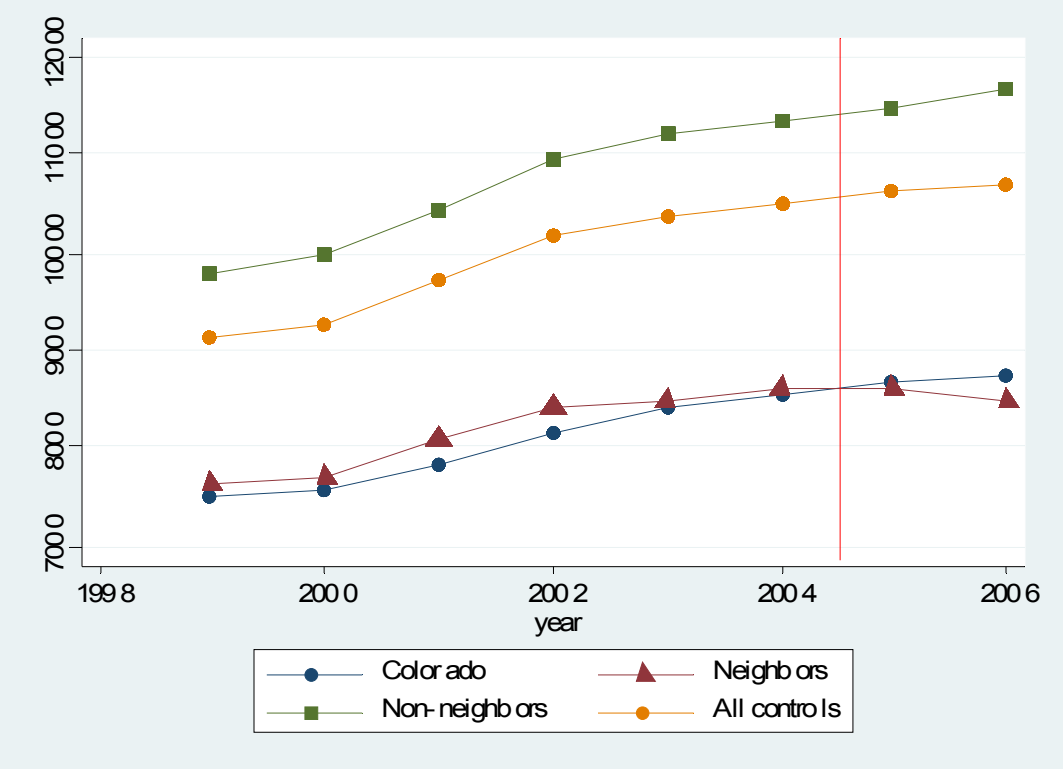

Figure 3.11: Average Freshman undergraduates in Private 4-year universities.

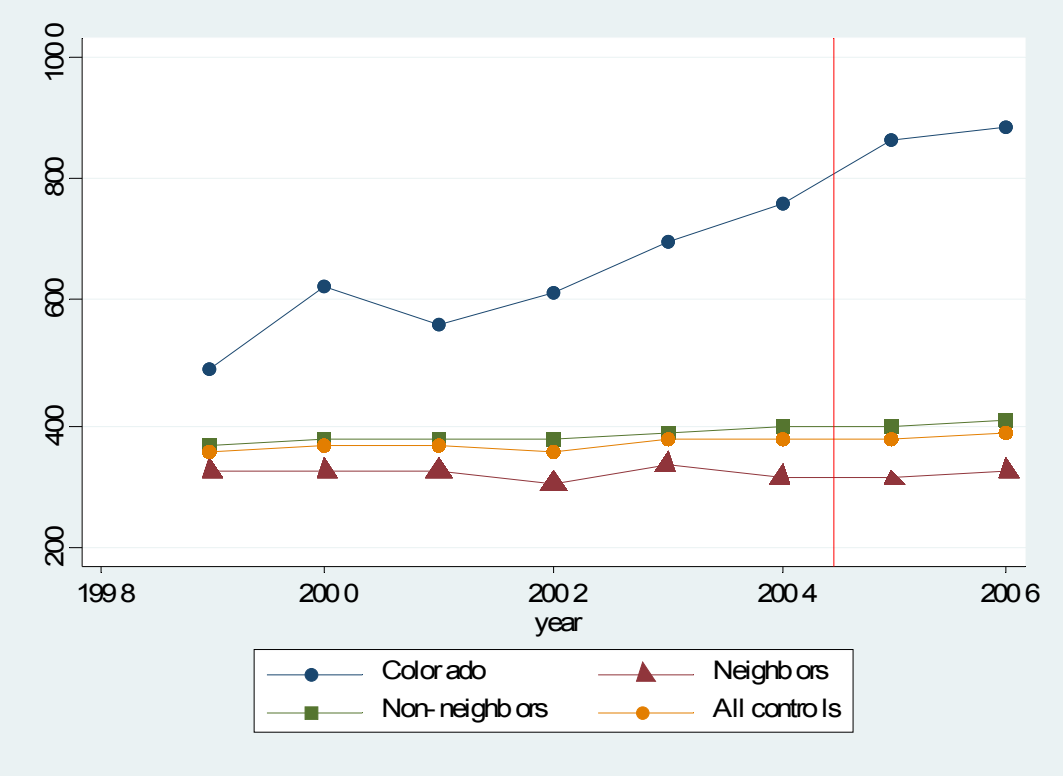

Figure 3.12: Average Total undergraduates in Private 4-year universities.

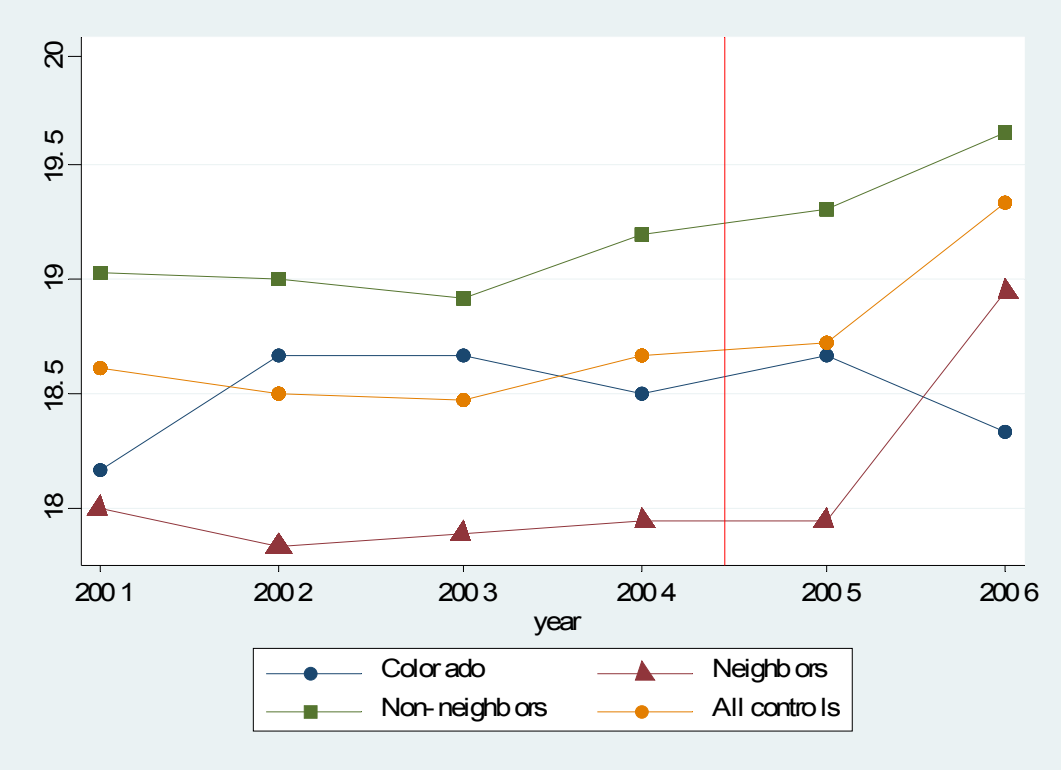

Figure 3.13: Average ACT Math 25th percentile score in Public 4-year universities.

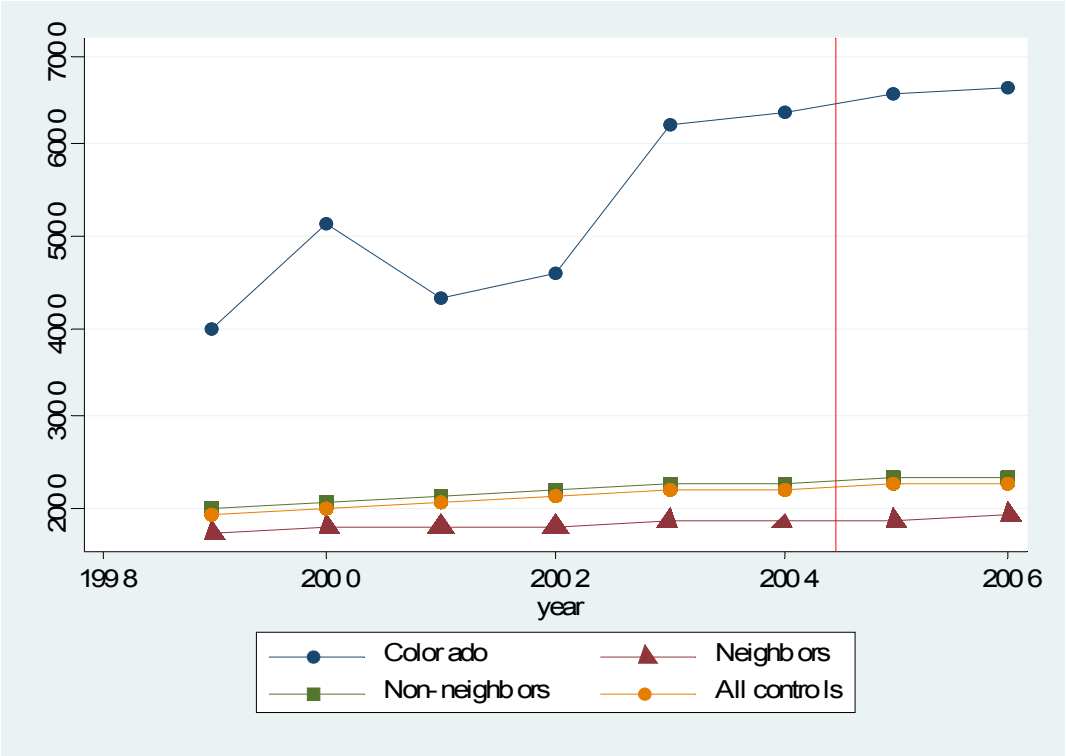

Figure 3.14: Average ACT English 25th percentile score in Public 4-year universities.

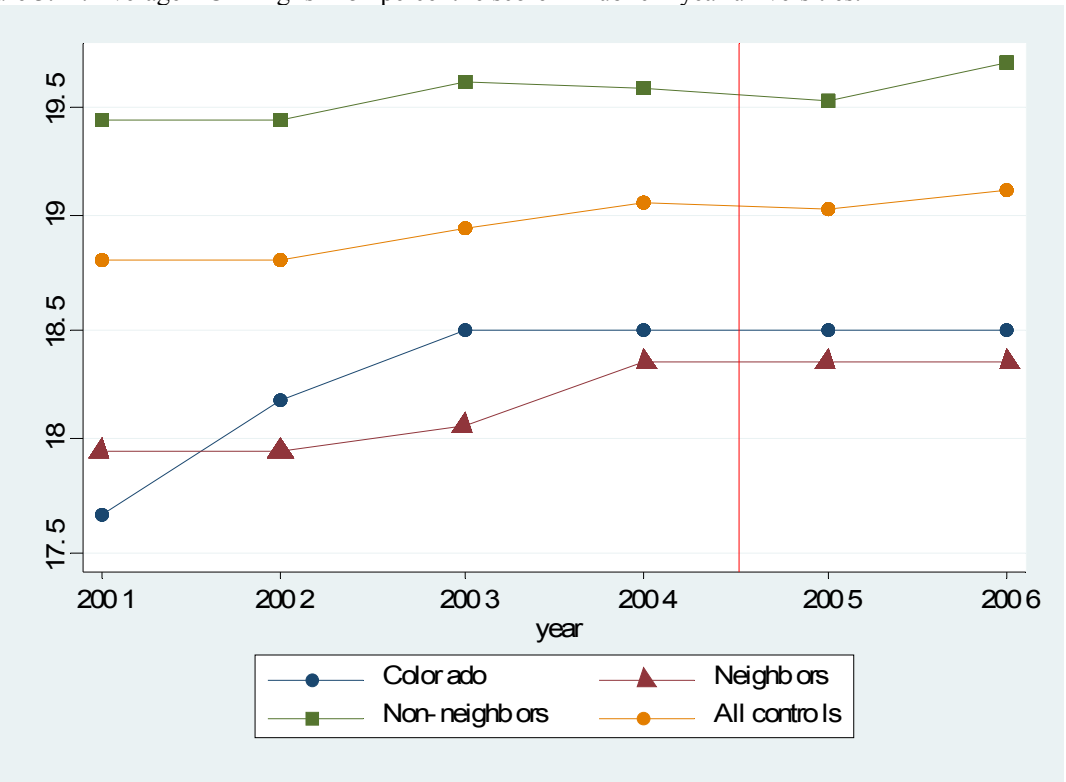

Figure 3.15: Average ACT Math 25th percentile score in Private 4-year universities.

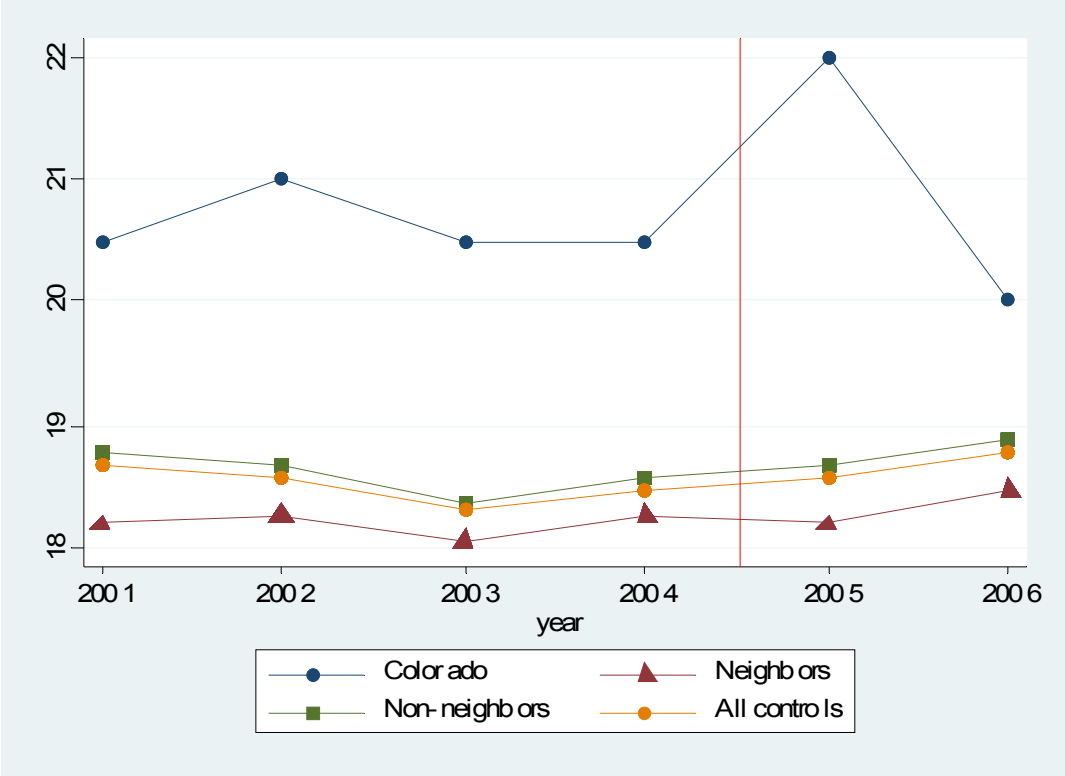

Figure 3.16: Average ACT English 25th percentile score in Private 4-year universities.

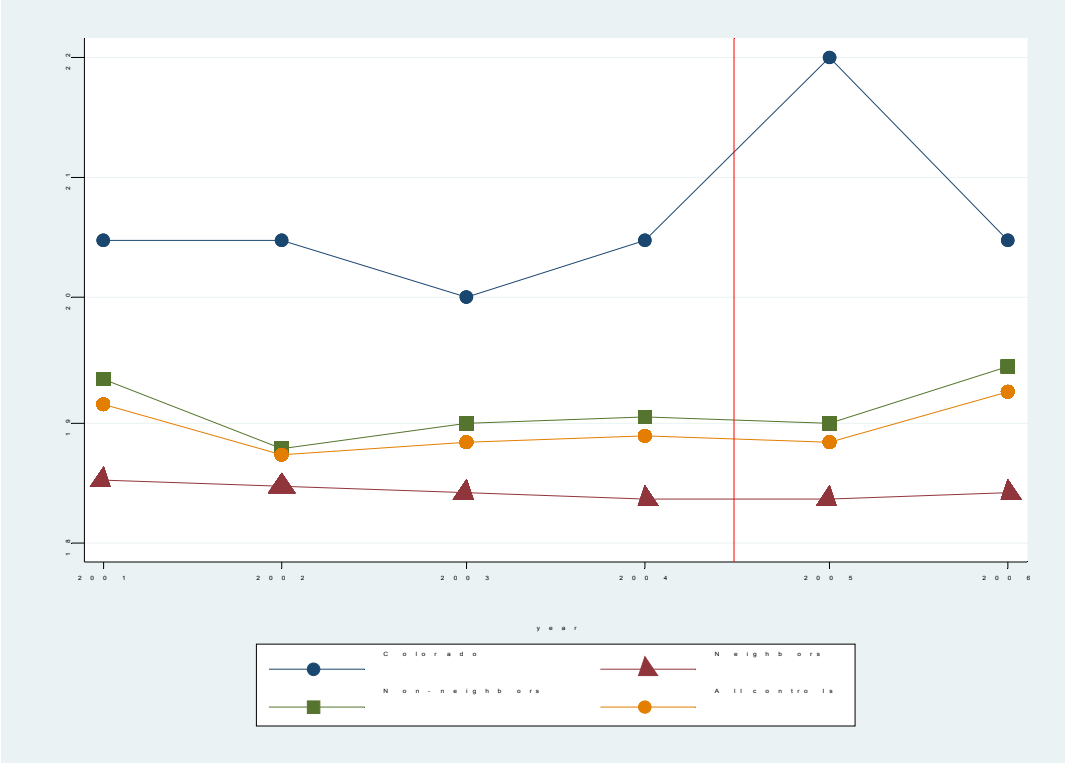

Table 3.1
Pre-COF Sample Means

	Colorado			Surrounding states		
	Public 2-year	Public 4-year	Private 4-year	Public 2-year	Public 4-year	Private 4-year
Attending price						
Tuition and fees	1,993.66	3,174.76	22,848.32	1,530.19	3,318.04	15,240.52
	(202.65)	(560.80)	(2,625.35)	(765.02)	(1,138.76)	(5,998.71)
Institutional aid	368.49	441.53	7,921.77	278.33	982.11	5,309.49
	(436.87)	(290.77)	(1,391.42)	(324.11)	(769.41)	(3,117.77)
Number of institutions	13	11	2	199	145	215
Number of observations	104	88	16	1,592	1,160	1,720
Enrollments						
Freshman undergraduates	473.79	1,521.16	625.58	612.64	1,656.67	365.96
	(319.40)	(1,405.25)	(371.67)	(536.34)	(1,358.90)	(494.33)
Total undergraduates	1,724.37	8,012.19	5,108.41	2,726.46	9,864.72	2,082.73
	(1,189.18)	(7,239.06)	(1,935.49)	(2,284.94)	(8,597.66)	(3,361.48)
Number of institutions	12	12	2	292	143	184
Number of observations	96	96	16	2,336	1,144	1,472
Admission test scores						
ACT Math, 25th percentile		18.50	20.62		18.56	18.50
		(2.48)	(0.51)		(2.07)	(2.70)
ACT English, 25th percentile		18.20	20.37		18.90	18.89
		(2.41)	(0.51)		(2.01)	(3.00)
Number of institutions		6	2		40	76
Number of observations		36	12		240	456
State characteristics						
State funding for higher education (billions)	2.93			2.87		
	(0.09)			(4.07)		
Median household income	53,717.16			46,340.82		
	(1,127.72)			(5,050.17)		
Average annual unemployment rate	4.48			5.14		
	(1.36)			(1.09)		
Share of 18 to 24 year-olds residing in the state	10.16			10.36		
	(0.24)			(0.76)		

Notes: The balanced panel includes program-eligible institutions in Colorado and non-program institutions in the surrounding states of Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Wyoming, Utah, Arkansas, California, Idaho, Iowa, Missouri, Montana, Nevada, South Dakota, and Texas. The year range is 1999-2006 except for ACT test score data for which it is 2001-2006. The standard deviations are reported in parentheses. All monetary variables are in 2005 dollars. The source of the institution-level data is the Integrated Postsecondary Education Data System from the National Center for Education Statistics. The source of the state characteristics data are the US Bureau of Census and the Bureau of Labor Statistics.

Table 3.2
COF impact on Attending Price

	Public 2-year Colleges				Public 4-year Universities				Private 4-year Universities			
	Tuition and fees		Institutional aid		Tuition and fees		Institutional aid		Tuition and fees		Institutional aid	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
CO*After		0.620***		-0.166		0.452***		0.522***		-0.04		-0.295**
		(0.019)		(0.225)		(0.049)		(0.144)		(0.028)		(0.123)
CO*2000	0.03		0.111		-0.014		-0.291		-0.006		-0.083	
	(0.022)		(0.239)		(0.010)		(0.350)		(0.012)		(0.077)	
CO*2001	0.004		0.08		-0.034**		-0.045		-0.013		-0.046	
	(0.035)		(0.230)		(0.014)		(0.400)		(0.018)		(0.058)	
CO*2002	0.008		0.034		-0.083***		0.23		-0.052		0.045	
	(0.040)		(0.236)		(0.020)		(0.316)		(0.045)		(0.074)	
CO*2003	-0.099**		0.313		-0.151***		0.158		-0.061		0.133*	
	(0.041)		(0.223)		(0.022)		(0.304)		(0.060)		(0.069)	
CO*2004	-0.187***		0.312		-0.226***		0.236		-0.055		-0.049	
	(0.040)		(0.242)		(0.045)		(0.280)		(0.055)		(0.066)	
CO*2005	0.581***		0.213		0.361***		0.560*		-0.075		-0.309**	
	(0.039)		(0.312)		(0.057)		(0.300)		(0.069)		(0.144)	
CO*2006	0.568***		-0.239		0.358***		0.614**		-0.067		-0.279**	
	(0.035)		(0.410)		(0.058)		(0.295)		(0.048)		(0.107)	
Pre-COF coefficients F test	8.46***		0.79		13.02***		1.12		1.07		5.29***	
Number of observations	1696	1696	1696	1696	1240	1240	1240	1240	1736	1736	1736	1736
Number of institutions	212	212	212	212	155	155	155	155	217	217	217	217

Notes: Each column reports coefficients from a separate regression. Robust standard errors are reported in parentheses. *** , **, * indicate significance at the 99%, 95%, 90% levels, respectively. The dependent variables are in logs. Each regression includes real median household income, average annual unemployment rate, and share of 18-24 year-olds of state population as control variables, as well as university and year dummies. The control states are Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Wyoming, Utah, Arkansas, California, Idaho, Iowa, Missouri, Montana, Nevada, South Dakota, and Texas. The year range is 1999-2006.

Table 3.3
COF-induced Enrollment at Institutions

	Public 2-year Colleges				Public 4-year Universities				Private 4-year Universities			
	Freshman undergraduates		Total undergraduates		Freshman undergraduates		Total undergraduates		Freshman undergraduates		Total undergraduates	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
CO*After		-0.062**		-0.072**		-0.037		-0.026		0.471*		0.239*
		(0.029)		(0.032)		(0.040)		(0.027)		(0.256)		(0.129)
CO*2000	0.113***		0.008		0.02		0		0.395**		0.346	
	(0.043)		(0.026)		(0.046)		(0.015)		(0.195)		(0.212)	
CO*2001	0.164***		-0.005		0.065*		-0.017		0.144***		0.012	
	(0.062)		(0.025)		(0.037)		(0.020)		(0.039)		(0.024)	
CO*2002	0.191***		-0.006		0.042		-0.04		0.286***		0.057	
	(0.067)		(0.035)		(0.051)		(0.031)		(0.076)		(0.056)	
CO*2003	0.324***		0.008		0.013		-0.062*		0.530**		0.425	
	(0.051)		(0.044)		(0.057)		(0.036)		(0.228)		(0.308)	
CO*2004	0.186**		-0.042		0.022		-0.059		0.562***		0.441	
	(0.081)		(0.051)		(0.070)		(0.042)		(0.194)		(0.307)	
CO*2005	0.018		-0.062		0.001		-0.06		0.791**		0.454	
	(0.064)		(0.053)		(0.074)		(0.046)		(0.375)		(0.287)	
CO*2006	0.199***		-0.095		-0.02		-0.058		0.795**		0.454*	
	(0.060)		(0.059)		(0.064)		(0.049)		(0.355)		(0.271)	
Pre-COF coefficients F test	11.62***		2.12*		1.01		1.09		14.93***		1.91*	
Number of observations	2432	2432	2432	2432	1232	1232	1232	1232	1488	1488	1488	1488
Number of institutions	304	304	304	304	154	154	154	154	186	186	186	186

Notes: Each column reports coefficients from a separate regression. Robust standard errors are reported in parentheses. *** , **, * indicate significance at the 99%, 95%, 90% levels, respectively. The dependent variables are in logs. Each regression includes real median household income, average annual unemployment rate, and share of 18-24 year-olds of state population as control variables, as well as university and year dummies. The control states are Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Wyoming, Utah, Arkansas, California, Idaho, Iowa, Missouri, Montana, Nevada, South Dakota, and Texas. The year range is 1999-2006.

Table 3.4
COF impact on Test Scores at Institutions

	Public 4-year Universities				Private 4-year Universities			
	ACT Math, 25th percentile		ACT English, 25th percentile		ACT Math, 25th percentile		ACT English, 25th percentile	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CO*After		-0.48*		0.12		0.24		0.79
		(0.24)		(0.23)		(0.84)		(1.20)
CO*2002	0.85***		0.38		0.82*		0.67	
	(0.32)		(0.49)		(0.48)		(0.87)	
CO*2003	0.96*		0.66		0.63		-0.02	
	(0.49)		(0.40)		(0.42)		(0.68)	
CO*2004	0.65		0.54		0.39		0.41	
	(0.45)		(0.40)		(0.43)		(0.58)	
CO*2005	0.54		0.52		1.89***		2.17**	
	(0.33)		(0.41)		(0.68)		(0.84)	
CO*2006	-0.27		0.5		-0.48		-0.04	
	(0.41)		(0.56)		(1.15)		(1.54)	
Pre-COF coefficients F test	3.09**		1.70		2.05		9.27***	
Number of observations	270	270	270	270	468	468	468	468
Number of institutions	45	45	45	45	78	78	78	78

Notes: Each column reports coefficients from a separate regression. Robust standard errors are reported in parentheses. *** , **, * indicate significance at the 99%, 95%, 90% levels, respectively. The dependent variable is the 25th percentile score at a university. Each regression includes real median household income, average annual unemployment rate, and share of 18-24 year-olds of state population as control variables, as well as university and year dummies. The control states are Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Wyoming, Utah, Arkansas, California, Idaho, Iowa, Missouri, Montana, Nevada, South Dakota, and Texas. The year range is 2001-2006.

Table 3.5
Robustness Checks

Dependent variable	With state-specific year trends	With corrected standard errors	Response in border states	Non-border states as control group
	(1)	(2)	(3)	(4)
Public 2-year Colleges				
Tuition and fees	0.749***	0.639***	-0.092***	0.619***
	(0.026)	(0.043)	(0.024)	(0.020)
Institutional aid	-0.299*	-0.163	-0.194*	-0.169
	(0.174)	(0.210)	(0.116)	(0.227)
Freshman undergraduates	-0.228***	-0.026	0.047	-0.080**
	(0.055)	(0.093)	(0.043)	(0.032)
Total undergraduates	-0.036	-0.079	-0.001	-0.062*
	(0.024)	(0.048)	(0.022)	(0.033)
Public 4-year Universities				
Tuition and fees	0.593***	0.446***	-0.002	0.459***
	(0.041)	(0.036)	(0.019)	(0.049)
Institutional aid	0.258	0.511**	0.051	0.523***
	(0.189)	(0.228)	(0.125)	(0.153)
Freshman undergraduates	-0.02	-0.029	-0.104***	-0.065
	(0.039)	(0.067)	(0.038)	(0.045)
Total undergraduates	0.034*	-0.031	-0.042	-0.026
	(0.018)	(0.033)	(0.038)	(0.028)
ACT Math, 25th percentile	-0.26	-0.46	-0.05	-0.48*
	(0.50)	(0.41)	(0.31)	(0.26)
ACT English, 25th percentile	-0.3	0.1	0.2	0.22
	(0.28)	(0.30)	(0.22)	(0.27)
Private 4-year Universities				
Tuition and fees	-0.008	-0.052	-0.016	-0.047
	(0.010)	(0.158)	(0.040)	(0.034)
Institutional aid	-0.364***	-0.316	-0.074	-0.317**
	(0.134)	(0.288)	(0.073)	(0.125)
Freshman undergraduates	0.098	0.475*	-0.095	0.460*
	(0.146)	(0.247)	(0.077)	(0.257)
Total undergraduates	-0.056	0.234*	-0.042	0.232*
	(0.079)	(0.121)	(0.038)	(0.129)
ACT Math, 25th percentile	0.53	0.26	-0.1	0.28
	(0.64)	(0.96)	(0.40)	(0.86)
ACT English, 25th percentile	1.05	0.82	-0.18	0.84
	(0.87)	(1.17)	(0.48)	(1.22)

Notes: Each coefficient is from a separate regression. The standard errors are reported in parentheses. *** , **, * indicate significance at the 99%, 95%, 90% levels, respectively. Robust standard errors are reported in column (1). The control institutions for column (1) are in all surrounding states including Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Wyoming, Utah, Arkansas, California, Idaho, Iowa, Missouri, Montana, Nevada, South Dakota, and Texas. The regressions in columns (2) and (3) are on a collapsed panel of one pre-COF and one post-COF prediod to correct the standard errors. Conventional standard errors are reported in columns (2) and (3). The treated institutions in column (3) are in states bordering Colorado, while the control universities are in other states in the region. The control states in column (4) are in states not bordering Colorado. Robust standard errors are reported in column (4). Each regression includes real median household income, average annual unemployment rate, and share of 18-24 year-olds of state population as control variables, as well as university and year dummies.

3.9 Appendix

Figure 3.A.1: Average State Higher Education spending (in billions).

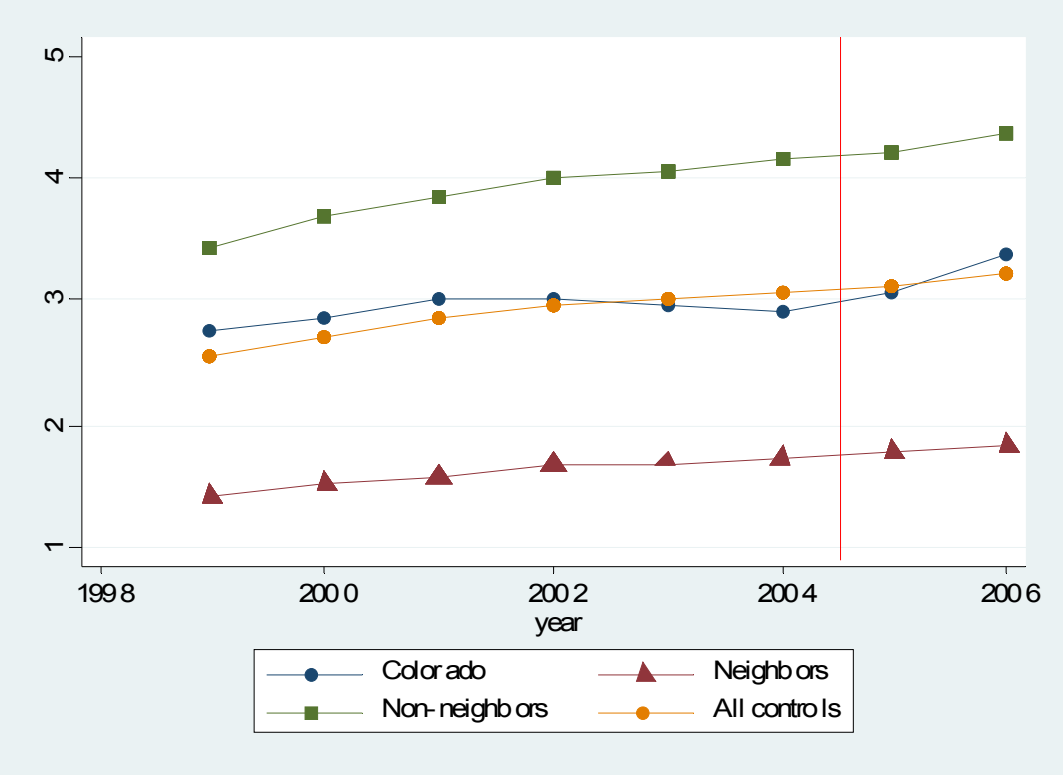

Table 3.A.1
State Higher Education Spending

	(1)	(2)
CO*After		-0.013
		(0.016)
CO*2000	-0.002	
	(0.020)	
CO*2001	0.012	
	(0.028)	
CO*2002	-0.003	
	(0.032)	
CO*2003	-0.067*	
	(0.032)	
CO*2004	-0.099***	
	(0.029)	
CO*2005	-0.060*	
	(0.032)	
CO*2006	-0.027	
	(0.030)	
Pre-COF coefficients F test	9.20***	
Number of observations	136	136
Number of institutions	17	17

Notes: The unit of observation is the state. Each column reports coefficients from a separate regression. Robust standard errors are reported in parentheses. *** , **, * indicate significance at the 99%, 95%, 90% levels, respectively. The dependent variable is in logs. Each regression includes real median household income, average annual unemployment rate, and share of 18-24 year-olds of state population as control variables, as well as university and year dummies. The control states are Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Wyoming, Utah, Arkansas, California, Idaho, Iowa, Missouri, Montana, Nevada, South Dakota, and Texas. The year range is 1999-2006.