Benefit Spillovers and Higher Education Financing:
An Empirical Analysis of Brain Drain and State-Level Investment in Public Universities

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Abstract

This paper analyzes the impact of out-migration of college graduates on state higher education investment. A three-stage least squares regression model with state and year fixed effects is developed and estimated, addressing the relationship between state legislative appropriations, tuition, and educated out-migration across 49 U.S. states from 2006-2015. The results support the notion that states respond negatively to benefit spillovers in higher education: for every one percent increase in the rate of educated out-migration, state appropriations decrease by 1.92 percent (roughly $140 per student). These findings suggest that an education subsidy provided to states may be necessary to prevent underinvestment in higher education.

JEL classification: H7, H75, I22, I28, R23

Keywords: Education Finance; State Expenditure; Regional Migration

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I. Introduction

The New York Times recently published an article titled, "The States That College Graduates Are Most Likely to Leave," in which the author notes that, "many of the most skilled workers — young people with college degrees — are leaving struggling regions of America for cities…in Southern and coastal states" (Bui, 2016). The article highlights a renewed focus within public and academic spheres on the growing education and migration divides within the United States, and suggests that there may be serious implications for individual states, depending on their gains and losses from educated migration.

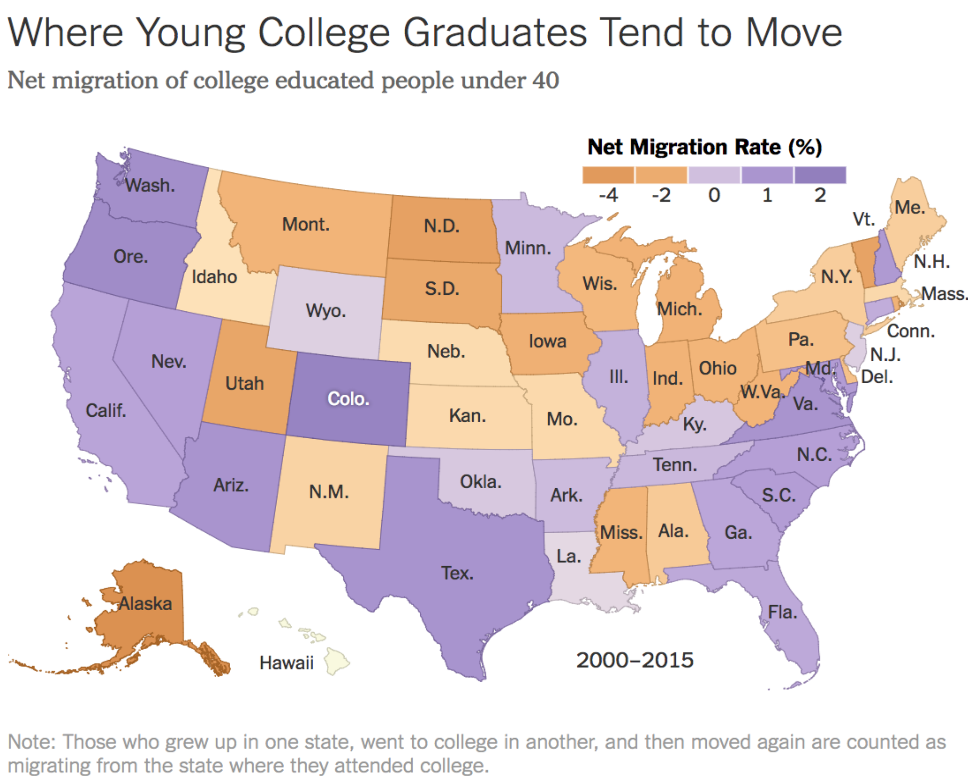

Figure 1. Where Young College Graduates Tend to Move (2000-2015). Figure describes the migration patterns of college graduates from 2000 to 2015. Bui, Q. (2016, November 22). The states that college graduates are most likely to leave. *New York Times*. Retrieved from https://www.nytimes.com/2016/11/22/upshot/the-states-that-college-graduates-are-most-likely-to-leave.html

Figure 1 displays evidence that the distribution of interstate migration over the past 15 years is not equal, and certain states, such as Colorado, Texas, and Virginia, are gaining talent while states such as North Dakota, Alaska, and Utah are losing talent. Shortly after the New York Times' article, a local Nebraskan newspaper, the Omaha World-Herald, published a piece lamenting the bleak report from the Census Bureau that "Nebraska has reverted to its past form in losing more college graduates than it attracts" (Robb, 2016). The article displays the brain drain – out-migration of the highly educated[1] – for each state. Similar to the findings in the New York Times article, the results are disappointing for many Midwestern states and pleasing to those states generally along the coasts.

Brain drain affects a wide set of actors, one of which is the state legislature since it must allocate resources to projects based on their rates of return and popular demand. Yet, the impact of brain drain on state spending has received little attention. This paper attempts to contribute to the literature by uncovering the influence of educated out-migration on state-level higher education expenditures. Specifically, I argue that greater out-migration of college-educated individuals creates negative incentives for states to invest in their higher education programs.

Previous studies have focused on the impact of migration on primary and secondary school funding while also analyzing the migration patterns of the general population, as opposed to that of a particular group. Additionally, the previous literature makes use of limited data covering very few years. This paper's approach differs from past studies of migration and public financing of education in that it explicitly analyzes a) the movement of *college-educated*

[1] "Highly educated", "college graduates", and "university graduates" are used interchangeably throughout the remainder of this paper. They refer to an individual who completed an academic or professional education beyond high school (i.e., "college"). Additionally, "educated out-migration" is synonymous with out-migration of the highly educated.

individuals and b) state legislative appropriations towards *higher education*. A three-stage least squares regression model using time and state fixed effects is applied to panel data covering all but one U.S. states over a 10-year period. This paper also makes use of refined micro-data to estimate educated out-migration at the state-level. This is an approach that, to this author's knowledge, has not been used to study the aforementioned relationship.

The remainder of the paper is structured as follows. In Section 2, I review the relevant literature related to migration of the highly educated and higher education financing. Section 3 then outlines the underlying theory of the benefit spillover hypothesis. Section 4 discusses the data utilized in the study and specifies the empirical strategy. Section 5 describes the results of the analysis, followed by a discussion of the results in Section 6. Section 7 concludes by briefly touching on future research opportunities.

II. Literature Review

Interstate Migration

The effects of general interstate migration – defined as the difference between the number of people who have changed their place of usual residence by moving into a given State within the United States and the number who have changed their place of usual residence by moving out of that State – have been analyzed through a number of different lenses, ranging from its effects on the suicide rate (Stack, 1980), the geographic distribution of stroke mortality (Lanska, 1995), public education financing (Strathman, 1994), and more.

Similarly, the factors that influence interstate migration have been scrutinized intently, anywhere from the influence of state taxes (Mazerov, 2014), education levels (Hernandez-Murillo et al. 2011), and characteristics of state of origin/destination (Fukurai et al., 1987) on migration rates. Hernandez-Murillo et al. (2011) examine a sample of over 200,000 Americans to identify the key drivers of migration, noting that the primary reasons for moving are employment related (joblessness, changing employers, or becoming employed) and disability related. Housing affordability and higher income are associated with lower out-migration while, conversely, unemployment claims are associated with greater out-migration (Sasser, 2010).

Several researchers have attempted to understand and explain the migration patterns within the United States. Between 1991 and 2011, interstate migration in the U.S. saw a secular decline; gross flows of people across states are about 10 times larger than net flows, but declined by around 50 percent over the 20-year period (Kaplan and Schulhofer-Wohl, 2015). Molloy, Smith, and Wozniak (2011) corroborate this conclusion, finding a consistent decline in interstate migration within the United States caused by reasons other than compositional changes in migrant backgrounds.

Despite the overall decline in interstate migration, migration of highly educated individuals – those with Bachelor's degrees or higher – still seems to be pervasive, which may have far-reaching effects. One such effect is on the public returns to higher education investments: out-migration may significantly decrease the benefits that states receive from allocating resources to universities (Trostel, 2010).

Broadly, the literature on interstate migration has found common ground on certain points regarding relevant individual characteristics, labor market conditions, and non-labor-market influences, despite the heterogeneity in methodology, as Kodrzycki (2001) has noted:

1. Studies have noted that migration is highest among the young and the college-educated, a "brain drain" of sorts, though significant heterogeneity does still exist.
2. Blacks are less likely to move than are whites, particularly after their large migration out of the South during the 1940s and 1950s.
3. Studies indicate that people who have moved in the past are more likely to move in the future.
4. For the working-age population, migration has been found to respond to relative labor market opportunities in different areas, such as earnings or unemployment differentials.

Ongoing topics of inquiry include whether migrants are influenced more by negative conditions in their initial location ("push") or the prospect of improvement upon moving ("pull"). Studies generally reach similar conclusions whether or not they account for measured pay differentials for overall living costs. However, at least one study finds that high housing costs discourage in-migration. No clear evidence exists on whether these economic variables have different impacts for people of different ages or different levels of educational attainment. Noneconomic factors also play a role in determining where people move. Research has found that amenities associated with climate have had an impact on the direction of moves, although most studies find that these are a less important influence than labor market conditions. The distance between two locations serves as a deterrent to migration between them. To some extent, this may be because of the financial costs of moving. However, the research tends to put more emphasis on the psychic costs of being away from family and long-time friends, as well as the barriers to obtaining accurate information about faraway locations" (Kodrzycki, 2001).

The impacts of migration, as discussed, can be varied and far-reaching. One element that seems to be under-analyzed is the relation between interstate migration of the highly educated and public financing of colleges and universities. Strathman (1994) investigated this topic from a community welfare-maximizing standpoint by regressing the level of state appropriations for higher education on gross in/out-migration of the general population. His findings suggest that states do, in fact, respond to non-internalized benefits of migration ("spillovers") by reducing their level of higher education expenditures. However, the universe of literature on the topic of migration and higher education financing is fairly limited, particularly when it comes to the migration of highly educated populations.

Goworowska and Gardner (2012) examine historical data from the 1970, 1980, 1990, and 2000 census years, finding that the population of the "young, single, and college-educated" (YSC) – defined as those aged 25 to 39 with a Bachelor's degree or higher and not married – is more mobile than the general population and tends to locate in areas that see net out-migration for the total population. Goworowska and Gardner (2012) further find that the population of YSC people has grown since 1970, despite a drop in the number of 25- to 39-year-olds in the 1990–

2000 period. Moreover, the sex ratio within the group has reached near parity, a significant shift from its male dominant feature 30 years ago. A key feature of the authors' findings is that regardless of marital status, today "young people with a bachelor's degree or higher were more likely to have changed residences in the 5 years preceding the census than those without a degree." These findings provide grounds to re-evaluate Strathman's (1994) paper, which analyzes the effect of migration of the *total* population on public financing of higher education. Exploring specifically the movement of college-educated people is conceivably a better proxy for brain drain and benefit spillovers, and thus states' financing incentives.

The states that these individuals move to are similar to the findings in the articles mentioned in Section 1. Over the past 30 years, the YSCs regularly migrated to states in the West region and a few in the South Atlantic division. On a sub-state level, certain metro areas with populations greater than 2.5 million were also top destinations for the YSCs. Critically, these were often areas of net out-migration for the total population, indicating that this specific sub-group of the population is worth observing independent of the total population. The authors find that just six metro areas (Seattle, Phoenix, Atlanta, Dallas, and Minneapolis) experienced "positive net migration rates in 2000 for both the young, single, college-educated population and the total population," claiming that these cities are the exception. In general, regions that attract college-educated individuals – including 14 of the top 20 metro areas – are also regions of severe out-migration of the general population, leading observers to believe that migration destinations for the college-educated "differ from the choice destinations for the total population." Due to the group's human capital and potential impact, this paper will investigate its effect specifically on public financing of higher education.

Benefit Spillovers

Public finance theory posits that local public expenditures are negatively affected by benefit spillovers (Oates 1972), which, in the case of public education, manifest in the movement of a person away from the community that provided her education (Weisbrod 1962). Using a community welfare-maximizing framework, Weisbrod postulated that persistent out-migration would place downward pressure on home jurisdictions to spend less on public education on a per-pupil basis. Weisbrod argued that communities (and states) can be viewed as evaluating educational expenditures as investments made in order to reap future benefits. However, the anticipated benefits, as mentioned, may be affected by spillovers. Since spillovers are often residence-related, out-migration of educated people results in spill-outs while in-migration leads to benefit spill-ins. Shifting demographic and migration patterns may then impact funding for higher education (Rizzo, 2003).

Weisbrod's empirical work confirmed this theory (Weisbrod 1965). He tested the community welfare-maximization hypothesis by regressing expenditures per public school student in 1960 on income per pupil in 1960 and net migration for states using 1950-58 data. His results showed a negative correlation between average expenditures per pupil made by state and local governments and net out-migration. Interestingly, he found that net in-migration, which causes "spill-ins", did not affect expenditure levels and also found only a very weak correlation between expenditures and income per pupil. These findings implied that out-migration led to state and local governments to reduce educational expenditures to offset anticipated losses resulting from spill-outs; meanwhile, in-migration had no apparent effect upon their expenditure decisions. Thus, as Weisbrod pointed out, these data suggest that spillovers may result in systemic underinvestment in education, and, altogether, Weisbrod seemed to establish that educational finance systems may suffer from allocation inefficiency and lower expenditures than would have occurred if mobility was completely restricted.

Clotfelter (1976) corroborated these findings by empirically testing the spillover hypothesis for public higher education funding. He concluded that states with higher likelihood of out-migration of the general population had significantly lower per capita instructional expenditures for public colleges and universities. Clotfelter did not test for in-migration, however, assuming that education spending does not influence the decision to migrate. Both Weisbrod's and Clotfelter's research is extremely important in grounding this paper's research thesis by establishing that migration may meaningfully impact local public policy decisions.

Public choice theory's median voter model has been the dominant framework in previous studies of state legislative appropriations to higher education (see Borcherding and Deacon, 1972; Clotfelter, 1976; Creedy and Francois, 1990, Hoenack and Pierro, 1990; Toutkoushian and Hollis, 1998). Meanwhile, tuition has largely been modeled off of hedonic price theory (see Dimkpah et al., 2004; Paulsen, 1991). This paper is different in that it is based off of the benefit spillover hypothesis and utilizes a fixed-effects, three-stage least squares regression methodology. Nonetheless, studies of state-level appropriations for higher education are particularly important for this paper as it seeks to identify the effect of benefit spillovers from the migration of the highly educated on state expenditures.

As a result, most pertinent to this research paper is the consideration that one of the drivers of state appropriations for higher education is the degree to which state policymakers believe they will benefit from their investment in higher education. Strathman (1994) shows that higher education appropriations may be in part influenced by the effect of benefits spillovers. Using data primarily from 1989–1990, he estimated a simultaneous equations model for all 50

U.S. states as a cross section, and accounted for the endogenous relationship between appropriations, tuition, and general out-migration. Strathman's results suggest a negative and statistically significant relationship between out-migration and appropriations for higher education, a key finding that further grounds this paper's research. Again, though, there is reason to believe that states are more concerned about the returns to higher education investments. Trostel (2010) studied the impact of college out-migration on public returns to higher education investments, stating that when states lose talent after investing resources and time into their college graduates, there are non-zero losses that may sway state-level public finance decisions. Therefore, the migration patterns of the highly educated are likely to be more indicative of state incentives to increase or decrease public expenditures. The emphasis on college migration will be the focus of this paper as it builds off of the spillover benefit hypothesis established by previous authors.

While many previous studies have also examined the impact of migration on primary and secondary public funding, focusing on public higher education offers a superior setting to test for benefit spillover effects since state-level migration data can be leveraged more effectively. Primary and secondary migration studies typically stick to inter-county movements, for which variation in migration and the strength of incentives for communities may not be as strong. Additionally, state-level data are less exposed to measurement error than the migration data exploited in the within-state studies discussed previously. Measurement error of this type can create a downward bias on the estimated migration coefficient.

While using state data, it is imperative to account for the difference in structure and execution between public higher education expenditures and public financing of lower levels of education (Strathman, 2014). Higher education financing is driven by two players: first, the state governments that provide legislative appropriations, and second, the consumers (i.e. students) who provide tuition.

The focus of public benefit spillover effects in public higher education relates primarily to the investment activity of the first player, the state government providing legislative appropriations, and its response to the changes in migration. The complicating factor is that the public outlays are highly intertwined with the second major component of higher education revenue: tuition. Government provisions are both "affected by and are determinants of tuition," Strathman notes, complicating the assessment of benefit spillovers and responses to such a phenomenon. To be explicit, because state legislatures play a significant role in both assigning appropriations to universities and in deciding tuition levels, these two variables are intimately related to one another and thus, the methodology must appropriately tease apart this complication. Figure 2 displays the average state-level public higher educational appropriations per FTE student as well as the average net tuition per public FTE college student from 1991 to 2016. On first glance, it is clear that educational expenditures have generally come down while tuition has consistently risen. Disentangling these two trends to understand the their responses to migration is crucial for this paper.

Thus, a primary task of the paper's empirical approach is to control for the confounding effects that spring from trade-offs between appropriations and tuition, among other factors. Prior evidence suggests that simultaneity concerns may also exist between out-migration and state-level appropriations for education. Frequently, the literature deems state appropriations as a determinant of tuition, but simultaneously includes tuition among the factors of state appropriations. These concerns are handled in the methodology using a three-stage, least squares regression strategy, which is discussed in greater detail in Section 4.

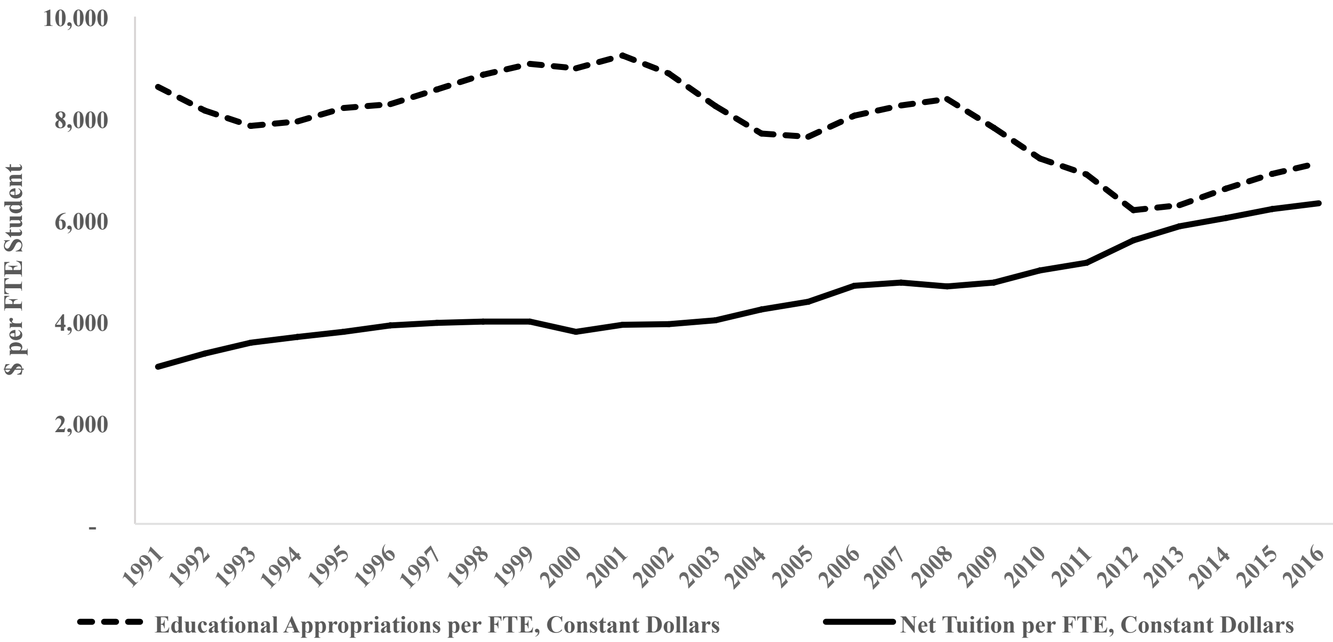

Figure 2. State-level educational appropriations per FTE student and net tuition per FTE student at public colleges (1991 to 2016**).**

This paper builds off of the literature's findings that college-educated individuals are the most likely to migrate and carry the largest potential social benefits. This paper analyzes the impact that brain drain has on state expenditures for higher education, an important topic in the context of today's tight labor markets where various states are considering how to retain and attract recent college graduates. "Such efforts involve identifying an area's relative strengths and weaknesses and taking actions as needed, either to capitalize on the strengths or mitigate the weaknesses" (Kodrzycki, 2011). This paper's thesis differs from previous studies of migration effects on public financing of education in that it specifically focuses on the movement of college-educated individuals and higher education. Additionally, this paper utilizes a set of panel data and fixed-effects estimators to improve on past empirical specifications.

III. Benefit Spillover Model

As discussed, the benefit spillover hypothesis posits that when the benefits of local government expenditures on public goods (such as higher education) are not fully internalized, the public good will be undersupplied. In the context of higher education, this occurs when college-educated individuals migrate out of the state, providing the community benefits of greater human capital to regions away from "home".[2] These benefits are different from the individual's private benefits,[3] such as increased hourly wages (see Figure 3),[4] and include greater citizen engagement, increased sanitation, lower fertility rate, lower crime rates, greater female labor force participation, and more.

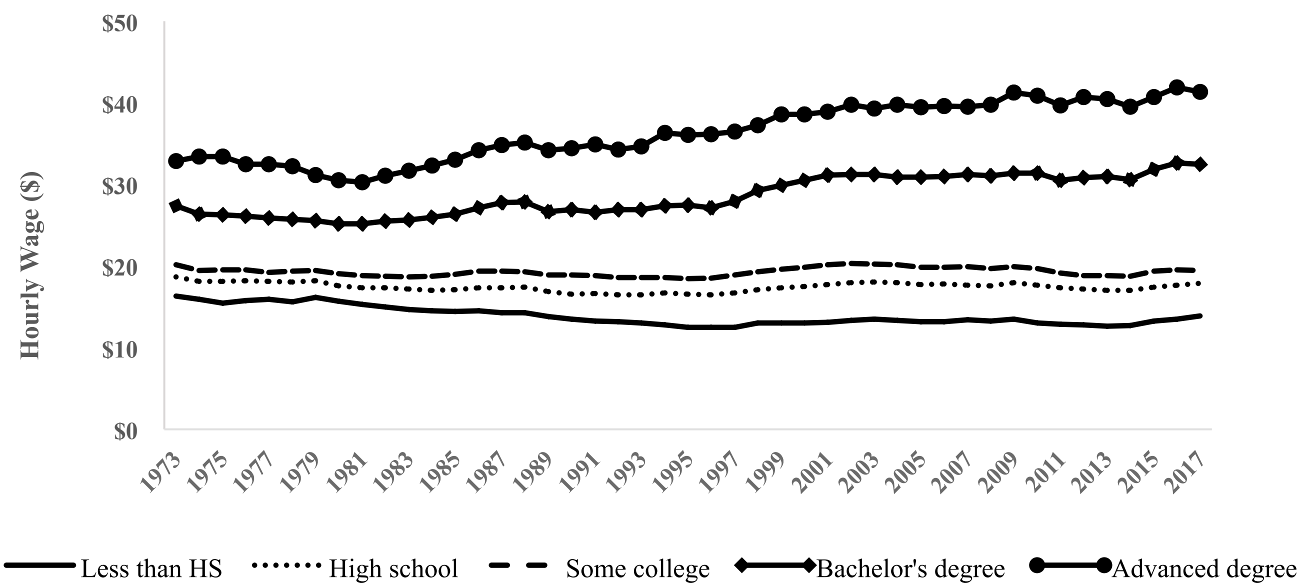

Figure 3. Hourly wage in the United States in 2017 USD by education level (1973 to 2017).

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[2] "Home" is used to refer to the state in which a student graduated from college.

[3] Weisbrod (1964) provides an extensive list of the direct and indirect benefits of education.

[4] Hourly wages for the most educated individuals in the U.S. have not only been greater, on average than those of less educated individuals, but have increased at a faster rate over time as well.

The benefits of an education are also residence-related, meaning that the individual's local community reaps some of the advantages of the individual's education, and the magnitude of the advantages is inversely related to a community's distance away from the educated individual.

Due to the lost benefits and the associated costs of providing a public good, a rational, utility-maximizing state may invest too little in the public good since it will set the output of the good at the point at which the sum of the private marginal rates of substitution between the good and private incomes is equal to the marginal cost of providing the good.[5] In this case, either the quantity or quality (or both) of the public good would suffer. Even if the state experiences spill-ins from other states (in the form of in-migration), the marginal cost of provision would not be affected so long as the benefits of the spill-in are viewed as a lump-sum gain.

In the following theoretical analysis, tax revenue is assumed to fund public schooling, with the municipality seeking to maximize net benefits as it pertains to quality and supply of education. External benefits of education are considered residence-related (meaning the social advantages have a finite range of impact); marginal costs of provision are assumed constant and equal across jurisdictions, with education being a normal good and consumers behaving rationally with respect to public education.

Within the community,[6] two groups of voters exist. The first group consists of families with children anticipated to attend the local university and residents attending the local university. This group's primary focus in determining education quality and supply is largely based off of

[5] This conclusion holds under the somewhat strict assumptions that a) taxpayers reveal their true preferences in voting for particular budgetary policies, b) local policy decisions account for all and only local, and c) the public good is not used to redistribute income (Aaron 1969).

[6] Community, jurisdiction, region, and state are used interchangeably in this section.

the direct benefits granted by the university. The second group consists of those families without children and those who cannot reap the direct benefits of the local university. As such, their demand for higher education is contingent simply on the external benefits associated with having highly educated individuals in the community. Therefore, their voting decision is a function of the proportion of residence-related benefits anticipated to stay within the state.

To determine the optimal amount of higher education for the i-th individual in the k-th state, the state-level marginal costs must be equated with the state-level marginal benefits. Thus, under the condition of no migration, the optimal amount of education, X_{ie}, for individual i in community k must satisfy the condition:

$$\frac{u_{ie}}{u_{ir}} + \sum_{j=1}^{J} \frac{u_{je}}{u_{ir}} = \frac{f_e}{f_r} \tag{1}$$

where u_{ie} is the marginal utility of a higher education to individual i, u_{ir} is the marginal utility of a numeraire private good, u_{je} is the marginal utility of i-th person's university education to individual j living in state k. J is the total population of k. The u_{ir} term is therefore the marginal utility of person i's private good consumption to another community member. The ratio of the marginal costs is represented by $\frac{f_e}{f_r}$.

Now, allowing for migration, the rational, utility-maximizing community would optimize according a slightly modified set of constraints; namely, it would obey the following condition:

$$\frac{u_{ie}}{u_{ir}} + (1 - P_k) \sum_{j=1}^{J} \frac{u_{je}}{u_{ir}} = \frac{f_e}{f_r} \tag{2}$$

with P_k representing the probability that local university graduates leave the state k. Quite clearly, for $0 < P_k < 1$, the community's willingness to invest in higher education diminishes in accordance to the loss in external benefits related to education. Thus, out-migration of the educated decreases the community's incentive to invest in higher education. Holland (1974) notes that prolonged out-migration driven by the young and educated should force communities to focus on external rather than direct benefits of education to determine public expenditures.

In an independent-provision equilibrium, provision of higher education will be suboptimal. The ideal amount of education follows the constraint

$$\frac{u_{ie}}{u_{ir}} + (1 - P_k) \sum_{j=1}^{J} \frac{u_{je}}{u_{ir}} + (P_c) \sum_{c=1}^{C} \sum_{l=1}^{L} \frac{u_{le}}{u_{lr}} = \frac{f_e}{f_r} \quad (3)$$

where P_c is the probability of migration to community c in the set of all communities C and u_{le} is the marginal utility of individual i's university education to individual l in state c. Thus, the student, the citizens in her "home" community, and the citizens in her potential migration destinations benefit from i's higher education. However, for a state that cares only for its constituents' preferences, the utility that other states derive from i's university education would not factor into the local government's expenditure function, leading to an underinvestment in higher education. Additionally, assuming the public benefits of education are monotonically increasing, *ceteris paribus*, the out-migration of a college-educated individual more dramatically harms the community's desire to invest in higher education than would the loss of a secondary school-educated individual.

IV. Methodology

Empirical Specification

The methodology utilizes a three-stage least squares (3SLS) regression model to estimate the impact of out-migration rates of the highly educated on state appropriations for higher education. The 3SLS strategy employs three simultaneous equations to resolve issues of endogeneity between three different variables: state appropriations, tuition, and out-migration rates.

3SLS combines two-stage least squares (2SLS) and the Seemingly Unrelated Regressions (SUR) estimations. The strategy accounts for co-variances between each of the three equations' disturbances, while also obtaining instrumental variable estimates for the variables of interest. The 3SLS objective function is the sum of squared transformed fitted residuals. In a simultaneous equations model, a variable cannot be endogenous to one equation and exogenous to another (Jorgenson and Laffont, 1975).

While this paper is particularly interested in the impact of educated out-migration on state appropriations to higher education, it is important to control for confounding influences. Trade-offs between state appropriations and tuition may cause such effects, as evidenced by the multitude of publications that treat tuition as a determinant of state appropriations and vice versa. Hoenack and Pierro (1990) are in the minority, recognizing the potential for simultaneity bias between state appropriations and tuition.

The relationship between educated out-migration and state higher education appropriations may be another source of simultaneity, a concern of utmost importance given that the crux of this paper is to disentangle the two factors' relationship and identify the unilateral impact of educated out-migration on state expenditures. Cebula (1980) identifies extensive evidence of simultaneity between general migration and public spending at the primary and secondary level. Strathman (1994) also finds simultaneity between general out-migration and tertiary level spending. These findings suggest that an empirical strategy is necessary to address endogeneity concerns between educated out-migration, state appropriations for higher education, and tuition.

Moreover, due to the nature of the data, a state-year is the unit of analysis. As a result, time- and state-specific variations must be controlled for, requiring time and state fixed effect controls. Thus, a 3SLS model with fixed effects estimators is the best empirical methodology given the data and variables of interest.

The barebones model will take the following three-equation form:

$$APPR = f(T, OUTBACH, INC, FED) \tag{4a}$$

$$T = g(APPR, ENR, GRAD, SAL) \tag{5a}$$

$$OUTBACH = h(APPR, T, U, CURR) \tag{6a}$$

where $APPR$ = state public appropriations per full-time equivalent (FTE) college student, T = tuition per FTE student, INC = state per-capita income, ENR = total FTE enrollment, $GRAD$ = average six-year graduation rate, SAL = average salary of full-time instructional faculty (full professors only), and $OUTBACH$ = gross state out-migration rate of individuals with a Bachelor's degree or higher. A variable for the federal contributions to supporting higher education, by state, is also included to account for the responsiveness of state legislatures to external sources of revenue. FED = annual federal appropriations per FTE student by state, U = state unemployment rate, and $CURR$ = the fraction of the state population that is made up of the college-educated population.[7] The unit of analysis for all variables is a state-year. Two fixed-effects estimators are included in each equation, one for time and one for state.[8]

The first equation relates state higher education appropriations per FTE student to tuition, income per capita, the out-migration rate of the highly educated (displayed as a percentage of educated individuals in a state who migrated out of state) and federal contributions to higher education. The second equation presents tuition as a function of state appropriations, total higher education enrollment, graduation rates, and professor salaries. Enrollment is included as a demand proxy, the graduation rate is included as a quality proxy, and professor salaries are included to account for regional variations in factor costs. The third equation describes out-migration rate of the highly educated as a function of state appropriations, tuition, unemployment, and the fraction of the state population with a Bachelor's degree or higher. Unemployment rates is intended to proxy for the economic outlook after graduation while $CURR$ is included to account for the phenomenon in which educated individuals are attracted to regions with other highly educated people.

[7] Strathman (1994) demonstrated that in-migration has an insignificant effect on state appropriations. Hence, in-migration was excluded from this paper's regression equation.

[8] With respect to the model specification, the rank condition – a necessary and sufficient condition for identification of each equation in the system – is fulfilled when the rank of the accompanying G - 1 by k matrix of variables is greater than or equal to G - 1 (where G represents the number of endogenous variables in the system and k represents the total number of variables excluded from each equation). In the current model with three endogenous variables, the associated ranks corresponding with the state appropriations, tuition, and educated out-migration equations are all two, signifying that the rank condition (and thus the identification condition) is satisfied.

A natural log transformation is performed on each variable to alleviate concerns of heteroscedasticity and to frame the interpretations of the results as percentage changes. Thus, the following three simultaneous equations are employed:

$$\ln(APPR_{t,i}) = \beta_1 \ln(T_{t,i}) + \beta_2 \ln(INC_{t,i}) + \beta_3 \ln(OUTBACH_{t,i}) + \beta_4 \ln(FED_{t,i}) + \eta_i + \zeta_t + \epsilon_{t,i} \quad (4b)$$

$$\ln(T_{t,i}) = \gamma_1 \ln(APPR_{t,i}) + \gamma_2 \ln(ENR_{t,i}) + \gamma_3 \ln(GRAD_{t,i}) + \gamma_4 \ln(SAL_{t,i}) + \eta_i + \zeta_t + \nu_{t,i} \quad (5b)$$

$$\ln(OUTBACH_{t,i}) = \varphi_1 \ln(APPR_{t,i}) + \varphi_2 \ln(T_{t,i}) + +\varphi_3 \ln(U_{t,i}) + \varphi_4 \ln(CURR_{t,i}) + \eta_i + \zeta_t + \mu_{t,i} \quad (6b)$$

The variables all hold the same definition as previously delineated, with ϵ, ν, and μ indicating error terms, η representing individual (state) fixed effects, ζ representing time-specific fixed effects, *t* referring to the year of analysis, and *i* referring to the state. Based off of the spillover benefit hypothesis, one would expect state appropriations to decrease as the rate of out-migration of the highly educated increases, so β_3 and φ_1 are anticipated to hold negative values. Moreover, β_1 and γ_1 are expected to be negative, since given a level of revenue for a university, as tuition (T) increases, the state appropriations ($APPR$) necessary to operate decrease.

Data

This study utilizes panel data covering 2006-2015 from 49 of 50 states.[9] Data come from a few primary sources. First, State Higher Ed Finance (SHEF) Data (2015) provide state-level financial data regarding higher education, including net public FTE enrollment, education

[9] Illinois data were removed for revision purposes.

appropriations per FTE from the state (constant 2015 USD), and net tuition per FTE. These data cover 49/50 states from 1991 to 2015, and only reflect public school information.

The second data source is the Integrated Public Use Microdata Series (IPUMS-USA). This source collects and harmonizes U.S. census micro-data regarding state populations, educational achievement by age group, migration patterns, and more. IPUMS provides annual information from 2000-2015 and sources its data from the American Community Survey (ACS), Current Population Survey (CPS) and U.S. Census Bureau. This dataset is used to approximate the out-migration rate by state each year. The database is sponsored by the Minnesota Population Center. Estimated education out-migration rates by state and year can be found in the appendix (Table A1).

The third data source is the Bureau of Economic Analysis (BEA), which provides data on state-level GDP per capita, per-capita income, and other relevant economic statistics. The Bureau of Labor Statistics (BLS) provides state-level unemployment data. While industry-specific unemployment rate data might better reflect the state of the job market for the relevant demographic (educated persons), industry-specific data at the state level is not readily available. Thus, overall unemployment rate is used here.

Data regarding teacher salaries are pulled from the Chronicle of Higher Education database, which collates data from the U.S. Department of Education's Integrated Postsecondary Education Data System (IPEDS). Graduation rates are derived from The National Center for Higher Education Management Systems (NCHEMS) Information Center, which collects data from the U.S. Education Department's National Center for Educational Statistics.

The final data source utilized is the *Digest of Education Statistics* supplied by the Department of Education. This source provides data regarding federal contributions to higher education in the form of Pell grants, work-study programs, and more, which forms the FED variable. The historical trend of federal contributions from 2006-2016 is displayed in Figure 4. Federal contributions are directed at alleviating students' burden of paying for college. As expected, federal provisions spiked after 2008, likely accommodating a wave of students whose families were negatively affected by the financial crisis. Since 2010, however, federal contributions have declined steadily.

All of the aforementioned variables are used in the 3SLS simultaneous equations to isolate for the drivers of education appropriations. Due to the multitude of data sources, this study focuses only on the years 2006 to 2015 in all U.S. states except for Illinois. Descriptions of each variable can be found in Appendix B.

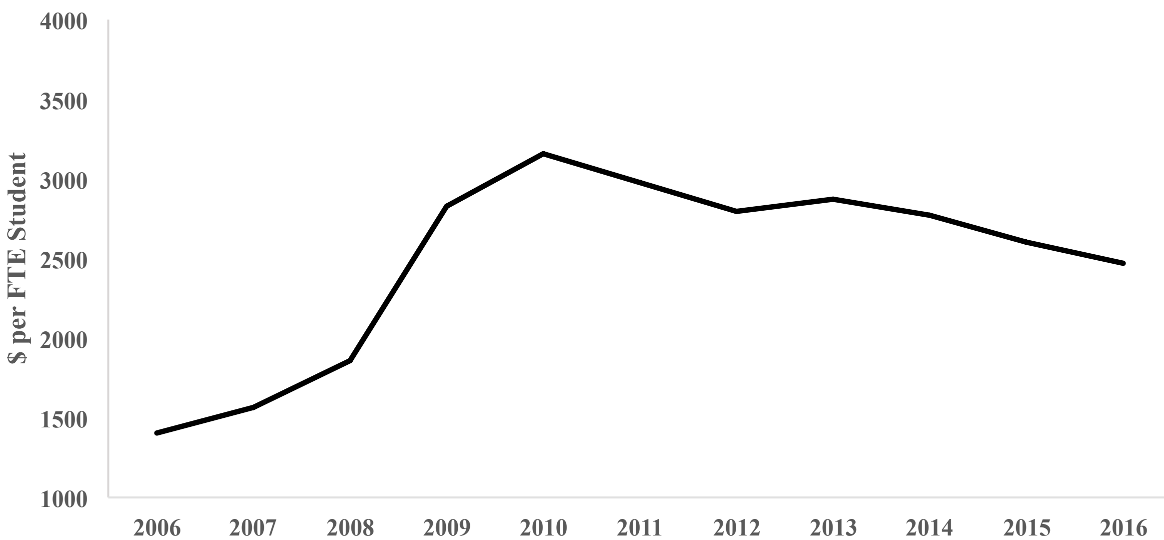

Figure 4. Federal contributions to state higher education per FTE student (2006 to 2016).

Correlations between the main variables in each of the three simultaneous equations are shown in Tables 1-3.[10] While correlations between several independent variables are statistically significant, the variance inflation factor (VIF) of each of the variables across the equations lies well below the permissible level, indicating that multicollinearity is not a concern in this analysis. VIF quantifies the acuteness of multicollinearity in an ordinary least squares (OLS) regression, estimating the degree to which the variance of a regression coefficient is inflated as a result of multicollinearity.[11] Tables A2-A4, found in the appendix, show each variable's VIF in a single equation, standard OLS model. No VIF exceeds 2.10, a value satisfactorily small (Henseler et al., 2015).

[10] These show the correlations between the natural log of each variable.

[11] VIF is calculated by dividing the ratio of variance in a model with multiple terms by the variance of a model with one term alone. A value of one implies that the no correlation exists between the regressors. Values greater than one suggest independent variables are correlated. Values below five are typically considered permissible.

Table 1

Table of Correlations for Variables in the First Equation of the 3SLS Model (APPR)

	1	*2*	*3*	*4*	*5*
1. APPR	--				
2. T	-0.494***	--			
3. INC	0.125**	0.322***	--		
4. OUTBACH	0.177***	0.154***	0.092*	--	
5. FED	-0.330***	0.150**	0.005	-0.205***	--

Table 2

Table of Correlations for Variables in the Second Equation of the 3SLS Model (T)

	1	*2*	*3*	*4*	*5*
1. T	--				
2. APPR	-0.494***	--			
3. ENR	-0.257***	-0.071	--		
4. GRAD	0.401***	-0.334***	0.288***	--	
5. SAL	0.204***	0.228***	0.332***	0.551***	--

Table 3

Table of Correlations for Variables in the Third Equation of the 3SLS Model (OUTBACH)

	1	*2*	*3*	*4*	*5*
1. OUTBACH	--				
2. APPR	0.177***	--			
3. T	0.154***	-0.494***	--		
4. U	-0.332***	-0.035	-0.106*	--	
5. CURR	-0.106*	-0.208***	0.532***	-0.138**	--

Note: *p < 0.05, **p < 0.01, ***p < 0.001, two-tailed. N=490.

Each variable's direction of influence appears intuitive except for the $APPR$ and $OUTBACH$ relationship. The two variables share a positive correlation, contrary to what the benefit spillover hypothesis would suggest. This fact may highlight the need for a more advanced model, namely one that incorporates other explanatory factors and controls for year and state.

Figure 5 displays the weighted average fraction of the population (ages 25 to 34) with a Bachelor's degree or higher and the weighted average out-migration rate of highly educated individuals from 2006 to 2015. Consistent with the literature's findings, out-migration of the highly educated hovers just above 3 percent annually; meanwhile, the proportion of educated individuals in the United States has slowly, yet steadily increased over the last decade.

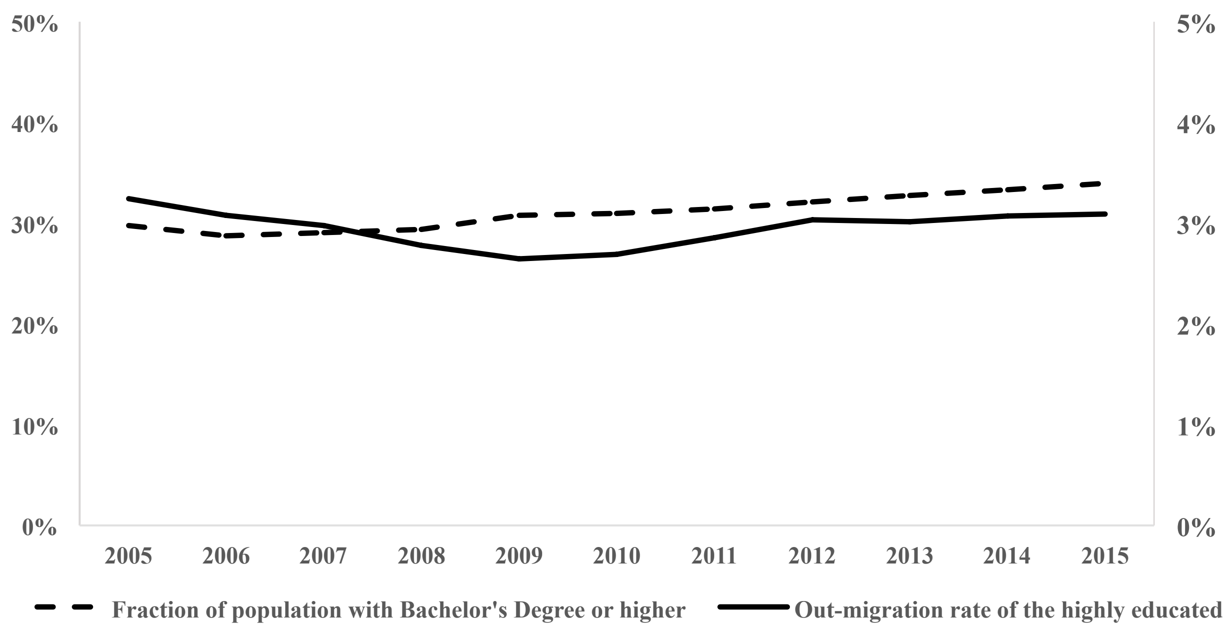

Figure 5. Fraction of population with Bachelor's degree or higher (left axis) and out-migration rate of the highly educated from 2006 to 2015 (U.S. weighted average).

Summary statistics of the relevant variables are displayed in Table 4.[12] The mean of state appropriations per student is $7,302 between 2006 and 2015 across all states (excluding Illinois).[13] Average tuition is $6,199 and the average federal contribution is $2,439 per FTE

[12] Note that the summary statistics of the non-transformed data are displayed.

[13] For variables in which data for Illinois was unavailable, N=490. For all other variables, N=500. However, in the econometric analysis, values for Illinois were ignored for all variables.

student, leading to $15,940 of total contributions per student. Out-migration rate of the highly educated averages 3.7 percent across the sample, with a maximum of 15.2 percent and minimum 1.6 percent.

Table 4

Summary Statistics Table

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
APPR	490	7302	2571	1973	17824
T	490	6199	2820	1179	17233
INC	500	41508	7246	27711	68329
OUTBACH	500	0.037	0.014	0.016	0.152
FED	490	2439	980	658	7628
ENR	490	214454	255422	18656	1624753
GRAD	500	0.538	0.091	0.221	0.709
SAL	500	103714	13556	70918	138287
U	500	6.428	2.199	2.600	13.700
CURR	500	0.304	0.062	0.195	0.509

Public school enrollment averaged 214,454 for a given state over the time period, but has risen significantly since 2006, with a slight decline from 2011 to 2015, as shown in Figure 6. Six-year graduation rates averaged 53.8 percent and professor salary averaged $103,714 annually. Unemployment averaged 6.4 percent over the time period, reaching a peak of 13.7 percent in Michigan in 2009, a year after the financial crisis. Income per capita averaged $41,508, reaching a maximum of $68,329 in Connecticut in 2015.

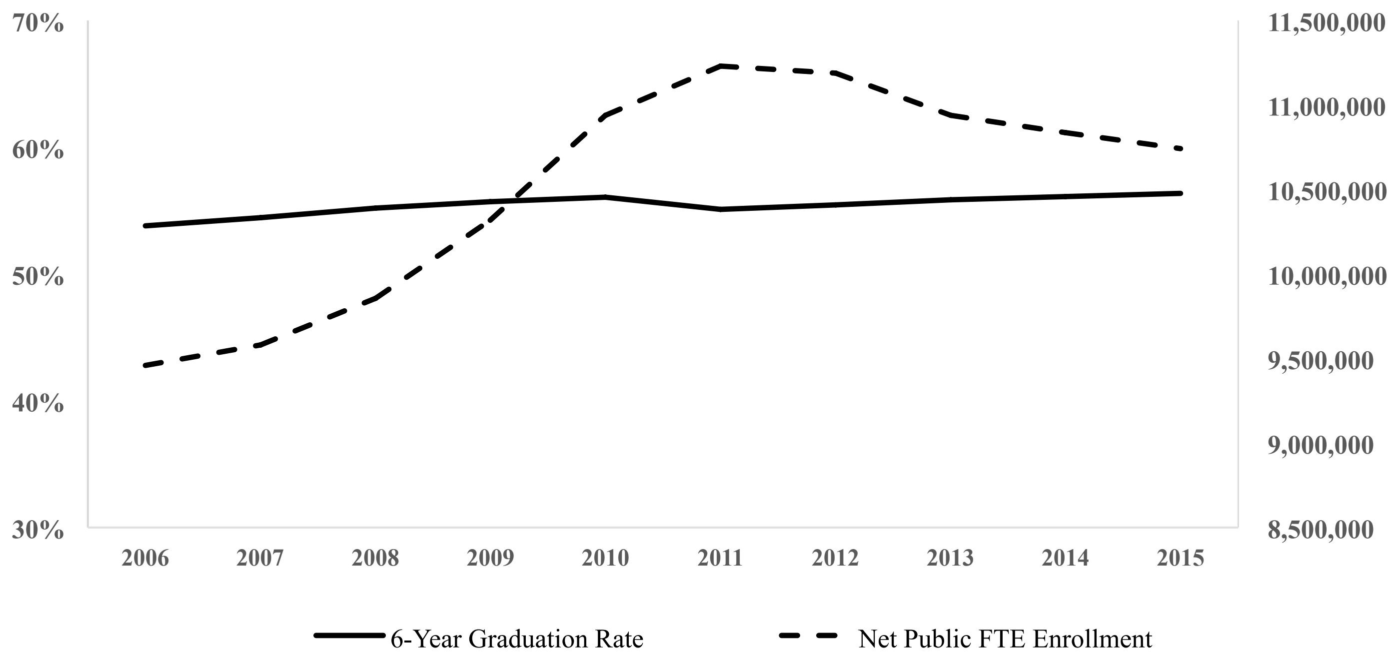

Figure 6. National six-year graduation rates for Bachelor's degrees (left axis) and net public FTE enrollment in the US (2006 to 2015).

V. Results

Table 5 displays the three-stage least-squares parameter estimates for the appropriations, tuition, and out-migration equations. As expected, out-migration of the highly educated has a significant negative impact on the level of state appropriations for higher education. A one percent[14] increase in the out-migration rate of highly educated individuals is associated with a -1.92 percent, or roughly \$140.20, decrease in educational appropriations per FTE student, significant to the α =0.001 level. Strathman (1994) found that a one *percentage-point* increase in the out-migration of the total population is associated with a \$103 drop in state appropriations; given an average educated out-migration rate of 3.7 percent in this paper's sample, one percentage-point equates to approximately 27 percent. Thus a one percentage-point increase in the educated out-migration would cause an approximately 51.9 percent drop in state appropriations, demonstrating the heightened sensitivity that states face towards college graduate migration as compared to general population migration.

This result is also extremely significant in a practical sense. States like Vermont and North Dakota, which saw out-migration rates of the highly educated go up by an average of 7 percent and 6 percent from 2012-2015, respectively, would see a corresponding estimated drop in state legislative appropriations to higher education of approximately \$840 to \$980 per student.

Equally important is the bi-directional nature of the relationship between state appropriations and the educated out-migration rate. A one percent drop in the state appropriations is estimated to contribute a 0.483 percent *increase* in the out-migration rate, significant to the α=0.001 level. This finding is similar to that found by Strathman (1994), who

[14] Note that this refers to a percent of a rate; it is not a percentage-point.

found a small, but significant impact of appropriations on out-migration.[15] Cebula (1980) reported similar results as well for primary and secondary education, though Cebula focused on the general migration as opposed to that of the educated.

Tuition and state appropriations are found to have a significant bi-directional relationship as well. A one percent increase in the tuition leads to an estimated 0.964 percent decrease in state appropriations, equating to approximately $70.39 per FTE student. This result is significant to the α=0.001 level. Conversely, significant to the α=0.01 level, a one percent decrease in state appropriations drives an estimated 0.344 percent increase in tuition, or roughly $21.32 per student. State appropriations are (insignificantly) positively impacted by federal contributions and per-capita income. Tuition, however, is significantly impacted by both student enrollment (α=0.01) and annual average faculty salary (α=0.01). A one percent increase in student enrollment causes an estimated 0.395 percent *drop* in tuition, likely indicating that certain university fixed costs could be distributed amongst a larger base of students, thus reducing the per-student tuition. Moreover, a one percent increase in professor salaries leads to an estimated 0.556 percent decrease in tuition.

[15] Strathman (1994) used gross out-migration among the entire population as his "out-migration" variable, which is different from the "out-migration rate of the highly educated" variable used in this paper.

Table 5

Three-Stage Least Squares Estimate of Benefit Spillover Model Parameters with State and Year Fixed Effects (Standard Deviations in Parentheses)

	Equation		
Variable	*Appropriations per student*	*Tuition per student*	*Annual out-migration rate, 2006-2015, Bachelor's Degree or higher*
Constant	9.328**	22.965***	5.077*
	(3.190)	(2.571)	(2.090)
Appropriations per student	--	-0.344**	-0.483***
		(0.127)	(0.105)
Tuition per student	-0.964***	--	-0.502**
	(0.275)		(0.171)
Income per capita	0.121	--	--
	(0.165)		
Out-migration rate (%)	-1.920***	--	--
	(0.414)		
Federal contributions to higher ed	0.011	--	--
	(0.039)		
Student enrollment	--	-0.395**	--
		(0.142)	
Graduation rate (%)	--	-0.119	--
		(0.080)	
Annual average faculty salary	--	-0.556**	--
		(0.203)	
Annual unemployment rate (%)	--		0.016
			(0.023)
Fraction of population with Bachelor's Degree or higher (%)	--	--	-0.080
			(0.043)
n	490	490	490
RMSE	0.199	0.085	0.103
"R-squared"	0.628	0.966	0.877

Note: *p < 0.05, **p < 0.01, ***p < 0.001, two-tailed.

With respect to the final equation regarding out-migration rates of the highly educated, unemployment rate has an insignificant influence on out-migration, a similar finding to that of Hadley (1985). The proportion of the total population that is educated has a negative influence out out-migration (significant to the α=0.1 level), acting as a mild pull factor. Tuition has a very significant (α=0.01) negative impact on out-migration rates: a one percent increase in tuition causes an estimated 0.502 percent decrease in out-migration rate. Overall, the explanatory power of the independent variables is considerably stronger than Strathman's, with well over half of the variation in each dependent variable explained by the regressors.[16]

A robustness test was performed in which the largest and smallest 25 educated out-migration rate observations from the data set were excluded. The results can be found in Table A6 of the appendix. Results from the robustness check show that the out-migration coefficient is, once again, statistically significant to the α =0.001 level and larger in magnitude than the coefficient found in the original 3SLS model. In the new model, a one percent increase in educated out-migration corresponds to a 2.497 percent drop in state appropriations. All other relationships maintained the same directionality, though the statistical significance varied slightly.

[16] A 3SLS model without any fixed effects can be found in the appendix (Table A5). The results have much lower R-squared values and much higher RMSE values than those found in the 3SLS model with time and fixed effects. Additionally, the results in Table A5 show coefficients with opposite directions than those in Table 5, which may demonstrate the importance of fixed effects estimators in the regression.

VI. Discussion

The results of the 3SLS analysis provide support for the benefit spillover hypothesis in the realm of higher education. When the social advantages of educating a set of constituents "spill" out of the home state through out-migration of the highly educated, a palpable disincentive is created for the home state, causing it to underinvest in higher education. This proposition is supported by the highly significant and negative β_3, signifying the impact of educated out-migration on state appropriations. β_3 is also economically significant, as will be discussed in greater depth later in this section.

The presence of a benefit spillover effect on state decisions indicates that state legislatures are rational actors, at least in the domain of higher education financing, and respond to anticipated losses in investment return due to out-migration of the highly educated. As discussed in Section 3, a number of benefits of higher education exist, for both the individuals and the states. From a public perspective, heightened tax revenue from educated constituents offers one lucrative channel to recoup the investment in education. Other indirect benefits include greater citizenry, lower crime rates, increased innovation, and more. When the "home" state does not expect to fully internalize the benefits of higher education, public underinvestment in higher education is predicted by the benefit spillover hypothesis. Based off of this paper's economic analysis, I fail to reject the null hypothesis that states do not react to spillovers. However, the second equation in which tuition is the dependent variable indicates that a reduction in state appropriations is somewhat offset by the subsequent increase in tuition. Unlike public education at the primary and secondary level, university institutions can theoretically make up the difference in the event that states underfund the schools. Thus, in primary and secondary education, existence of a large benefit spillover would correspondingly imply an under-provision of funds towards education, whereas at the tertiary level, the effects may be partially counterbalanced by increased tuition. Benefit spillovers can therefore cause a sub-optimal allocation mix between state and student financing.

Unlike previous papers, which have noted simultaneity between educational appropriations and migration of the general population, this paper observed the reinforcing nature of state appropriations and educated movers. States expect to reap the largest rewards from society's most educated individuals, and the movement of such individuals, more so than of the broader population, would be of utmost interest to states setting their budgets for higher education. The danger of the significant bi-directional nature of out-migration and state appropriations is that a self-reinforcing cycle develops, in which out-migration (caused by a variety of factors) discourages state investment in higher education; as state appropriations decrease, a number of factors are likely impacted, including higher education institutional quality, resulting in greater out-migration of educated people. The cycle continues as greater out-migration further reduces state incentives to invest in higher education. If the state does not anticipate the spiraling effect of reducing appropriations, then the state's behavior is only myopically rational; that is, the state responds rationally in the short-term to out-migration, but in the long-term, inflicts irrational damage on itself.

Though the relationship between $OUTBACH$ and $CURR$ is significant only to the α=0.1 level, having a greater relative portion of the population educated appears to discourage educated out-migration, meaning that there is a type of "double-hit" effect of lower state appropriations on the out-migration rate. As appropriations decrease and out-migration increases, the relative population share of the highly educated may decrease as well, further dropping the attractiveness of a particular state to potential educated movers. Underinvestment can lead to brain drain from the state, causing the state to lose several of the benefits from investing in a robust population of educated individuals.

The results of this analysis also indicate a significant bi-directional relationship between state appropriations and tuition levels, indicating that universities and state legislatures respond to each other's decisions when it comes to financing higher education. While the analysis at hand does not delve into the specific game-theoretical dynamics played between the two actors, the present results provide some insight into the relationship.

For example, Strathman (1994) conducted a rudimentary analysis of the 1970s and 1980s, finding that as the economic benefits of higher education decline, tuition growth is restricted and heightened pressure is placed on state legislatures to support public higher education. On the other hand, as the benefits increase, the burden shifts from state financing to tuition. Updating Strathman's analysis, I conducted a rough calculation of the period between 2006 and 2016, estimating that the hourly wage differential between college and high school graduates grew at an annual rate of 1.41 percent, indicating that the benefits of a college degree steadily increased (Table A7). Thus, one would expect the burden of financing higher education would shift towards tuition and away from state appropriations. Figure 7, displaying the nationwide share of higher education costs covered by students (through tuition), states, and the federal government, appears to support this conclusion. From 2006-2016, tuition grew at an annual rate of 1.78 percent while state appropriations declined by an annual rate of 1.35 percent.[17] Student share is defined as net tuition less federal contributions, as a proportion of

[17] Wage data comes form the Economic Policy Institute (EPI) and tuition data comes from SHEF. An average of the annual changes of each metric was calculated above. Federal contributions were deducted from the raw tuition amount to account for tuition increases caused by increased scholarship access. Annual percentages are calculated using a compound annual growth rate (CAGR) formula from 2006 to 2016.

total educational revenues, while state share is defined as state appropriations as a proportion of total educational revenues. Federal share is FED as a proportion of total education revenues.[18]

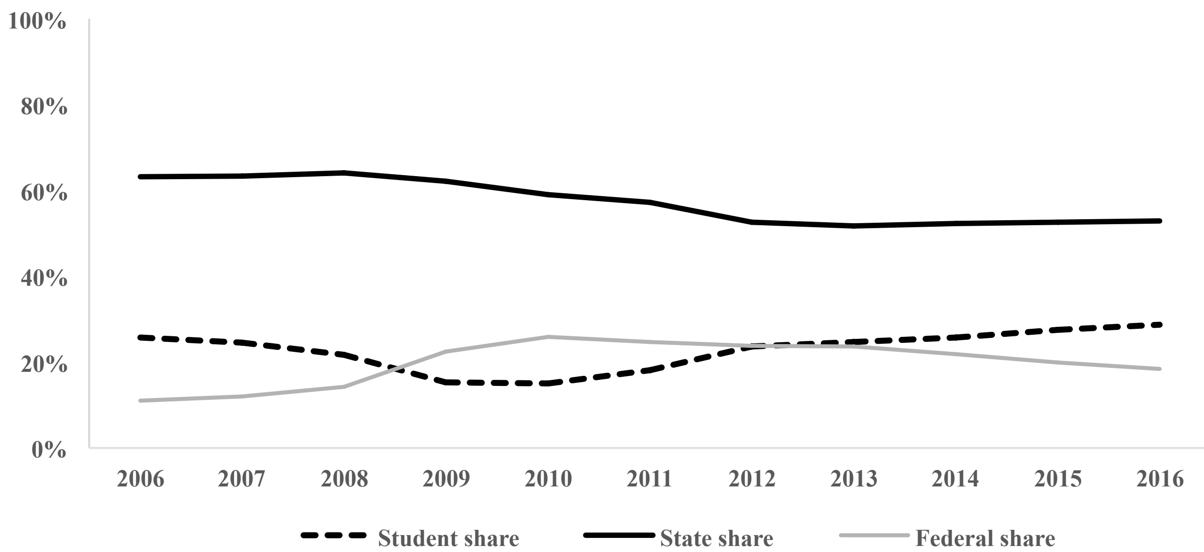

Figure 7: Student, state, and federal share of higher education costs (2006 to 2016).

This finding, paired with the earlier results revealing a significant bi-directional relationship between tuition and state appropriations, pushes back against a commonly held view that tuition acts merely as a "filler" for public higher education budgets after the state allocation towards public financing has been established. Some have argued that the tuition level is set only after institutional needs and legislative appropriations are confirmed (Ostar, 1987; Van Alstyne, 1977). In this view, the university's tuition level makes up the difference between university needs and state provisions, putting tuition at the whim of the state legislature. The legislature could radically reduce state funds if it faced a tight budget, freely passing on the burden of financing higher education to the universities, and from the universities to the students. The past

[18] Note that the sum of state share, student share, and federal share must equal 1. Private scholarships are not accounted for separately in this analysis and are simply incorporated within student share.

decade appears to give credence to this argument, with tough financial times squeezing state budgets and transferring the burden to the universities themselves.

However, the statistically significant results found in the 3SLS model that point to a bi-directional relationship between state appropriations and tuition give reason to pause at the argument that tuition is just a filler. Noting that tuition rose as the benefits of college education rose from 2006-2016, it could be that states determine their higher education allocation only after tuition is set. Granting that tuition is a reflection of the value provided by a university, tuition growth may have simply been driven by increased demand. Thus, state allocations may merely fill the difference between the tuition revenue and university costs.

The tuition and out-migration relationship yielded a significant negative relationship. One would not expect the tuition level to have any effect on college graduates, unless of course the graduates are considering the implications of high tuition for their children. Another possible explanation is that the relationship goes the opposite direction: states experiencing lower out-migration of the highly educated may also be experiencing increased demand for college, resulting in a rise in tuition.

Another surprising relationship occurred between average professor salary and tuition. The negative coefficient is unexpected, as one would think that increasing professor salary would increase tuition costs. A potential explanation here is that the increased costs associated with increased professor salaries are over-shifted to state appropriations. When labor costs rise, the universities may pass those costs (and more) to the states while reducing their own contributions. A rudimentary OLS model with the natural log of state educational appropriations as the dependent variable and the natural log of tuition, the out-migration rate of the highly educated, income per capita, and average annual professor salary results in a highly significant *positive* relationship between professor salary and state appropriations, supporting the hypothesis that universities over-shift labor costs to the state. The results of the regression can be found in Table A8 of the appendix.

Due to the complex relationships and bi-directional relationships between the various factors involved with public higher education financing, simple solutions to the out-migration and state appropriations issue are impractical and may have negative, unintended consequences. One such "solution" was suggested by Johnson (1965), who proposed taxing educated migrants (or their destination state) and forcing them to pay the home state an amount equivalent to any educational subsidy they enjoyed while living in the home state. The negative side effects of such a proposal are obvious. Interstate migration would be dis-incentivized and the costs of monitoring and enforcing such a rule would be high.

A credit transfer from the federal government to the states is a potentially more viable remedy to the situation. The transfer accounts for the positive externality that states bestow on other states through migration of the highly educated. The federal government, therefore, should encourage states to invest in education at the same level as they would if out-migration did not occur, effectively internalizing the entire investment in education. The equilibrium transfer amount for a given state would then simply equal the difference between the existing educational state appropriations to higher education and the theoretical state appropriations in the absence of educated out-migration. The average per-student transfer value R for a given state-year is approximated using the following formula:

$$R = 100 \times |\beta_3| \times APPR_{t,i} \tag{7}$$

where $APPR_{t,i}$ represents, as before, the state appropriations to public higher education in state i in year t, β_3 is the coefficient from the 3SLS analysis that represents the percent change in state appropriation for every one percent change in the educated out-migration rate, and the 100 represents a 100 percent reduction in the educated out-migration of a given state. $APPR$ translates β_3 into a dollar value.

According to Equation 7 and the 3SLS model, a 100 percent decrease in the educated out-migration is associated with a 192 percent increase in per-student expenditures, meaning approximately two-thirds of the benefits of a college education spill over to other states when a college graduate migrates. Using the sample state appropriations value of \$7,302 per FTE student, the per student federal transfer to states equals approximately $R = \$14{,}019.84$, a two-to-one federal-to-state transfer value. Given the U.S. public college enrollment of 10,939,436 in 2010, the total federal transfers to states that year would amount to approximately \$153.4bn.

The structure of the federal transfer is critical to see a material impact on education spending. A Pigouvian price subsidy, in the form of a matching grant, would alter states' incentives to invest in higher education by effectively reducing their cost to appropriate funds to colleges. This form of transfer would be preferable to a block grant, which, because money is fungible, would not result in a significant difference in state expenditures. A state could simply reduce its own appropriations, replacing it instead with the federal grant money. The Pigouvian subsidy, however, would correct for the distortion that arises from the externality – the benefit spillover – produced by states' investment in higher education.

The federal transfers to states would have a secondary impact on the institutions' tuition levels, which can be approximated using the tuition equation in the 3SLS. Assuming the entire federal transfer to states is allocated to state appropriations for higher education, the federal transfer of $R = \$14{,}019.84$ would increase existing state appropriations by approximately 192 percent. Since γ_1, the regression coefficient for state appropriations in

Equation 5b, is equal to -0.344, and because the 3SLS was conducted using the natural log of each variable, a 192 percent increase in $APPR$ would lead to a percent reduction in tuition of $192 \times 0.344 = 66.05$ percent, equating to roughly $4,094 per FTE student.

A third policy proposal is one in which states develop various incentives to keep college students in state to work after graduation. This could manifest in tax breaks, direct transfers, or loan repayments, equal in value to the expected total benefits from keeping the graduate within the home borders. Maine, for example, has an evolving policy known as the Opportunity Maine Tax Credit. Prior to 2008, Maine offered a tax credit to all those who had earned a Bachelors or Associates degree from any accredited school in Maine after 2007. The tax credit was meant to offset any taxes owed to the State of Maine. Since then, the state has adjusted the eligibility requirements to allow anyone who earned a Bachelors or Associates degree from any accredited college in the United States to qualify for the tax credit. Additionally, anyone who earned a Graduate degree from a Maine school is eligible for the credit as well. This type of policy creates a positive incentive for individuals to educate themselves and work in a particular state, allowing the state to internalize the full benefits of its higher education investments.

VII. Conclusion

The results indicate a number of significant bi-directional relationships, most importantly between state appropriations and educated out-migration as well as between state appropriations and tuition. Bi-directional influences complicate the policy implications of the results, lending to an array of varying, at times contradictory, recommendations to policymakers and universities alike.

On an absolute scale, the findings suggest that state budgets are extremely sensitive to educated out-migration, more so than they are to the general population as a whole, according to previous studies. The benefit spillover hypothesis is thoroughly supported by these findings, as college graduates on average carry greater potential social benefits that a home community loses when a graduate migrates elsewhere.

Further research is needed to evaluate the robustness of the model with respect to its specification and some elements of the data. Due to certain data limitations, information regarding higher education included both public and private 4-year institutions, while others were specific to just public schools. A study with access to data delineated by public and private university could better compare the states' responses to educated out-migration of public and private school graduates to see if the state responds solely to its own investment return function or to the general loss of quality talent, regardless of the type of institution a migrant attended. Additional considerations must also be given to the unintended consequences of alleviating the out-migration concerns, such as reduction of state control over higher education policymaking among others. The policy prescriptions described in Section 6 should be carefully analyzed as well for their efficacy.

This paper has demonstrated that the benefit spillover hypothesis exists within the context of public higher education state appropriations. This is a real concern for states facing high out-migration rates, and demand continued research to better understand the mechanisms at play and potential policy solutions moving forward.

VIII. References

Aaron, H. J. (1969). Local public expenditures and the "migration effect". *Western Economic Journal, 7*(4), 385-389.

Bolnick, B. R., & Alper, N. O. (1990). Determinants of university costs: regional effects. *Regional Science Review, 17,* 190-2016.

Borcherding, T. E., & Deacon, R. (1972). The demand for the services of non-federal governments. *American Economic Review, 62*(5), 891-901.

Brainard, W. C., & Dolbear, Jr., F. T. (1967). The possibility of oversupply of local "public" goods: a critical note. *Journal of Political Economy*, *75*(1), 86-90.

Buchanan, J. M. (1965). An Economic Theory of Clubs. *Economica 32*(125), 1-14. 10.2307/2552442

Bui, Q. (2016, November 22). The states that college graduates are most likely to leave. *New York Times*. Retrieved from https://www.nytimes.com/2016/11/22/upshot/the-states-that-college-graduates-are-most-likely-to-leave.html

Clotfelter, C. T. (1976). Public spending for higher education: an empirical test of two hypotheses, *Public Finance*, 31, pp. 177-194.

Cebula, R. J. (1980). Voting with one's feet: a critique of the evidence. *Regional Science and Urban Economics, 10*(1), 91-107.

Coughlin, C. C., & Erekson, O. H. (1986). Determinants of state aid and voluntary support of higher education. *Economics of Education Review*, *5*(2), 179-190.

Creedy, J., & Francois, P. (1990). Financing higher education and majority voting. *Journal of Public Economics*, *43*(2), 181-200.

Delaney, J. A. & Doyle, W. R. (2011). State spending on higher education: testing the balance wheel over time. *Journal of Education Finance, 36*(4), 343-368.

Dimkpah, Y. O., Eseonu, M. O., & Akpom, U. N. (2004). The impact of college quality on tuition: a hedonic analysis. *Journal for Economic Educators, 4*(2), 1-7.

Economic Policy Institute. (2018). *State of Working America Data Library* [Wage data]. Retrieved from https://www.epi.org/data/#?subject=wage-avg

Fukurai, Butler, E. W., & Huebner-Dimitrius, J. (1987). Spatial and racism imbalances in voter registration and jury selection. *Sociology and Social Research, 77*, 33-38.

Goworowska, J., & Gardner, T. K. (2012). Historical migration of the young, single, and college-educated: 1965 to 2000. U.S. Census Bureau, No. 94. Retrieved October 31, 2017.

Hadley, G. R. (1985). Interstate migration, income and public school expenditures: an update of an experiment, *Public Choice*, 46, pp. 207-214.

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, *43*(1), 115–135. https://doi.org/10.1007/s11747-014-0403-8

Hoenack, S. A., & Pierro, D. J. (1990). An econometric model of a public university’s income and enrollments. *Journal of Economic Behavior and Organization, 14*(3), 403-423.

Holland, D. W. (1974). The impact of benefit spillovers upon economic efficiency in public school finance. *American Journal of Agricultural Economics, 56*(2), 300-305.

Hernández-Murillo, R., & Shell, H. (2014). The rising complexity of the fomc statement. *Economic Synopses, 23*.

Hoenack, S. A., & Pierro, D. J. (1990). An econometric model of a public university's income and enrollments. *Journal of Economic Behavior & Organization, 14*(3), 403-423.

Isserman, A. M. (1976). Interjurisdictional spillovers, political fragmentation and the level of local public services: a re-examination. *Urban Studies, 13*(1), 1-12.

Johnson, H. G. (1965). The economics of “brain drain”: the Canadian case, *Minerva, 3*(3), 299-311.

Jorgenson, D. W., & Laffont, J. J. (1975). Efficient estimation of nonlinear simultaneous equations with additive disturbances. *Annals of Economic and Social Measurement,* 3(4), 615-640.

Kane, T. J., & Orszag, P. R. (2003). Higher education spending: the role of medicaid and the business cycle. The Brookings Institution Policy Brief #124. Brookings Institution Press.

Lanska, D. J., & Kuller, L. H. (1995). The geography of stroke mortality in the United States and the concept of a stroke belt. *American Heart Association, 26*(7), 1145–1149.

McGuire, M. C., & Aaron, H. J. (1969). Efficiency and Equity in the Optimal Supply of a Public Good. *The Review of Economics and Statistics, 51*(1), 31-39.

National Information Center for Higher Education Management Systems. (2015). *Graduation Rates* [Six-year graduation rates of Bachelor’s students]. Retrieved from http://www.higheredinfo.org/dbrowser/?level=nation&mode=graph&state=0&submeasure=27

Oates, W. E. (1972). *Fiscal Federalism.* New York: Harcourt Brace Jovanovich.

Ostar, A.W. (1987). State tuition policies and public higher education In L. E. Goodall (Ed.), *When colleges lobby states: the higher education/state government connection*. Washington, DC: American Association of State Colleges and Universities.

Paulsen, M. B. (1991). College tuition: demand and supply determinants from 1960 to 1986. *Review of Higher Education, 14*(3), 339-358.

Rizzo, M. J. (2003). A (less than) zero sum game? State funding for public education: How public higher education institutions have lost (CHERI Working Paper #42). Retrieved November 1, 2017, from Cornell University, ILR School site: http://digitalcommons.ilr.cornell.edu/student/7/

Robb, J. (2016, December 12). Brain drain: census shows more people with degrees leaving Nebraska. *Omaha World-Herald*. Retrieved from http://www.omaha.com/news/education/brain-drain-census-shows-more-people-with-degrees-leaving-nebraska/article_c93b91d4-bd67-11e6-a298-3f0964e79255.html

Ruggles, S., Genadek, K., Goeken, R., Grover, J., & Sobek, M. (2017). *Integrated Public Use Microdata Series: Version 7.0* [Educational attainment and state of residence 1 year ago]. https://doi.org/10.18128/D010.V7.0

Samuelson, P. A. (1966). Pure theory of public expenditure and taxation. *The Review of Economics and Statistics*, *36*(4), 387-389.

Sasser, A. C. (2010). Voting with their feet: relative economic conditions and state migration patterns. *Regional Science and Urban Economics*. 40, 122-135.

Stack, S. (1980). Occupational status and suicide: A relationship reexamined (research note). *Aggressive Behavior, 6*(3), 233-234.

State Higher Education Finance. (2017). *Appropriations, Tuition, and Enrollment, by State* [Data file and code book]. Retrieved from http://www.sheeo.org/projects/shef-%E2%80%94-state-higher-education-finance

Strathman, J. G. (2010). Migration, benefit spillovers and state support of higher education. *Urban Studies*, *31*(6), 913-920.

The Chronicle of Higher Education. (2017). *Faculty and Staff Salary Data*. Retrieved from https://data.chronicle.com/?cid=wsinglestory

Tiebout, C. M. (1956). A pure theory of local expenditures. *Journal of Political Economy, 64*(5), 416-424.

Toutkoushian, R., & Hollis, P. (1998). Using panel data to examine legislative demand for higher education. *Education Economics, (6)*2, 141-157.

Trostel, P. A. (2010). The fiscal impacts of college attainment. *Research in Higher Education*, *51*(3), 220-247.

U.S. Bureau of Economic Analysis. (2017). *Personal Income, Population, Per Capita Personal Income*. Retrieved from https://www.bea.gov/itable/iTable.cfm?ReqID=70&step=1#reqid=70&step=1&isuri=1

U.S. Bureau of Labor Statistics. (2018). *Local Area Unemployment Statistics* [Unemployment rates for states, seasonally adjusted]. Retrieved from https://www.bls.gov/web/laus/laumstrk.htm

U.S. Department of Education. (2017). *Digest of Education Statistics* [Pell grants, work-study programs, educational opportunities funding]. Retrieved from https://nces.ed.gov/programs/digest/

Van Alstyne, C. (1977). Rationales for setting tuition levels at public institutions. *Educational Record*, 58, 66-82.

Weisbrod, B. A. (1962). Education and investment in human capital. *Journal of Political Economy*, *70*(5), 106-123.

Weisbrod, B. A. (1965). Geographic spillover effects and the allocation of resources to education, in: J. Margolis (ed.) *The Public Economy of Urban Communities*, Washington, DC: Resources for the Future, Inc.

Williams, A. (1966). The optimal provision of public goods in a system of local government. *Journal of Political Economy, 74*(1), 18-33.

Zellner, A., & Theil, H. (1962). Three stage least squares: Simultaneous estimate of simultaneous equations. *Econometrica, 29,* 54-78.

IX. Appendix A

Table A1

Out-Migration Rates of the Highly Educated from 2006 to 2015. Calculated Using Data from IPUMS.

State	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Alabama	0.0310	0.0331	0.0281	0.0254	0.0268	0.0283	0.0333	0.0304	0.0311	0.0294
Alaska	0.1065	0.1151	0.0663	0.0980	0.1034	0.0969	0.1247	0.1525	0.0934	0.0906
Arizona	0.0338	0.0339	0.0351	0.0296	0.0319	0.0325	0.0332	0.0341	0.0358	0.0333
Arkansas	0.0332	0.0347	0.0293	0.0327	0.0358	0.0321	0.0260	0.0253	0.0317	0.0295
California	0.0198	0.0179	0.0173	0.0172	0.0166	0.0163	0.0173	0.0182	0.0188	0.0195
Colorado	0.0367	0.0355	0.0311	0.0297	0.0328	0.0335	0.0361	0.0353	0.0338	0.0361
Connecticut	0.0334	0.0342	0.0272	0.0283	0.0266	0.0323	0.0325	0.0296	0.0329	0.0340
Delaware	0.0406	0.0451	0.0418	0.0382	0.0331	0.0369	0.0389	0.0371	0.0439	0.0446
Florida	0.0291	0.0257	0.0243	0.0218	0.0207	0.0239	0.0251	0.0253	0.0252	0.0239
Georgia	0.0323	0.0321	0.0287	0.0261	0.0284	0.0333	0.0351	0.0302	0.0351	0.0298
Hawaii	0.0473	0.0494	0.0456	0.0346	0.0475	0.0392	0.0517	0.0492	0.0450	0.0424
Idaho	0.0473	0.0525	0.0550	0.0400	0.0559	0.0507	0.0505	0.0483	0.0514	0.0517
Illinois	0.0296	0.0299	0.0272	0.0276	0.0259	0.0279	0.0329	0.0335	0.0314	0.0364
Indiana	0.0370	0.0351	0.0339	0.0308	0.0351	0.0373	0.0331	0.0413	0.0336	0.0362
Iowa	0.0326	0.0401	0.0352	0.0344	0.0388	0.0401	0.0375	0.0410	0.0465	0.0384
Kansas	0.0374	0.0402	0.0365	0.0305	0.0410	0.0430	0.0419	0.0371	0.0439	0.0419
Kentucky	0.0303	0.0294	0.0296	0.0232	0.0278	0.0267	0.0345	0.0277	0.0340	0.0331
Louisiana	0.0365	0.0365	0.0277	0.0261	0.0243	0.0285	0.0284	0.0254	0.0291	0.0234
Maine	0.0401	0.0370	0.0436	0.0356	0.0345	0.0362	0.0329	0.0319	0.0397	0.0371
Maryland	0.0394	0.0360	0.0340	0.0318	0.0289	0.0294	0.0360	0.0386	0.0356	0.0376
Massachusetts	0.0346	0.0315	0.0290	0.0304	0.0275	0.0287	0.0304	0.0284	0.0335	0.0319
Michigan	0.0307	0.0345	0.0297	0.0294	0.0282	0.0262	0.0294	0.0291	0.0280	0.0274
Minnesota	0.0294	0.0269	0.0307	0.0254	0.0240	0.0314	0.0285	0.0307	0.0341	0.0319
Mississippi	0.0358	0.0319	0.0339	0.0262	0.0279	0.0279	0.0315	0.0327	0.0348	0.0297
Missouri	0.0379	0.0312	0.0289	0.0315	0.0319	0.0327	0.0379	0.0328	0.0375	0.0397
Montana	0.0408	0.0476	0.0382	0.0500	0.0316	0.0463	0.0356	0.0379	0.0363	0.0395
Nebraska	0.0339	0.0366	0.0406	0.0272	0.0380	0.0346	0.0368	0.0354	0.0377	0.0376
Nevada	0.0419	0.0431	0.0431	0.0384	0.0373	0.0429	0.0361	0.0488	0.0344	0.0368
New Hampshire	0.0458	0.0351	0.0373	0.0375	0.0358	0.0416	0.0357	0.0405	0.0467	0.0350
New Jersey	0.0261	0.0246	0.0228	0.0230	0.0237	0.0266	0.0276	0.0263	0.0299	0.0262
New Mexico	0.0406	0.0465	0.0433	0.0328	0.0388	0.0441	0.0555	0.0450	0.0488	0.0511
New York	0.0309	0.0286	0.0258	0.0256	0.0252	0.0262	0.0305	0.0320	0.0323	0.0314
North Carolina	0.0343	0.0298	0.0265	0.0260	0.0276	0.0299	0.0323	0.0332	0.0296	0.0359
North Dakota	0.0565	0.0743	0.0537	0.0548	0.0451	0.0628	0.0539	0.0435	0.0582	0.0597
Ohio	0.0282	0.0290	0.0280	0.0248	0.0265	0.0291	0.0306	0.0273	0.0313	0.0295
Oklahoma	0.0374	0.0301	0.0297	0.0252	0.0306	0.0325	0.0406	0.0423	0.0375	0.0418
Oregon	0.0273	0.0282	0.0298	0.0279	0.0283	0.0336	0.0284	0.0292	0.0329	0.0329
Pennsylvania	0.0336	0.0333	0.0280	0.0310	0.0299	0.0311	0.0338	0.0350	0.0352	0.0387
Rhode Island	0.0441	0.0401	0.0472	0.0389	0.0455	0.0485	0.0507	0.0519	0.0524	0.0473
South Carolina	0.0312	0.0265	0.0313	0.0296	0.0313	0.0393	0.0313	0.0322	0.0334	0.0357
South Dakota	0.0475	0.0525	0.0412	0.0401	0.0401	0.0453	0.0515	0.0439	0.0450	0.0463
Tennessee	0.0336	0.0337	0.0336	0.0264	0.0299	0.0309	0.0341	0.0319	0.0304	0.0351
Texas	0.0203	0.0206	0.0183	0.0174	0.0189	0.0196	0.0215	0.0190	0.0206	0.0217
Utah	0.0431	0.0404	0.0403	0.0365	0.0366	0.0412	0.0448	0.0400	0.0395	0.0356
Vermont	0.0482	0.0556	0.0562	0.0458	0.0453	0.0368	0.0484	0.0408	0.0482	0.0570
Virginia	0.0426	0.0402	0.0366	0.0377	0.0398	0.0403	0.0395	0.0406	0.0410	0.0409
Washington	0.0261	0.0291	0.0313	0.0261	0.0281	0.0273	0.0307	0.0294	0.0276	0.0300
West Virginia	0.0354	0.0397	0.0395	0.0365	0.0376	0.0402	0.0405	0.0401	0.0440	0.0428
Wisconsin	0.0345	0.0306	0.0305	0.0330	0.0271	0.0320	0.0317	0.0323	0.0322	0.0326
Wyoming	0.0633	0.0507	0.0680	0.0620	0.0721	0.0539	0.0434	0.0777	0.0633	0.0506

Table A2

Table of VIFs for Equation 1

Variable	*VIF*	*1/VIF*
1. T	1.17	0.86
2. INC	1.11	0.90
3. OUTBACH	1.09	0.92
4. FED	1.08	0.92

Table A3

Table of VIFs for Equation 2

Variable	*VIF*	*1/VIF*
1. T	2.10	0.48
2. INC	2.08	0.48
3. OUTBACH	1.57	0.64
4. FED	1.16	0.86

Table A4

Table of VIFs for Equation 3

Variable	*VIF*	*1/VIF*
1. T	1.77	0.56
2. INC	1.41	0.71
3. OUTBACH	1.35	0.74
4. FED	1.02	0.98

Table A5

Three-Stage Least Squares Estimate of Benefit Spillover Model Parameters without Fixed Effects (Standard Deviations in Parentheses)

	Equation		
Variable	*Appropriations per student*	*Tuition per student*	*Annual out-migration rate, 2006-2015, Bachelor's Degree or higher*
Constant	12.608***	10.570***	-21.407***
	(0.642)	(1.608)	(1.233)
Appropriations per student	--	-1.302***	1.000***
		(0.121)	(0.072)
Tuition per student	-0.576***	--	1.003***
	(0.042)		(0.088)
Income per capita	0.299***	--	--
	(0.062)		
Out-migration rate (%)	0.447***	--	--
	(0.047)		
Federal contributions to higher ed	-0.060*	--	--
	(0.025)		
Student enrollment	--	-0.214***	--
		(0.015)	
Graduation rate (%)	--	-0.095	--
		(0.143)	
Annual average faculty salary	--	1.042***	--
		(0.209)	
Annual unemployment rate (%)	--		-0.167***
			(0.039)
Fraction of population with Bachelor's Degree or higher (%)	--	--	-0.704***
			(0.120)
n	490	490	490
RMSE	0.269	0.360	0.375
"R-squared"	0.319	0.390	-0.6157

Note: *p < 0.05, **p < 0.01, ***p < 0.001, two-tailed. Standard deviations are listed in parentheses.

Table A6

Table 6 Robustness Check: Largest and Smallest 25 OUTBACH Observations Excluded (Standard Deviations in Parentheses)

	Equation		
Variable	*Appropriations per student*	*Tuition per student*	*Annual out-migration rate, 2006-2015, Bachelor's Degree or higher*
Constant	2.701	25.458***	1.891
	(5.533)	(3.488)	(2.413)
Appropriations per student	--	-0.639***	-0.365**
		(0.187)	(0.130)
Tuition per student	-0.506	--	-0.250
	(0.371)		(0.194)
Income per capita	0.182	--	--
	(0.186)		
Out-migration rate (%)	-2.497***	--	--
	(0.493)		
Federal contributions to higher ed	0.005	--	--
	(0.021)		
Student enrollment	--	-0.644***	--
		(0.193)	
Graduation rate (%)	--	-0.152	--
		(0.110)	
Annual average faculty salary	--	-0.288	--
		(0.212)	
Annual unemployment rate (%)	--		0.012
			(0.012)
Fraction of population with Bachelor's Degree or higher (%)	--	--	-0.029
			(0.031)
n	440	440	440
RMSE	0.214	0.088	0.472
"R-squared"	0.472	0.959	0.801

Note: *p < 0.05, **p < 0.01, ***p < 0.001, two-tailed. Standard deviations are listed in parentheses.
Both state and year fixed-effects included in all three equations.

Table A7

Percent Change in Hourly Wage Differentials and Student Contributions to Higher Education from 2006 to 2016

Year	*T*	*FED*	*Student Contribution*	*Hourly Wage Differential (College - HS)*
2006	4691	1404	3287	13.22
2007	4763	1567	3196	13.53
2008	4682	1857	2825	13.50
2009	4758	2830	1928	13.35
2010	4991	3157	1833	13.69
2011	5151	2975	2175	13.18
2012	5587	2795	2792	13.62
2013	5863	2871	2992	13.95
2014	6029	2773	3256	13.55
2015	6207	2602	3605	14.42
2016	6321	2469	3852	14.99
CAGR	3.37%	6.47%	1.78%	1.41%

Table A8

State Higher Education Appropriations Regression Estimate (Standard Deviations in Parentheses)

Variable	*Model 1*	*Model 2*	*Model 3*
Constant	-0.107	8.559***	-8.371***
	(0.953)	(2.308)	(1.998)
Tuition per student	-0.473***	-0.423***	-0.094*
	(0.024)	(0.050)	(0.039)
Income per capita	0.111	-0.253**	1.134***
	(0.076)	(0.083)	(0.124)
Out-migration rate (%)	0.454***	-0.071	-0.039
	(0.039)	(0.050)	(0.037)
Annual average faculty salary	1.159***	0.551**	0.537***
	(0.102)	(0.190)	(0.154)
State FE	No	Yes	Yes
Year FE	No	No	Yes
n	490	490	490
RMSE	0.228	0.109	0.075
"R-squared"	0.517	0.901	0.954

Note: *p < 0.05, **p < 0.01, ***p < 0.001, two-tailed.

X. Appendix B

Data Description and Source

1. $\boldsymbol{APPR}$**:** Educational Appropriations are the **s**tate and local support available for public higher education operating expenses. Educational appropriations are defined to exclude spending for research, agriculture-related programs, and medical education, as well as support for independent institutions or students attending them. Since funding for medical education and other major non-instructional purposes varies substantially across states, excluding these funding components helps to improve the comparability of state-level data on a per student basis. Source: State Higher Education Finance.
2. $\boldsymbol{T}$**:** Net Tuition Revenue is the gross amount of tuition and fees, less state and institutional financial aid, tuition waivers or discounts, and medical student tuition and fees. This is a measure of the resources available from tuition and fees to support instruction and related operations at public higher education institutions and includes revenue from in-state and out-of-state students as well as undergraduate and graduate students. Net tuition revenue generally reflects the share of instructional support received from students and their families, although it is not the same as and does not take into account many factors that need to be considered in analyzing the "net price" students pay for higher education. Source: State Higher Education Finance.
3. $\boldsymbol{INC}$**:** Per capita personal income is calculated as the total personal income of the residents of a state divided by the population of the state. In computing annual per capita personal income, the Census Bureau's annual midyear population estimates are used. Source: Bureau of Economic Analysis.

4. $\boldsymbol{ENR}$**:** Full-Time Equivalent Enrollment (FTE) is a measure of enrollment equal to one student enrolled full time for one academic year, calculated from the aggregate number of enrolled credit hours (including summer session). Most non-credit or non-degree program enrollments are excluded; medical school enrollments also are excluded. The use of FTE enrollment reduces multiple types of enrollment to a single measure in order to compare changes in total enrollment across states and sectors, and to provide a straightforward method for analyzing revenue on a per student basis. Source: State Higher Education Finance.
5. $\boldsymbol{GRAD}$**:** Graduation rate is defined as the percentage of first-time full-time bachelor's degree-seeking students earning any formal award (certificate, associate, or bachelors degree) within six years at Title IV degree-granting institutions. Source: The National Center for Higher Education Management Systems (NCHEMS) Information Center; U.S. Department of Education's National Center for Educational Statistics.
6. $\boldsymbol{SAL}$**:** Faculty pay data comprises degree-granting colleges that participate in Title IV funding. The faculty data refer to full-time, nonmedical, instructional staff (either "instructional only" or "instructional combined with research and/or public service") as of November 1 of the corresponding academic year. Additionally, only salaries of full Professors were included in this study. Associate professors, Assistant professors, Instructors, Lecturers, and those with no academic rank were excluded. To determine the average nine-month-equivalent salary, the Department of Education calculates the total number of months of faculty salaries paid by the college (the number of faculty members on each contract length, multiplied by the contract length) and divides that figure into total outlay. The result is multiplied by nine to determine the nine-month-equivalent

salary. Data for 2003-4 through 2011-12 are calculated slightly differently. The department collected data on the number of faculty members on nine-month or 10-month contracts, along with the total amount paid to those faculty members and to those on 11-month or 12-month contracts. It then reported the nine-month-equivalent salary based on those figures. Source: Chronicle of Higher Education; U.S. Department of Education's Integrated Postsecondary Education Data System (IPEDS).

7. $\boldsymbol{OUTBACH}$**:** Out-migration rate of the highly educated is estimated as the total number of educated individuals (Bachelor's degree or higher) within the sample who migrated away from state i in year t divided by the total number of educated individuals in the sample who lived in state i in year t. Source: Integrated Public Use Microdata Series.
8. $\boldsymbol{FED}$**:** Federal contributions are defined as federal moneys intended to support college students in the form of work-study programs, supplemental educational opportunity grants, and Pell grants. Figures reported on a per FTE student basis. Source: Department of Education's Digest of Education Statistics.
9. $\boldsymbol{U}$**:** The unemployment rate is the number of unemployed as a percent of the civilian labor force. Unemployed people are those who were not employed during the reference week, had actively looked for a job sometime in the 4-week period ending with the reference week, and were currently available for work; people on layoff expecting recall need not be looking for work to be counted as unemployed. Unemployed people are measured based on a place-of-residence basis and includes the civilian population 16 years of age or older. Source: Bureau of Labor Statistics.
10. $\boldsymbol{CURR}$**:** Current fraction of the population with a Bachelor's degree or higher is defined as the portion of a state's population ages 25 to 34 years with a Bachelor's Degree or

higher divided by the total state population in a given year. Source: American Community Survey.